# Pearl Harbor Naval Shipyard Industrial Analysis

and

# Shipyard Industrial Analysis – Phase II-V

## Final Report

**Prepared under:**

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# Table of Contents

**Section** **Page**

# List of Figures

# List of Tables

**Table** **Page**

# Acronyms and Abbreviations

| Term | Definition |
| --- | --- |
| AI | Artificial Intelligence |
| AoA | Analysis of Alternatives |
| AWP | Advanced Work Packaging |
| BESS | Budget Estimate Summary Sheet |
| BFE | Base Flood Elevation |
| BOD | Basis of Design |
| BOCE | Basis of Cost Estimate |
| CB | Covered Bridge |
| CDF | Confined Disposal Facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability |
| CF | Cubic Feet |
| COA | Course of Action |
| CTMA | Commercial Technologies for Maintenance Activities |
| CY | Calendar Year |
| DD | Dry Dock |
| DDCF | Dry Dock Covered Facility |
| DFE | Design Flood Elevation |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOH | Department of Health |
| DRSL | Department of Defense Regional Sea Level |
| ECI | Early Contractor Involvement |
| EIS | Environmental Impact Statement |
| EO | Executive Order |

| | |
|---|---|
| EPA | Environmental Protection Agency |
| EPC | Engineering, Procurement and Construction |
| ESS | Explosive Safety Submissions |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| FIS | Flood Insurance Study |
| FY | Fiscal Year |
| FS | Factor of Safety |
| ft | Feet |
| GAO | Government Accountability Office |
| GSLR | Global Sea Level Rise |
| H | Horizontal |
| ha | Hectare |
| HECO | Hawaiian Electric Company, Inc. |
| HUBZone | Historically Underutilized Business Zone |
| IMF | Intermediate Maintenance Facility |
| IMS | Integrated Master Schedule |
| kV | Kilovolts |
| LHMM | Lifting, Handling and Material Management |
| LUCs | Land Use Controls |
| MCER | Maximum Considered Earthquake |
| MCON | Military Construction Active Force |
| MEC | Munitions and Explosives of Concern |
| MLW | Mean Low Water |
| mod/sim | Modeling and Simulation |
| MPGA | Modified Peak Ground Acceleration |

| | |
|---|---|
| MSL | Mean Sea Level |
| NAVFAC | Naval Facilities Engineering Command |
| NAVSEA | Naval Sea Systems Command |
| NCMS | National Center for Manufacturing Sciences |
| NDAA | National Defense Authorization Act |
| NEPA | National Environmental Policy Act |
| NPDES | National Pollutant Discharge Elimination System |
| NPV | Net Present Value |
| ODASD-MR | Office of the Deputy Assistant Secretary of Defense, Materiel Readiness |
| ODCs | Other Direct Costs |
| P&IDs | Piping & Instrumentation Diagram |
| PCBs | Polychlorinated Biphenyls |
| PCN | Pre-construction Notification |
| PEP | Project Execution Plan |
| PF | Productivity Factor |
| PHNSY | Pearl Harbor Naval Shipyard |
| PMO | Project Management Organization |
| RACI | Responsible, Accountable, Consulted, and Informed |
| RFID | Radio Frequency Identification |
| ROM | Rough Order of Magnitude |
| SB | Small Business |
| SD | Station Datum |
| SDB | Small Disadvantaged Business |
| SDC | Seismic Design Category |
| SDVOSB | Service-Disabled Veteran-Owned Small Business |
| SGT | Siemens Government Technologies Inc. |

| | |
|---|---|
| SIOP | Shipyard Infrastructure Optimization Plan |
| SLC | Sea Level Change |
| SLR | Sea Level Rise |
| SME | Subject Matter Expert |
| SOW | Statement of Work |
| TSCA | Toxic Substance Control Act |
| UFC | Unified Facilities Criteria |
| UG | Uncovered Gantry |
| U.S. | United States |
| USACE | U.S. Army Corps. of Engineers |
| USFWS | U.S. Fish and Wildlife Service |
| USN | United States Navy |
| UXOs | Unexploded Ordinances |
| V | Vertical |
| VOSB | Veteran-owned Small Business |
| WPF | Waterfront Production Facility |
| WQC | Water Quality Certification |
| yd | Yard |
| YFD2 | Pearl Harbor Floating Dock |

# 1. Executive Summary

In June 2018, the Program Management Office formed a team called PMS 555 (comprised of United States Navy (USN) Installations, Naval Sea Systems Command (NAVSEA), Naval Facilities Engineering Command (NAVFAC) and public shipyards representatives) to oversee the shipyard optimization effort to help increase operational efficiencies at the four public shipyards. The effort presented in this report details Bechtel's scope of work at the first of the four shipyards to be assessed: the Pearl Harbor Naval Shipyard & Intermediate Maintenance Facility (PHNSY & IMF).

Bechtel's scope of work focused around two primary projects, the Dry Dock 3 (DD3) replacement project and the Dry Dock Production Facility project to address identified capability gaps at PHNSY. Currently, the PHNSY has three dry docks for submarine maintenance: Dry Docks 1, 2 and 3 (DD1, DD2, and DD3). DD1 and DD2 can accommodate Virginia Class Blocks I-V submarines. DD3 currently cannot support maintenance of these submarines without lengthening and strengthening the dock floor.

Funding for the collaborative effort was secured through the National Center for Manufacturing Sciences (NCMS) Commercial Technologies for Maintenance Activities (CTMA) Program and the Office of the Deputy Assistant Secretary of Defense, Materiel Readiness (ODASD-MR).

## 1.1 DD3 Replacement

In August 2019, Bechtel conducted an Analysis of Alternatives (AoA) to analyze the mission requirement to have three PHNSY dry docks capable of docking current and future classes of submarines. The preferred alternative from the AoA is to replace DD3 with a new graving dry dock, Dry Dock 5 (DD5). The AoA was presented to USN decision makers who determined that Course of Action (COA) for DD3 replacement to be a new DD5.

Bechtel then prepared deliverables, including 15 percent design and cost estimate, for (USN) Installation and Cost Certified Department of Defense (DD Form 1391) submittals for DD5. The DD Form 1391, herein after referred to as DD1391, is used by the DOD to submit requirements and justifications in support of funding requests for military construction to Congress.

## 1.2 Dry Dock Production Facility

The Dry Dock Production Facility name was changed to the Waterfront Production Facility (WPF) and will be referred to as the WPF acronym throughout the remainder of this report. The second project, WPF, is an important component that will afford the USN the capability to meet its core mission at PHNSY – performance of depot-level maintenance that supports operational availability schedules crucial to naval readiness. The WPF is expected to improve the shipyards' ability to deliver submarine maintenance on schedule, make work processes more efficient, apply advanced technology, and replace aging infrastructure and equipment.

Bechtel worked in concert with Siemens Government Technologies Inc. (SGT) to look at different optimization options and then develop preliminary/concept designs and prepare a series of estimates and schedules for the WPF. The primary deliverables for the Bechtel scope include a DD5 Cost Certified DD1391, a Class 5 WPF Estimate and supporting documentation as required.

## 1.3 Project Development

Prime contract execution with NCMS for the PHNSY budget development for the DD5 continued seamlessly upon completion of negotiations and first issue of the Collaboration Agreement. The contracts were issued by NCMS in the following order: Phase I, which was a pass through from SGT for design work picked up by Bechtel National Inc., Phases II though IV, and Phase V (Increments I through IV).

The work started in April 2019 and included the following components:

- Bechtel Professional Labor Services for Non-Manual Employees
- Subcontracted services for performing Land and Water Borings to confirm site conditions
- Other subcontracted specialty Engineering and Consultant services required to support local labor, conditions, supplier availability and government expertise, etc.
- Other supporting material costs, such as travel, assignment costs, supplies and as-needed equipment/software to aid in the performance of the work

During the project development process, several changes occurred to the basis of the scope of the work as cost and schedule information was presented to the USN. These changes resulted in the following:

- Original scope of WPF expanded to include a new dry dock
- Changes to facilities sizes and assumptions
- Staggered funding, resulting in new plans and work scopes to ensure both projects continued to satisfy USN mission requirements
- Descoping of June 2020 deliverables
- Revised due dates for the Cost Certified DD1391 Estimates as follows:
  - DD5: submittal changed to 30 September 2020
  - WPF: submittal changed to 31 March 2021 and was replaced with a Class 5 Estimate
- Addition of Lifting, Handling and Material Management studies
- Addition of WPF Workshops to transfer preliminary sizing and functional configuration of each public shipyard's WPF

This report represents the process and status associated with the original scope of work and is comprised of the five phases of work. As noted, the change in scope and schedule allowed for the original budget to be stretched to approximately the end of 2022 with ongoing environmental and additional engineering support/tasks between 2021 and 2022.

## 1.4 Results

### Phase I and II – Scope and Planning Phases (Original Scope)

The objective of Phase I and II was to define the project requirements, initiate mobilization of the project team, and conduct a project kickoff meeting.

They resulted in the following main findings:

- Bechtel prepared a Project Execution Plan (PEP), project organization chart, and an Integrated Master Schedule (IMS) of key activities for the initial two years of the program necessary to achieve mission critical need date
- USN established a need for the dry dock with an initial dimension of 800 ft by 130 ft to accommodate up to Columbia Class submarines
- USN established a mission critical need date of fiscal year (FY) 2028 for the operational readiness of the new dry dock. The Responsible, Accountable, Consulted, and Informed (RACI) chart, Risk Matrix and the schedule were used to strategically identify courses of action and support a comprehensive AoA for the dry dock that was used to assist the USN's final determination of the best path/plan for future use
- USN directed that the dry dock and WPF be "coupled" or in other words considered together
- Bechtel performed an AoA following the USN process for four credible alternatives:
  - DD3 lengthen, deepen, and reconfigure
  - DD3 lengthen and add Superflood
  - DD5 new Graving Dry Dock
  - DD5 new Floating Dry Dock
- DD5 new Graving Dry Dock scored highest against USN defined evaluation criteria and selection factors
- USN determined DD5 Graving Dry Dock to be the preferred alternative. It was designed to accommodate Columbia Class SSGNX dry dock, with dimensions refined to 755 ft by 125 ft
- Bechtel initiated a Risk Management program including USN and government contractor participants. The initial Risk Register included 19 Risk Titles with over 70 causes and severity consequences
- The Risk Register was advanced during future phases of the work and incorporated into the DD1391 Cost Certified package

### Phase III and Phase IV – Preparation of DD1391 Documents (Original Scope/Notification of First Scope Revision)

The objective of Phase III and IV was to continue efforts toward the creation of three DD1391 documents, or primary deliverables, based on the configurations approved in earlier phases:

1. Cost Certified DD1391 for a new dry dock
2. Installation level DD1391 for the WPF
3. Cost Certified DD1391 for the WPF

These phases resulted in the following main findings:

- Bechtel Engineering team produced designs and design documents of the approved DD5 configuration (original scope). Designs were advanced to the 15 percent design level of effort (as defined in the NAVFAC Engineering & Construction Bulletin)

- Two Design Reviews were performed to present the current status of the DD1391 15 percent dry dock design to USN reviewers and stakeholders and solicit feedback with the following goals:
  - Provide in-process view of current design and construction
  - Open engineering exchange
  - Close any remaining open issues
- As a result of the Design Reviews, additional engineering tasks were performed to help inform the initial Cost Certified DD1391 (representing the original scope) for a new dry dock
- The design reviews and comment resolutions resulted in the 15 percent dry dock design being accepted by USN as submitted on 31 October 2019
- Phase IV included an initial draft DD1391 (original scope) for the new dry dock on 31 October 2019. The DD1391 was based on the original scope, and consisted of:
  - Basis of Design (BOD)
  - Cost Estimate
  - Basis of Estimate
  - DD1391 Graphics
  - DD1391 Block 10 and 11
  - Equipment List
  - Assessment of Design Flood Elevation for DD5
  - Groundwater Seepage Technical Note
  - Utility Study
  - DD5 Structural Analysis
  - Hazards of Electromagnetic Radiation to Personnel, Fuels, and Ordnance Study
- An estimate review package was prepared to present the initial DD1391 estimate information to the USN. An estimate review meeting was held in Hawaii 12-14 November 2019 where the estimate was presented and discussed. It exceeded the amount the USN had allocated for the DD3 Replacement resulting in reductions to the dry dock scope as follows:
  - Design vessel changed to Virginia Block 5
  - Dry dock dimensions reduced to 650 ft by 100 ft (First Scope Revision)
- First Scope Revision resulted in Bechtel incorporating changes into the DD1391 documents and Cost Estimates in Phase V

### Phase V Increments I, II, III, and IV – DD5 Additional Engineering Studies and Revised Cost Estimates (Incorporate First and Second Scope Revisions)

The principal objectives of Phase V were to continue work previously started in Phase III and IV and incorporate the changes from the First and Second Scope Revisions. Bechtel worked with the USN to update the plan to support the First Scope Revision for DD5:

1. Added Dry Dock Budget Ready DD1391 Estimate (based on the revised size)
2. Added Additional Engineering Studies to remove conservatism in the design thereby reducing material quantities and estimated cost
3. Moved Dry Dock Cost Certified DD1391 Estimate submittal to Calendar Year (CY) 3Q 2020

With the Second Scope Revisions, the DD1391 documents, principal deliverables, and other Statement of Work (SOW) tasks/deliverables to support the USN's revised direction/schedule delay were further modified as follows (Second Scope Revisions are in bold italics font):

1. Dry Dock Budget Ready DD1391 Estimate (based on the revised size)
2. DD Cost Certified DD1391 Estimate
3. Addition of ***WPF Class 5 Cost Estimate (which includes DD3 Backfill scope)*** ***(Deleted WPF Budget Ready DD1391 Estimate and WPF Cost Certified DD1391 Estimate)***

Phase V Increments I, II, III, and IV resulted in the following main deliverables:

- Dry Dock Budget Ready DD1391 Estimate
- Dry Dock Cost Certified DD1391 Estimate
- WPF Class 5 Estimate

Phase V also included additional USN requested support tasks which included:

- Advanced Technology Continued Support
- Post DD1391 Submittals Other Engineering Tasks
    - Transition of Bechtel Design Information to USN and A&E Contractors
    - Gantry Crane Foundation Study and Rough Order of Magnitude (ROM) Estimate
    - Sea Level Rise (SLR)/Flooding Evaluation Support
    - Revised Dry Dock Cost Certified DD1391 Estimate to include USN scope changes
    - Environmental Impact Statement (EIS) Information Requests Support
- Lifting, Handling and Material Management Time and Motion Study
- Lifting, Handling and Material Management Standard Analysis Study
- WPF Workshops for technology transfer of preliminary sizing and functional configuration information

## 1.5 Benefits

### 1.5.1 Benefits to the General Public

The benefits of this project to the general public were two-fold. First, Bechtel provided the USN with a unique industry process that helped give higher fidelity to the estimating process. This included additional engineering performed to identify the most efficient design and cost saving construction methods for DD5.

Secondly, the process in developing the estimates set the groundwork for an integrated modeling approach that will help optimize the new shipyard layout and the future WPF to increase efficiency and improve overall productivity, labor utilization and storage/material handling operations and improved schedule turnarounds. Due to the descope of the WPF DD1391, the integrated modeling approach and process-based design were not completed.

The process of translating modern design concepts for a commercial shipyard WPF into more focused resource requirements allowed for the results to be measured and verified using both fiscal and physical parameters. The utilization of software modeling tools by engineering, including process expertise, created a more efficient and effective end state that could have applicability beyond the scope of this project and could aid the public in making sound large business decisions. Across the United States (U.S.), infrastructure in many industries has not kept pace with technology changes resulting in inefficiency and decreased market share.

Although a large portion of the WPF work was descoped, the project did complete a WPF AoA and developed a preliminary roadmap for future projects to use an integrated modeling approach, applicable for any industry, which allow for the development of budgets that can be utilized in evaluating commercial operations that are suffering from aging infrastructure. This will allow organizations to not only determine whether to invest in capital improvements but will generate the ability to prioritize and schedule those projects based on their available funds. Derived benefits from piloting a project to model and simulate aging infrastructure to a future end state include the potential for:

- Improved competitiveness of U.S. manufactured products
- Improved job opportunities in manufacturing in high technology sectors
- Improved economic health of U.S. companies
- Reduced dependence on foreign goods with associated impacts in logistics support

This project's success will contribute to better quality production cycles and repairs to the ship that are completed more accurately and require less re-work, leading to improved performance and safety. The result is of benefit to the general public, in several aspects, including:

- Quality and safety aspects are of importance in contributing to the public welfare through a reduction in product failure, the longevity of operation, and successful service delivery
- The accurate and efficient delivery of products and services are of importance in contributing to the economy via successful business and government fiscal operation, and creation or sustainment of demand for valued products and services
- Security – a highly secure yet efficient shipyard for our workforce and submarines will be produced

Success in these objectives drives the economic engine both directly and indirectly, e.g., avoiding diversion of funds to replace or repair products by companies, government, or consumers, thereby enabling growth, profit, fiscal soundness and other desired business benefits (as appropriate to the commercial or government entity), including increased employment opportunities. Examples include data and insights into a product or service's lifecycle can be mined, translated into improved processes, documented and effectively shared across a company or government organization, such as:

- Streamlined processes result in quantifiable efficiencies, such as lower levels of inventory, improved maintenance schedules, supplier information, and equipment reports that ultimately convert into lower costs of production and lower costs of delivered product or service
- Similarly, more accurate manufacturing data increases the insight and knowledge of supply chain and logistics needs, and increases the performance relative to parts ordering, e.g., reduces the cost of parts acquisition, including reduction of shipping and expediting fees
- This results in improved accuracy, quality, and reduction in re-work along with associated wasted time, cost, and resource consumption

Over the last ten years, manufacturers of instrumentation, industrial machinery, consumer electronics, packaged goods, medical, nuclear, and aviation industries, as well as other complex engineered products have discovered the benefits of digital modeling software solutions and are adopting digital modeling software in increasing numbers.

For this project, and other shipyards like it, to compete in today's highly competitive maintenance and sustainment community, marketplace supply chains must also be improved to match product characteristics and customer requirements for the general public. Detailed information about budgets, equipment, and processes is not only a good exercise in understanding a scope of a project, but also imperative to have on hand to justify expenditures to auditors, governing boards, or company shareholders.

### 1.5.2 Benefits to the DOD

As with the benefits identified above, the DOD ultimately stands to benefit from the work performed by a lower overall budgeted cost of the new shipyard facilities, as well as recognize improved operating efficiencies once in operation. In the development of the budget, a thorough understanding of the process used to arrive at the new design is required in order to result in reduced maintenance burdens and to achieve the required levels of equipment availability and completion/schedule turn-arounds. This translates into supply, maintenance management, and touch labor reductions. Logistics and supply chains are an important component of the maintenance and sustainment process, so an upgrade in the dry dock facilities will not only speed the process but also ensure efficiency and best costs.

Other additional direct benefits from improving efficiency and effectiveness of the Defense Industrial Base include:

- Improved use of taxpayer funds
- Improved operational availability of USN ships contributing to the mutual defense
- Improved economy in the local area of the shipyards with high-quality, meaningful jobs
- Reduction in the required number of spares and consumable parts needed
- Enable improvements in data exchanges for information between operational, logistics maintenance, and sustainment

All new submarine classes and carrier platforms are currently utilizing industry partners' technology for design, construction planning, and maintenance execution. This digital data can be accessed and utilized by all depot and intermediate level maintenance facilities and fed into availability optimization models. This technology can be used for engineering work packages, containment set-up, worksite allocation artisans and status reporting on availability progress. Incorporating the successful results derived from this project will allow the DOD (at an enterprise level) to greatly reduce the cost of maintenance and sustainment errors, which will ultimately improve and better support the readiness of all USN ships. Additional project benefits include:

- Increased at-sea time for submarines that make them available for tasking and operations
- Maximizing allocation of resources
- Improved sharing of spares inventory across shipyards by digital tracking (Radio Frequency Identification (RFID))

- Allow for supported decisions on layout alternatives to reach defined objectives within cost constraints
- Maximize workforce allocation
- Target faster return on investment from project investments
- Establishment of a NAVSEA enterprise simulation management command and control system (utilized at NAVSEA headquarters as a redundant offsite location to access information from disparate NAVSEA organizational, depot, and intermediate level maintenance facilities) – which coincides with the "One Shipyard" concept
- Deployment support activities – logistics side – support for Marines
- Energy optimization and generation based on the realization of actual consumption versus a newly instituted energy platform
- Establish priority on readiness
- Ability to obtain data to perform models and simulations using Lean Six Sigma concepts that can be translated into newly formed methodologies and potential inventions for the public good

Other results from detailed tasks which provided information pertinent to the construction and logistics of performing large complex projects in Hawaii; best practices and recommendations made by the team; regulatory hurdles; and the gathering of data required to both look at supplier capabilities in Hawaii as well as site conditions. Creating a DD1391 not only satisfies federal requirements, but also provides an overview of spending, equipment, and project scope that will assist in providing a comprehensive overview of the project in prescribed documentation.

## 1.6 Invention Disclosure

Invention Disclosure Report(s):

DD882 Sent to NCMS ☐
No Inventions (Negative Report) ☒

## 1.7 Project Partners

- Pearl Harbor Naval Shipyard & Intermediate Maintenance Facility (PHNSY & IMF)
- Bechtel National Inc.
- Siemens Government Technologies, Inc. (SGT) – On a separate contract with the USN, one of the many SGT scopes was to perform submarine repair and sustainment data collection, modeling and simulation (mod/sim) at the PHNSY. The deliverables of this scope included an "as-is shop-based" digital WPF model and an "optimized process- based" WPF model. The outputs from these two models were used primarily in support of development of requirements in the WPF AoA
- WSP USA Inc. – WSP provided civil and marine engineering support to include marine engineering support for the caisson design, dry dock dewatering systems, dry dock super

flood capabilities, and structural buoyancy criteria for the dry dock design. These efforts supported the conceptual 15 percent design work for a new dry dock at Pearl Harbor

- Geolabs, Inc. – A local contractor from Waipahu, Hawaii provided geotechnical exploration services for borings both on land and over water. Using a fleet of drill rigs, Geolabs conducted drilling and sampling to depths of 200 ft and compiled the data for reporting to determine site conditions
- National Center for Manufacturing Sciences (NCMS)

# 2. Introduction

## 2.1 Background

The USN shipyards are critical to maintaining the readiness of its fleet of nuclear-powered submarines for supporting ongoing operations around the world. There are four public naval shipyards: Norfolk Naval Shipyard in Virginia, PHNSY & IMF in Hawaii, Portsmouth Naval Shipyard in Maine, and Puget Sound Naval Shipyard and IMF in Washington. In 2017, the U.S. Government Accountability Office (GAO) reported that the four public shipyards were not meeting the USN's operational needs, specifically the ability to meet the operational schedules for depot-level maintenance to help increase operational efficiencies at the four shipyards.

The GAO report disclosed that a contributing cause is the age and poor condition of the infrastructure including the dry docks, facilities, and capital equipment. A second GAO report noted that the USN has spent billions of dollars to support submarines that sit idle while waiting to enter a shipyard for maintenance. The delay in maintenance availability has caused the loss of thousands of submarine operational days. The GAO also reported that shipyards could not support one-third of planned depot maintenance periods for the current fleet over the next two decades. Additional findings included that the layout of existing shipyard facilities is not conducive to efficient and effective maintenance operation in support of USN readiness needs.

In June 2018, the Program Management Office, called PMS 555, was created to oversee a shipyard optimization effort to help increase operational efficiencies at the four public shipyards. PMS 555 includes representatives from USN Installations, NAVSEA, NAVFAC and public shipyards.

This effort, which focused on the PHNSY, will be the first shipyard modernization project that the USN has taken on in many years. The success of this project and the outcomes and lessons derived from this effort will be utilized on the other USN shipyards which require the same improvements and modernization techniques.

## 2.2 Purpose

The overall purpose of the Shipyard Industrial Analysis was to leverage the efforts of the Bechtel project team in the development of concept designs and estimates for the Pearl Harbor Shipyard. In order to provide the DOD with the preliminary designs, the team performed engineering studies and research, including where available, shipyard modeling and operational simulations in order to perform in-depth fiscal modeling required to perform the necessary budgetary analysis and generate documentation needed to resource the modern shipyard infrastructure created.

