Naval Station Everett
Small Craft Piers Delta and Echo
Replace or Repair Analysis
With Recommendations

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In 1994 the U.S. Navy resurrected a base in Everett, Washington and commissioned it as Naval Station Everett (NS Everett), the new homeport for six Naval vessels. Prior to 1994 the base had seen primary use as the homeport for a number of vessels during World War II. In the early 1940s Piers Delta and Echo were constructed to berth aircraft carriers and other warships. Piers Delta and Echo are 560 feet and 578 feet, respectively, and 46 feet wide. They are constructed out of pier decking and pile caps on timber piles. Naval vessels currently assigned to NS Everett berth at new piers on the base, while Piers Delta and Echo berth the small craft that support the larger vessels. The small craft mission includes tugboat services, base security and environmental response functions, and vessel boarding and search training for local units.

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Executive Summary

In 1994 the U.S. Navy resurrected a base in Everett, Washington and commissioned it as Naval Station Everett (NS Everett), the new homeport for six Naval vessels. Prior to 1994 the base had seen primary use as the homeport for a number of vessels during World War II. In the early 1940s Piers Delta and Echo were constructed to berth aircraft carriers and other warships. Piers Delta and Echo are 560 feet and 578 feet long, respectively, and 46 feet wide. They are constructed of pier decking and pile caps on timber piles. Naval vessels currently assigned to NS Everett berth at new piers on the base, while Piers Delta and Echo berth the small craft that support the larger vessels. The small craft mission includes tugboat services, base security and environmental response functions, and vessel boarding and search training for local units.

In spite of several upgrades and repair projects in the mid 90s, the original piles under the piers have degraded substantially in recent decades. Increasingly restrictive environmental standards have raised the water quality around the piers and promoted the growth of two species of marine wood boring microorganisms. On average the marine borers have consumed 10-15% of the piles' cross-sectional area. Studies conducted by engineer firms on behalf of NS Everett from 1998 to 2003 confirmed the continued presence and action of marine borers. Alarmingly, pile degradation has not only continued but accelerated, even after wrapping hundreds of piles with plastic wraps to eliminate the marine borers. Reduced pile cross-sectional area has diminished the piers' structural capacity to the extent that live loads are restricted to foot traffic and necessary light government vehicle traffic.

The Naval Facilities Engineering Command (NAVFAC) has stipulated utility, size, live load, and crane requirements for Naval piers. Comparison of the piers against these requirements, presented in Section Three of this paper, shows the piers' inadequacy. When

combined with the condition of the piles, either a comprehensive program of future repair projects or a complete pier replacement is becoming increasingly necessary.

In the Department of Defense the primary obstacle in implementing any long-term solution for the piers is funding. Projects of this magnitude are above the Military Construction (MILCON) threshold of $750,000 and require congressional authorization and specific funding appropriation. Competition across the armed services for MILCON funds is severe and restricts how realistically one can anticipate a project's funding. Further, the planning timeline for MILCON projects is approximately five years.

The simplest long-term alternative to consider is repair. This option requires a series of projects on a five-year cycle that exceed the MILCON threshold. A repair program alternative only maintains the piers at a level that will progressively degrade from current, inadequate conditions. Based primarily on funding and secondarily on the low level of service that repair efforts will yield, this alternative is not recommended.

	Repair Alternative	Concrete Pier Alternative	Modified Concrete Pier Alternative	MHP Alternative	Modified MHP Alternative
Initial Project Cost	n/a	$17,203,868	$13,979,608	$21,140,847	$15,840,212
Continuing Maintenance/ Project Costs	$15,265,041	$19,095,912	$15,590,033	$21,553,229	$16,252,594

The only viable choice is to replace the piers, either with a single pier or two similar piers. To minimize the cost of potential projects, reduce pier footprint, and maximize project-funding competitiveness, only the single pier option was studied in detail. Two single pier alternatives are considered – a fixed pier and a floating, Modular Hybrid Pier (MHP) – with a modified option for each alternative tailored to the base's minimum requirements. The fixed pier follows the traditional design for Naval piers with concrete piles, pile caps, and decking. The

MHP implements emerging material developments in a conceptual precast, prestressed, floating concrete pier. Both alternatives include a boat launch/recovery system and five smaller, floating finger piers to increase pier side efficiency. The modified option for each alternative reduces the width (fixed and MHP) and modifies the cross section (MHP only) of the presented alternative to appropriately size the replacement pier for NS Everett and reduce project costs.

Given the heavy weighting of funding restraints in this analysis, this study recommends pursuit of a modified fixed pier replacement alternative with a width of approximately 50 feet. The study further recommends that repair efforts be limited to those necessary to prolong pier use until the replacement project timeline. This replacement alternative offers the lowest initial project cost and provides all the necessary capabilities the current piers lack. The MHP option could be cheaper and a better alternative than a fixed pier, however the MHP concept program is still underway and exact project costs are not yet fully understood. Inclusion of large contingencies in the MHP estimate cover this unknown but effectively price this alternative out. A fixed concrete pier programmed in the FY 2012-2013 timeframe will replace Piers Delta and Echo to maintain the operational capabilities that NS Everett requires for its small craft missions.

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Section 1: Introduction

Since its commissioning in April 1994, Naval Station Everett (NS Everett) has been the primary Naval installation on the east side of the Puget Sound and is complimented by Naval installations on the Olympic Peninsula in several communities around Bremerton, Washington (see Figure 1). Everett is 29 miles north of Seattle, 50 miles northeast of Bremerton, and directly east of South Whidbey Island. NS Everett's pier space is accessed from both Port Gardner and the East Waterway within the Puget Sound (see Figure 2). The base also sits just to the south of the mouth of the Snohomish River.