The detailed objectives of this initiative were to support the USN's goal to replace DD3 with a new graving dry dock at the PHNSY to support future drydocking activities, to be designated as DD5, as follows:

- Prepare a DD AoA
- Develop the conceptual design and cost estimates for the submission of Cost Certified DD1391 budget documents for DD5
- Prepare a WPF AoA

- Incorporate the integrated Shipyard Infrastructure Optimization Plan (SIOP) mod/sim optimized shipyard repair processes into the prototype WPF
- Develop the conceptual design and cost estimates for the submission of the Installation Level and certified DD1391 prototype WPF

The timing and tasks planned to achieve these goals were changed by the USN on 1 November 2019, with an additional change of scope that occurred on 12 June 2020. The revised plan and timing are explained in detail in subsequent sections of this report.

## 2.3 Scope/Approach

### 2.3.1 Goals & Deliverables

The goal of the project was to provide the USN with a Cost Certified estimate, along with the accompanying documentation, to allow the USN to make budgetary and future planning decisions regarding the installation of a new dry dock and WPF facilities. A principal goal of the project was to change the approach for preparing the DD1391 deliverables to avoid what has become a series of inaccurate estimates and schedules that understate the final cost and construction duration of USN military construction projects.

### 2.3.2 Industry Approach

The USN tasked Bechtel with utilizing an integrated "industry approach" to produce realistic DD1391 estimates verses utilizing separate contributors and built-up, historical costs. Bechtel's approach for integrating Engineering, Procurement, Construction, and Risk Management into the estimate included the following:

- **Engineering:** designs were prepared considering supply chain limitations/opportunities and construction means and methods. Engineering quantity takeoffs and technical requirements were integrated with procurement, construction, and estimate plans
- **Procurement:** local supply chain and contractor surveys were performed. Global supply chain was leveraged, where required. Information was integrated into material and contractor acquisition plan(s) where site-specific cost data was obtained
- **Construction:** local labor and contractor surveys were performed. Construction means and methods were established using subject matter experts (SMEs). Construction informed design through a robust constructability program. Temporary facilities and construction areas were defined and incorporated directly into the cost estimate and construction schedule
- **Risk Management:** all project risks (design, procurement, construction, operations, etc.) are identified, tracked, mitigated, and dispositioned. Mitigating actions for realized risks are incorporated directly into the cost estimate and construction schedule. Remaining risks are considered in the project contingency analysis
- **Estimating:** performed bottoms up estimate from material quantity takeoffs, temporary facilities, supplier pricing, construction unit rates, and other project cost categories

Details on each approach are presented in the following sections.

#### 2.3.2.1 Engineering Approach

The overall engineering approach was to develop a conceptual engineering design to support a Cost Certified DD1391 Estimate for a new Dry Dock and a WPF for PHNSY. Note, later in the project the USN deferred the WPF DD1391, and engineering supported a higher-level Class 5 WPF Estimate.

The focus of the conceptual design was to develop engineering quantities to support an integrated design with procurement for equipment/bulk material pricing and construction for planning, scheduling, and cost estimating.

Typical Conceptual Engineering Deliverables were captured in the BOD. These deliverables include:

- Functional Requirements
- Design Inputs
- USN Mission Requirements
- Assumptions/Constraints
- DOD Standards/National Codes and Standards
- Site Plan Drawings
- Demolition Drawings
- Piping & Instrumentation Diagram (P&IDs)
- Stormwater and Drainage Plan
- Marine Dredging and Quay Wall Design
- Electrical Load Schedule and Equipment List

The approach also identified National Environmental Policy Act (NEPA) and EIS interfaces and requirements, long-lead procurement items, and executed geotechnical subcontracts and studies to validate soil design assumptions.

Key to the engineering approach were periodic Design Charrettes with the USN and stakeholders. This allowed for design iterations as mission requirement and shipyard requirements changed or matured. Additional engineering was completed on key areas of the design to further refine and reduce quantities and cost. The final integrated engineering design with engineering quantities was used by procurement and construction to develop the cost estimate and project construction schedule.

In addition to the primary scope, the USN also requested a Class 5 Elevated Gantry Crane Foundation Design estimate, added a Lifting, Handling and Material Movement time/motion study, a Lifting, Handling and Material Movement crane standards comparison study, and the development of a series of technology transfer workshops for WPF preliminary sizing and functional configuration information to support additional internal USN evaluations.

#### 2.3.2.2 Procurement Approach

The procurement approach for the PHNSY estimate was conducted out of the Bechtel Reston, VA office. Solicitations were issued as requests for budgetary quotation, both written and by phone. The solicitations were issued based on preliminary scopes of work and did not typically contain specifications or drawings due to the preliminary state of design on the project. The budgetary quotes received were reviewed to ensure they met the requirements of the preliminary scope of work prior to acceptance for use by the estimating team.

The pricing received from small business (SB) received an additional factor to increase the proposed values anticipating increases based on the USN past estimate history on similar work.

The project approached local Hawaiian suppliers and contractors that aligned with the scope of work, but when a supplier was not locally available or there was a lack of local response, the quotations were solicited from the U.S. mainland and a minor selection of materials and equipment from international suppliers that would align with the Buy American Act for future use in a final prime contract.

Including future SB goals was an important factor in the DD1391 estimate. The method used to develop the subcontracting goals for SB, Small Disadvantaged Business (SDB), Women-Owned Small Business, Historically Underutilized Business Zone (HUBZone), Veteran-Owned Small Business (VOSB), and Service-Disabled Veteran-Owned Small Business (SDVOSB) concerns for the PHNSY Estimate is described as follows:

- To establish preliminary SB goals, the project gathered available information, forecasted probable acquisition needs, and analyzed project estimates. The project used procurement historical data and experience to determine potential requirements and contingencies. The methods used to identify potential sources for solicitation purposes included:
  - ThomasNet website
  - Discussions with the Office of Small Business Administration
  - Discussions with Bechtel SME familiar in developing USN Small Business Plans
  - National Defense Industry Association
  - The Elite SDVOSB Network
  - Recommendations from other local SBs
  - Utilize the System for Award Management Dynamic Small Business Search Database

The project created an informal subcontracting plan for the DD5 Cost Certified estimate in accordance with FAR 52.219-9 and based on what is presumed to be the USN's approach. The informal subcontracting plan was created to determine if the SB goals were attainable with respect to the following factors:

- Total dollars subcontracted
- Percentage of total dollars subcontracted
- Total dollars planned to be subcontracted for individual subcontracting plans

For assumption purposes, the project used subcontracting goals that have been established on similar DOD and Department of Energy (DOE) projects which include:

- 40 percent of the value of all subcontracts available to SB
- 5 percent – SDB
- 3 percent – HUBZone
- 5 percent – WOSB
- 5 percent – SDVOSB

Along with a vessel study prepared for the substantial movement of aggregate, sand and fly ash, all the large equipment quoted had shipping movements estimated to verify cost and vessel availability as defined under the Jones Act.

Moreover, the project created a draft schedule of services, materials and equipment that will be required to be purchased and identified those with potential long lead (delivery to the jobsite would be over 30 weeks) that could have an impact on the project schedule.

#### 2.3.2.3 Construction Approach

**Construction Coordination**

The construction approach was developed to provide realistic construction cost and schedule input for the DD1391 cost estimate and other submittals. This was accomplished by evaluating site conditions and the local construction market for opportunities and constraints, then developing a construction execution approach specific to the local conditions. The construction team performed local labor studies, contractor assessments, supply chain surveys, site access, material movement, and laydown studies. An important element in the construction approach was to support the development of design products and studies by incorporating the construction execution and constructability into the 15 percent design. As Figure 1 shows, the earlier the contribution in the project lifecycle, the greater the ability to influence the outcome, including total installed cost and schedule. Experienced construction professionals supported the DD1391 estimate project team. This allowed the proposed design products to not only more accurately reflect the site configuration and choice of commodities, but also allowed for the ability to realize the incorporation of past lessons learned from similar applications early in the process, minimizing re-work and change requests. A construction schedule was prepared for the DD1391 estimate that led to a design that is constructible and tailored to the site conditions and constraints and contributed to total cost reductions.

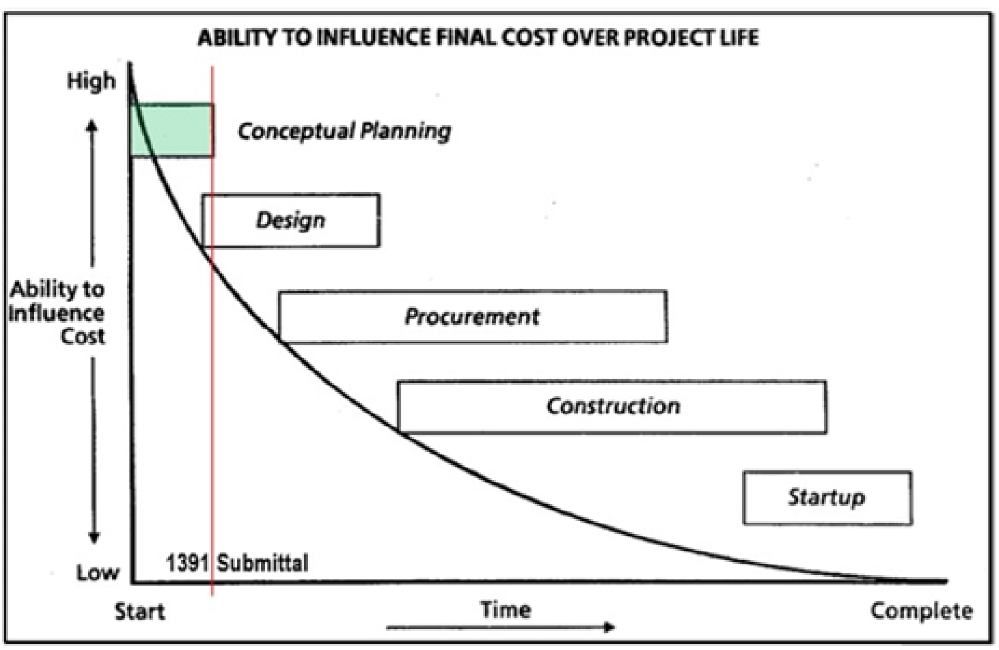



***Figure 1. Ability to Influence Cost Over Project Life***

Fundamental to the construction methodologies evaluated was the baseline guidance that the dry dock should be constructed in the wet. This guidance was based on past USN experiences with dewatering attempts that resulted in several mishaps and changes in methodology during a longer than planned construction schedule.

Given the overall shallow nature of the Pearl Harbor estuaries, the existing buildup of marine structures at the shipyard and the continuing naval operations during construction, a “lift-in” approach to the marine works construction has been chosen. In this approach, individual elements (e.g., pre-cast concrete panels, reinforcement cages, etc.) are lifted into place in the wet, with concrete being placed utilizing the tremie method. The bases for this selection included the following:

- A larger field of potential contractors can be considered for the work as there is less need for larger scale application specific cranes and lift systems
- The manufacture of pre-cast elements can be achieved by Oahu pre-cast suppliers as well as west-coast mainland suppliers
- Marine transport equipment can be conventional deck barges and twin-screw or z-drive tugboats
- Marine or landside cranes can be conventional lattice boom crawler cranes

While lift-in was selected as the base construction methodology, a “float-in” method was evaluated and is viable. Float-in methods involve larger prefabricated sections or caissons of the dry dock wall sections that are cast in place or assembled from pre-cast units on a nearby fabrication yard. Roll-on, roll-off technology is required for delivery of the caissons onto transport barges, when fabricated on land. The transport barge is then sunk, lowering the caisson into the estuary, so that it can be floated and towed to the dry dock site and set. Alternatively, there are catamaran barges with lift and ballasting systems so that the caisson is transported and set by lift-in method at the dry dock site. The Corps of Engineers Olmsted Project utilized this method. The catamaran barge lift barge is shown in Figure 2.

***Figure 2. Catamaran Lift Barge***

*2019 – First DD5 800 ft x 130 ft*

The initial dry dock cross-section and plan view at the start of the study is shown in Figure 3 and Figure 4. The initial dry dock overall dimensions required significant dredging volume removal, cut further into the existing shoreline and extended further out into the shipyard. The construction methodology at the time included cellular cofferdams around the dry dock perimeter to both contain the amount of dredging required, (350,000 $yd^3$) and serve as crane runways for the marine and civil works construction. The wall and floor thicknesses of this gravity based graving dock were 27 ft, with concrete placement at depths underwater of 76 ft. An overall 48-month schedule was developed, with manual labor man- hours on the order of 4.7 million, with a peak manpower between 800 and 900 craft per day.

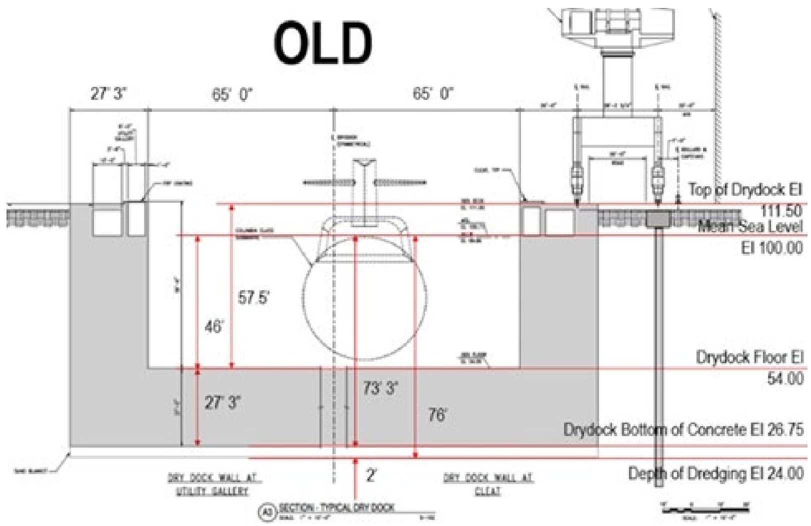



***Figure 3. Initial Dry Dock Cross-Section***

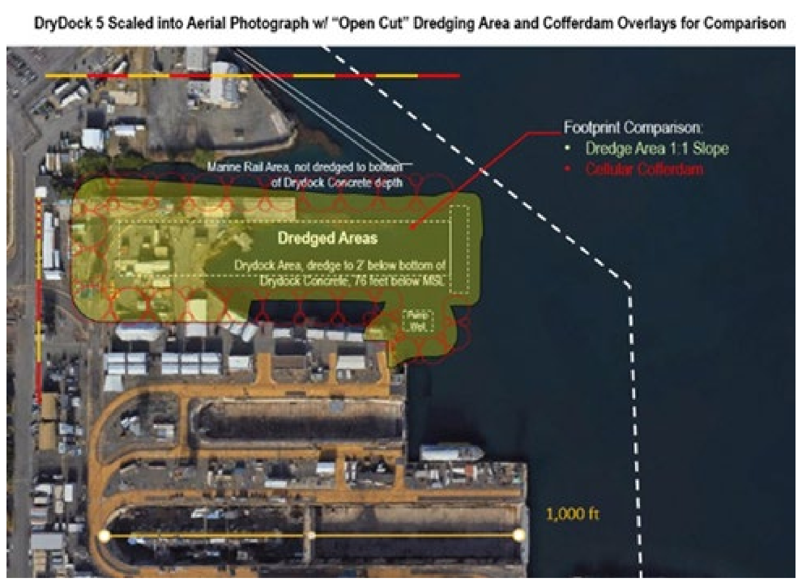



***Figure 4. Initial Dry Dock Plan View***

The decision to use cellular cofferdams to reduce the dredging volume as well as to provide access in the work area for crawler cranes added considerable construction costs mainly due to the general quantity of piles given an assumed 90-ft diameter cofferdam and pile installation durations. The initial decision to use 90-ft diameter cofferdams was made prior to completion of land and water core borings to ascertain the substrata material properties. The lack of boring data necessitated a floor design that included 2,650 pre-cast piles, requiring eight months of schedule time to install. The following piling activities were also planned to run concurrent with dredging: 1) dredge to depth, shift dredging equipment; and 2) deploy piling equipment, set piles in available dredges area. Owing to the larger dry dock size which resulted in a larger dredging and tremie volume, as well as less available land for staging equipment, there was considerable risk associated with the schedule. Some of the causal factors for the risk included:

- Need for two concrete batch plants, one mounted on a deck barge
- Placement of tremie at depths up to 74 ft and achieving a placed depth of 24 ft of concrete over the 900+ ft length and nearly 200 ft width, when considering the walls and open-end thicknesses
- Managing tremie placement around the tops of the driven piles
- The extended time frame of delivering concrete constituents, reinforcing steel and backfill to the dry dock site by barge and the coordination required to open and close the East Loch security boom

*2020 – Revised DD5 650 ft x 100 ft*

In December 2019, NAVFAC revised the working dimensions for the dry dock. The cross-section and comparison to the older dry dock version is shown in Figure 5 and Figure 6. The resulting reductions in dredging and concrete volumes were considerable and favorably impacted the ability to execute the work. A decision was made to not utilize the cellular cofferdams as construction aids. The reasons were primarily threefold: 1) the cost of installation versus the benefit to schedule was not favorable; 2) adding the cofferdams added time to the schedule; and 3) the barge mounted crawler cranes could provide the lift capacity needed out to 180 ft and the new dry dock size, (width), was favorable for this approach. In addition, given the reduced volume of concrete, it became apparent that a single batch plant located on land could meet the required demand for supply of concrete to all locations on the dry dock. With this, the maximum pumping length of concrete to placement location would be less than 1,000 ft.

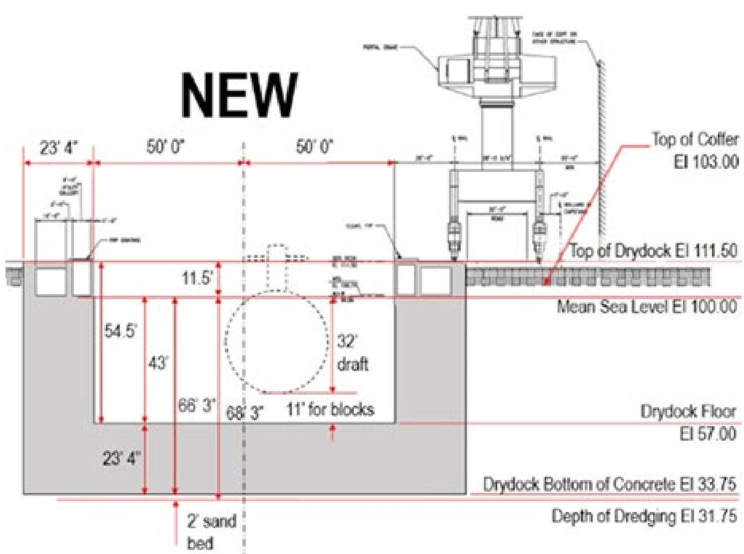



*Figure 5. Revised Dry Dock Cross-Section*

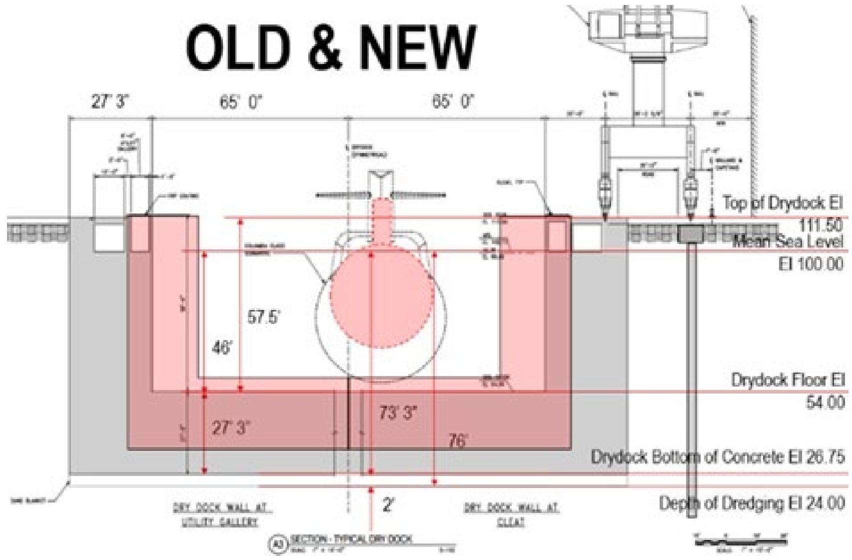



*Figure 6. Overlay of Initial ("Old") and Revised ("New") Dry Dock Cross-Section*

During the development of the estimate, marine and concrete workshops were conducted in Oahu. These workshops included NAVFAC personnel, local marine contractors, local ready-mix concrete suppliers, University of Hawaii engineering staff, and representatives from organized labor. The decision to manage the supply of concrete for DD5 at the "main contractor" level for the estimate was an important outcome from these workshops. Specifically, the basis of the estimate assumed that the main contractor would manage the various supply chains for concrete constituent materials along with their delivery to the site and stockpile areas. The rationale for assigning the main contractor with managing the supply chain and delivery of the concrete constituent materials included the following:

- Maintaining an appropriate difference in core temperature versus surface temperature for the thick concrete placements requires the inclusion of fly ash, slag or silica fume in the concrete mix design and local Oahu ready-mix suppliers do not maintain a significant supply
- Local ready-mix suppliers import sand from Canada, as qualified local sand supply and "crusher fines" is not substantial
- The delivery of sand to Oahu from Canada starts at Barbers Point marine terminal. Then overland trucking would be required to deliver sand to the site stockpiles

Consequently, it was concluded that supply of concrete constituent materials would be managed by the main contractor and coordinated in the following manner:

- Awarded contracts to local quarries would start yearly adsorptive silica reaction testing a year in advance of first concrete in order to comply with Unified Facilities Criteria (UFC) design requirements
- Multiple suppliers would get contracts to supply coarse aggregate that is qualified, in order to mitigate risks that either of the quarries when mined, run into unacceptable material for a duration of mining time
- Coarse aggregate would be trucked and stockpiled at Waipio Confined Disposal Facility (CDF) 4

- The sole supplier of cement in Hawaii would supply the main contractor, by truck delivery, cement from their cement storage silos located at Barbers Point
- Qualified sand and fly ash would be supplied by the main contractor, via purchase orders to mainland suppliers and barged for delivery to the temporary dock at Waipio peninsula for stockpiling in CDF 4, eliminating the extra handling and overland travel from Barbers Point marine terminal
- The main contractor would erect a batch plant and storage bins on site and deliver concrete constituent materials stockpiled in CDF 4 by barge and receive cement by truck

#### 2.3.2.4 Risk Management

The team implemented a Risk Management approach, including conducting a risk analysis for the purpose of identifying key risks associated with the engineering design and construction of DD5 for the PHNSY. To screen all project risks and utilize the Pearl Harbor team expert resources in the most efficient way possible, the team performed both qualitative and quantitative risk analysis on the Project Risk Register. These analyses consider risks presented through the complexities of executing construction activities on an active site, labor and materials availability concerns, environmental concerns, and other relevant issues. The key risks identified were continually updated to reflect the proposed, active, and completed risk treatments and the consequent current risk exposure level after treatment.

During the initial risk evaluation, the team identified various potential risk events. These events were then ranked on a qualitative basis using the Risk Priority Matrix and Probability and Impact diagram. The purpose of this approach is to screen risks and focus the team's resources on the most severe ones. The qualitative analysis of the Risk Register identified 26 risks that have been evaluated.

Once the qualitative risk analysis was complete, a quantitative cost analysis was performed on the top quantifiable project risks. The quantitative cost analysis entails importing the significant risks from the risk register to an @RISK template. For each risk event, the team developed a three-point cost estimate (P10, Most Likely and P90) and a distinct probability of occurrence.

The @Risk Monte Carlo simulation was then executed, and multiple reports and graphics produced for review, analysis and decision-making including probability curves and tornado charts.

#### 2.3.2.5 Estimating Approach

As an objective, the USN requested utilizing an "industry approach" to produce realistic DD1391 estimates verses utilizing segregated contributors and historical costs that have resulted in inaccurate estimates.

To meet this objective, the estimating approach included performing a bottom's up estimate from material quantity takeoffs, temporary facilities, supplier pricing, construction unit rates, and other project cost categories. A normal construction estimating process was implemented which integrates the scope, cost, and schedule parameters of a project. The Engineering, Procurement and Construction (EPC) functions providing the necessary data sets to include in developing the base estimate and schedule. A detailed critical path baseline schedule was developed in Primavera scheduling software to reflect the procurement, permitting, and construction effort required for the construction of DD5. Data sets were produced and inputted to the ProPricer Estimating software to develop a detailed product driven output to align with the project work break down structure and the USN Budget Estimate Summary Sheet (BESS) format. The base estimate was escalated to the mid-point of the construction schedule.

The base estimate was analyzed using Monte Carlo techniques to define the cost uncertainty and used the Primavera Risk Analysis software to define schedule uncertainties. All four contingency components (cost uncertainty, schedule uncertainty, risk event cost and risk event schedule impacts) were included in a Consolidated Cost, Schedule, and Risk overall Monte Carlo analysis using @RISK software. The resulting contingency value was added into the estimate.

For the WPF Class 5 Estimate approach, the cost estimate is based on the quantity and cost identified in the RSMeans models with enhancements identified from the engineering review. The estimate is based on the scope described in the WPF Scope Narrative document including fill-in of existing DD3 and decoupling costs associate with systems interfering with building piling work. No further engineering design was developed.

The RSMeans 2019 Cost Book was used as a baseline with the Hawaiian region selected. Three RSMeans square foot modules were used with square footage sized as follows:

- WPF = Light Industrial Warehouse building model (456,000 $ft^2$)
- DDCF = Aircraft Hanger model (187,500 $ft^2$)
- WPF/DDCF Office Space = Office building model (250,000 $ft^2$)

Engineering reviewed the RSMeans model output line items and provided enhancements as required to support the specific scope of this project. Adjustments were made to these cost models to better represent the parameters supplied by engineering, including design life, environment, mechanical and electrical utility capacities, structural components, and building dimensions. Additional adders were applied for field indirects, contractor general conditions, shipyard congestion, and security requirements.

Similar to the DD1391 estimates described above, a critical path schedule was developed, escalation applied to the mid-point of the construction schedule, a risk analysis was performed and resulting cost estimate developed using the USN BESS format.

# 3. Project Narrative

## 3.1 Project Initiation

The Shipyard Industrial Analysis project started out as a joint effort between SGT and Bechtel, with Bechtel being a subcontractor to SGT. Early on, NAVSEA changed the contracting philosophy that resulted in Bechtel's contract being administered separately through the NCMS. SGT's scope was redefined to leverage their expertise in modeling and optimization and were tasked to provide Bechtel with its findings and data associated with an as-is shop-based digital WPF model and an optimized process-based WPF model. As a result, the subsequent discussion of the project was divided into the following phases, as follows:

**Phase I and II (Scope and Planning Phases)** – Represented the collaborative effort with SGT on mod-sim efforts (Phase I) and the subsequent expansion of scope to develop the planning tasks to replace DD3 and subsequent WPF (Phase II).

**Phase III and IV (Development and Execution of Original Scope)** – Represented the efforts to create three DD1391 documents (*or Primary deliverables*), as originally defined by the USN:

1. Cost Certified DD1391 for a new dry dock
2. Installation level DD1391 for the WPF
3. Cost Certified DD1391 for the WPF

In support of the original scope, Bechtel issued the draft Cost Certified DD1391 (original scope) for the new dry dock on 31 October 2019. However, subsequent to the draft submittal of the Cost Certified DD1391 (original scope) and completion of all or part of the work scope for Phases III and IV, on 1 November 2019, the USN provided direction, due to a funding delay, to re-evaluate the timing, staffing, and requested Bechtel to revise the SOW. The revised SOW incorporated the USN-directed changes in the size and specifications of the dry dock along with the dates for the overall completion of the facilities. The resultant SOW incorporating these scope changes were delineated in Phase V.

**Phase V (Development and Execution of First and Second Scope Revisions)** – Phase V included four increments. Following the 1 November 2019 USN redirection, Bechtel re-evaluated the timing, level of effort and revised plan for the submittal of deliverables. The revised DD1391 principal deliverables to support the USN's directed changes to the dry dock size and deliverable schedule are as follows (first scope revision changes are in bold font):

1. Added Dry Dock Budget Ready DD1391 Estimate **(based on the revised size) forecast for 28 February 2020**
2. Dry Dock Cost Certified DD1391 Estimate: **November 2019 revised forecast to CY 3Q 2020**
3. WPF Installation Level DD1391 **(now Budget Ready DD1391)** Estimate: **February 2020 revised forecast to CY 4Q 2020**
4. WPF Cost Certified DD1391 Estimate: **June 2020 revised forecast to CY 1Q 2021**
5. Revise the AoA structure and strategy for the WPF

On 12 June 2020, Bechtel was informed of a Second Scope Revision from the USN based upon the USN's reprioritization of projects and a further delay in the WPF for several years. The impacts of this Second Scope Revision were analyzed, and the SOW updated and submitted by Bechtel to NCMS. With these Second Scope Revisions, the DD1391 documents, primary deliverables, and other SOW tasks to support the USN's revised direction/schedule delay are now as follows *(Second Scope Revisions are in bold italics font):*

1. Dry Dock Budget Ready DD1391 Estimate (based on the revised size)
2. Dry Dock Cost Certified DD1391 Estimate
3. Addition of ***WPF Class 5 Cost Estimate (which includes DD3 Backfill scope)***
4. ***Deleted both the WPF Budget Ready DD1391 Estimate and WPF Cost Certified DD1391 Estimate***

During July and August 2021, Bechtel worked with the USN to identify additional applicable scope to assist NAVSEA in implementing the SIOP. On 27 August 2021, Bechtel received Amendment Number 02 to the NCMS Phase V-Increment IV Collaboration Agreement which included adding Tasks 3A and 3B to support Lifting, Handling and Material Management (LHMM) scope.

On 17 July 2022, Bechtel received Amendment Number 04 to the NCMS Phase V-Increment IV Collaboration Agreement which added Task 4 to support conducting workshops to share knowledge of efforts completed to date on preliminary sizing and functional configuration of WPFs at the various shipyards.

## 3.2 Phase I and II – Scope and Planning Phases (Original Scope)

The objectives of these two phases were to define the project requirements, initiate mobilization of the project team, and conduct a project kickoff meeting.

Phase I – Commencing in April 2019, Bechtel mobilized and developed project plans, including: PEP, Organization Chart, Staffing Plan, Project Controls Plan, and Estimating Plan.

Phase II – Commencing in May 2019, continued to center around planning along with the beginning efforts of project initiation. The following tasks, along with the associated AoA and DD1391 Development Deliverables, were performed during Phase II as outlined in the SOW:

- Task 1: Mobilization and Project Set-up
  - PEP summarizing Bechtel's mobilization efforts
  - Project Organization Chart describing the Bechtel team
- Task 2: Conduct Planning Charrette and Design Charettes
  - Summary minutes of the May planning charrette
  - Summary minutes of the July design charrette
- Task 3A: Prepare AoA for the New Dry Dock
  - Final dry dock AoA report
- Task 3B: Prepare AoA for the WPF
  - WPF AoA study (to be developed in follow-on task order for 1391 development)

- Task 4: RACI Chart Support
  - RACI matrix from the May charrette
- Task 5: IMS Development
  - IMS
- Task 6: Risk Matrix
  - Risk matrix and register for the project
- Task 7: Prepare a Geotechnical Investigation Scope
  - Geotechnical scope of work
- Task 8: DD1391 Preparatory Activities
  - SOW and estimate required to complete DD1391 submittals for the new dry dock and the related WPF
- Task 9: Integration with Siemens

As Phase I and II centered around scoping and project planning, the discussion is organized by the tasks presented in the SOW. Each of the deliverables associated with the Phase I and Phase II tasks, presented above and in the SOW, are discussed in detail in the subsequent sections.

### 3.2.1 Task 1: Mobilization and Project Set-Up

The PEP set the overarching mission and execution elements unique to the Naval Shipyard Optimization Program. It documented the objectives, structure, means, methods, and controls necessary to achieve the government's goal. The PEP has the following purposes:

- Defines program & project(s) goals and objectives
- Provides a thorough description of the project baseline
- Provides a framework on how risk will be identified, tracked, and mitigated
- Document the plans, organization, structure, system, and methodology that will be used to manage the project(s)
- Defines roles, responsibilities, and accountabilities for program & project participants (Project Organization Chart)
- Guides the technical, managerial, and administrative participants
- Ensures the project is conducted in accordance with applicable standards and processes

The PEP was issued at the start of the project and updated two times to adjust to customer changes to the project scope and baseline schedule. It was used by Bechtel staff as a reference guide on project objectives, scope, interfaces, and process. The PEP included a list of current projects, project baselines, organizational structure, procedures, systems, and methodologies.

### 3.2.2 Task 2: Conduct Planning Charrette and Design Charettes

#### May 2019 Dry Dock Production Facility Concept/DD1391 Planning Charrette

A planning charette to establish dry dock requirements and WPF concepts was conducted the week of 20–24 May 2019. The May 2019 Dry Dock Production Facility Concept/DD1391 Planning Charrette was held at the Naval Submarine Training Center Pacific, Ford Island, Building 39 and attended by USN representatives from NAVFAC Pacific, NAVFAC Hawaii, PHNSY, and PMS 555. Representatives from Bechtel, Orbis, SGT, and WSP were also in attendance.

The planning charrette involved a series of meetings with key USN stakeholders and examined major aspects of a dry dock/WPF at PHNSY. These aspects included: Stakeholder Identification, Requirement Verification, Operational Requirements, Change Management, Dry Dock Options, WPF Concepts, Environmental Considerations, Technology, Risk Management and DD1391 deliverables and schedule.

Outcomes from the charrette included:

- Establishment of Mission Critical Need Date of Dry Dock start of FY2028 (validated by NAVSEA – this date will require an expedited process in order to achieve project requirement of Virginia Class Block V capable dry dock)
- Dry Dock and WPF to be considered together
- WPF concept to be based on PHNSY modeling & simulation work being carried out by SGT
- Bechtel to prepare an AoA for four dry dock alternatives presented at the charrette:
  - Alternative 1 DD3 Lengthen, Deepen, and Reconfigure
  - Alternative 2 DD3 Lengthen and add Superflood
  - Alternative 3 DD5 New Graving Dry Dock
  - Alternative 4 DD5 New Floating Dry Dock
- Charrette participants developed a list of evaluation criteria for use in the AoA and COA decisions
- A milestone schedule was developed for key activities over the next two years necessary to achieve the Mission Critical Need Date

Key project decisions, responsibilities, and actions were captured and recorded on a Project RACI chart that was actively managed by the USN Project Manager (NAVFAC Pacific). Detailed notes from the five-day charrette were recorded by Bechtel and issued to the USN for their review and approval.

The planning charrette adjourned on Friday, 24 May 2019 with participants expressing better understanding and direction for this project. A briefing was given to the PHNSY Command on objectives, accomplishments, and next steps.

#### July 2019 Dry Dock Concept/DD1391 Design Charrette

A design charrette to establish dry dock requirements and concepts was conducted the week of 22-26 July 2019. The July 2019 Dry Dock Concept/DD1391 Design Charrette was held at the Afloat Training Center, Ford Island, Building 39 and attended by USN representatives from NAVFAC

Pacific, NAVFAC Hawaii, PHNSY, and PMS 555. Representatives from Bechtel, Orbis, SGT, AECOM, Eng USA, and WSP were also in attendance.

The design charrette involved a series of meetings with key USN stakeholders and examined design bases and design direction for the preferred alternative to replace DD3, a new graving dry dock, DD5 at PHNSY. The results and information shared during the design charrette served to form the basis for the preparation of a Cost Certified DD1391 budget request to the U.S. Congress. Charrette topics included: AoA results, Geotechnical Issues, Dry Dock Planning & BOD, Requirement Verification (including location, type, design dimensions, and vessel(s) to be accommodated), Navigation & Marine Operations, Environmental Considerations, Dry Dock Technology, Construction Methods, Process and Procedures for Military Construction Active Force (MCON) 1391s, Risk Management and DD1391 deliverables and schedule.

Outcomes from the charrette included:

- Dry dock dimensions revised to 125 ft x 755 ft (validated by NAVSEA/PEO SUBS)
- New Graving Dry Dock, DD5, is the preferred alternative
- Design ship class revised to Columbia Class SSGNX
- Support building and utility requirements and concepts were verified
- A milestone schedule was developed for key activities over the next two years necessary to achieve the Mission Critical Need Date

Key project decisions, responsibilities, and actions were captured and recorded on a Project RACI chart that was actively managed by the USN Project Manager (NAVFAC Pacific). Detailed Notes from the five-day charrette were recorded by Bechtel and issued to the USN for their review and approval.

The design charrette adjourned on Friday, 26 July 2019. A briefing was given to the PHNSY Command on objectives, accomplishments, and next steps.

### 3.2.3 Task 3A: Prepare AoA for the New Dry Dock<br>Task 3B: Prepare AoA for the WPF (Completed in Phase V)

Bechtel issued the Dry Dock AoA Report in August 2019. The AoA considered four dry dock alternatives as assigned and agreed in the May 2019 Dry Dock Production Facility Concept/DD1391 Planning Charrette. The AoA, an important element of the DOD requirements and acquisition process, is an analytical comparison of the operational effectiveness, suitability, risk, and lifecycle cost (or total ownership cost, if applicable) of alternatives that satisfy validated capability needs. The main objective of the AoA was to support project management decision making by ensuring that feasible alternatives (those meeting mission needs or capability gaps) were identified and analyzed prior to making costly investment decisions. AoAs are not decisional documents but are inputs that may be used to recommend a preferred alternative. The AoA process integrated requirement analysis, alternative analysis, risk identification and analysis (including application specific technical maturity, safety, security, health, and environmental considerations), acquisition strategies, and concept exploration in order to determine a preferred solution to meet a mission need.

The Dry Dock AoA was prepared following the DOE document 413.3-22, AoA Guide, 6 June 2018 for best practices, report format, and overall content. The AoA investigated four dry dock options at PHNSY to provide the USN the capability to perform maintenance level maintenance on the

Columbia Class SSNGX and Virginia Class V submarines. These four dry dock alternatives included:

- Alternative 1: DD3 Lengthening, Deepening, and Reconfiguring
- Alternative 2: DD3 Superflood
- Alternative 3: DD5 New Graving Dry Dock
- Alternative 4: DD5 New Floating Dry Dock

The AoA combined information and data from previous studies with new data generated by Bechtel to analyze each alternative. Analysis results were scored over five (5) criteria and combined using the evaluation criteria and weighting factors established by the USN at the May 2019 Planning Charrette. Ranking scores were presented in the following Evaluation Matrix, Table 1.

**Table 1. Dry Dock AoA Evaluation Matrix**

| No. | Alternatives | Factor | Mission Requirements | Time | Cost | Environment | Technical/ Engineering | Weighted Total |
|---|---|---|---|---|---|---|---|---|
| | | Factor Weight | 30% | 25% | 20% | 15% | 10% | 100% |
| 1 | DD3 Deepening, Lengthening, and Reconfiguring | | 2.8 | 0.0 | 6.2 | 4.5 | 4.0 | **3.1** |
| 2 | DD3 Superflood | | 1.5 | 0.0 | 3.8 | 2.8 | 3.0 | **1.9** |
| 3 | DD5 New Graving Dock | | 8.8 | 6.8 | 8.7 | 4.8 | 9.0 | **7.7** |
| 4 | DD5 Floating Dry Dock | | 7.3 | 8.3 | 3.4 | 4.0 | 5.0 | **6.0** |

AoA Conclusion: Alternative 3: DD5 New Graving Dry Dock was the preferred alternative for consideration, receiving the highest weighted score of 7.7 out of 10.0. The USN utilized this conclusion to brief senior USN Command in the determination the PHNSY dry dock COA.

### 3.2.4 Task 4: RACI Chart Support

An outcome of the May 2019 Dry Dock Production Facility Concept/DD1391 Planning Charrette included development and documentation of a RACI chart. The RACI chart development included the Development of Responsibility on producing all the required documentation and information for the AoA, COA, DD1391 (Dry Dock), and DD1391 (WPF). A detailed listing of stakeholders was developed at the session with the attending RACI assignments made. The purpose of the RACI chart was to insure timely, relevant, and consistent coordination and communication among all stake-holders. This initial RACI chart was discussed, agreed and documented in the May 2019 Dry Dock Production Facility Concept/DD1391 Planning Charrette notes.

The RACI chart was owned and actively managed by the NAVFAC Project Manager and reissued after major project review meetings (e.g., July 2019 as part of Dry Dock Design Charrette).

### 3.2.5 Task 5: IMS Development

A detailed critical path baseline schedule was developed in Primavera scheduling software to reflect the development of the dry dock and WPF engineering scope and DD1391 estimate deliverables. Level 1, Level 3, and Critical Path schedules were utilized to manage the project. The project schedule was primarily grouped by Major Scope/Location (e.g., Dry Dock, WPF, Siemens/SGT Modeling), secondarily grouped by Discipline (e.g., Civil, Mechanical, Electrical, Procurement, Construction, Management), and by Lead Responsibility. The project team managed the progress with weekly reviews of the six-week look ahead schedule. A Programmatic Level 1 schedule was reviewed with the customer on a monthly basis. In addition, a major milestone layout which aligned to a listing of key USN defined milestones was provided to the USN with an accompanied schedule variance analysis discussion on a weekly basis.

### 3.2.6 Task 6: Risk Matrix

The dry dock/WPF Risk Management program kicked off on 25 July 2019 during the Dry Dock Design Charrette with full USN and Contractor team in attendance. The kickoff session was conducted utilizing an established Risk Management process. Risks were documented, analyzed, prioritized, and dispositioned using Active Risk Manager software. Nineteen Risk Titles were identified in the 25 July 2019 session with over seventy causes and seventy consequences and documented in the initial Project Risk Register.

The team analyzed these risks following the Risk Management process conducting additional Risk Management sessions with the USN team and other stakeholders in subsequent charrettes and project reviews. The initial Project Risk Register was eventually separated into two separate registers, one for the DD3 Replacement and one for the WPF. Risk Owners were assigned, and mitigations identified and evaluated. Risks were actively managed throughout preparation of the DD1391 deliverables. Risks that were realized during the DD1391 development phase were incorporated into the Cost Certified DD1391 cost estimate and schedule. Remaining risks were considered in the cost and schedule contingency analysis. The Project Risk Registers for the dry dock, submitted with DD1391 and WPF, submitted with WPF Class 5 Estimate, are documented to be used in future design, procurement, and construction activities.

### 3.2.7 Task 7: Prepare a Geotechnical Scope of Work

A geotechnical site investigation for the planned DD5 location was conducted in two phases – Phase I included five borings on land and Phase II included six borings over water. An Exhibit D (Scope of Work) to the contract was prepared and outlined specific tasks required for the investigation. An engineering specification was also prepared and included in the contract. This document provides specific direction on how to accomplish these tasks, providing reference standards where appropriate. NAVFAC was provided these initial documents for review and comment. Their comments were incorporated prior to letting the contract for bid. During execution of the contract, an amendment was authorized to conduct shear wave velocity measurements in one of the boreholes. This amendment identified a local method of conducting these measurements necessitated by the unique geology at Pearl Harbor.

Exhibit D and the specification were revised to incorporate the Phase II borings and associated work. An amendment to the contract was authorized for this work. Associated work included diving for coral and sea grass inspection and diving and over water inspection for unexploded ordinances (UXOs). This associated work was included in the permit conditions for the Nationwide Permit (POH-2020-00043) that was obtained for the over water work.

### 3.2.8 Task 8: DD1391 Preparatory Activities

The BOD, Revision A, was included as part of the Draft DD1391 (original scope) submittal package submitted on 31 October 2019. The BOD provided the fundamental engineering description through the 15 percent design progression of the project to support development of the DD1391. It captured the functional requirements, design inputs, assumption and constraints associated with DD5 based on the original scope. It also contained industry codes and standards that define engineering practices that dictate the design of DD5. The document described the DD5 design details for the following areas: structural, architectural, geotechnical, civil, fire protection, mechanical, electrical, telecommunications, environmental, anti-terrorism, force protection and cybersecurity and sustainability.

### 3.2.9 Task 9: Integration with Siemens

In a separate subcontract to SGT, Bechtel's mod/sim support team provided master planning and technical support to the SGT modeling team beginning in April 2019. The SGT modeling team, comprised of SGT, Eng USA, Orbis, LCE, and Bechtel, reviewed the PHNSY database (e.g., Job Order/Key Operation and Advanced Industrial Management) and interviewed repair shop personnel to collect pertinent submarine repair data. The data included equipment, worker, material, weight handling, storage, worker muster area, and project team information. The data was used as inputs to SGT's submarine repair and sustainment modeling and simulation efforts. The outputs of SGT's model were reviewed and approved by PMS 555 before release to Bechtel's DD1391 team for use in designing and cost-estimating the pilot WPF at Pearl Harbor. From the SGT model outputs, Bechtel developed WPF space requirements for repair production floor, repair support facilities, storage areas for components, equipment, tools, consumables and fabricated material, worker muster spaces, and project team office spaces. The space requirements were then used to determine the WPF building layout and number of floors based on available land footprint at the Pearl Harbor Dry Dock waterfront. This effort began in Phase II and continued through to Phase V.

An additional task was added to the Phase V SOW to develop and facilitate workshops to provide how the sizing and functional configuration information was developed for each of the four shipyards.

During the course of the Pearl Harbor WPF project, SGT provided four sets of WPF model outputs. Bechtel has subsequently developed three sets of WPF space requirements based on USN approval and direction of model outputs.

1. In August 2019, SGT provided the first set of WPF model outputs, which were shop-based outputs. Based on the shop-based model outputs, Bechtel developed the preliminary shop-based "single" WPF space requirements.
2. During the November 2019 project slowdown, the mod/sim work was paused. In January 2020, SGT restarted their mod/sim work. On 27 March 2020, SGT submitted a revised set of shop-based "single" WPF model outputs to PMS 555 for review and approval for Bechtel use. Based on the shop-based "single" WPF model outputs, Bechtel developed the revised shop-based "single" WPF space requirements.
3. On 7 May 2020, SGT submitted a set of shop-based "double" ("multi") WPF model outputs to PMS 555 for review and approval for Bechtel use. On 12 May 2020, a revised set of shop-based "double" ("multi") WPF model outputs were submitted in response to PMS 555 comments to move more shops to the second floor because of limited land footprint near the DD5 location. After review, PMS 555 approved the SGT model outputs for Bechtel use in the preparation of WPF AoA. Based on the revised shop-based "double" ("multi") WPF model outputs, Bechtel prepared the shop-based "double" ("multi") WPF space requirements.

4. On 15 June 2020, SGT delivered a shop-process (“hybrid”) model to PMS 555 for a single avail WPF. It is not a “product process-based” model. This model was not approved by PMS 555 and Bechtel was asked, instead, to use the 14 May 2020 SGT Shop-based model output for a “double-avail” WPF.

## 3.3 Phase III and Phase IV-Preparation of DD1391 Documents (Original Scope/Notification of First Scope Revision)

The original objectives for Phase III and Phase IV were to continue efforts toward the creation of three DD1391 (original scope) documents, or Primary deliverables:

1. Cost Certified DD1391 for a new dry dock
2. Installation level DD1391 for the WPF
3. Cost Certified DD1391 for the WPF

Thus, Phase III and Phase IV began by building upon the studies, design, modeling, and schedule development that were completed in Phase I and II and mainly concentrated on the following activities prior to the first scope revision.

Phase III implemented the planning activities and tasks defined by the Engineering team, with support from supplier and constructability analyses, that identified the requirements, schedule, and information required to create the Budget Ready documents. The RACI chart, Risk Matrix and the schedule were used to strategically identify courses of action and supported a comprehensive AoA for the dry dock that was used to assist the USN’s final determination of the best path/plan for future use.

Phase IV included development of an initial draft DD1391 (original scope) for the new dry dock on 31 October 2019. The DD1391 was based on the original scope, and consisted of the following components:

- BOD
- Cost Estimate
- Basis of Estimate
- DD1391 Graphics
- DD1391 Block 10 and 11
- Equipment List
- Assessment of Design Flood Elevation for DD5
- Groundwater Seepage Technical Note
- Utility Study
- DD5 Structural Analysis
- Hazards of Electromagnetic Radiation to Personnel, Fuels, and Ordnance Study

Subsequent to the draft submittal of the Cost Certified DD1391 (original scope), on 1 November 2019, during Phase IV, the USN provided direction, due to a funding delay, to re-evaluate the timing and staffing, and requested that Bechtel revise the SOW. The revised SOW incorporated the USN-directed changes in the size and specifications of the dry dock along with the dates for the overall completion of the facilities. Specifically, the revised requirements included:

- Changing the requirement from support of a Columbia class submarine to a Virginia class submarine with revised size and specifications (The originally scoped USN requirements included designing a dry dock around a Columbia class submarine [SSGNX that resulted in a dry dock with the following dimensions: 800 ft long, 130 ft wide and 54 ft deep [53 ft with a 1 ft coping]).
- Delaying completion of the WPF deliverables until such time that adequate funding could be approved.