The Navy developed NS Everett base infrastructure on the 116-acre site from the late 80s to the mid 90s, completing the aircraft carrier pier and acquiring Naval vessels after 1992. NS Everett serves as the homeport location for a total of six ships: one aircraft carrier (CVN), two destroyers (DDG), and three frigates (FFG). The base also serves as host to many tenant units, to include the U.S. Coast Guard (USCG), the National Oceanic and Atmospheric Administration (NOAA), and the Afloat Training Group (ATG), which operates from Pier Delta. (MARCOA, 2006)

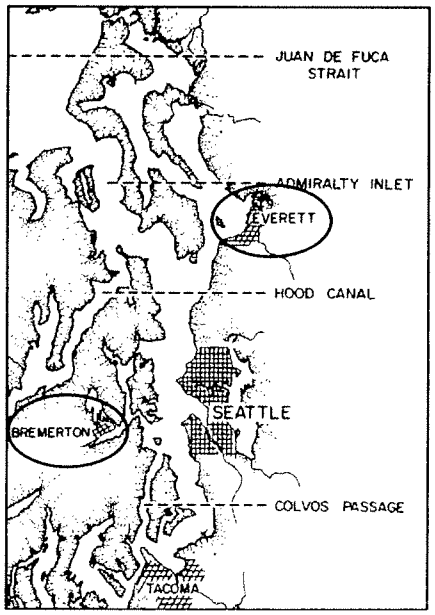

Figure 1 – Puget Sound Navy presence

Waterfront support services for all assigned and visiting Naval vessels include; tug boats to maneuver vessels near the wharfs, force protection boats for security, response boats to contain hazardous material spills in the harbor, and "foot ferries" (ferry boats) to move personnel between ships and other Puget Sound bases. All of these support functions require pier space from which they operate and conduct internal support. For many years these requirements have

been met at the small craft berthing piers, Piers Delta and Pier Echo, to the northeast of Piers Alpha and Bravo where the larger Naval vessels moor (see Figure 2).

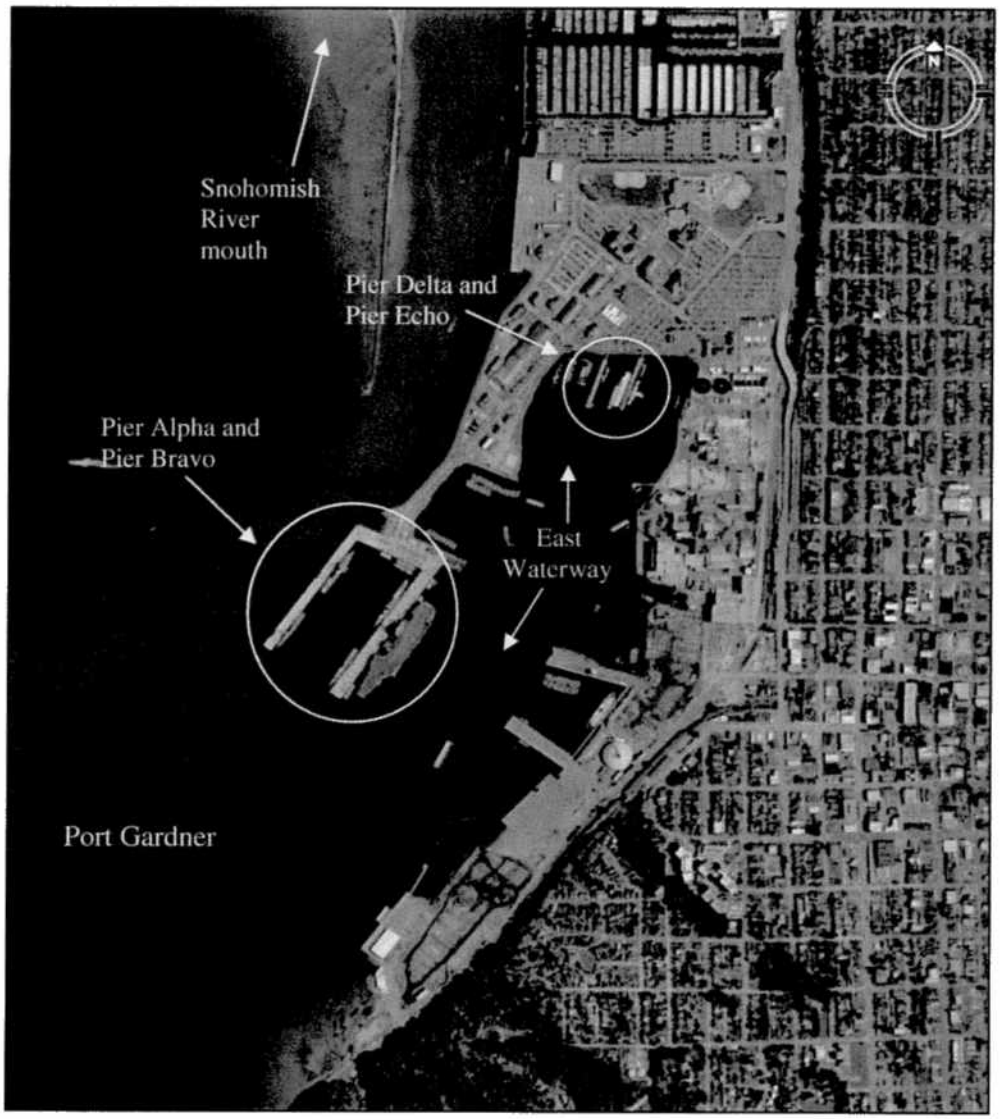

Figure 2 – Aerial view of NS Everett and surrounding waterways (Google, 2002)

Both piers are situated within the East Waterway in Port Gardner, which is a subordinate port inside Port Susan in the Puget Sound. Pier Delta lies approximately 250 feet west of Pier Echo and approximately 70 feet east of the Base Marina and private boat slips (operated by the base Morale, Welfare, and Recreation Department). Pier Echo lies approximately 250 feet to the

east of Pier Delta and a greater distance from obstructions to the east. Kimberly-Clark operates a large pulp mill and treatment plant[1] to the east of Pier Echo (see Figure 3).