The SOWs were structured such that tasks necessary in the management and development of the Primary deliverables, described above, were also identified for the respective phase. For ease of discussion, the intermediary deliverables/tasks were segregated into three general groupings, (Project Management; Engineering; and Estimating).

### Phase III Deliverables/Tasks

The following Phase III deliverable/tasks are discussed in detail in the respective sections:

Project Management Tasks:

- August Monthly Report Issue
- Issue Design Charrette Report
- Local Labor Study (In Hawaii)
- Develop & Issue Dry Dock Design Review 1 Report

Engineering Tasks:

- Advanced Technology Study for Dry Dock
- Civil Site Plans (Dry Dock)
- Civil (Demo) Site Plans (Dry Dock)
- Architectural Floor Plans (Dry Dock-Pump House)
- Explosive Safety Drawing (Dry Dock)
- DOD 1391 Checklists (BOD) – Rev. A
- Fire Protection Life Safety Floor Plan (Dry Dock)
- Complete Pavement Design (Dry Dock)
- Specify drainage pumps and sump requirements
- Base flood elevation (BFE) assessment & Study Report
- Electrical Aboveground Overall Plan
- Civil Site Demo Plan (Dry Dock)
- Fire Protection Suppression Plan
- Seismic Evaluation

Estimating Tasks:

- Issue Dry Dock Estimate Plan

#### Phase IV Deliverables/Tasks

The following Phase IV deliverables/tasks are discussed in detail in the respective sections:

Engineering Tasks:

- Develop Mechanical Equipment List
- Develop Engineering Deliverables for Dry Dock DD1391
- Preliminary Dry Dock caisson design
- Specify Closed Loop Cooling System Requirements
- Fire Protection Code Compliance Summary Sheets
- Dry Dock Power One Line Diagram
- Dry Dock Basis of Estimate and Quantities Report (Electrical, Instrumentation and Controls)

Estimating Tasks:

- Compile Estimate Review Package

### 3.3.1 Phase III and Phase IV Project Management Deliverables/Tasks

#### August Monthly Report Issue (Issue Monthly Reports)

Starting in September 2019, monthly status reports were provided each month during the DD3 Replacement project. The initial efforts for May 2019 through August 2019 were summarized into a single report issued in September 2019. The monthly status reports included what was worked on or accomplished during the month, what was planned for the next month, and included any issues encountered and mitigation strategies implemented to overcome the identified issues. It also included a monthly status of the Phase III/IV deliverable schedule (Project Level 1 Milestone Summary Schedule) and the monthly Financial Summary table.

#### Issue Design Charrette Report

A planning charette to establish dry dock requirements and WPF concepts was conducted 19–22 August 2019.The August 2019 Dry Dock Production Facility Planning Charrette was held at the Historic Hickam Officers Club, Joint Base Pearl Harbor-Hickam, and attended by USN representatives from NAVFAC Pacific, NAVFAC Hawaii, PHNSY, and PMS 555. Representatives from Bechtel, Orbis, SGT, and WSP were also in attendance.

The planning charrette involved a series of meetings with key USN stakeholders and examined planning aspects for a WPF at PHNSY. These aspects included: Architectural Layouts and Concepts, Advanced Technology, Crane Technologies, Geotechnical and Hydrology assumptions (including SLR), Relationship to dry dock and deck plate, BOD for the WPF, Construction Planning, Cost Estimating, Risk Matrix, and RACI items.

The following goals were achieved:

- Agreement on the options that will focus the AoA
- Agreement on the location of the WPF
- Reviewed the configurations for the WPF
- Reviewed the technological innovations to be included in the WPF
- Reviewed the processes and workstations to be accommodated in the WPF

- Agreement on the forecasted dimensions for the design of the WPF
- Reviewed existing utility plans and issues for the WPF
- Reviewed the parameters for the BOD for each engineering discipline
- Reviewed process and procedure for the Installation and Cost Certified MCON 1391s
- Confirmed the preferred dry dock lifting options since this choice affects the WPF
- Reviewed the security protocols for the new construction dry dock & WPF area
- Obtained charrette consensus on the schedule going forward for both the dry dock and WPF

Notes and actions were provided. The actions were tracked, resolved and implemented through Phases III and IV of the contracts.

### Develop & Issue Dry Dock Design Review 1 Report

*September 2019 Dry Dock Engineering Design Review Report*

A dry dock engineering design review was conducted 17–18 September 2019. The September 2019 Dry Dock Engineering Design Review was held at the Historic Hickam Officers Club, Joint Base Pearl Harbor-Hickam, and attended by USN representatives from NAVFAC Pacific, NAVFAC Hawaii, PHNSY, and PMS 555. Representatives from Bechtel were also in attendance.

The design review was conducted to present the current status of the DD1391 15 percent dry dock design to USN reviewers and stakeholders and solicit feedback with the following goals:

- Provide in-process view of current design and construction
- Open engineering exchange
- Close any remaining open issues

The desired results of the review were to ensure there were no surprises with the 31 October 2019 15 percent dry dock design submittal. Presentation, notes, and agenda were documented to provide information on topics discussed, decisions reached, and follow-on actions from the design review.

*October 2019 Dry Dock Engineering Design Review Report*

A second dry dock engineering design review was conducted on 15–17 October 2019. The October 2019 Dry Dock Engineering Design Review was held at the Historic Hickam Officers Club, Joint Base Pearl Harbor-Hickam, and was attended by USN representatives from NAVFAC Pacific, NAVFAC Hawaii, PHNSY, and PMS 555. Representatives from Bechtel and WSP were also in attendance.

The second dry dock engineering design review was completed in October 2019 with the following objectives in mind:

- Draft review of the overall DD1391 program
- Obtain consensus on scope of dry dock
- Address remaining open issues
- Review of WPF AoA progress, including consensus on functional requirements, criteria and criteria weighting

The desired result of the second dry dock engineering design review was to review further design progress and to ensure there were no surprises with the 31 October 2019 15 percent design submittal.

Similar to the previous design review, presentation, notes, and agenda were documented to provide information on topics discussed, decisions reached, and any actions from the design review.

#### Local Labor Study (Hawaii)

The availability of craft labor was based on the Department of Labor and Industrial Relations study, "Employment Projections for Industries and Occupations," Honolulu Metropolitan Statistical Areas, 2016 to 2026, issued July 2019. To validate this data set, follow-on discussions were held with the respective directors of the Hawaii Construction Alliance and the Hawaii Building and Construction Trades along with business agents for local labor unions. The results of these discussions were summarized in the Labor Availability Study and is an attachment to the Basis of Cost Estimate (BOCE) in the DD1391 submittal package. The following parameters were included in the study: wage rates and fringes, forecasted increases, labor supply for local Hawaii personnel and those crafts which would need to be sourced from the mainland, labor productivity, crew sizes, and badging for site access.

### 3.3.2 Phase III and Phase IV Engineering Deliverables/Tasks

#### Advanced Technology Study for DD3 Replacement Project

In August 2019, Bechtel began the study of advanced technologies for potential inclusion in the DD5 design. During the September 2019 Dry Dock Engineering Design Review meeting in Pearl Harbor, Bechtel presented a list of potential technologies for inclusion in the DD5 design. Some of the list of technologies presented included:

- Advanced Production Brows (previously referred to as Superbrows)
- Advanced concrete material (fiber-reinforced concrete)
- Integrated utility plug-in system
- Laser-guided docking system
- Robotic monitoring system

Stemming from the August 2019 presentation and collaboration during the August 2019 Dry Dock Production Facility Planning Charrette, the DD5 Technology Capability Definitions, DD5 Technology Functional requirements, and DD5 Technology Descriptions were developed and submitted to PMS 555 management on 10 March 2020. Follow-on work included the development of the conceptual design of the Advanced Production Brow.

#### Additional Engineering Tasks

Additional engineering tasks, requested by the USN that were not part of the original Phase IV SOW, were performed to help inform the initial Cost Certified DD1391 (representing the original scope) for a new dry dock:

- Task 1: Evaluate the addition of a new High-Pressure Air System/Facility
- Task 2: Evaluate and provide various Substation capacities, interfaces, and pricing
- Task 3: Evaluate changes to the underground design and addition of tunnels
- Task 4: Re-evaluate seepage quantities/potential for new treatment system
- Task 5: Evaluation of revisions to DD5 size and angle options
- Task 6: Evaluation of SLR
- Task 7: Evaluation of requirement for a closed loop cooling system

- Task 8: Request to add freight elevators to the design
- Task 9: Request for a ROM estimate for Cybersecurity system changes
- Task 10: Preparation of U.S. Army Corps of Engineers (USACE) Pre-construction Notification (PCN) and Hawaii Water Quality Certification (WQC) permit applications to conduct geotechnical borings to inform the design

The additional engineering tasks studies are presented in further detail below.

***Task 1: Evaluate the Addition of a New High-Pressure Air System/Facility***

High-pressure air is required to support submarine maintenance activities. During discussions with the USN, there was uncertainty around whether a central shipyard system would supply high-pressure air to DD5 or if a new standalone system would need to be provided at DD5. The decision was made by the USN to include a standalone system capable of meeting the vessel high-pressure air requirements for DD5.

During the Additional Engineering initiative, the need for providing a standalone high-pressure air at DD5 was revisited as a potential cost saving measure. Discussions resulted in the USN final decision being made that the current shipyard system would not be capable of meeting the requirements for DD5 and that a standalone system needed to be provided. Quantities were provided for compressors, inline components, pipe, and structural work and included in the BOD and depicted on P&IDs.

***Task 2: Evaluate and Provide Various Substation Capacities, Interfaces and Pricing***

At the July 2019 Dry Dock Concept/DD1391 Design Charrette, it was proposed by shipyard personnel that Substation C would be used as the power supply station for the new dry dock. However, after further coordination with electrical personnel from the Shipyard Utility group, NAVFAC Hawaii and PHNSY & IMF (September 2019), Bechtel was informed that Substation C did not have sufficient capacity to support the new DD5 and the planned WPF. For this reason, the idea of a new substation, Substation X, was discussed to meet the projected loads of the new dry dock and WPF. Bechtel was asked to take an action to provide an 11kV switchgear quote with the 45kV feed; step-down transformers would be provided by Hawaiian Electric Company, Inc. (HECO) (action for NAVFAC Hawaii).

At a subsequent meeting, the October 2019 Dry Dock Engineering Design Review, NAVFAC confirmed that Substation X be specified to account for the additional/new power capacity required for the dry dock and WPF. Initially, NAVFAC requested a price for Substation X would be provided, but this price would not be included in the scope of the primary Cost Certified DD5 estimate. The price of Substation X would include the non-segregated bus between the Substation X step-down transformers and the 11.5kV switchgear, 11kV switchgear itself, and underground raceway from the proposed Substation X location to the dry dock area (with two feeds reserved for each e-House and the WPF).

It was later requested by NAVFAC management that the cost to feed Substation X from the on-site power plant was to be included; this would add the cost of the 46kV underground raceway and cable from the on-site power plant to Substation X. NAVFAC Hawaii indicated that the proposed power plant will be located in one of five potential locations on base. The most conservative option (longest distance from Substation X location) was used and included in the Substation X price.

On 3 June 2020, as recorded by meeting minutes, NAVFAC project management requested that Bechtel provide the cost of the H-frame overhead line structure, step-down transformers, and protective relaying and metering instrument transformers (as well as non-seg bus, 11kV switchgear and 11kV underground duct bank to the DD5 area). Substation X was included in the original design at the location identified in the BOD. After further discussion and comment resolution, the new Substation X location was approved by the USN and included in the Revised DD5 Cost estimate submitted on 29 January 2021.

***Task 3: Evaluate Changes to Underground Design and Addition of Tunnels***

During the September 2019 Dry Dock Engineering Design Review, the USN requested that service tunnels be added into the gallery from outside the crane rail. Incorporation of the request was achieved by adding a total of six tunnels, three to each side of the dry dock, one outside each crane rail, and two between the rails. Each tunnel would have access with an inside dimension of 6 ft by 6 ft. The design shows continuous galleries, except where interrupted by stairwells (five per side), with multiple access points to mechanical tunnels from galleries. The service tunnels were added to accommodate the design request and included in the DD1391 estimate based on input from the USN.

***Task 4: Re-evaluate Seepage Quantities and Evaluation of Potential for a New Treatment System***

A seepage volume of 200,000 gallons per day (gpd) was originally estimated for DD5. As the DD5 design progressed, especially with respect to the size of the DD5, the USN requested a re-look at this estimate. In response, an engineering study was performed to investigate design changes and potential seepage mitigation actions and provided an updated seepage flow volume. The results of the study reduced the initial estimated seepage flow volume from 200,000 gpd to 120,000 gpd. The updated seepage volume was incorporated into the BOD and led to reduced sizing of water treatment equipment.

A study was also performed to evaluate the cost and impact of implementing a zero liquid discharge facility into the design. The study provided approximate footprint requirements of the facility as well as the cost of equipment and installation associated with the facility. The recommendation of the study was not to implement a zero liquid discharge system due to the high costs (both installation and operating).

***Task 5: Evaluate/Incorporate Various Revisions to the Dry Dock Size and Angle Options***

During the July 2019 Dry Dock Concept/DD1391 Design Charrette, the USN requested evaluation of an alternative that included an angled DD5. This request for an angled alignment was intended to minimize fill and maximize the WPF footprint. The angled alignment was studied, and a decision was made to not include this option due to the channel proximity and size of turning basin.

***Task 6: Evaluation of SLR Consequences***

The National Defense Authorization Act (NDAA), Section 2805I requires that assessment for climate projections anticipated for the design life of existing or planned new facilities and infrastructure, such as DD5, be considered and incorporated into military construction designs and modifications. Accordingly, UFC 4-213-10 Method 3 specifies that local sea level change (SLC) shall be evaluated for three Global Sea Level Rise (GSLR) Scenarios: medium, high and highest. The Undersecretary of Defense directs that the DOD Regional Sea Level (DRSL) database shall be used for GSLR scenarios with site-specific adjustments for all DOD sites. For DD5, these data were retrieved and provided by NAVFAC for use in this flood report.

The DRSL database provided SLC data relative to 1992 for five global scenarios and for three different time horizons 2035, 2065 and 2100. The DRSL report also provided functional relationships to predict the GSLR values. Three components of site-specific adjustments are provided in the DRSL database:  vertical land movement, ocean circulation and ice-melt effects. The Local SLC is obtained by combining the contributions from GSLR and site-specific adjustments. Figure 7 shows the Local SLC projections up to the year 2025. The data shows that for the lowest and highest GSLR scenarios, the Local SLC near DD5 varies from 0.8 ft to 11.6 ft, respectively, for the year 2125. The range of uncertainties by the year 2125 therefore is over 10 ft. The Local SLC is included in developing the Design Flood Elevation (DFE) for DD5, which is discussed in the "Base Flood Elevation Assessment & Study Report" section. Included in the DD1391 estimate for SLR, Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) data were used to integrate with SLR scenarios for a risk-based design framework in conjunction with supplemental field data and applying regional frequency analysis as necessary. The estimate utilized an elevation of 112.5 ft Station Datum (SD) as coping elevation which would exceed the design storm event in ~2065 if the sea level rises by the highest rate scenario. The coping will be flooded by the design storm in ~2080 and ~2100 for the scenarios with high and medium SLR rates respectively. For detailed design efforts, developing a dynamically coupled tide, SLR, storm surge and wave model for the extreme water levels and adopting a risk-based design is recommended.

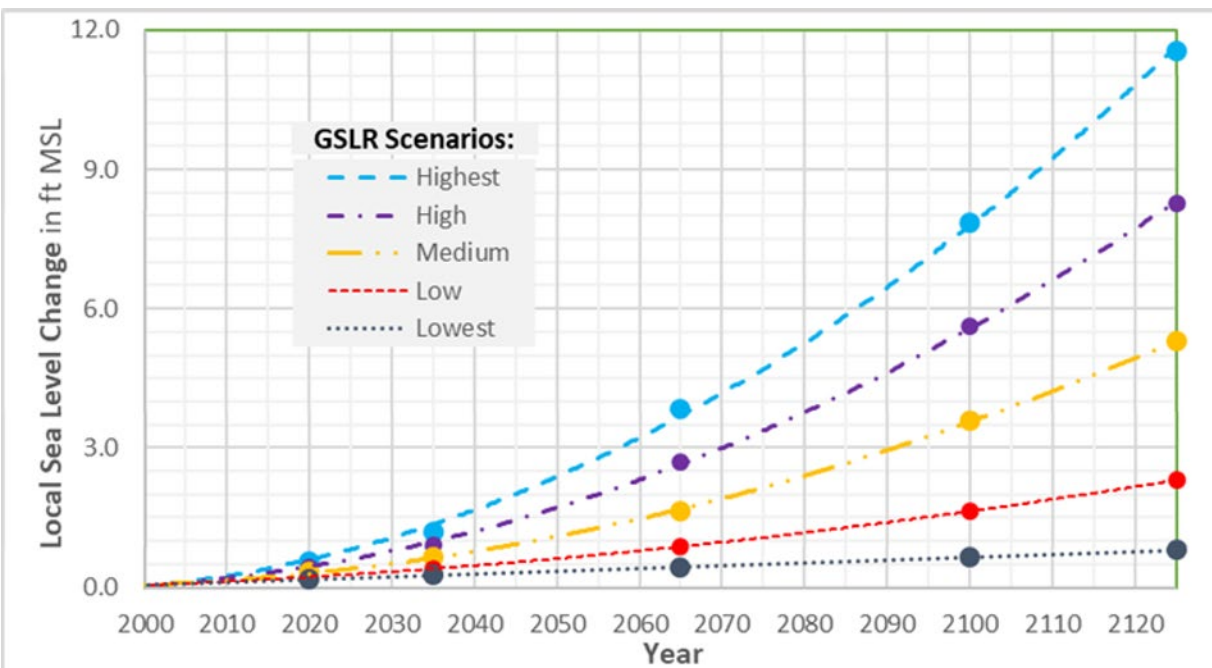



*Figure 7. Local SLC Near DD5*

### *Task 7: Request for Adding a Closed Loop Cooling System*

Pearl Harbor is considered an impaired water body. Due to this, the National Pollutant Discharge Elimination System (NPDES) permit has strict discharge requirements for water coming from the shipyard. In particular, the copper limits in the current NPDES permit have been found to be problematic for the current PHNSY dry docks. The primary source of copper in water at the dry docks is from the once-through cooling of the vessels that is required while in the dry dock.

In anticipation of this issue, the USN requested the design include closed loop cooling systems to provide chilled water to the vessels during maintenance periods. Accordingly, during the July 2019 Dry Dock Concept/DD1391 Design Charrette, the design requirement was given to include the closed loop cooling system in the estimate. Subsequent meetings were also held with shipyard engineers to clarify the requirements of the system as scope/design revisions occurred. For example, the Columbia class submarine was included as part of the originally scoped design requirements. Following the first scope change which included removal of the Columbia class requirement, the closed loop cooling system was modified to meet the newly scoped design requirements, the Virginia class.

***Task 8: Request to Add Freight Elevators to the Design***

A potential option to optimize the movement of materials at DD5 was presented during the Design Review in September 2019. Options to provide freight elevators were presented and discussed with the USN. As a result, freight elevators were added to the dry dock design and located on the west and south side of DD5. The requirements for the elevators were developed with input from the shipyard. The equipment was then added to the mechanical equipment list and the basis was documented in the BOD. Removal of the freight elevators was analyzed during additional engineering as a potential cost saving measure. The recommendation was made to keep the elevators in the design and cost estimate. The USN provided concurrence with this recommendation.

***Task 9: Request for a ROM Estimate for Cybersecurity System Changes***

At the beginning of the project, it was indicated that the Cybersecurity cost for the new dry dock be calculated using a fixed percentage (0.5 percent) of the Primary Facilities cost. However, in September of 2019, NAVFAC management indicated that because of the high capital cost of the Primary Facilities associated with this project, that a ROM estimate would need to be developed to determine the project Cybersecurity cost. This ROM estimate was developed in coordination with NAVFAC management, Joint Base Pearl Harbor-Hickam site Chief Information Officer, and Bechtel's in-house Cybersecurity SME.

***Task 10: Prepare USACE PCN and Hawaii WQC Permit Apps***

To develop an appropriate foundation design for DD5, it was necessary to conduct borings to inform the subsurface conditions. Variable subsurface conditions including soft sediments and hard rock may influence pile driving and installation of sheet piles. Further, coralline gravels and sands encountered beneath the site, which make up a significant proportion of the subsurface materials, are susceptible to crushing during pile driving, resulting in reduced pile capacities. Therefore, five soil borings were conducted on land near the head of the dry dock with exploration depths extending to 200 ft below grade with six additional soil borings conducted in water (approximately 50 ft deep), within the footprint of the dry dock with exploration depths of 150 ft below mud line.

The performance of the in-water borings necessitated obtaining an USACE Nationwide Permit PCN along with the State of Hawaii WQC. The Bechtel Environmental team worked with the NAVFAC Hawaii, Environmental Planning to successfully prepare the permit applications along with the required supporting documents, including, Best Management Practices Plan, Record of Categorical Exclusion, Hawaii Coastal Zone Management Federal Consistence Concurrence for De Minimis

Activities, and Applicable Monitoring and Assessment Plan. The USACE provided notification on 9 March 2020 that it had completed review of the PCN permit application for the drilling of approximately six in-water soil test borings in the vicinity of Southeast Loch of Pearl Harbor, Honolulu, Island of Oahu, Hawaii issuing the notification of the Nationwide Permit Verification (POH-2020-00043). Further, the State of Hawaii Department of Health (DOH) provided concurrence on 20 February 2020, covering the project under the Blanket 401 WQC1073.

### Engineering Tasks Included in the BOD Documents

Revision A of the BOD was submitted on 31 October 2019 prior to the 1 November 2019 first scope revision (the first scope revision included changes to the size and specification of the dry dock). The BOD included the following plans, reports, drawings, and specifications as identified in the SOW intermediary deliverables:

- DOD 1391 Checklists Rev. A (Not Required with revised scopes)
- Civil Site Plans (includes Electrical Aboveground Overall Plan)
- Civil (Demo) Site Plans
- Dry Dock Power One Line Diagram
- Preliminary Dry Dock Caisson Design
- Complete Pavement Design
- Explosive Safety Drawing
- Architectural Floor Plans (Pump House)
- Fire Protection Code Compliance Summary Sheets (Determined to be no longer applicable)
- Fire Protection Life Safety Floor Plan
- Equipment List (Includes Mechanical Equipment List)
- Specify Closed Loop Cooling System Requirements
- Specify drainage pumps and sump requirements

The BOD provided the fundamental engineering description through the 15 percent design progression of the project to support development of the DD1391. It captured the functional requirements, design inputs, assumption and constraints associated with DD5 prior to the first scope revision in November 2019. It also contained industry codes and standards that defined engineering practices that dictated the design of DD5. The document described the DD5 design in the following areas: structural, architectural, geotechnical, civil, fire protection, mechanical, electrical, telecommunications, environmental, anti-terrorism, force protection and cybersecurity and sustainability.

### Engineering Tasks Not Included in the BOD (Original Scope)

The following two reports were not included in the BOD, but instead issued as standalone reports.

*Dry Dock Basis of Estimate and Quantities Report (EI&C)*

The electrical equipment list incorporated the major electrical and telecommunications equipment required to support DD5 (switchgear, substations, generators, switches, controllers, etc.). Temporary services equipment used during docking evolutions and vessel maintenance are not included.

The electrical equipment included was sized and specified according to the UFCs and through coordination with NAVFAC and PHNSY. Site-specific design requirements and features were implemented based on the operation and design of the existing electrical distribution systems.

The telecommunications scope included legacy systems that need to be incorporated at the new dry dock (these existing systems were those that NAVFAC and PHNSY requested to be included at the new dry dock) and new/upgraded systems that allow for further system growth, future technology development, and improved operations performance.

Periodic changes to the scoping and design of the mechanical, fire, and security systems at the new dry dock also heavily influenced the final telecommunications and electrical equipment. The USN provided input to the electrical and telecommunication system designs throughout the design phase, and updates were made as applicable.

*BFE Assessment & Study Report*

The NDAA Section 2805(a)(1) and UFC 3-201-01 require that a project-specific flood mitigation plan be adopted for all military construction projects that are located within or partially within the 100-year floodplain. The 100-year floodplain is the extent of the BFE, which is defined by Federal Emergency Management Agency (FEMA) as the elevation of the 1 percent annual flood (100-year flood).

As prescribed in the NDAA, UFC 3-201-01 and UFC 4-213-10, the minimum DFE shall consist of an expected flood level, and provisions for water level increase due to extreme events and future SLC. Local SLC shall be projected to the year 2100 for three GSLR scenarios, “Medium,” “High” and “Highest.” The “Medium” GSLR scenario is used in the determination of the DFE and DD5 coping elevation. The “High” and “Highest” GSLR scenarios are used for the assessment of DD5 buoyancy factor of safety (FS).

UFC 4-213-10 requires that the flood water level is determined considering three different methods:

- Method 1: Combines the BFE with an additional water level increase of 3 ft or the Local SLC for the Medium GSLR scenario for 2100 (3.6 ft for DD5), whichever is higher
- Method 2: Combines the 0.2 percent annual exceedance probability still water level, as defined by the FEMA, coincident wave impacts and an additional water level increase of 1 ft
- Method 3: Combines the BFE with the Local SLC for the three GSLR scenarios. Local SLC projections are obtained from the DOD DRSL database

The BFE was obtained from FEMA FIS and FIRMs as 8.0 ft above the local mean sea level (MSL). The 0.2 percent flood still water level (4.1 ft MSL) was also obtained from the FIS. Coincidental wave impacts were not provided in the FIS and are assumed to be similar to that of the BFE. Using the three methods for evaluating flood elevations, a DFE of 112.5 ft SD (11.8 ft MSL, 12.5 ft Mean Low Water (MLW)) was selected for DD5.

The flood elevation data along with the selected DFE are also presented in Figure 8. The figure shows that if Local SLC is to progress at the highest GSLR scenario, the projected flood elevation would exceed the coping elevation by approximately the year 2065.

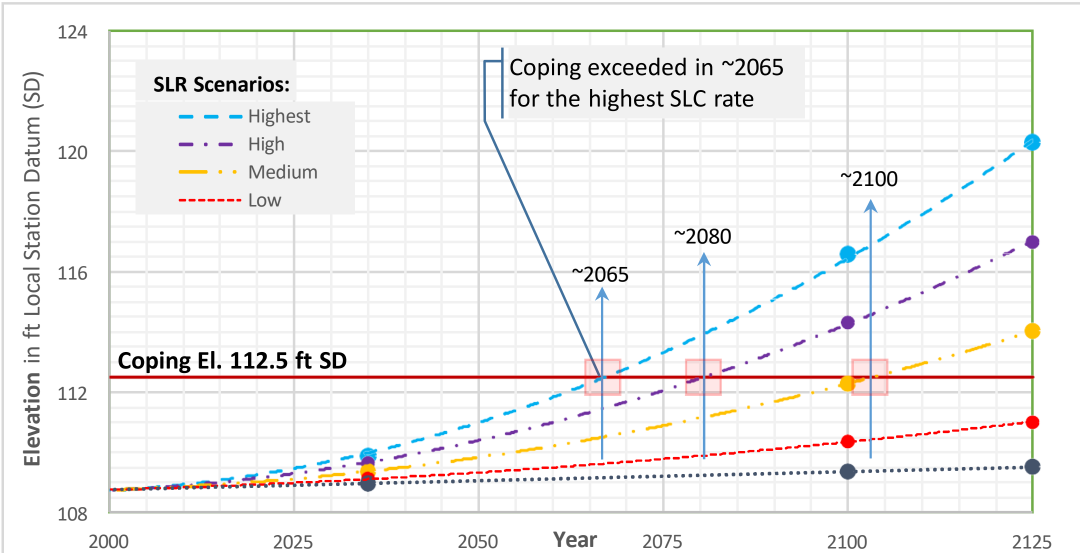



***Figure 8. Flood Elevations and DD5 Coping***

Elevation data (including tides, storm surges, bathymetry and topography), compiled from multiple sources with different vertical datums, were converted to local SD. For the site, Elevation 100 ft SD is the same as the MLW tidal datum, as shown in UFC 4-213-12.

Aside from future SLC, other climate change effects on the flood elevation, for example, changes in hurricane intensity, speed and frequency, were not considered in this study. Also, the three methods considered in developing the DFE includes alternative flooding values each with an associated level of uncertainty. These uncertainties have not been analyzed further for the DOD Form DD1391. A site-specific flooding assessment is therefore recommended to inform the most effective and resilient SLC adaptation strategy for the DD5 design.

A summary of the flooding assessment for the DD5 site is in the report titled "Assessment of Design Flood Elevation for Dry Dock 5 and Adjacent Areas for PHNSY Dry Dock 3 Replacement."

### 3.3.3 Phase III and Phase IV Estimating Deliverables/Tasks

#### Issue Dry Dock Estimate Plan

An Estimating plan was prepared to support the dry dock estimate development. The purpose of the plan and kickoff meeting was to 1) secure alignment on estimating approach and underlying basis and assumptions and 2) surface deliverables/inputs that are required from the Team specifically addressing who the responsible point person was and when the deliverables/inputs were due.

The scope section described the tasks that will be undertaken in conjunction with PMS 555 to produce a Cost Certified DD1391 submittal for the new dry dock with completion by late November 2019. In parallel with the dry dock work, the schedule was to prepare an installation level DD1391 for a WPF by 7 February 2020. After completion of the installation level DD1391, it was scheduled to prepare a Cost Certified DD1391 for the WPF to be completed by late June 2020. As part of the planning effort for the new DD5, the team participated in a design charette with the USN at the PHNSY to develop key design issues and parameters. By August 15, these design parameters and issues were finalized for use in the development of the DD5 DD1391 documentation. Design for

Cost Certified DD1391s were taken to approximately 15 percent level of completion while the design for the installation level DD1391 was roughly 5 percent.

The estimate purpose section outlined the process and effort required to develop a Cost Certified DD1391 for DD5. Per USN procedures, a DD1391 estimate is only intended to support budgeting purposes. In addition, the estimate must have the required detail to split out the Engineering – Procurement – and Construction Scope separately. Based on feedback from the PHNSY Team, the estimate must reflect a "reasonable" approach to perform the engineering, procurement, construction, and commissioning support of the new DD5.

This effort produced a USN cost-certifiable estimate. In order to ensure certifiability by the USN, the team worked closely with PHNSY on an ongoing basis to verify requirements were met. The estimate type section described was based on discussions with the USN and anticipated 15 percent level of design completion. This estimate was a Class 3 estimate in accordance with FC 1-300-09N.

#### Compile Estimate Review Package

An Estimate Review meeting was held in Hawaii 12–14 November 2019 where the estimate was presented and discussed. The package included the full estimate Excel file, the summary USN tables for the BESS and the BOCE documentation. Review comments were collected and summarized in the cost estimate review report submitted to the USN on 26 November 2019.

## 3.4 Phase V – Increments I, II, III, and IV

The intent of Phase V was to continue work previously started in Phase III and IV, however as described in Section 3.3, in November 2019, Phase V – Increment I funding was delayed. At that time Bechtel re-evaluated the timing, level of effort and submittal plan for deliverables. This resulted in a staff reduction and work slowdown during November 2019 through January 2020 due to re-alignment of timing for the dry dock deliverables and stoppage of work on the WPF AoA.

Several of the key assumptions and deliverables changed or were added as follows resulting from the first scope revision (See Section 3.1):

- Reduction of the dry dock size (Dry Dock Requirements at PHNSY, Ser 555/001), reflecting the change in classification for the types of ships that are expected to be serviced in the facility. (As a result, re-engineering was started and completed in January 2020 to provide an impact to cost and quantities and deliver a Budget Ready 1391 with the new dry dock size to the USN on 28 February 2020.)
- Additional Engineering studies/activities were initiated for the DD3 Replacement to analyze the size reduction during the preparation of the follow-on Cost Certified estimate
- Revised WPF AoA structure and strategy identified
- Development of a parametric ROM estimating approach to support the WPF AoA and other reviews

Bechtel worked with the USN to create the revised scope of work, schedule, and resources required to execute to the new plan during Phase V – Increments I and II resulting from the first scope revision. This plan was presented to the USN on 14 February 2020, and based on USN feedback, an updated plan was submitted to the USN on 15 April 2020. The primary deliverables to support the first scope revision were as follows:

1. Added Dry Dock Budget Ready DD1391 Estimate (based on the revised size): 28 February 2020
2. Dry Dock Cost Certified DD1391 Estimate: Original November 2019 date delayed to CY 3Q 2020
3. WPF Installation Level DD1391 (now Budget Ready DD1391) Estimate: Original February 2020 date delayed to CY 4Q 2020
4. WPF Cost Certified DD1391 Estimate: Original June 2020 date delayed to CY 1Q 2021
5. Revised the WPF AoA structure and strategy

The original objectives for Phase V Increments III and IV were to finalize the Additional Engineering and complete the Dry Dock Cost Certified estimate for the modified scope, the WPF AoA, the WPF Budget Ready Estimate and the WPF Cost Certified estimate. However, on 12 June 2020 Bechtel received initial communication from the USN stating that there were additional significant changes to the programming of the WPF (delay of several years) necessitating a further, or second, change in the scope of work (Second Scope Revision) (See Section 3.1). Subsequent meetings/communication determined that following key assumptions and primary deliverables had changed, been added or deleted resulting from the Second Scope Revision:

- Deleted WPF Budget Ready DD1391 Estimate
- Deleted WPF Cost Certified DD1391 Estimate
- Addition of WPF Class 5 ROM Cost Estimate (which includes DD3 Backfill scope)
- Provide minimal support hours for Engineering, Environmental and Cost Estimate questions

Revised list of Primary deliverables:

1. Dry Dock Budget Ready DD1391 Estimate (based on the revised size)
2. Dry Dock Cost Certified DD1391 Estimate
3. Addition of WPF Class 5 ROM Cost Estimate (which includes DD3 Backfill scope)

As discussed in Section 3.3, the SOWs were structured such that tasks necessary in the management and development of the Primary deliverables, described above, were also identified for the respective contract phase. The Phase V intermediary deliverables are included and discussed within each of the Primary deliverable section that it supported.

### Phase V Deliverables/Tasks

The following Phase V deliverables/tasks are discussed in detail in the respective sections:

General Project Management Tasks:

- Develop the revised baseline schedule to support the February 28th Budget Ready DD1391 for the dry dock based on the revised dimensions
- Issue the meeting minutes for the reviews held at PHNSY
- Status all of the activities from previous phases (NCMS request)

- NCMS Final Report – Issue Contract Final Report to NCMS (this report)

Primary Deliverable 1 – Dry Dock Budget Ready DD1391 Cost Estimate Documentation Package:

- Estimating Tasks
  - Prepare a ROM estimate for the revised dry dock dimensions within one week after contract extension (First Scope Revision)
  - Present Estimate to USN (Dry Dock Budget Ready DD1391)
  - Issue Final Dry Dock DD1391 Pkg to PMS 555 (Budget Ready)

Primary Deliverable 2 – Dry Dock Cost Certified DD1391 Cost Estimate Documentation Package:

- Engineering Tasks
  - Submit Additional Engineering Study
  - Complete Civil Site Plans (demolition)
  - Complete Mechanical Value Engineering Report
  - Electrical/Telecoms Evaluation Report
  - Submit Draft Land Boring Data Report
  - Submit Final Report for Land Borings
  - DD – G&HES-Submit Draft Land Boring Data Report
  - DD – SubC-Submit Draft Data Report for Water Borings
  - Environmental Evaluations
  - Seismic Evaluations
  - NEPA and Permitting Considerations
- Estimating Tasks
  - Prepare Economic Evaluation Document for DD5
  - Submit Draft DD5 Cost Certified 1391 Estimate
  - Submit Final DD5 Cost Certified 1391 Estimate

Primary Deliverable 3 – WPF Class 5 Cost Estimate Documentation Package:

- Revised AoA Structure and Strategy
- Provide Sketches /Drawings /Images AoA2 Prep (WPF Orientation)
- Develop Class 5 ROM Estimates for AoA Options
- Submit WPF Final Class 5 ROM Estimate to USN

Additional USN Requested Support Tasks – Post Primary Deliverables:

After completion of the three Phase V Primary deliverables, the USN requested additional support activities from the Bechtel team. The following additional scope support activities were provided:

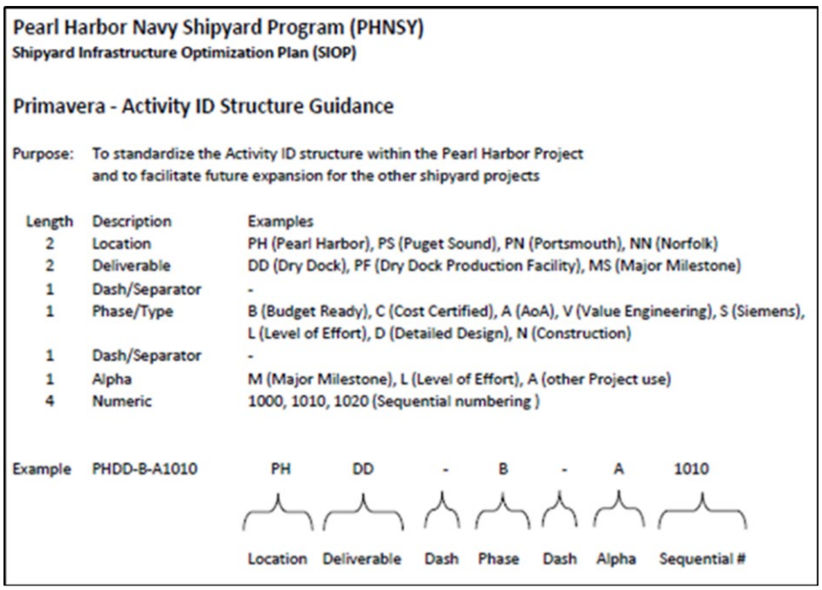
- Advanced Technology Continued Support
- Post DD1391 Engineering /Estimating Tasks
  - Transition of Bechtel Design Information to USN and A&E Design Contractors
  - Gantry Crane Foundation Study and ROM Estimate
  - SLR/Flooding Evaluation Support
  - Revised Dry Dock Cost Certified DD1391 Estimate

  - EIS Information Requests Support
- Lifting, Handling and Material Management Time and Motion Study
- Lifting, Handling and Material Management Standard Analysis Study
- Addition of WPF Workshops to transfer preliminary sizing and functional configuration of each public shipyard's WPF

### 3.4.1 Phase V Project Management General Deliverables

#### Develop Revised Base Line Schedule

During the Phase V effort, Bechtel was requested to develop a revised baseline IMS using the Primavera software. A structured Primavera Activity ID guidance document format (see Figure 9) was established to create a uniform approach to schedule development to facilitate better planning for the future SIOP program. A detailed critical path schedule was developed to track the development and submittal of the Phase V deliverables. The Acumen Fuse Schedule health software was utilized to analyze the DD1391 deliverable schedule. A schedule health report was provided with the Phase V re-baseline schedule to the USN.


**Pearl Harbor Navy Shipyard Program (PHNSY)**
**Shipyard Infrastructure Optimization Plan (SIOP)**

**Primavera - Activity ID Structure Guidance**

Purpose: To standardize the Activity ID structure within the Pearl Harbor Project and to facilitate future expansion for the other shipyard projects

| Length | Description | Examples |
|---|---|---|
| 2 | Location | PH (Pearl Harbor), PS (Puget Sound), PN (Portsmouth), NN (Norfolk) |
| 2 | Deliverable | DD (Dry Dock), PF (Dry Dock Production Facility), MS (Major Milestone) |
| 1 | Dash/Separator | - |
| 1 | Phase/Type | B (Budget Ready), C (Cost Certified), A (AoA), V (Value Engineering), S (Siemens), L (Level of Effort), D (Detailed Design), N (Construction) |
| 1 | Dash/Separator | - |
| 1 | Alpha | M (Major Milestone), L (Level of Effort), A (other Project use) |
| 4 | Numeric | 1000, 1010, 1020 (Sequential numbering ) |

Example PHDD-B-A1010

| PH | DD | - | B | - | A | 1010 |
|---|---|---|---|---|---|---|
| Location | Deliverable | Dash | Phase | Dash | Alpha | Sequential # |

*Figure 9. Primavera Activity Guidance*

#### Issue Meeting Minutes for Reviews held at PHNSY

Meeting minutes for reviews held at PHNSY during Phase V were prepared and issued as follows:

- January 2020 – Marine Construction Workshop in Honolulu Summary Report
- January 2020 – Marine Concrete Workshop in Honolulu Summary Report
- March 2020 – Participated in Team Integration and Integrated Schedule Meeting at the PHNSY – meeting minutes developed by USN

Starting in mid-March 2020, COVID-19 impacts placed a travel ban to Hawaii which ended reviews held at PHNSY. The remaining meetings were all held virtually.

### 3.4.2 Primary Deliverable 1 – Dry Dock Budget Ready DD1391 Estimate Documentation Package (First Scope Revision)

#### Estimating Tasks

*Prepare a ROM Estimate for the Revised Dry Dock Dimensions (First Scope Revision)*

During December 2019 and January 2020, Bechtel had various discussions with the USN on assumed dry dock dimension changes. Bechtel developed the following ROM estimates to align with the USN requests for the revised dry dock dimensions and supporting infrastructure:

- New Dry Dock Size Reconciliation
- Substation X Summary
- Various Depth Unit Pricing

*Issue Final Dry Dock DD1391 Package to PMS555 (Budget Ready) submitted Feb 2020*

The original DD1391 estimate submittal provided in October 2019 was based on the July 2019 Dry Dock Design Charrette sizing requirements. Reviews were held on this original DD1391 estimate. The USN developed comments which were analyzed and dispositioned. Further dry dock sizing and design requirements were adjusted by the USN during the November 2019 through January 2020 period which resulted in development of a new 1391 Budget Ready estimate, initially submitted 29 January 2020, with final submitted on 28 February 2020.

A complete, bottoms up estimate was prepared to develop the total cost for DD5. This estimate included all materials, craft labor, non-manual labor and supervision, subcontractors, freight, and other direct costs required to complete the scope. The estimate was developed using industry standard pricing, methods, and techniques. The following BOCE factors were included in the DD1391 cost estimate.

**Material and Subcontracts –** Material pricing was obtained from several sources listed below:

- Vendor Quotes – For large or specialty pieces of equipment, market vendor quotes were solicited. Every effort was made to source local Hawaiian vendors to provide quotes with mainland vendors being used if none were available or responsive. For items priced using a mainland quote, it is assumed these items would be purchased from the mainland vendor and shipped to Hawaii.

- Standard Reference – In cases where a vendor quote could not be supplied, or for common, off-the-shelf bulk items, 2019 R.S. Means pricing was used. The Hawaii location factor was applied. However, given known limitations with R.S. Means pricing, it is assumed these items would be purchased on the mainland and shipped to Hawaii.

- Internet Pricing, Estimated and Allowances – If available, online pricing was obtained showing current market purchase prices. If no other pricing sources were available for a line item, the estimating team made educated assumptions and gave an estimated allowance. It is assumed these items would be purchased on the mainland and shipped to Hawaii.

- Local Subcontract Quotes – Local subcontract quotes were received for the dredging, piling, and multiple field indirect scopes. The subcontractors provided complete pricing, inclusions/exclusions, assumptions, and methodology.

For material pricing that was obtained via a mainland vendor quote, or material that was priced using a cost book, freight costs were included to ship the material to Hawaii. Freight costs were developed using Compass International, Inc. an industrial/commercial construction cost book. Mainland freight costs of four percent are included to ship the material to a port, and then ocean barging freight costs of eight percent were added to ship the material to Hawaii. Finally, on-island freight costs of two percent were added to receive the material and deliver to the jobsite laydown area. The total freight premium applied equals 14 percent.

**Craft Labor** – R.S. Means installation unit rates were used as the basis for labor productivity. A productivity factor (PF) in the form of a percentage over the base rate was assigned to each of the following categories, where required, resulting in a total PF value to be applied to the base rate. The PFs range from 1.0 to 3.5.

- Craft skill and availability in Hawaii
- Site/work area congestion
- Security requirements (Concept of Operations)
- Complexity
- Working at height/under water
- Distractions/safety hazards
- Marine works hazard
- Travel time (to and from site, camp location)

Additionally, a shipyard factor of 15 percent was applied to account for the level of inefficiency caused by the process of obtaining access, (security badging) and then the daily requirement for shipyard entry. Craft wage rates were calculated using the State of Hawaii, Department of Labor & Industrial Relations, Wage Rate Schedule Bulletin No. 496 published on 16 September 2019.

Fringe benefits were included based on the journeyman classifications. Taxes, social security, and worker's compensation were calculated based on the federal and state rates. Two dollars per hour was added for retention and completion bonuses. An overtime rate of one and a half times base salary was used for hours exceeding forty hours per week. Additionally, a night shift premium of one and a half times base salary was included for hours exceeding 7.5 hours per day for those craft working night shift.

**Non-Manual Labor** – Non-Manual (Professional Services) staffing requirements were determined using the construction schedule, scope of work, and procedural requirements. In order to calculate non-manual labor cost, each full-time equivalent was assigned a function and experience level. National average wage rates for each position and skill level from the Western Management Group Government Contractors Survey were used with a ten percent incentive added to attract staff. National average fringe benefits and payroll adds were also applied.

**Other Direct Costs (ODCs)** – The following ODCs were included:

- Business Travel – Includes costs for transportation, lodging, meals, and incidental expenses incurred by personnel on official company business. Also included flights for craft coming from the mainland.

- Relocation and Living Allowances – Included for non-manual staff. Assume ten percent will be local hires and receive no relocation or living allowances.

- Business Systems – Software and license costs are included for finance and accounting, human resources, project controls, procurement, communications and document control functions.
- Project Insurances – Premiums included for builder's risk insurance, marine cargo insurance and General Liability/Comprehensive Personal Liability/Marine Liability Insurances.
- Bonding – A surety bond cost has also been included representing the security from the prime contractor as well as his key subcontractors.

**Field Indirects** – Indirect labor associated with support of direct construction activities (crane support, scaffold support, material handling and delivery, janitorial support, etc.) was estimated at a task level based on the construction approach and applied over the durations defined in the construction execution schedule. Construction equipment was included as a field indirect cost. A man camp was included to provide housing for mainland craft. The man camp was sized to account for 200 craft and includes a canteen, exercise area and sundries shop. The estimate includes local Hawaiian pricing to lease private land to establish the man camp. Pricing was based on an obtained vendor quote.

Other Field distributable costs consist of the following major accounts:

- Temporary construction facilities including trailers, parking areas, and utilities
- Miscellaneous construction services, maintenance and surveying
- Construction equipment, tools, supplies, and utilities
- Camp facilities
- Safety equipment and Personal Protective Equipment
- Medical services including first aid and trauma centers
- Fire watch, environmental protection
- Special security equipment and staff
- Personnel recruiting, drug testing and craft training
- Local transportation, boats and barging for construction

**Escalation** – This cost estimate was based on current-day dollars escalated using the midpoint method in accordance with the Military Construction Program (MCP) indices provided by UFC-701-01.

**Contingency** – Cost contingency was included using the Monte Carlo method to calculate the appropriate rate. The estimate was evaluated for likely underruns and overruns for the main commodity grouping across three specific topics:

- Probability for quantity variation
- Probability for pricing variation
- Probability for (craft) productivity variation

The results of the Monte Carlo simulation produced a cost contingency of 17.27 percent at the P85 confidence level. This is applied to total contractor cost.

Primavera Risk Analysis software was used to run the schedule risk model. Initial analysis indicated 80 percent likelihood of reaching the target completion date would require 4.8 months contingency, currently not reflected in the schedule. In order to account for this uncertainty, a hotel load was included. The hotel load includes those items that would be ongoing throughout a schedule extension, such as non-manual labor, office space and construction site services.

**Prime Contractor's General and Administrative, Cost of Working Capital and Fee** – A general and administrative rate of two percent was included on all costs. The cost of working capital was calculated using 60-day payment terms and a prime rate of 4.61 percent. A fee of 8.65 percent was calculated using the Profit Weighted Guidelines provided by the USN.