Pier Delta is 560 feet long and 46 feet wide. It is supported by 532 timber piles, 191 of which have been wrapped for protection from marine borers and 341 of which have not. Pier Delta has a reinforced concrete deck and concrete pile caps – result of a past improvement project – and is accessed by a trestle to the shore 69 feet long and 18 feet wide. Pier Echo is 578 feet long and 46 feet wide. It is supported by 626 timber piles, 266 of which have been wrapped and 360 of which have not. Pier Echo has the original 18" x 18" timber beam deck and pile caps and is accessed by a trestle to the shore 41 feet long and 19 feet wide. (See Figure 3.)

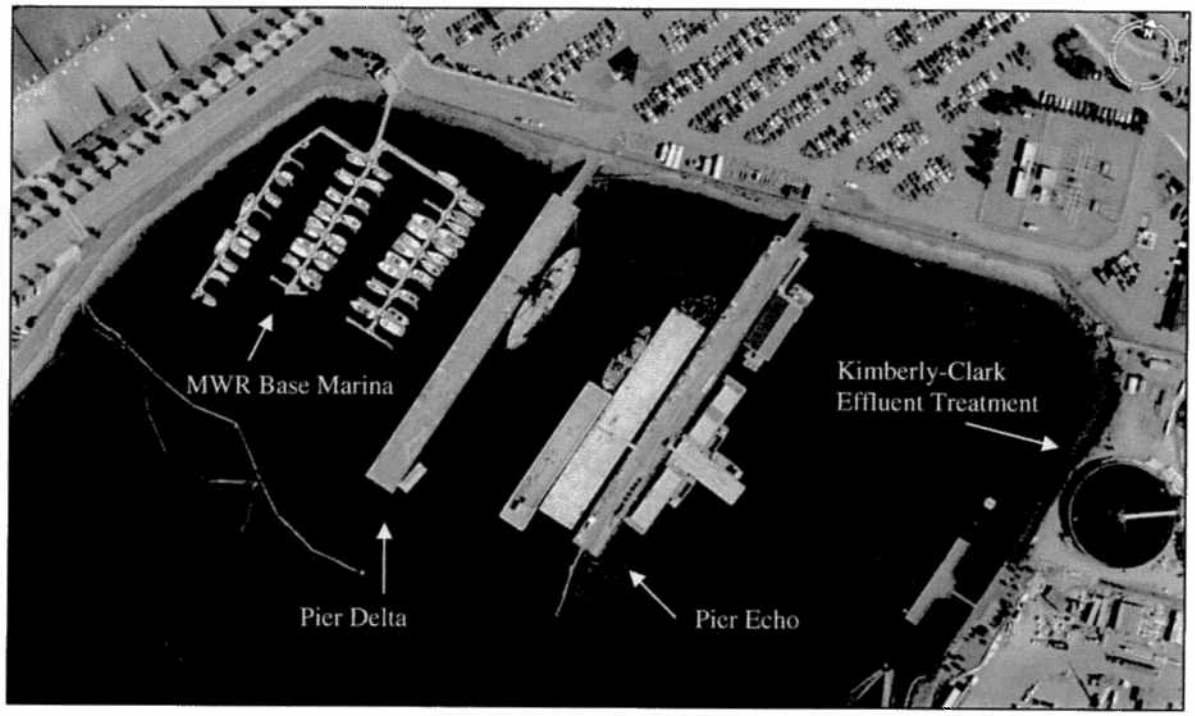

Figure 3 – Close up aerial view of Piers Delta and Echo (Google, 2002)

[1] See Section 4 for further description of pulp mill effluent treatment and its impacts on water quality.

Section 2: Background

Piers Delta and Echo were originally constructed as aircraft carrier piers in World War II (see Figure 4). While records do not indicate exact time of construction, the piers' construction is accepted as circa 1941. The piers were constructed of a network of timber piles with timber pile caps and 18" x 18" timber decking. Given the 1941 construction timeframe, the two piers are nearly 70 years old. Their present condition shows their age and is of growing concern to Port Operations and the Afloat Training Group (ATG) who operate from the piers, as well as the base Public Works Department (PWD) who maintains them.