**USN Adders –** Several additional rates were added at the direction of the USN and following the 1391 preparation guides:

- Post Construction Award Services – 1.5 percent
- Operations and Maintenance Support Information – 1 percent
- Contingency – 5 percent
- Supervision, Inspection and Overhead – 6.2 percent

*Present Estimate to USN (Dry Dock Budget Ready DD1391)*

The Dry Dock Budget Ready DD1391 estimate package was developed and presented during February 2020 which included several documents as agreed upon in discussions with the USN. The estimate package included the following:

- BESS
- Budget Ready estimate (Excel version)
- Updated Blocks 10 and 11
- Updated drawings and sketches for
  - G001: Location Map
  - G002: Vicinity Map
  - C001: General Arrangement
  - C003: Figure – Dry Dock Dredge
  - CD001: Dry Dock 5 Building Demo Plan
  - S001: Dry Dock Deck Plan
  - S002: Typical Dry Dock Section
  - S003: Elevation – Entrance Wall

The final Dry Dock Budget Ready DD1391 estimate which incorporated USN comments was delivered on 28 February 2020.

### 3.4.3 Primary Deliverable 2 – Dry Dock Cost Certified DD1391 Cost Estimate Documentation Package (First Scope Revision)

#### Engineering Tasks (First Scope Revision)

*Dry Dock Additional Engineering Studies*

Once Bechtel received the first scope revision in November 2019, an additional engineering phase was initiated. The additional engineering efforts concentrated on key areas of the design to further refine and reduce quantities and cost. As part of the redesign effort, the USN requested the project explore different areas to reduce/overhaul project implementation cost. These additional engineering studies were completed and provided the USN various design options for the dry dock. The options were presented to the USN in the DD Additional Engineering Design Review held on 16 June 2020. The objectives of this meeting were to:

- Provide quantity reductions and engineering basis
- Agreement on incorporation of additional engineering in Cost Certified estimate
- Understanding of additional engineering cost savings

The USN subsequently provided direction for the various options in Letter 11420 Ser 555/014 dated 1 July 2020. Bechtel incorporated this direction in the final dry dock design and used the additional engineering study to inform the Cost Certified DD1391 for the new dry dock.

*Civil Site Plans (Demolition)*

As part of DD5 construction along with the associated support buildings, the demolition of existing buildings is required. The demolition and civil site plans are part of the Dry Dock 5 Estimate and BOD Document. These two civil demolition drawings were titled CD001 Dry Dock 5 Building Demo Plan and CD101 Dry Dock 5 Surface and Demo Plan. The demolition and civil site plans are part of the BOD Document.

*Fire Protection Suppression Plan (Listed as a Phase IV Deliverable)*

A drawing was prepared to show fire hydrant locations, fire department access and site hazards. The fire hydrant coverage complies with UFC 3-600-01, Fire Protection Engineering for Facilities. The drawing depicted the fire hose lay length from the various fire hydrants across the site. Circles and arcs show the coverage area provided by the hose from the hydrant. The drawing includes egress and dimensional data of the fire lanes for the fire department. Hazards such as flammable fuels or gases were included with safety exclusion zones.

*Geotechnical Evaluations*

Both land and water borings were obtained in the footprint of the new DD5 and analyzed to provide data for performing additional geotechnical evaluations. This data set was utilized in the below identified studies.

*Evaluate Land Boring Data for Dry Dock Foundation*

Final subsurface data from the land borings have been incorporated into the analyses for the dry dock foundation and other geotechnical aspects of the project. These analyses indicated that the dry dock can be founded on a grade supported basemat without the need for pile support. Three calculations were prepared 1) Pile Foundations, 2) Liquefaction Potential, and 3) Bearing Capacity and Settlement of Dry Dock 5. The pile foundations calculation considered a variety of piles and provides capacities to support buildings, crane rails, and the dry dock floor, if needed. The liquefaction potential calculation evaluated the potential for liquefaction at the dry dock location, considering conditions both above and below the dry dock floor. The calculation concluded that liquefaction is unlikely but if it occurs, it will be isolated. The bearing capacity and settlement calculation considered the subsurface conditions below the dry dock floor and determined that an elastic model can be used to estimate settlement. The calculation concluded that there is sufficient margin against bearing failure and estimated about 6 inches of elastic settlement will occur during initial loading/construction. No long-term settlement is expected.

Draft subsurface data from the water borings were reviewed and found to be generally consistent with the subsurface data from the land borings. These data did not suggest any changes to the conclusions of the analyses discussed above.

### *Conduct Water Borings*

Over water borings were conducted by the subcontractor Geolabs, Inc. Field work was conducted between 7 April and 8 May 2020. Field work included diving for coral and sea grass inspection, diving and over water inspection for UXOs and drilling and sampling at six locations to depth of 150 ft below mudline. Diving operations were conducted from a small boat while drilling and sampling were conducted from a self-propelled landing craft that was secured on station using a 4-point anchorage system. The vessel was moved for each boring. Drilling waste (soil and water) was drummed and subsequently tested and disposed of at a local landfill. In addition to Geolabs, Inc., the following subcontractors were used for the over water work:

- Element Environmental, LLC – environmental testing and disposal of drummed waste
- Sea Engineering, Inc. – marine and dive support
- USA Environmental, Inc. – dive and over water UXO inspection
- Marine Research Consultants, Inc. – dive inspections for coral and seagrass

### *Analyze Reduction of Piles Based on Subsurface Investigation Data*

Five soil borings (landside) were conducted on land near the head of the dry dock with exploration depths extending to 200 ft below grade. Shear wave velocity testing was conducted in one of the boreholes. Laboratory tests, including strength and corrosion potential, were conducted on recovered soil and rock samples. Six additional soil borings were conducted in water (approximately 50 ft deep), within the footprint of the dry dock with exploration depths of 150 ft below mud line. These boring locations are shown on Figure 10. Data from these borings were used to validate the current foundation design.

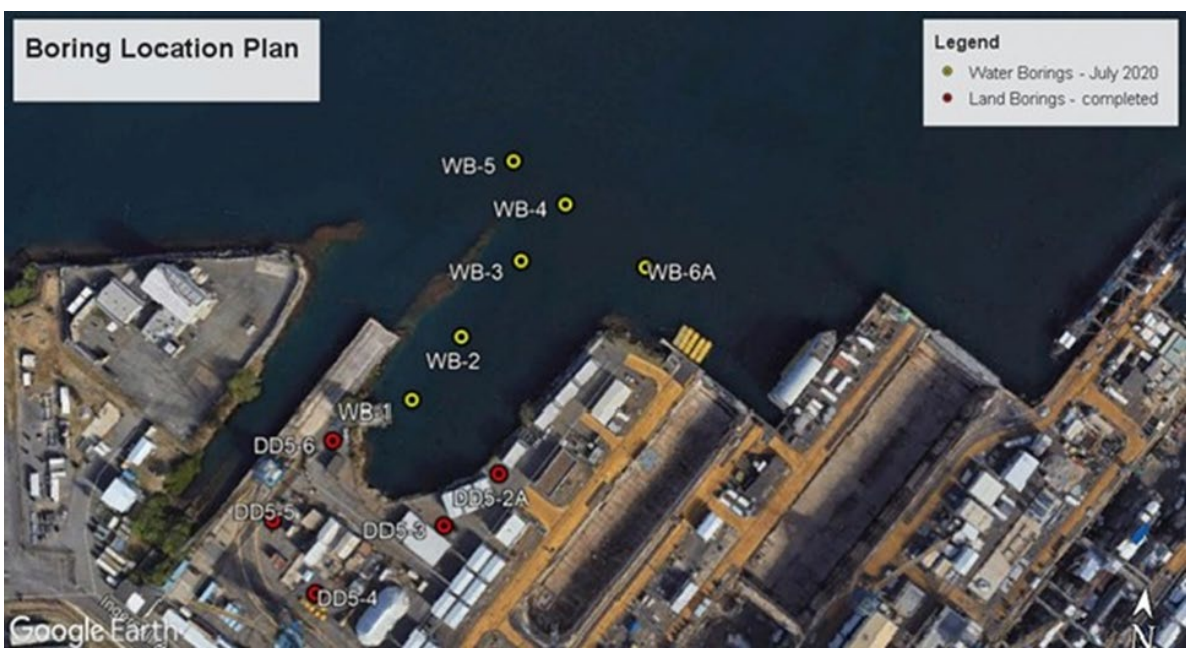



***Figure 10. Soil Boring Plan – Locations of Land and In-Water Borings Performed***

*Evaluate 2:1 Slope Gradient to Reduce Dredge Quantities*

An excavation support plan using cofferdam surrounding the dry dock excavation at PHNSY in the DD5 location was the proposed plan in the initial estimate for the original scope. This plan was replaced with an open cut excavation around the dry dock with a temporary 1 Horizontal (H):1 Vertical (V) slope for the dredging to the existing ground and a temporary 1H:1V slope for the fill to the proposed Elevation of 111.5 ft (See Section 2.3.2.3). A 10-ft wide offset is suggested to be established at the toe of the slope to mitigate any sloughing or raveling of material on the slope. These slopes, expected to be open for up to 12 months, will be backfilled after the dry dock walls are constructed.

Historically, 1H:1V slope angles have been used to construct DD2, DD3, and DD4. A review of historic drawings from DD2 and DD3 showed dredged excavation slopes 1H:1V and steeper. A review of the current bathymetry in the area of DD5, previously identified as Pearl Harbor Floating Dock (YFD2), also showed dredge slopes of 1H:1V and steeper. A slope stability study conducted during detail design will confirm these slope angles. A report titled "Additional Engineering Report – Cofferdam Removal for PHNSY Dry Dock 3 Replacement" was completed to identify the changes due to removal of the cofferdams and replacement with a 1H:1V slope.

*Seismic Evaluation Results (Dry Dock)*

In accordance with Section 5-6 of UFC 4-213-10, DD5 was designed for seismic loads in accordance with UFC 4-152-01 and MIL-STD-1625D(SH). MIL-STD-1625D(SH) contains the more stringent seismic design criteria. According to MIL-STD-1625D(SH), the Level 1 earthquake has a 475-year return period and the Level 2 earthquake has a 2375-year return period. The design performance for a Level 1 earthquake is no damage requiring post-earthquake remedial action. For a Level 2 earthquake, the design performance is no collapse with repairable damage while maintaining the safety of any vessel in the facility during the earthquake. Repairable damage to the structure and/or foundation, and limited permanent deformation are expected under this level of earthquake. The facility will remain operational so that a vessel in the dock during an earthquake can be safely undocked after the earthquake but prior to repairing the facility. The following are the seismic loading factors used in the seismic evaluation of DD5:

- Modified Peak Ground Acceleration, MPGA= 0.349
- Risk Category, IV (Table 2-2 of UFC 3-301-01)
- Site Class, D
- Seismic Design Category, SDC = D
- Importance Factor, Ie = 1.5
- Mapped Maximum Considered Earthquake (MCER) ground motion (period = 0.2s), Ss = 0.566
- Mapped MCER ground motion (period = 1.0s), S1 = 0.162
- Spectral response acceleration for short periods, SDS = 0.508
- Spectral response acceleration for short periods, SD1 = 0.246

Earthquake loads were evaluated per component for the maximum considered force applied to the dry dock and applicable structural components. Seismic analysis conformed to Section 5-9 of UFC

4-213-10, EM 1110-2-6053, Earthquake Design and Evaluation of Concrete Hydraulic Structures was referenced for the general approach for the seismic analysis of the dry dock. Seismic Evaluation results are documented in "Conceptual Wall and Foundation Design for DD5" Calculation (26048-000-DBC-0000-00002).

### *Environmental Data Review for Design Consideration*

The review of the environmental conditions at the PHNSY played a key role in the formulation of the environmental criteria for both the Dry Dock AoA and the WPF AoA, informed the dry dock design, and formed the basis for estimating environmental mitigation costs and waste handling requirements. The PHNSY has a unique set of environmental conditions owing to the PHNSY's mission and, consequently, is identified on the National Priorities List under U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The CERCLA actions at PHNSY are being addressed under CERCLA Section 120 by the USN with regulatory oversight by EPA Region 9 and the DOH, State of Hawaii.

The DD3 Replacement Project has the potential to primarily impact two (2) remediation projects, requiring coordination and collaboration to leverage the mitigation efforts between projects and to ensure compliance with the following identified CERCLA remediation actions:

- Pearl Harbor Sediment Remediation – Sediments have been impacted by contaminant sources associated with naval mission activities. The impacted area included the disturbance area for the DD5 project. The primary chemicals of concern for this area included copper, lead, mercury, and polychlorinated biphenyls (PCBs). Figure 11 illustrates the extent of the soil contamination area and remedial action.
- Shoreline Site Northwest of DD3 – The CERCLA Record of Decision identified the selection of a final remedy to protect human health from potential exposure to residual asbestos fibers in surface and subsurface soil at the Shoreline Site, and from exposure to asbestos-containing material, such as refractory cloth and cement kiln bricks, which may be present in subsurface rubble fill of the surrounding areas. Construction activities, such as excavation or disturbance of subsurface soil at the site could result in a potential for worker exposure to asbestos-containing material (refractory cloth) that may be present in subsurface rubble adjacent to the previous removal action portions of the Shoreline Site. The selected remediation included containment of soils with residual asbestos fibers (less than 1 percent in soil by volume) using a concrete cover over exposed surface soils, land use controls (LUCs), routine inspections, and long-term management. Notification of potential disturbance and adherence to LUCs will be required and must be planned accordingly. Figure 12 shows the extent of the remediation area and LUCs.

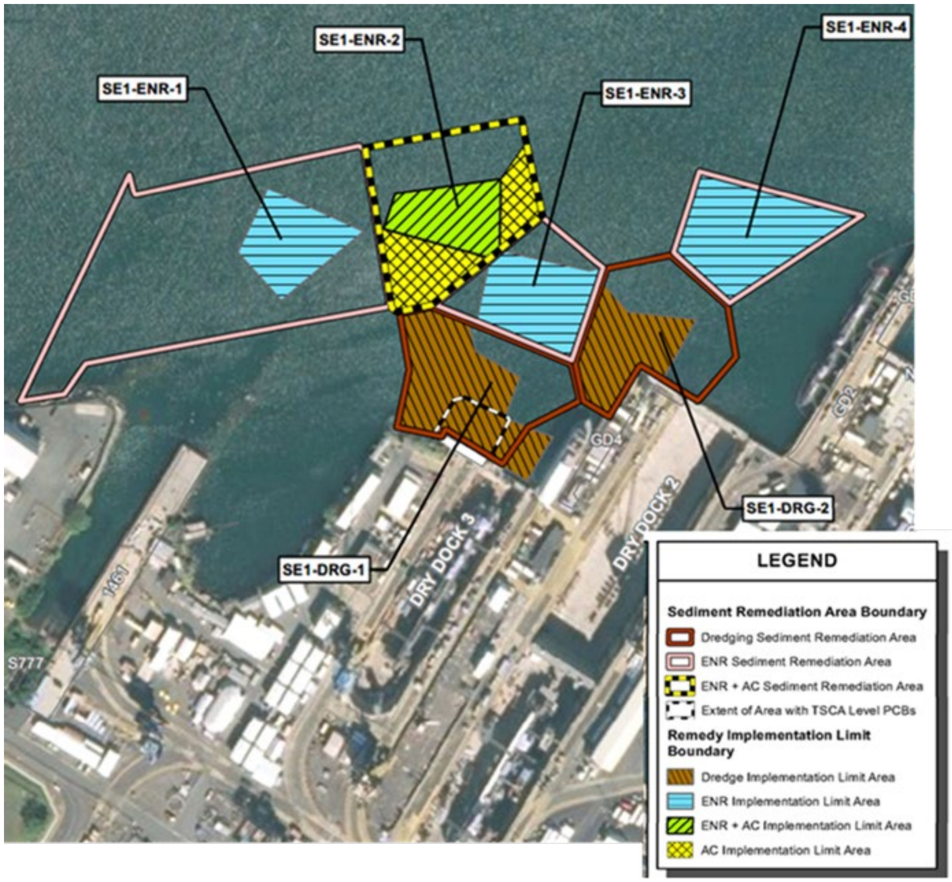



***Figure 11. Sediment Remediation Area Boundary Extents – The DD5 Project Area is Outside of the Extent of Area with TSCA Level PCBs but Within SRA Boundary***


***Figure 12. Land Use Control Area Extent DD5 Project Extent is Within LUC Area***

In addition to CERCLA remediation documents, desk-top research was performed including review of environmental resource documents, to research additional environmental attributes and identify other the potential impacts related to the activities associated with the DD3 Replacement project. The desk-top review consisted of searches on the EPA, U.S. Fish and Wildlife Service (USFWS), and National Park Service websites, NEPAssist, supported with USN supplied documentation and review. In particular, marine (water) resource, terrestrial (land), and historical/cultural resources were studied for potential environmental mitigation impacts. Highlights are provided below:

- Marine (Water) Resource – Included review of two USN Diver Surveys. The marine resources primarily impacted and selected as the main contributors in estimating environmental mitigation costs/impacts, were the impacts to coral species and the threatened green sea turtle. Both surveys were conducted in areas of the dredging footprint for the DD5 project. (See Figure 13 for survey locations studied for the quay wall replacement project and the proposed DD3 replacement project.) The identified corals are within the dredging footprint of the DD5 construction area. Environmental mitigation cost estimates are discussed in greater detail in the “Environmental Mitigation Cost Determination” section.
- Terrestrial (Land) Resource – There are no known or endangered plants and terrestrial fauna in the vicinity of the dry docks where direct activities for each of the alternatives is located. However, the endangered Hawaiian Stilt is known to nest in and around cells of the CDF where the spoils from dredging operations would potentially go for dewatering/segregation/disposal. Endangered Species Act Section 7 consultation will be necessary. Avoidance measures may include not using the CDF during nesting season. Additional soil and groundwater remediation areas were also reviewed.
- Historical/Cultural Resources – The PHNSY is located within the Shipyard Historic Management Zone and the Pearl Harbor National Historic Landmark. The dry docks and many of the buildings in the shipyard are considered eligible for listing on the National Register of Historic Places. The project will include demolition of historic buildings. The USN is in the process of consulting to develop a National Programmatic Agreement in order to meet the unique mission requirements of the SIOP.

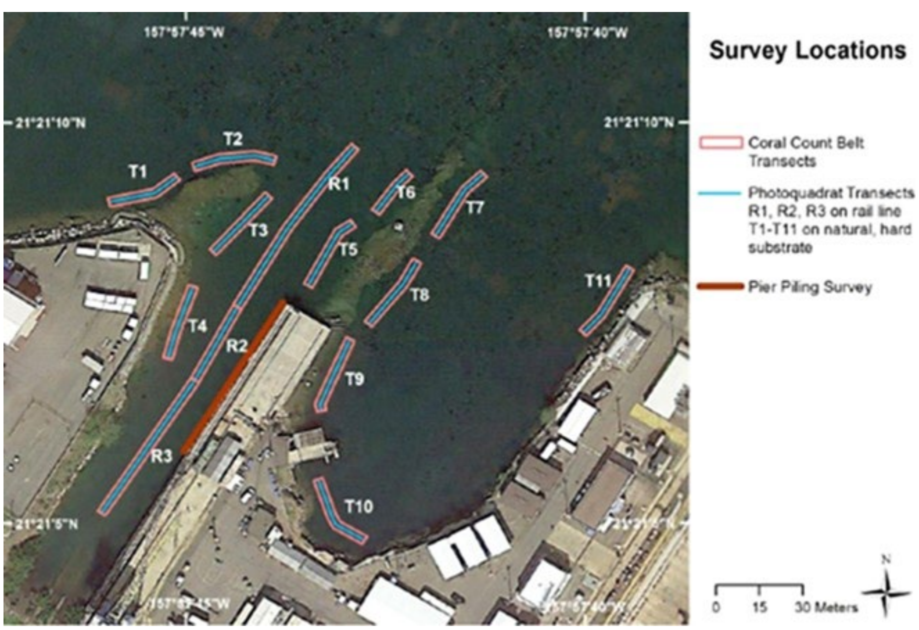



***Figure 13. Coral Survey Locations***

### *Environmental Mitigation Cost Determination*

Building upon the environmental data review, environmental mitigation costs were estimated for:

TSCA Disposal Costs Related to Dredging in CERCLA Remediation Area:

As presented in the "Environmental Data Review for Design Consideration" section, the project has the potential to disturb the soil remediation area in the vicinity of the new DD5 where dredging is to occur. Therefore, planning and estimating disposal costs for Toxic Substance Control Act (TSCA) level PCBs in dredged materials were conservatively estimated utilizing the Final BOD as primary input. The following basis was used:

- TSCA Disposal Basis: The estimated lateral extent of PCBs with concentrations greater than 50 mg/kg, based on extent of Thiessen polygons with concentrations exceeding 50 mg/kg for PCBs, are limited to the areas immediately off of the DD3 area as shown in Figure 11. While the dredging extent of the project does not encroach on the extent of area with TSCA level PCBs, the project's dredging extent does encroach on portions of the dredge implementation area along with other remediation remedy areas. Conservatively the estimate, 1000 $yd^3$, includes the total estimated TSCA dredge volume for off-island disposal to account for the possibility of discovering other pockets/areas of contamination not identified.
- Dredging Extent Basis: The dredging extent and quantities are based on the dredging plan for the DD3 Replacement project.

TSCA Disposal Costs Related to Building Demolition:

- Building Demolition TSCA Basis: Building Demolition Assumption: 3750 cubic feet (CF) of TSCA disposal costs for potential PCB contaminated building demolition waste based on information that indicated Building 233, contained PCB contamination. Based on drawings, a conservative estimate of 3750 CF, accounting for indicated soil contaminated area/building square footage, was included in the estimate for off-island TSCA disposal. (Non-TSCA would be disposed of on-island).

Marine Resources/Coral Mitigation Estimate:

As presented in the "Environmental Data Review for Design Consideration" section, dive surveys were conducted in areas of the dredging footprint for the DD5 project. The surveys identified corals within the dredging footprint of the DD5 construction area and potentially within disturbance foot-prints of other in-water areas associated with construction (specifically, Waipio Warf, Victor, and Landing C). Because of the potential high costs of coral mitigation, conservative coral mitigation costs were used to inform marine resource mitigation costs. It should, however, be noted that the final determination on the amount of compensatory mitigation needed to offset unavoidable adverse impacts is made by the appropriate permitting authority in accordance with applicable regulatory requirements. For example, projects of this nature, that require USACE authorization, the final determination lies with the USACE. The EPA and National Marine Fisheries Service, and USFWS often provide comments and recommendations regarding the need for and extent of compensatory mitigation.

A summary of the assumptions considered in deriving a conservative value for the marine resource compensatory mitigation costs are provided below:

- Acreage of disturbance was calculated based on the DD3 Replacement project Dredging Study and distributed based on permanent versus temporary disturbance:
  - Permanent: Dredging Area (approximately 4.25 acres)
  - Temporary: Waipio Warf, Victor, and Landing C (approximately 3.85 acres)
- Several research papers were reviewed to estimate a mitigation cost per hectare (ha)
- 100 percent of permanent disturbed acreage was accounted for in the mitigation costs
- 10 percent of the temporary disturbed acreage was included in the estimated environmental mitigation costs for Best Management Practices implementation and potential mitigation

Cultural/Historic Resources:

- Dry Dock Cost Certified DD1391 (Revised Scope): Estimate from USN based on continuing Nationwide Programmatic Agreement work was included in the estimate
- WPF Class 5 ROM Cost: Estimate from USN based on continuing Nationwide Programmatic Agreement work was included in the estimate

*NEPA/Permitting Considerations*

Among the provisions in the Executive Orders (EO), EO 13807 states that "processing of environmental reviews and authorization decisions for new major infrastructure projects should be reduced to not more than an average of approximately two years" measured from publication of the notice of intent to prepare an EIS. EO 13807 defines "major infrastructure project" as one for which "multiple authorizations" by federal agencies will be required to proceed with construction, the lead federal agency has determined that it will prepare an EIS, and "the project sponsor has identified the reasonable availability of funds sufficient to complete the project." The project would be a major infrastructure project and careful coordination will be required to meet the project's aggressive construction schedule. To ensure coordination, weekly environmental coordination calls were implemented with the USN during the environmental data review. Coordination is continuing with the EIS team to ensure they have all the necessary design information and construction sequencing.

Because the activities associated with the project will require permits/consultations to protect impacted natural resources, careful consideration should be given to ensuring the permitting process is started early and in parallel with the NEPA process. The principal permits/consultations necessary include:

- Clean Water Act
  - Section 401, State WQC
  - Section 402, NPDES permit- regulates point sources that discharge pollutants to waters of the U.S.
  - Section 404, permitting discharges of dredge or fill material into waters of the U.S., including wetlands (USACE)
- TSCA, PCB disposal requirements/contamination limits
- CERCLA, sediment and asbestos remediation efforts
- Endangered Species Act

  - Section 7, Consultation with USFWS
- Magnuson-Stevens Fishery Conservation and Management Act
  - Essential Fish Habitat Consultation (National Marine Service (National Oceanic and Atmospheric Administration))
- National Historic Preservation Act
  - Section 106, Consultation with State Historic Preservation Division
- Explosive Safety Submissions (ESS), dredging plan is located within an area with a medium to high potential for munitions and explosives of concern (MEC) requiring shielding/safety requirements

### Estimating Tasks (First Scope Revision)

*Prepare the Economic Evaluation for Dry Dock Cost Certified DD1391 Estimate (First Scope Revision)*

As part of the Dry Dock Cost Certified DD1391 Estimate package, the USN required an Economic Evaluation of the Dry Dock AoA be performed. Based on the results of the Dry Dock AoA with input from the USN, an Economic Analysis was prepared following the guidelines in *NAVFAC Pub 442 Economic Analysis Handbook* dated 9 November 2009.

The following alternatives were considered in the Economic Analysis:

<u>Status Quo</u>: After review, it was determined that shipyard facilities in the Hawaiian Islands do not support the mission requirements of three dry docks that can service Virginia Class Blocks I-V as well as an additional dock for emergent dockings. This alternative is nonviable.

<u>Renovation DD3 – Lengthening, Deepening and Reconfiguring</u>: This alternative would decommission existing DD3 utilities followed by a reconstruction of DD3 to include deepening and lengthening. The reconfigured dry dock would utilize a fully hydrostatic non-relieved structure relying on the weight of the structure to resist buoyancy loads. The floor of the dry dock would be supported by steel piles and new reinforced concrete walls would be used for lengthening the dry dock. It was determined that this alternative was unable to meet mission need date and introduces unmitigable risk in current operations of DD2. This alternative is nonviable.

<u>Renovation/New Construction Mix DD3 SF – Dry Dock Superflood</u>: This alternative would lengthen, reconfigure and provide superflooding capability for DD3 which would eliminate the need to deepen the dry dock. Preliminary engineering shows that the superflood basin would require walls to be approximately +25 feet MLW which is approximately 17 feet above the current coping elevation of 108 ft. It was determined that this alternative was unable to meet mission need date and introduces unmitigable risk in current operations of DD2. This alternative is nonviable.

<u>New Construction GDD5 – DD5 New Graving Dry Dock</u>: This alternative consisted of the construction of a new graving dry dock in the basin area northwest of DD3. The floor of the dock would be a reinforced concrete slab supported by steel piles and a steel caisson. The design included pile supported wharves located on each side of the dock to provide usable space and support WPF operations. Dredging would be required in order to construct the new dry dock and deepen the approach to the dock. There would be minimal impact to current mission and operations during construction and schedule risk is low. It was determined that this is a viable alternative.

Innovative Alternatives or Combo Alts FDD5 – DD5 Floating Dry Dock: This alternative would provide a floating dry dock that would be constructed at the basin to the northwest of DD3. This option includes a pile supported wharf and pier to the northwest of DD3 which would provide laydown space and support crane rails. Dredging would be required at the sinking basin to allow for docking of submarines. The floating dry dock would need to be removed from service for a six-month period every 10 years. Additionally, the dry dock would need full replacement every 50 years. It was determined that this is a viable alternative.

After the identifying the two viable alternatives, the following cost factors were identified and were input into ECONPACK software for analysis.

Construction Cost: The construction costs for the DD5 New Graving Dry Dock were obtained from the Budget Ready Estimate submitted on 28 February 2020. The construction costs for the DD5 Floating Dry Dock were obtained from the USN and found in the *Business Case Analysis Graving Dry Dock versus a Floating Dry Dock at Pearl Harbor Naval Shipyard*, published January 2020.

Sustainment Costs: The sustainment cost for the DD5 New Graving Dry Dock were calculated based on the UFC 3-701-01 DOD Facilities Pricing Guide. The sustainment cost for the DD5 Floating Dry Dock were obtained from the *Business Case Analysis Graving Dry Dock versus a Floating Dry Dock at Pearl Harbor Naval Shipyard*, published January 2020.

Major Replacement: The DD5 Floating Dry Dock would require a major replacement every 50 years and must be docked every five years for major repairs. The cost for these were obtained from the *Business Case Analysis Graving Dry Dock versus a Floating Dry Dock at Pearl Harbor Naval Shipyard*, published January 2020.

Dredging Cost: The DD5 Floating Dry Dock would require maintenance dredging to maintain the basin depth. This cost was calculated based on the area of the basin and historical dredging cost per cubic yard obtained from the USN.

Terminal Value: The Terminal Value benefit was calculated using the Residual Tool in ECONPACK and using straight-line depreciation.

Using the factors above the Net Present Value (NPV) for both viable options were calculated. The DD5 New Graving had a lower NPV and was determined to be the preferred option. The full Economic Analysis report was included as part of the DD1391 Cost Certified package.

#### *Dry Dock Cost Certified Estimate Development (First Scope Revision)*

Following the Budget Ready estimate submission, additional follow-on requirements and design changes were explored and considered. Accepted additional engineering initiatives were quantified and priced into a Draft DD1391 Cost Certified estimate, which was prepared and delivered on 17 August 2020. Several review meetings were held with the USN, comments received, reviewed and incorporated into a Final DD1391 Cost Certified estimate, which was prepared and delivered on 25 September 2020.

Generally, the same approach was used to develop the Cost Certified estimate as was used for the Budget Ready. The Budget Ready estimate quantities were revised and updated to reflect applicable design changes.

An estimate was prepared using existing pricing supplemented by new pricing sources where needed. This estimate included all materials, craft labor, non-manual labor and supervision, subcontractors, freight, and ODCs required to complete the scope. The estimate was developed using industry standard pricing, methods and techniques.

The following pricing changes were made:

- The concrete unit pricing approach was modified to include the labor, materials and equipment required for batching concrete as a direct cost. These costs were previously included with field indirects. Material pricing was also sourced from vendors as opposed to using pricing from a cost book. This revised pricing included freight to ship constituents that are not available on-island.
- A 20 percent SB participation requirement was added. To account for increased cost of using these businesses, a SB markup of 9.2 percent was developed and applied to any scopes where a Hawaiian SB capable of performing the work was identified. This rate was developed using actual subcontractor and vendor pricing from previous projects. The percentage is a function of mobilization, demobilization, submittals, site-specific conditions and bonding.
- A night shift premium was developed and priced to reflect shift work. Based on the existing labor agreements and construction schedule, this increased the craft wage rate nominally.
- Clean-out of existing CDF cells was also included as a field indirect cost, at the direction of NAVFAC. This work included emptying, loading and disposal of spoils in four CDF cells.
- Substation X was also incorporated as part of the scope. Previously, this had been included as a “below-the-line” ROM estimate.

The BOCE document that was developed and submitted with the 31 October 2019 cost estimate was completely revised based on direction and guidance from the USN received during the original DD1391 Estimate Review meeting. The format and content were changed and a draft BOCE was submitted. Between March and June 2020, several conference call meetings were held for further clarification and understanding. The comments were then resolved and incorporated. The following activities were performed to document comments and responses:

- Submitted Excel file for USN review – 20 March 2020
- Received USN comments – 7 April 2020
- Responded to USN comment Excel file – 1 May 2020
- Submitted revised BOCE – 21 May 2020
- Received final USN comment Excel file – 15 June 2020

An updated BOCE was included as part of the Final DD1391 Cost Certified estimate package.

The complete Dry Dock Cost Certified DD1391 Estimate package included the following components:

- Cost Estimate
- BOCE
- Vendor Quotes
- Spending Plan
- Economic Analysis

- Construction Schedule
- Cost and Schedule Risk Analysis
- MII Input File
- Collateral Equipment List
- Risk Assessment

### 3.4.4 Primary Deliverable 3 – WPF Class 5 Cost Estimate Documentation Package (Second Scope Revision)

#### Revised WPF AoA Structure and Strategy

As discussed in Section 3.1, the first scope revision occurred in November of 2019. The first scope revision changes included delaying the WPF AoA until June 2020, and, included decoupling the DD5 design from the WPF – although the decoupling would not be part of the AoA analysis, i.e., the assumption remained that the two projects would be completed simultaneously. The delay would allow the USN to make a more informed decision with respect to space allocation requirements resulting from the SGT modeling work and provide direction with regard to a Dry Dock Cover Facility (DDCF) and weight handling system. However, ultimately, the USN determined the decisions regarding the DDCF and weight handling system should be evaluated as part of the AoA.

Another aspect not originally included in the WPF AoA scope included the evaluation of two concepts. The two concepts for the WPF now evaluated in the WPF AoA include:

- The original single support concept implemented as a single facility for one dry dock, DD5, ultimately necessitating multiple WPFs at PHNSY; and, alternatively,
- A multiple support concept implemented as a larger single facility supporting multiple dry docks, DD5 and DD2.

The following subsections detail the expanded WPF AoA scope and analyses.

*Agreement on the SOW for the WPF Scope*

The WPF Project AoA was conducted to investigate different WPF alternatives at the PHNSY. The primary precept of the WPF was to provide a permanent purpose-built waterfront facility to support operations at the PHNSY. The analysis was based on several USN identified considerations, including, mission requirements, time, cost, environmental impacts, and technical engineering. With the inclusion of additional AoA scope, the agreed upon scope/assumptions included:

- WPF to be substantially complete by 2027 to support testing and commissioning dates for the proposed DD5 with operations beginning 19 January 2028.
- Development of the key functional requirements for inclusion in the AoA. Tables 3-1, 3-2, 3-3, and 3-4, in the AoA document, present the requirements, design goals, assumptions, and constraints, respectively, as defined for the WPF AoA. Agreement/concurrence from the USN on this set of requirements were obtained during the April, May, and June 2020 AoA Charrettes and small group sessions.
- Location of the WPF based on DD5 location—the preferred alternative to replace DD3.
- Two other integral parameters/elements identified as necessary for inclusion in the alternative selection – the possible integration of a DDCF to further expand productive

capabilities, and the selection of an appropriate weight handling technology/system as DD5 currently does not have infrastructure for a crane system/technology. (Initially these elements were going to be decided by the USN but was later added as scope for evaluation in the AoA.)

*Process for AoA Analysis*

The AoA process primarily followed the AoA Guide for best practices, report format, and overall content, as well as U.S. GAO reports, GAO-16-853 and GAO-16-22. The developed stepwise process for the WPF evaluation used to conduct the WPF Project AoA is shown below.

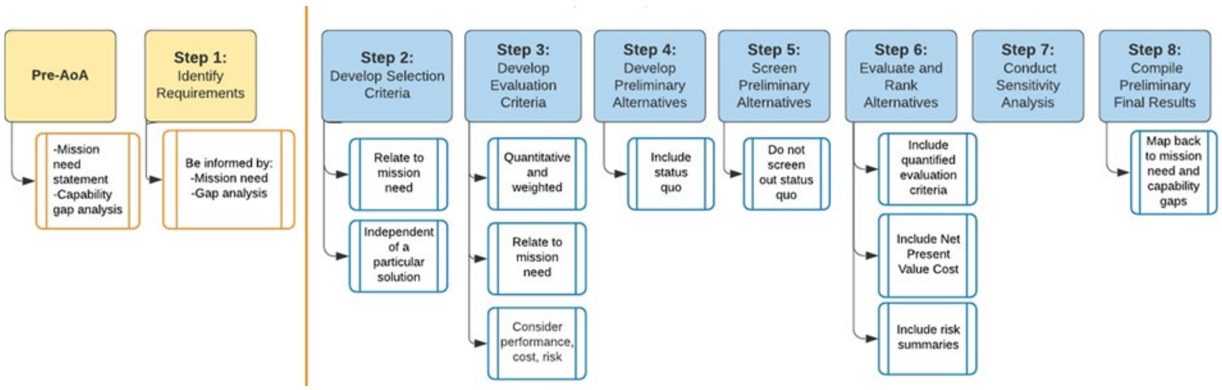



***Figure 14. AoA Process – Stepwise Process Developed Based on AoA Guide (DOE G 413.3-22)***

A crucial goal in formulating the AoA process was to provide, at each step, input and concurrence from all stakeholders. To that end, the AoA team conducted several AoA review sessions, including planning charrettes, alternative development reviews, criteria and selection factor reviews, and small group evaluation sessions. AoA team members and stakeholders included members from the USN (e.g., PMS 555, PHNSY, NAVFAC PAC) and Bechtel.

Prior to performing the AoA evaluation, it was necessary to formulate the mission need statement. The resultant mission need statement, based on the identified capability gap, was crafted, as follows (Sections 1 and 2 of the AoA):

> *Mission Need Statement: The WPF project, comprising the concentration and modernization of at least 80 percent of the shipyard's productive capacity near the waterfront, is an important element in advancing the attainment of the USN's mission need-enabling the U.S. Naval shipyards to perform nuclear-powered submarine depot-level maintenance that meets the nation's readiness needs.*

Another important component required prior to initializing the AoA evaluation process, is development of the key functional requirements (Section 3 of the AoA). Requirements were tied to the mission need to allow for the quantification of the benefits (selected evaluation criteria) of each alternative relative to what is required. This also aids decision makers in assessing how the capability gap will be addressed by each alternative. Tables 3-1, 3-2, 3-3, and 3-4, in the AoA document, present the requirements, design goals, assumptions, and constraints, respectively, as defined for this AoA.

Agreement/concurrence from the USN on this set of requirements were obtained during the April, May, and June 2020 AoA Charrettes and small group sessions.

The AoA analysis began with the identification of preliminary alternatives which, after application of screening criteria, ultimately led to a set of viable alternatives (Section 4 of the AoA document). One of the primary precepts in identifying selection criteria and the resultant preliminary alternatives is consideration of the mission need and program requirements. Hence, the primary parameter/element for selecting potentially viable alternatives included consideration of concentrating and collocating production shops near the waterfront, or more specifically adjacent to DD5. Two other integral parameters/elements identified as necessary for inclusion in the selection and included as part of the WPF project to meet mission need, include the possible integration of a DDCF to further expand productive capabilities, and the selection of an appropriate weight handling technology/system as DD5 currently does not have infrastructure for a crane system/technology. After review/screening of the preliminary alternatives, Section 4 of the AoA document and concurrence with the USN, the resultant viable alternatives, along with the status quo (the no action alternative which provides a basis for comparison), were advanced for further evaluation.

In keeping with the developed AoA process, after identification and agreement with the identified alternatives, the alternatives were evaluated relative to each other during several small group sessions led by SMEs with participation and feedback from stakeholders. These small groups were carefully designed to include representation from each stakeholder group. A score was assigned for each of the evaluation criteria for each of the alternatives.

Table 2 provides a heat map to indicate the scores of the alternatives. Scores have been color coded to indicate how well each alternative is scoring in each criterion. The darker the shade of red, the higher the score (the closer to the high score of 10).

**Table 2. Heat Map of WPF AoA Analysis Results**

| Results | West of DD5 | | | East of DD5 | | | East of DD5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Single | | | Single | | | Multiple | | |
| | Uncovered | | Covered | Uncovered | | Covered | Uncovered | | Covered |
| | Portal | Gantry | Bridge | Portal | Gantry | Bridge | Portal | Gantry | Bridge |
| | 1UP | 1UG | 1CB | 2UP | 2UG | 2CB | 3UP | 3UG | 3CB |
| Mission Requirements (30%) | 4.2 | 4.8 | 7.5 | 3.4 | 4.0 | 6.8 | 3.6 | 4.2 | 6.9 |
| Time (20%) | 6.4 | 7.6 | 8.2 | 7.6 | 8.8 | 9.4 | 7.3 | 8.5 | 9.0 |
| Cost (20%) | 3.0 | 3.0 | 1.0 | 3.0 | 2.0 | 0.0 | 10.0 | 10.0 | 9.0 |
| Environmental (15%) | 8.0 | 8.0 | 8.1 | 5.1 | 5.1 | 5.2 | 5.8 | 5.8 | 5.9 |
| Technical Engineering (15%) | 6.1 | 7.3 | 8.8 | 5.5 | 6.7 | 8.2 | 5.0 | 6.3 | 7.8 |
| **Total Weighted** | **5.2** | **5.8** | **6.6** | **4.7** | **5.1** | **5.9** | **6.2** | **6.8** | **7.7** |

Based upon the evaluation, the top three highest scoring alternatives were:

- Alternative 3CB (Covered Bridge): Includes a WPF located adjacent to DD5, on the east side; employs the multiple support concept, supporting DD2 and DD5; inclusive of a DDCF for DD5; and utilizes the bridge crane technology as the weight handling system.
- Alternative 3UG (Uncovered Gantry): Includes a WPF located adjacent to DD5, on the east side; employs the multiple support concept, supporting both DD2 and DD5; excludes a DDCF for DD5; and utilizes the gantry crane technology as the weight handling system.
- Alternative 1CB: Includes a WPF located adjacent to DD5, on the west side; employs the single support concept, supporting only DD5, inclusive of a DDCF for DD5; and utilizes the bridge crane technology as the weight handling system.

A risk assessment was conducted as part of the AoA evaluation. This assessment involved implementing an appropriately scaled Risk Management approach that recognized the differentiators associated with each of the alternatives. A sensitivity analysis was also conducted to determine the impact of the different evaluation criteria. Alternative 3CB (covered bridge crane, east of DD3, supporting multiple dry docks) scored the highest in every evaluation criterion except for cost, where it placed third, for all five sensitivity analysis evaluations.

### *Development of WPF Class 5 ROM Estimates for AoA*

The construction cost for all nine alternatives were obtained from ROM cost estimates developed in 2020. The ROM estimates were developed using high level cost per square foot models. The models were developed using R.S. Means for a light industrial warehouse building, an office building, and an aircraft hangar, which most closely resemble the structures being estimated. Adjustments were made to these cost models to better represent the parameters supplied by engineering, including design life, environment, mechanical and electrical utility capacities, structural components and building dimensions. This estimating methodology was documented in a white paper. Additional adders were applied for field indirects, contractor general conditions, architectural fees and shipyard congestion and security requirements. Engineering supplied square footage for each alternative which was multiplied by the unit cost.

In addition to the WPF and dry dock cover, several other variables were estimated depending on the alternative. These included sitework, including demolition and potential hazardous material handling, additional dredging and structural fill, quay wall extension, retaining wall and portal crane track demolition, storage area, crane support structures (portal crane track, elevated gantry rail, bridge crane structural steel), and the demolition and fill-in of existing DD3. A unit cost was developed for each variable from a multitude of sources including R.S. Means, the previously completed Dry Dock Budget Ready Estimate (February 2020), vendor quotes, and awarded subcontracts for similar work.

A subtotal was developed for each alternative based on the building square footage and appropriate variables. Contingency was then applied as well as USN defined Owner's Costs. The ROM estimates were used as an input into the NPV calculation that was used as the Cost Criteria for the WPF AoA. The ROM estimate methodology used for the WPF AoA was subsequently used to develop the Class 5 WPF Estimate.

### WPF Class 5 Cost Estimate Documentation Package (Second Scope Revision) (which includes DD3 Backfill Scope)

During August 2020, the USN selected WPF AoA Alternative 3CB as the basis for preparation of a Class 5 estimate. WPF Alternative 3CB is a single structure located east of DD5 with a maximized ground floor print and would support both DD5 and DD2. To fit the facility between DD2 and DD5, the existing DD3 facility will require fill-in. The alternative also includes a DDCF with a bridge crane constructed over DD5. As an additional component, the scope identified a series of impacts which would occur due to the planned delay in construction of the WPF project several years after the DD5 construction is completed. The cost of constructing these projects separately, referred to as "decoupling costs", were included and identified in the WPF Class 5 Estimate.

A complete Class 5 estimate was prepared to develop a range of costs for this option. This estimate included all materials, craft labor, non-manual labor and supervision, subcontractors, freight, and ODCs required to complete the scope. The scope was identified in the WPF Scope Narrative document that accompanied the estimate and was submitted to the USN as part of the WPF Class 5 Estimate deliverable package. The estimate was developed using RSMeans square foot modules, enhanced with conceptual engineering analysis to align with the scope. Industry standard pricing, methods and techniques were applied.

The RSMeans 2019 Cost Book was used as a baseline with the Hawaiian region selected. Three RSMeans square foot modules were used with square footage sized as follows:

- WPF = Light Industrial Warehouse building model (456,000 $ft^2$)
- DDCF = Aircraft Hanger model (187,500 $ft^2$)
- WPF/DDCF Office Space = Office building model (250,000 $ft^2$)

Engineering reviewed the RSMeans model output line items and provided enhancements as required to support the specific scope of this project. Adjustments were made to these cost models to better represent the parameters supplied by engineering, including design life, environment, mechanical and electrical utility capacities, structural components and building dimensions. Additional adders were applied for field indirects, contractor general conditions, shipyard congestion and security requirements.

In addition to the WPF and DDCF, several other variables were estimated. These include sitework, including demolition and structural fill, retaining wall and portal crane track demolition, storage area, crane support (bridge crane structural steel), and the demolition and fill-in of existing DD3.

Decoupling costs associated with removal, storage and reinstallation of some DD5 mechanical, piping and electrical systems that had interferences with WPF and DDCF building piling work were included.

Vendor and subcontract quotes were also sourced and replaced RSMeans costs whenever possible. Additional information from the previously completed DD5 Cost Certified estimate including vendor quotes for similar work were utilized.

The WPF Class 5 Cost Estimate deliverable package was provided to the USN on 20 November 2020. The deliverable package included the following components:

- Detailed Estimate

- BESS including DD1391 Block 9
- BOCE with Vendor Quotes
- Facility Scope Narrative
- Construction Schedule
- Risk Register
- Spending Plan

### 3.4.5 Additional USN Requested Support Tasks Provided for the Advancement of the DD3 Replacement Project

After completion of the three Primary deliverables and support tasks described in the above sections, the USN requested additional follow-on tasks from the Bechtel Team. These requested tasks are discussed below.

#### Advanced Technology Continued Support

Advanced technology key features include digitalization, process automation, dynamic digital twins, dynamic optimization, artificial intelligence (AI), machine learning, central brain, sustainability, quality of life, and additive manufacturing. For the Pearl Harbor Shipyard of the future, two categories of technologies were recommended. The first technology category was process related to improve time on tools utilizing new technologies and optimizing process equipment layouts.

The second category of advanced technology was infrastructure upgrades to prepare the shipyard for decades of new smart technology incorporation.

Proposed advanced technology for both DD5 and the WPF included wireless network, robotics equipment, automated work planning and management system, advanced material handling systems, and advanced and autonomous weight handling.

- The proposed wireless network improvements would provide a communication network with 4G or 5G speed capability and secured connectivity in open air, high bay dry dock and WPF facilities enabling communication, data transfer, equipment or tool and material monitoring, availability progress tracking, work process support, and operational control.
- The proposed autonomous robots and robotic equipment for deployment at the dry dock floor, apron level, and WPF enables more efficient operations, material transport, repair and maintenance work processes, and eliminate worker safety related issues. Proposed DD5 robotics included metal cutting; de-coating; de-painting; welding; cold spray; painting; material, tool, component and part transport; firefighting robots; robotic crawlers; weight handling; and safety related sustainment work processes. WPF proposed robotics included laser cutting, laser welding, de-coating, cold spray, paint spray, oblation, production robots; robotic crawlers for ship inspections; drones for ship hull 3D scanning; drones for underwater ship inspection, and firefighting robots.
- Automated work planning and management system technology included Project Lifecycle Management, digital scanning, augmented or virtual reality, electronic tagging (RFID) of tools, equipment, components, parts, materials, equipment sensors, dry dock operations related sensors. With this technology, AI and machine learning capabilities would be optimized to generate performance indicators and dashboards. Modules were proposed for management of tools, components, workforce, equipment, material, operations, facility

assets, availability, quality of life, and emergency responses in both the WPF and dry dock. The projected improvements would include automated production reconfiguration for different availability and during availability and continual optimization of production processes and operations.