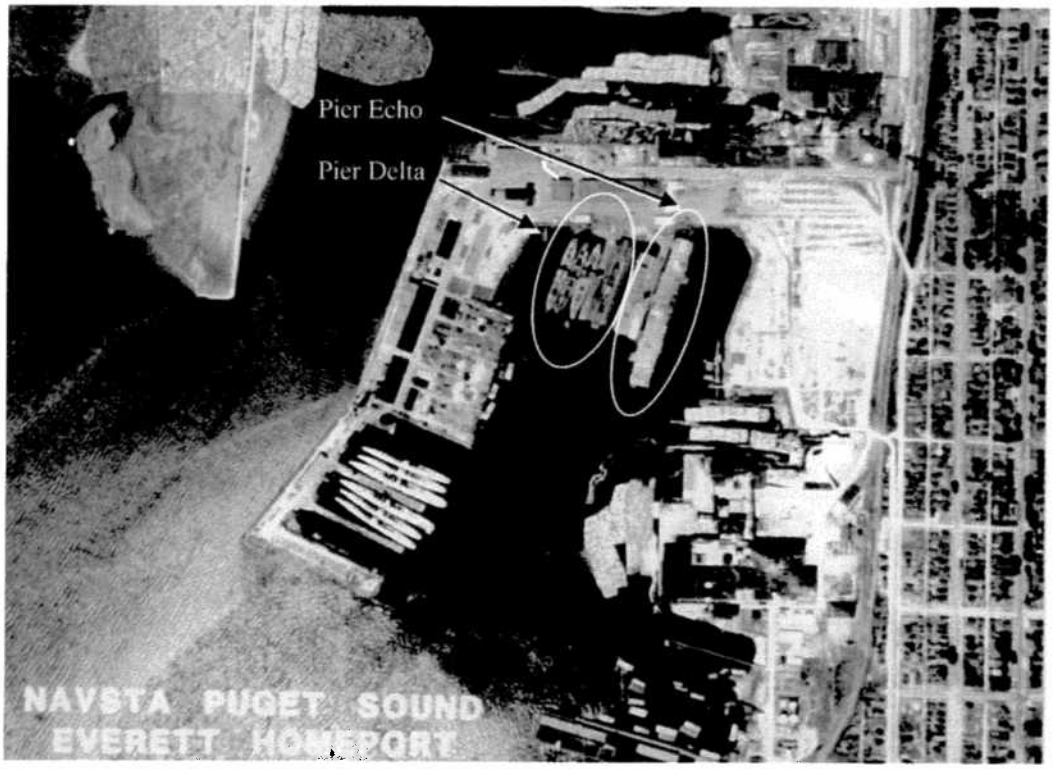

Figure 4 – Aerial view of NS Everett, circa 1946

The piers were designed according to the standards at the time, but design practices and codes have matured significantly since World War II. Pier design and construction share many similarities with typical vertical structures. Live, service, and lateral loads are determined according to actual load analysis and/or regulations – in this case the NAVFAC pier

requirements[2] – and piers are designed to resist those loads. In a pier, vertical loads are resisted either through a network of vertical piles or, in the case of a floating pier, buoyancy. Lateral loads are resisted either through the use of stiff, vertical piles or through diagonal piles, called batter piles. To protect the structural system under the pier from foreign debris, "camels" are frequently installed around the exterior of the pier such that they rise and fall with the tide and deny presence of floating debris under the pier that causes pile damage. Figures 5 and 6 below show typical cross sections, structural elements, and materials in Piers Delta (Figure 5) and Echo (Figure 6).

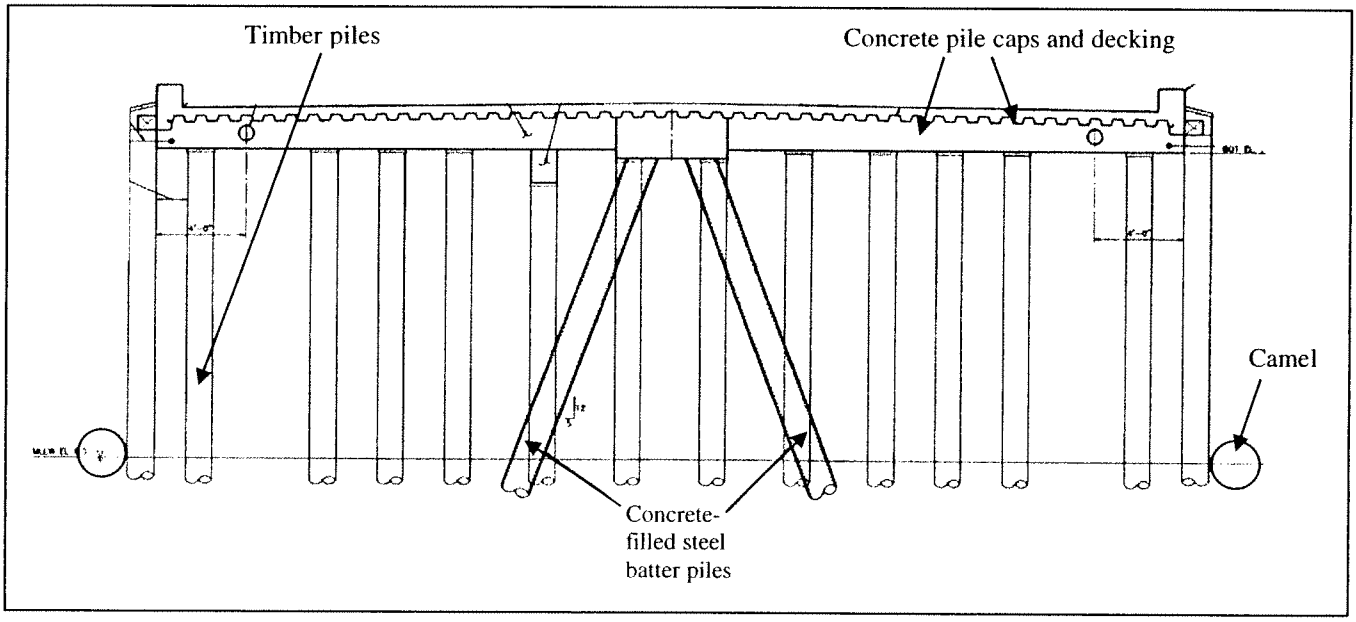

Figure 5 – Typical cross section of Pier Delta

The piers have provided over 60 years of service to the base and its variety of vessels. In spite of a long track record of successful performance, the structural capacity of the piers has degraded at an accelerating rate in the last 15-20 years. Increasing environmental awareness in the Pacific Northwest has led to tighter controls on effluents and emissions into coastal waters – most significantly from the adjacent pulp and paper mill – thus substantially raising water

[2] See Section 3.