- Advanced and automated material handling systems technology would provide multi-functional super brow, gantry or hybrid cranes, ability to easily relocate material towers, quality of life allowance, elevators, robotic tracks and rails, and integrated utility plug-in systems to meet the automated material handling highway and systems including supply materials, tools, equipment, ship components, and waste. Advanced and autonomous material handling systems would transport and deliver supply material, tools, equipment, ship components, and waste from within dry dock, WPF, and support facilities efficiently, safely, and on time.
- Advanced and autonomous weight handling technology required meeting weight handling systems to provide flexibility to perform various load lifting, moving, maneuvering, transport, and relocation of supply materials, tools, equipment, ship components, and waste efficiently, safely, and securely. To meet this requirement, 100-ton bridge, 50-ton bridge, hybrid, gantry, travel lift cranes, forklifts, elevators, drones, and robots were proposed.

*DD5*

Specific to just DD5, other advanced technologies included an advanced concrete system and an automated docking and ship survey guidance system.

- To meet the requirement for a 100-year lifecycle dry dock with extended durability, strength, and flexibility in seawater and open air environments utilizing more efficient construction techniques and sensors for temperature change and crack detection, technology for self-consolidating concrete and fiber-reinforced concrete material; self-repairing concrete; crack sensing concrete skin; temperature, crack, and seismic sensors; and concrete inspection drones and crawlers was proposed to introduce advanced concrete technology for the shipyard.
- Also requested was a guidance system for fast, secured, safe, accurate, and automated ship docking and ship survey system. A laser guidance docking and 3D laser digital ship scanning system, drones, and undersea drones were proposed to meet the requirement for automated docking and ship survey.

*WPF*

Specific to just the WPF, advanced technologies included solutions for modular workstations or cells, advanced utility supply systems or highways, smart quality of life facility and warehousing, and augmented and virtual reality systems.

- Optimization for facility layout with flexible, reconfigurable, and transportable product focused shops, work cells, and workstations equipped with integrated utility plug-in systems and accommodating equipment skits would increase time on tools.
- Advanced utility supply systems or highways would provide smart, integrated flexibility supplying docked ships, modular shops, work cells, or workstations in the dry docks and WPF to required utilities to support work needs. Consolidated utility systems would integrate

clean water, sewage, electricity, compressed gases, heating, ventilation, and air conditioning, and fire extinguishing systems for portable shipside specific needs.

- Smart, wireless, sustainable, flexible, and automated worker quality of life facility; vertical warehouses for component, equipment, tool, and material; WPF specific back shops; and integrated laydown areas will reduce workforce hour losses for personal travel for lunch and breaks or misplaced warehouse materials. Proposed human interface improvement for work-force quality of life included internet cafes, smart phones and iPads with RFID, cafeterias, bathrooms, smart lockers, parking shuttles, walking and jogging paths, and workforce training and professional advancement for continuous advanced technologies.
- Augmented and virtual reality systems technology included automated maintenance and repair information delivery system and tools for the WPF. This technology would provide automated work packages, training, procedures, inspection, instant equipment and com-ponent performance evaluation, remote maintenance and repair, troubleshooting, and issue identification to aid in work planning and scheduling efforts.

These proposed technologies would provide the shipyard with the infrastructure to modernize and reconfigure maintenance needs to meet the fleet's operational requirements for the next century.

### Post DD1391 Submittal Engineering/Estimating Tasks

#### *Transition of Bechtel Design Information to USN and A&E Contractors*

Bechtel provided transition information through several reviews with the USN and A&E design contractors by clarifying and providing additional information on the Final Dry Dock DD1391 Cost Certified estimate package. All requests for information and clarifications were tracked in an Excel file titled "PH Transition Actions." Approximately 200 responses are documented in this Excel file and provided to the USN. Bechtel also provided BIM model files which included a 3D representation and take-off quantities.

#### *Gantry Crane Foundation Study and ROM Estimate*

Bechtel developed conceptual foundation design(s) for three elevated gantry crane options to service an SSN Submarine dry dock developed by Engineered Rigging for a Class 5 estimate. Bechtel developed various foundation designs based on geotechnical data obtained for the Pearl Harbor DD3 Replacement Project and provided conceptual foundation sketches for all three options. During further discussions and meetings with Engineered Rigging and the USN, Bechtel was tasked with providing further details for a 4 ft and 7 ft diameter bored concrete pile conceptual foundation design to support two of the three Engineered Rigging designs including a Class 5 estimate for each foundation design. Pile cap one-way and two-way shear, and bending were done based on ACI 318-19 and ASCE 7-16 to provide pile cap thickness and reinforcing bar quantities.

Bechtel was also requested to provide a Class 5 estimate for routing electrical power to a gantry crane from a power source located 300 feet away. Engineering Rigging provided electrical load requirements to support the conceptual estimate for electrical power to the gantry crane. The scope of the estimate included installing power to the crane at a single location including the duct bank, conduit, wire, and instrumentation with the assumption a power source was within 300 foot of the crane. Engineered Rigging provided an electrical load requirement (2000 amps, 480V) to support this scope. The final ROM estimates were submitted and delivered to the USN and included the following information:

- Engineering Summary – Elevated Gantry Crane Foundation
- Elevated Gantry Crane – 4 ft and 7 ft Diameter Pilings and Cap Class 5 Estimates
- Gantry Crane Electrical Power for 300 Ft Class 5 Estimate

#### *SLR/Flooding Evaluation Support*

Bechtel received additional comments on the purge tank, SLR, and an alternative approach to review concerning the SLR and flooding. An evaluation was performed to address comments. For the suggested alternate approach, concerns were provided to the USN for internal discussion and resolution.

#### *Revised Dry Dock Cost Certified DD1391 Estimate*

Following the Final Dry Dock DD1391 Cost Certified estimate submission in September 2020, several reviews were held with the USN to explain the estimate package and provide transition of the information to the USN A&E design contractors. After these reviews, the USN identified additional scope/changes to be included and requested a revised Dry Dock DD1391 estimate submission. The additional scope changes were priced into the estimate and a revised estimate delivered to the USN on 29 January 2021.

The changes from the previous submission included the following:

- The demolition and relocation of building P-089 Low Pressure Air Building was added to the scope due to location interferences with the DD5 portal crane maintenance area. Demolition includes the building, heat exchangers and switchgear, and assumes no reuse of equipment. Replacement of the building and yard features was estimated as a subcontract based on the building's previous DD1391 cost estimate.
- The planned location of Substation X was modified due to underground utility interferences, soil/groundwater contamination at the original proposed location and adjacent sewer plant corrosion concerns. This resulted in a reduction of ductbank, additional stormwater piping and demolition of potable water piping.
- The assumed depth of MEC dredging increased from 4 ft to 10 ft due to water boring sample results. This adjusted the volumes to account for an additional 26,400 cubic yards of MEC dredging and reduction of 26,400 cubic yards of normal dredging. The total dredging quantity was unchanged.
- A consolidated cost, schedule and risk contingency value was calculated using @Risk modeling software. This value replaced the separate cost contingency, schedule contingency and associated hotel load, and risk register impacts.

The Revised Dry Dock DD1391 estimate package included the following documentation:

- BESS
- Detailed Cost Estimate Excel file
- Spend Plan
- Consolidated Cost and Schedule Risk Analysis

The submittal letter for the estimate package also provided a summary of impacts to the remaining documents provided in the previous 25 September 2020 Dry Dock Cost Certified DD1391 submittal estimate package.

*EIS Support*

As discussed in the "NEPA/Permitting Considerations" section, the DD3 Replacement Project and the WPF Project would be a major infrastructure project necessitating an EIS. Coordination continued with the EIS subcontractor during this phase of the project which primarily entailed answering requests for information, such as site layouts, construction scheduling and emissions inventory Bechtel developed during the estimate. This allowed project personnel to ensure that the aggressive schedule can be realized.

### Lifting, Handling and Material Management Time and Motion Study

A Time and Motion Study was requested by the USN that focused on the portal cranes and items going to and from the dry dock and docked vessels at two USN shipyards. The focus was to provide a comprehensive picture of LHMM for further process analysis and provide the USN both a comprehensive dataset and a standard means to further study and improve existing LHMM processes and activities.

Bechtel sent two-person teams of engineers to the Puget Sound Naval Shipyard and Portsmouth Naval Shipyard to perform observations and collect data on the LHMM operations of portal cranes at each site. The teams were responsible for collecting LHMM data, providing regular updates, and uploading observation data for statistical analysis. Both teams conducted observations at each shipyard over three observation visits which lasted for three-to-six-week durations. These observations were then analyzed, and the results assessed for validity, by Bechtel data science and Bechtel construction crane SMEs. At the completion of the study, the team then combined the complete analysis and observational conclusions to form a comprehensive look at the shipyard LHMM process. The LHMM Time and Motion Study report was provided to the USN.

### Lifting, Handling and Material Management Standard Analysis Study

Bechtel was requested by the USN to undertake an analysis to compare the EN standards and the FEM specifications to corresponding U.S. standards utilized by current USN crane specifications. The standards included structural (inclusive of wind and seismic forces), mechanical, and electrical requirements.

The purpose of the analysis was to document the following:

- A comparison between the USN Portal Crane Specification, equivalent American, European, and International industry standards, and Standard Work Process Procedure for crane use and operation
- Identify provisions of the USN Portal Crane Specification where requirements either exceed industry standards or they are overly prescriptive
- Identify any provision or requirement of the USN Portal Crane Specification that is deemed to be a potential infringement of manufacturer's intellectual property
- Analysis and recommendations for precise provisions of the specification where modification should be considered to encourage bidder participation

A Comparison Matrix was created to document requirements from the USN Portal Crane Specification compared to similar requirements from the reviewed standards. The LHMM Standards Analysis report was provided to the USN.

### Conduct WPF Sizing Workshops

Bechtel organized and conducted several workshops for shipyards under the direction of PMO555. The shipyard participants included representatives from Code 900s and Indefinite Delivery/ Indefinite Quantity contractors and the workshops were conducted virtually. The purpose of the workshops was to present the data used and approach employed in the preliminary WPF sizing development. Specific preliminary WPF functional configurations were developed and presented separately for each shipyard.

# 4. Conclusions

### Graving Dry Dock

A new graving dry dock at the existing crane maintenance area is the best COA for the USN at PHNSY. This alternative scored best across four (4) of five (5) evaluation criteria factors and most favorable overall.

A new graving DD5 can be ready for operation on or before the mission need date (January 2028) at a lower cost than any of the other viable alternatives. As long as the constructor contract is awarded on or before 01 February 2023. After this date the mission need will be in jeopardy. This also assumes that the detailed design being performed by the A&E firm remains as close to the original design criteria as possible and is coordinated with construction industry to include construction means and methods.

### WPF

A WPF located on the east side of the new DD5, with a covered building/bridge crane over DD5, serving both DD5 and DD2, as evaluated, is presently the best COA for the USN at PHNSY. This alternative scored near the top in four (4) of five (5) evaluation criteria factors and highest overall making it the most favorable.

Two other alternatives, 1) WPF located on east side, uncovered with gantry crane, serving multiple dry docks and 2) WPF located on west side, covered with bridge crane, serving single dry dock, also scored favorably compared to the other alternatives.

It should be noted that the shipyard receives the maximum benefit (capacity, throughput, efficiency) when the two projects (DD5 and WPF) are united.

Construction of a new WPF, when combined with construction of the new DD5, can be ready for operation on or before the mission need date (January 2028). Separating the two construction projects will increase the overall cost and schedule of both projects.

### DD1391 Submittals

#### *DD5 Cost Certified DD1391*

All contract deliverables for supporting a DD5 Cost Certified DD1391 submittal were issued to the USN on 17 August 2020 and 25 September 2020.

#### *WPF Class 5 Estimate*

The original WPF Installation DD1391 estimate was changed to a WPF Budget Ready DD1391 estimate and subsequently deleted by contract scope changes. It was replaced by the WPF Class 5 Estimate. Deliverables supporting a WPF Class 5 Estimate submittal were issued to the USN on 20 November 2020. The list of deliverables was developed by the USN and incorporated into the project scope in Phase V.

### *WPF Cost Certified DD1391*

Preparation of documents for supporting WPF Cost Certified DD1391 submittal were removed from the project scope in Phase V.

## Integration with SIOP Simulation & Modeling Work

Advancement of a "process flow" based WPF optimization model should be pursued. Current "shop" based optimized model may not accurately reflect space requirements and potentially impact current AoA scoring.

## Conclusion Summary

1. DD5 Graving Dock is required and can be delivered within mission requirements with earlier caveats.
2. DD5 alone does not address USN's efficiency needs at PHNSY.
3. WPF building size used in the AoA was based on the un-optimized simulation model, potentially impacting WPF footprint requirement.
4. Constrained building site for the WPF sub optimizes design solutions.
5. Splitting the DD5 and WPF construction delays optimization and requires an extended outage of DD5 during WPF construction.
6. Splitting the DD5 and WPF projects incurs a substantial amount of re-work of the DD5 support structures once construction is begun on the WPF.
7. Combining the projects yields both optimization and mission need by eliminating future outages of DD5.

# 5. Recommendations

Based on the findings and conclusions, it is recommended that the USN takes the following actions to ensure the successful continuation of the Shipyard Optimization Program at PHNSY.

## 5.1 Design Phase Recommendations

### 5.1.1 Early Establishment of the Project Management Organization (PMO)

NAVFACPAC should establish and lead a PMO as soon as possible to oversee the dry dock and WPF design, procurement, and construction work. The PMO should be comprised of technical and management personnel from the USN, the A&E contractor and the Early Contractor Involvement (ECI) contractor who are directly supporting the project and have decision making and contract authority. It should function as an integrated team in executing project-expediting program decisions and collaborating on the IMS, which will be administered by the ECI contractor.

This combined organization would help align targets, goals, and milestones, assign risk to the best owners, and manage these risks throughout the project lifecycle. Additionally, the PMO will identify and adjudicate schedule conflicts, technical issues, and unforeseen conditions that may negatively impact the project.

With representation from the A&E and ECI contractors, as well as the USN, the PMO should agree on a standard set of engineering deliverables to ensure the ECI contractor is provided deliverables that meet its requirements and will not need to be regenerated later, contributing to on time delivery. Part of the function of the PMO will also be to shape the advanced procurement scope and ensure advanced procurement is conducted early in the project.

### 5.1.2 Alignment with the A&E Contractor through ECI Contract

It is recommended that USN considers and awards where needed an ECI contract to ensure alignment of the design with the construction program to reduce risk and better ensure the program cost and schedule. Following the ECI award, to help create better alignment between the engineer of record and the constructor, the USN should modify the A&E contract to align the design budget to the initial target price established by the ECI contractor. The A&E contract should include a contractual obligation to design a project within this funding limitation.

**Constructability Reviews**

A well-implemented constructability program focused on efficient construction execution and the minimization of construction risks is critical to project success. It has been found that the greatest benefits of a constructability process result from involving construction personnel early in the planning, engineering, and procurement phases. As the project progresses, it becomes increasingly harder to modify completed designs, change project strategies, or choose alternative approaches to avoid construction risks or take advantage of construction opportunities. The greatest ability to influence the project cost and schedule is early in the project lifecycle. A well-implemented constructability program, based upon Construction Industry Institute data, has historically yielded a four percent reduction in project cost and a seven percent reduction in project duration.

Because the ECI is ultimately responsible for delivering the project, it is recommended that the ECI be actively engaged in the design process to periodically perform constructability reviews to identify and resolve design errors that may impact construction efficiencies, cost, and schedule. Constructability analysis should be performed at each design phase where design charettes are usually established (e.g., pre-conceptual, conceptual, preliminary, and final). Constructability review meetings will allow the ECI to periodically review the constructability process, provide support to improve the process, and provide input and resolution to barriers impeding progress of constructability items. The constructability process is an ongoing program that should continue through the life of a project.

Initially, topics such as site layout and access, execution strategy (direct-hire, subcontract, etc.), environmental, safety, and health requirements, and scoping of construction packages will be communicated during the planning and conceptual engineering phases. As the design evolves, the constructability reviews will focus on construction methods and sequencing, material selection preferences, packaging, delivery configuration and sequence, and installation methods. Finally, as engineering moves through final design, constructability reviews will focus on specific construction details that affect the drawings and specifications. The A&E and ECI contracts will need to include terms to allow for changes to design based on constructability analysis that impact the A&E deliverables.

### Advanced Work Packaging (AWP)

It is recommended that the ECI contractor utilizes work packaging to prevent sub-optimization during the design process and support constructability and on time delivery. This will improve project productivity and predictability. AWP ensures the right design and materials are available to the workforce, supporting the direct-hire approach and optimizing productivity. AWP achieves this by integrating planning and execution activities throughout the project lifecycle, from project set-up to start-up and turnover.

AWP supports the ability to take an early planning approach with respect to integrating engineering and construction. This enables the ECI to verify constructability and ensure that the right tools are in place prior to construction start. Applying AWP to integrated EPC processes and leveraging strong internal lines of communication, the prime contractor can mitigate loss of productivity caused by field change request or re-work. Early project planning that integrates AWP with EPC, and project controls increases the probability of the following:

- The engineering team supporting the construction sequence and schedule
- Design documents are correlated to the field work packages and schedule for completion to support the procurement cycle for commodity delivery and work start dates in the field
- Vendor-supplied equipment remaining on schedule
- Materials are purchased and delivered to support the direct-hire construction craft
- Communication of specific work tasks improved at the work front, from the superintendent level through the direct-hire craft ranks
- Constraints such as craft availability, material laydown, scaffolding, and Issuance for Construction drawings are better managed
- Work toward closeout and turnover is better controlled

### 5.1.3 Leveraging the Expertise of Organizations with ECI Experience

The USN could also consider leveraging the expertise of other USG organizations that have significant experience initiating and running ECI contracts to augment the NAVFACPAC ECI contracts organization. This would provide NAVFACPAC with additional experienced resources to assist with the ECI execution.

### 5.1.4 Joint Risk Register

In addition to early commencement of enabling works, it is recommended that the USN work with the contractor to create and maintain a common risk register for the project to be utilized throughout the project to proactively identify and address differing site conditions. The maintenance and alignment of the risk register will help the USN manage overall risk and create steps along the process to mitigate, transfer, or eliminate risks. Table 3 describes potential risk and ownership for the project for the purpose of opening discussion on the topic.

**Table 3. Potential Risk and Ownership**

| USN | Contractor |
|---|---|
| Provide design and all area(s) needed for construction clear of interferences or impediments, utility tie-ins at the construction boundary, and logistical access to the shipyard (land and sea).<br>Scope to include: | Provide all materials, equipment, labor, and supervision, and management needed to procure, construct, and turn over DD5 and WPF.<br>Scope to include: |
| • final design - designer of record | • construction/procurement work packages and supplier documents, including shop drawings |
| • environmental permits | • construction permits |
| • permit mitigations outside of construction | • mitigations inside of construction |
| • site for CDF | • mobilization |
| • UXO identification and disposal | • utilities inside the construction fence |
| • handling and disposal of all contaminated soil | • earthwork |
| | • dredging |
| • demo/relocation facilities in construction area | • temporary construction facilities |
| • CIA & construction site fences | • interface management/systems integration |
| • reroute/demo utilities in construction area | • graving dry dock |
| • decom, demo, and filling in DD3 | • WPF |
| • utilities outside of the construction fence | • construction labor and supervision |
| • Joint Base and Shipyard access | • construction/project management |
| • Harbor access for marine operations | • safety program |
| • new electrical service e.g., 100MW HECO feed | • turnover completed facilities |
| • site(s) for on-base construction areas | • completed documentation |
| • area for camp or berthing vessel | • quality program QA/QC, inspection, test, hold |
| • production equipment inside WPF | • return areas to pre-construction condition |
| • commissioning of turned over facilities | • demobilization |
| • Superbrow and other GFE | • site(s) for off-base construction areas |

### 5.1.5 EIS Participation

It is recommended the ECI contractor be significantly involved throughout the EIS for this project to facilitate the EIS process and support on time delivery.

## 5.2 Construction Phase Recommendations

### 5.2.1 Early Commencement of Enabling Works

It is recommended that the ECI contractor commence enabling works prior to the formal start of construction. This would facilitate early site preparation, as well as the identification and mitigation of issues related to site conditions before they affect critical schedule milestones. This ultimately reduces schedule risks and increases the likelihood of delivering the project on time.

USN should consider designating tangible scopes of work to the ECI contractor. Recommended scopes of work would include oversight, supervision, and execution of small field projects with local subcontractors for the preparation of the project site and support areas. These enabling works would ensure that construction of the dry dock and WPF is not encumbered by known unacceptable site conditions or existing interferences, supporting on time project execution.

Enabling works may include the following:

- Establishment of survey benchmarks
- Demolition of surface facilities/site grading and readiness for conversion to a construction job site
- Demolition and decontamination of the DD3 area
- Utility re-routing for existing utility lines that will remain but will be in the footprint of the new facilities
- Filling in DD3 and performing other earthwork preparation
- Soil testing
- Concrete testing and sourcing
- Security fencing, gates, signage and boundary designations for the project area
- Similar activities noted above for the Substation X project
- Dock maintenance and grading at Landing C
- Upgrades to the East Loch security boom and mooring to improve open/closing operations, given the demands the project will place on conveyance of materials by barge into the dry dock area
- Upgrades to project support areas:
  - Pearl City/Victor Wharves
  - Maintenance of Waipio docks and CDF and preparation to accept and stockpile materials
  - Acquisition and preparation of off-base private property that is identified as essential to project execution, (e.g., laydown and pre-assembly yard) and requires improvements prior to its use during construction

The early completion of the scopes of work listed above, and potentially other scopes, will be key to project execution and mitigate schedule risks. Further, the early integration of the ECI contractor will allow the core team to develop strong working relationships with joint base personnel and an understanding of joint base requirements.

### 5.2.2 Jointly Bidding/Executing the Dry Dock and WPF

It is critical for the dry dock and WPF be procured as one project and executed by one contractor. Due to the complexities and dependencies of the two projects, having multiple companies perform the work would be sub-optimal and present significant schedule and execution risks.

For instance, by the very nature of using the ground or coping level for maintenance and production tasks, the dry dock utilities will be staged on upper levels of adjacent facilities. This will result in the final commissioning of the dry dock to run concurrently with that of the WPF. In addition, the utility demands between the dry dock and the WPF for electrical services can be merged and optimally (least cost) designed and installed.

### 5.2.3 Craft Labor

The construction of the dry dock and WPF is predicted peak at approximately 1,200 to 1,400 craft professionals.

Due to the complex nature of the dry dock and WPF scope and tight schedule requirements, it is recommended that the prime contractor self-performs the majority of construction work, with a target of 50 percent to 70 percent direct-hire hours. Self-performing a significant portion of the work provides integration efficiencies, clear direction, workforce continuity, and project cohesiveness, eliminating the challenges that arise when too many subcontractors are involved. Local subcontractors with key skills and equipment should be identified for specific scopes of work, where their unique skills, job knowledge, and experience with the Hawaiian site conditions can be utilized.

This project, combined with normal maintenance and construction work and major competing projects, could exhaust the supply of local labor in certain key trades such as ironworkers and cement masons. Where shortages exist, the contractor will need to have a specific labor plan in place, ahead of mobilization.

Housing resources should also be evaluated in the labor surveys should off-island labor be required, and an assessment and recommendation on housing will be provided accordingly.

### 5.2.4 Early Work on Concrete Supply Issue

With respect to sourcing concrete and aggregate for the project, it is recommended that the USN pay specific attention to the following:

**Cement Supply** – Currently, all cement is imported to Hawaii through a single supplier. They maintain two storage silos at Barbers Point, and supplies cement powder to all ready-mix suppliers on the Hawaiian Island chain (as well as their own plants) from this location.

**Fly Ash Supply** – Because there are no local fly ash sources, a detailed approach/plant to supplying this resource should be developed.

**Aggregate Supply** – Coarse aggregate for concrete can be sourced locally but might not meet durability requirements. A detailed approach to supplying this resource should be developed.

**Material Qualification Testing** – The local aggregate sources will need to qualify to USN standards to ensure that aggregates meet the specifications for a durable concrete.

**Durability and Service Life Requirement** – Durability is part of the concrete mix qualification process and appropriate verification testing will be needed prior to concrete placement.