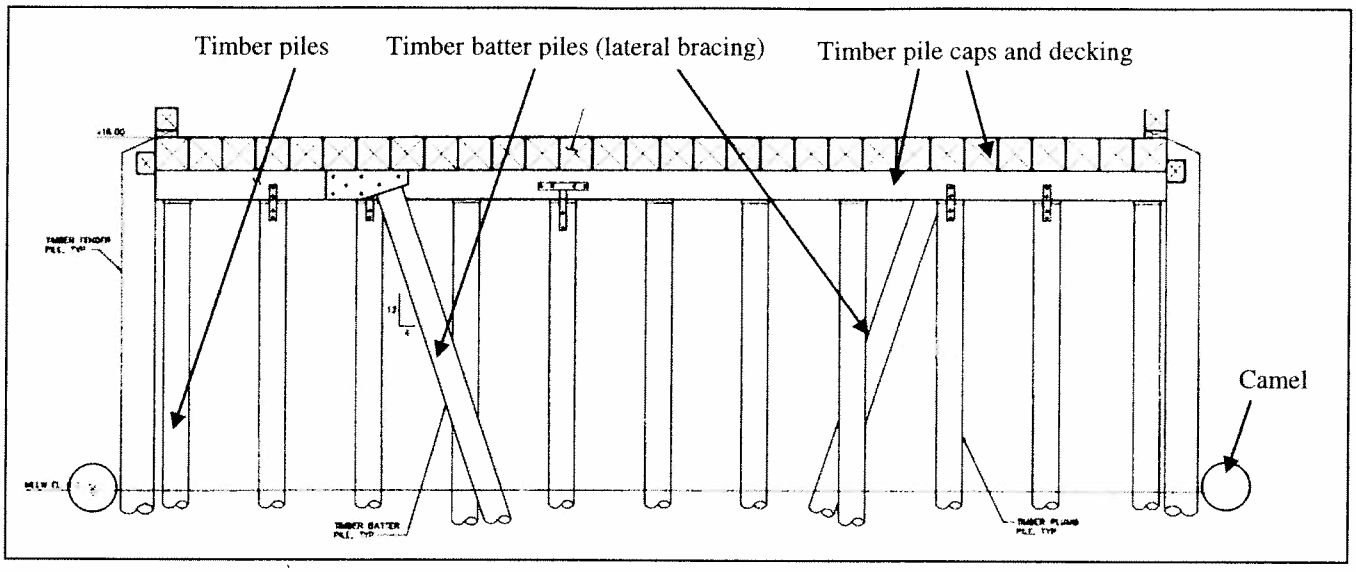

Figure 6 – Typical cross section of Pier Echo

quality. While this has yielded enormously positive effects on marine life and ecological systems in the area, it has increased dissolved oxygen levels in the waters around the piers. Greater dissolved oxygen in the water has promoted growth of and improved living conditions for microorganisms termed "marine borers," as referenced in prior pier studies presented in Section Four of this paper. Two species, the shipworm *Bankia* (Figure 7) and gribble *Limnoria* (Figure 8), now thrive in the East Waterway and consume the wood fiber of the timber piles that support the piers. The creosote exterior treatment on the piles has proved very effective in repelling the marine borers, though they have still penetrated the piles through cracks in the exterior treated surface and consumed the wood material within pile interiors. Through this mechanism marine borer action has reduced the cross-sectional area of piles to anywhere between 50% and 90+% of their original area, greatly reducing their strength. The reduced

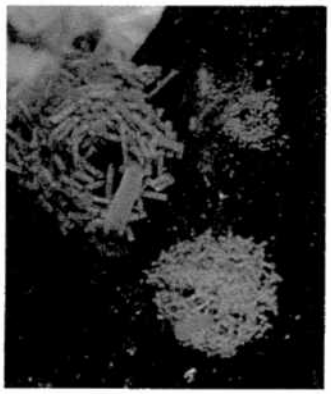

Figure 7 – Shipworm *Bankia*

Figure 8 – Gribble *Limnoria*

strength of the piles has decreased allowable loads on the piers and operational utility to the end user.

In increasingly poor condition, the piers are – or will be by the time of planned construction in 2012-2013 – at a point where program-level decisions must be made. Either complete replacement or a number of repair projects as components of a comprehensive repair program is necessary to maintain operational adequacy of the piers.

Section 3: Operational Requirements

In order to establish specific operational requirements that the small craft pier infrastructure must support, interviews were conducted with the NS Everett Port Operations staff and with ATG representatives.[3] The current inventory of small craft assigned to Port Operations and ATG includes the following:

Table 1 – Vessel and structure inventory utilizing Piers Delta and Echo

Designation	User*	Qty	Length	Beam	Comments
Yard Tug Boat (YTB)	PO	2	110 feet	28 feet	Future addition, 1 ea
Boom platform (oil spill response)	PO	2	30 feet	11 feet	None
Security boats (force protection)	PO	5	28 feet	8 feet	None
Log bronc (log clearing in port)	PO	1	29 feet	13 feet	None
Skimmer	PO	1	28 feet	14 feet	None
Utility boats	PO	4	20 feet	8 feet	None
Mariposa (training vessel)	ATG	1	170 feet		Permanently moored
High Speed Boat (HSB)	ATG	1	28 feet	8 feet	
Rigid Hull Inflatable Boat (RHIB)	ATG	2	36 feet	11 feet	
Littoral Combat Ship (LCS)	n/a	2-3	TBD	TBD	Potential new mission
Visiting craft	NOAA/USCG	1	< 200 feet	Varies	Case-by-case use
Miscellaneous functions	PO	1-4	Varies	Varies	Ferries, fuel barge, etc
Utility Float (UF)	PO	2	110 feet	35 feet	
Small craft boathouse	PO	1	95 feet	42 feet	4 security boat slips
YFN	PO	2	110 feet	35 feet	Offices/oil response

* PO = Port Operations, ATG = Afloat Training Group

All boats listed from YTB through utility boats are operated by Port Operations and exclusively utilize Pier Echo. The *Mariposa* is owned by the Afloat Training Group (ATG) and occupies the majority of the east side of Pier Delta. The vessel is used by local Puget Sound units for many types of training. ATG uses it to train students on a host of practical shipboard skills. Coast Guard and Navy units use it to train for vessel boarding and searching. Security forces also use it to train their personnel and military working dogs for vessel boarding and searching. The *Mariposa* remains moored to the pier and is used only for training purposes and only in its moored location. An alternate location acceptable for the training mission would significantly

[3] Port Operations staff, Interview with the author, 29 March 2007. ATG Chief, Interview with the author, 27 April 2007.

increase pier availability along Pier Delta. The LCS mission will likely fall to Naval installations in the San Diego area, relieving NS Everett of infrastructure requirements necessary to support it.

In addition to providing pier space for the boats, Piers Delta and Echo also provide additional resources to Port Operations that constitute mission-critical assets. First, the base's oil spill containment equipment is housed onboard the boom platforms (boats), on Pier Echo itself, and in a Yard Float Non-Nuclear barge (YFN). The equipment consists of several hundred yards of floating surface containment apparatus. While the boom platform boats have initial containment onboard, additional containment equipment must be available for immediate retrieval and use. Any solution reached for future pier infrastructure must incorporate this requirement, either in the pier design or through use of an external facility, such as a YFN.

Second, a floating boathouse located on the east, inboard side of Pier Echo houses all the security boats and increases the efficiency of pier side space. Further, the boathouse is covered and provides protection for the boats to reduce the boat maintenance burden (See Figure 9). The slips in the current boathouse, however, are too short to accommodate the current 28-foot security boats and should someday be replaced.

Figure 9 – Security boats in boathouse at Pier Echo

Third, the second YFN is utilized as office space for 10 Port Operations personnel. The YFN's location adjacent to the security boathouse and boom platforms enables quick response for security breaches and hazardous material spills. The space relationships for these functions

must be maintained in the final pier solution. This requirement could be met directly in the pier design or through use of an external facility, such as a YFN.

Fourth, the Port Operations staff performs a number of miscellaneous functions in support of both homeported and visiting vessels. Given the substantial distance from ships' berthing location at the wharfs, Port Operations accommodates contractor-operated "foot ferries" at Pier Delta to transport sailors between ships and Puget Sound bases. Foot ferries are currently accommodated at Utility Floats (UFs) alongside Pier Delta (see Figure 10). The base also berths and services a contracted fuel barge in support of ship refueling. Last of the *anticipated* additional support functions is the berthing of smaller visiting vessels (200 feet or less) at Pier Delta.

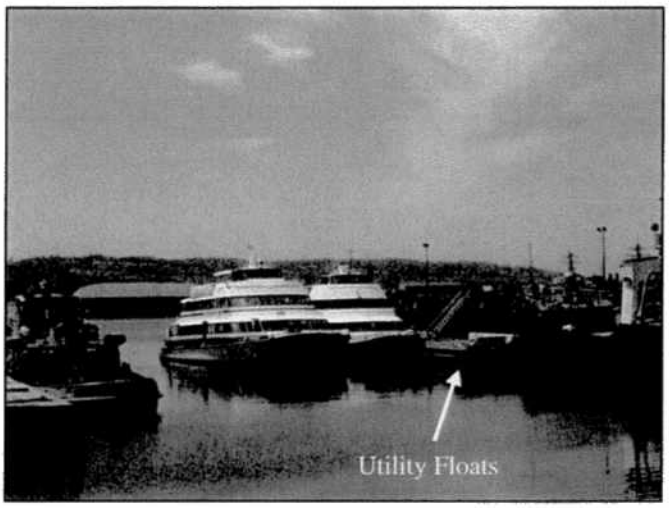

Figure 10 – Foot ferries moored at UF along Pier Delta

The above functions, both major and minor, must be incorporated into pier planning along with the following additional requirements and considerations:

- Crane support: the current piers offer no capacity, but crane support is necessary *on* the piers.
- Tug boat "pushing" space: For inspections and boat qualifications, tugs must push against a stable object at a continuous RPM for a designated amount of time. No such space currently exists and tugs push against one *another* for this function at present.
- Restrooms: Provided on shore at end of Pier Echo only but needed on all piers.
- Utilities: Future arrangements should provide adequate utilities for moored boats, pier facilities, and all YFNs.

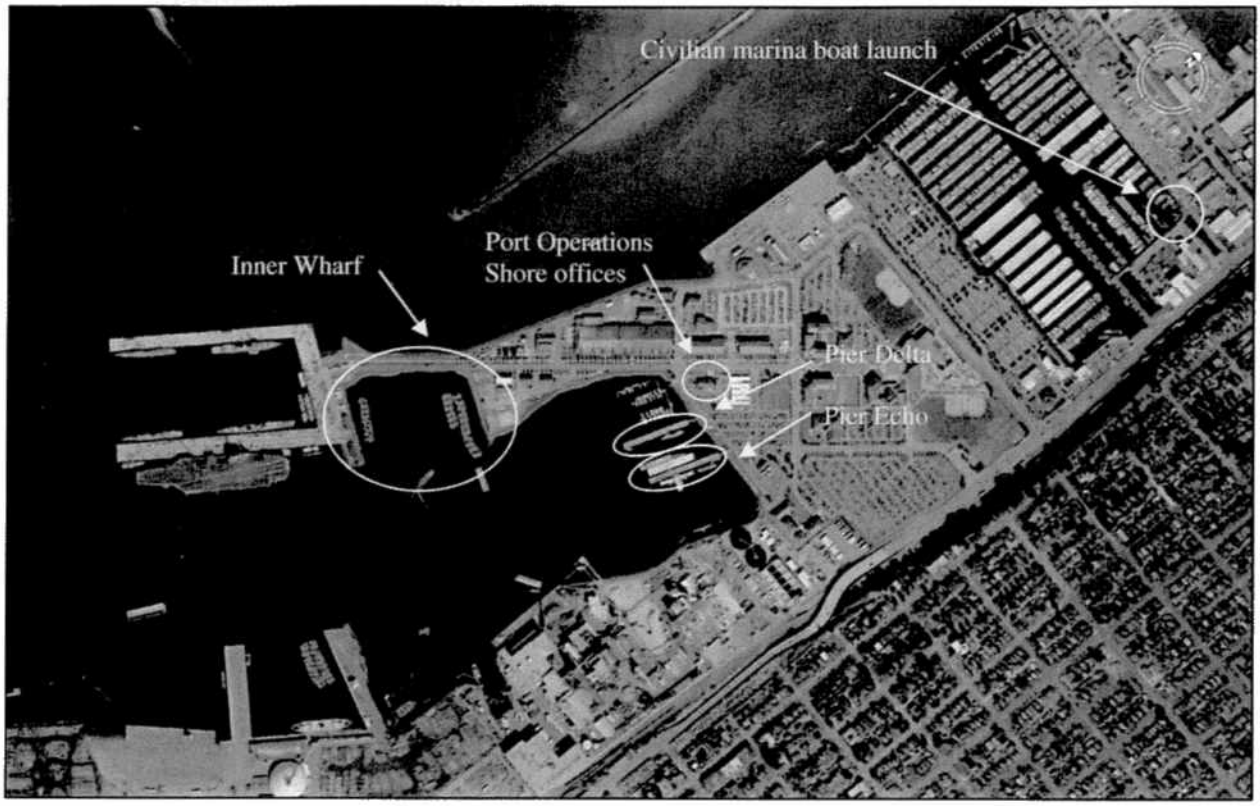

Figure 11 – Aerial view of Naval Station Everett and civilian marina (Google, 2007)

- Sling/boat ramp: NS Everett currently does not have a small craft launching and receiving facility, which necessitates use of a civilian ramp in the marina off base, approximately one mile north at 10th Street (See Figure 11). Location of this ramp presents three problems to the base.
  1. Response time is increased by an average of 40 minutes per boat launch for hazardous material spill containment. Long lines of civilian boats further lengthen response time in the summer months.
  2. To exit the water for sanitation, a hazardous material response boat must leave the contaminated area, traverse clean areas, cross the civilian marina, and be removed at the boat ramp, polluting the clean waters through which it travels.
  3. Time requirements to launch and recover boats results in significant loss of manpower to Port Operations and ATG.

4. The government's liability increases substantially when operating government watercraft around civilian boats in the marina.

- Pier height: Small craft are more affected by tidal changes than are large ships. Hence, design/other measures must be incorporated in planning to provide access from pier to boat. The tidal change for NS Everett ranges from 10-11 feet, though it can be as great as 14 feet.[4] Selection of either a floating pier option or of a fixed pier option with UFs/floating finger piers will meet this requirement.[5]
- Existing assets planned for removal: Several existing pieces of infrastructure will go away and are not included in this planning process. First, a piece of the I-90 floating bridge floats alongside the southwest corner of Pier Echo and is used by the YTBs to eliminate the effects of tidal change on the pier's relative height above the boat (see Figure 12). Known as "the brick," plans are in motion to remove it. Second, a UF on the eastern side of Pier Echo between the YFNs will also be removed prior to the execution timeline here considered.

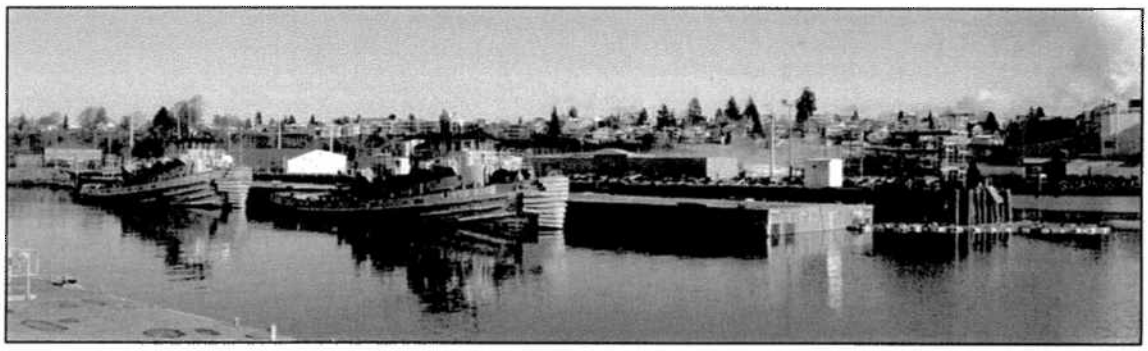

Figure 12 – YTBs berthed to "the brick" along Pier Echo

While Port Operations and ATG are currently accomplishing mission with the existing piers, a disparity exists between the operational requirements presented in this section and the current condition of the piers. Projecting conditions to the project timeframe (FY 2012-2013)

[4] National Oceanic and Atmospheric Administration. 'Historic Tide Data', 1996, http://www.co-ops.nos.noaa.gov, viewed 2 June 2007.
[5] See Section Six.

and beyond, the disparity will only grow. Additionally, NAVFAC Pier policy[6] states requirements that numerically demonstrate the disparity between current and projected conditions, as shown in Table 2.

Table 2 – NAVFAC Pier requirements compared to Piers Delta and Echo existing conditions

Item	NAVFAC Requirement	Pier Delta (existing)	Pier Echo (existing)	Adequate?
Pier Length, feet	208 ft/tug (416 ft for two)	560	578	YES
Pier Width, feet	80	46	45.5	NO
Slip Width, feet	300 (minimum)	~250 (between piers) ~70 (to Marina)	~ 250 (between piers) >300 (to east)	NO
Berth Depth, feet	18	40	30-40	YES
Live Load, lb/SF	600	Minimal	Minimal	NO
Vehicle Load, class	HS-20	GOV as necessary	GOV as necessary	NO
Crane Load, Tons	90	No capacity	No capacity	NO
Utility Location	Looped and above MHHW	Looped and above MHHW	Not looped and some below MHHW	YES/NO
Potable Water	Required	Provided	Provided	YES
Fire Water	Required	Through potable	Provided	YES
Steam	Required	None	None	NO
Compressed Air	Required	None	None	NO
Electricity (480 VAC, 30)	Required	Provided, in disrepair	Provided, in disrepair	NO
Telephone	Required	Provided	Provided	YES
Fire Alarm	Required	Provided (not occupied)	None (occupied)	NO

In addition to specific operational requirements, the general topics of pier location and total number of piers were addressed with interviewed personnel to establish planning constraints. PWD offered the possibility of locating new piers in the "inner wharf" instead of the current location (see Figure 11). Advantages and disadvantages of both options, based on discussion with Port Operations and ATG, are presented in Table 3.

[6] Naval Facilities Engineering Command. Military Handbook Piers and Wharfs; MIL-HDBK-1025/1, 30 October 1987.

Table 3 - Piers Delta and Echo location analysis

Location	Advantages	Disadvantages
Status Quo	Confidence in the current location and current ability to meet mission	Maximum disruption to Port Operations during construction
	Close to Port Operations' shore offices for quicker emergency response augmentation and "field command and control"	More susceptible to debris intrusion and damage to piles and under-pier utilities
		Infringement on legal property lines
Inner Wharf	No disruption to Port Operations during construction	Decreased water depth (compared to status quo) which could be a problem for YTBs during low tide, depending on exact location of piers
	Potentially increased weather protection for moored boats	Increased distance from shore offices, affecting emergency response augmentation and "field command and control"
		Lack of operating experience in this location and unknown degree of ability to meet mission there

Also discussed with operations personnel were several replace and repair options resulting in an end state of either a single pier or two individual piers. According to these discussions, one pier would put small craft operations at a disadvantage, given the space constraints of the area. As a general rule for this planning study, the quantity of pier side space available with multiple piers is more advantageous to end users than consolidating services into one pier. In the case of a single pier, the staff was concerned with 1) accommodating the *Mariposa* 2) accomplishing miscellaneous functions previously mentioned 3) maintaining the ability to reconfigure pier space to berth LCSs or other vessels. As an additional data point, adequate space exists without "the brick" to replace Pier Echo with a finger pier option[7] and still keep Pier Delta for the three functions above.

[7] See Section 6.

Section 4: Past Studies and Repair Projects

Piers Delta and Echo have a long history of use at NS Everett. The repair and maintenance history directly compliments the age of the piers and has continued since their construction in the 1940s. While attention increased in the early 90s when NS Everett resurged as a major Naval installation on the Puget Sound, primary focus remained on the piers that accommodate the larger vessels and directed attention away from these small craft piers. As the piers were nearly 50 years old and provided effective service when the base resurged in use in the early 90s, one might question how their condition could have degraded so quickly since then. Several key factors aside from age have contributed to their accelerated decay:

1. Pier use: Increased since the early 90s owing to NS Everett's expanded mission.
2. Adjacent operations: Paper mill effluent treatment increased in recent decades.
3. Environmental standards: Tightened considerably across the Pacific Northwest in past decades. Higher water quality and higher dissolved oxygen levels in the East Waterway have contributed to growth of marine borers that consume the timber piles.

In lieu of complete replacement, NS Everett has adopted mitigating efforts to slow degradation and lengthen the piers' longevity. The primary measure utilized was to wrap identified piles with any of several forms of a plastic wrap (see Figure 13). Tightly sealing the wrap along its length serves to reduce the dissolved oxygen level within the wrap, thus killing the marine borers resident in the timber piles and preempting additional growth behind the wraps. Correct employment of this measure will, in theory, limit continued pile degradation.

Figure 13 – Sample pile wrap

A detailed list of projects spanning the entire existence of Piers Delta and Echo is unavailable, though information on projects in recent years *is* available. Below is a chronological summary of projects and studies completed since 1993:

1993 All deck timbers on Pier Echo showed signs of major surface wear and were rotated 90 degrees to expose a different face of the timbers as the wearing surface. At the same time, *some* piles and pile caps were replaced on an as-critical basis.

1995 Pier Delta received a major above-water upgrade. The timber deck and pile caps were replaced with a reinforced concrete deck/pile cap system on the existing timber piles.

1998 Blaylock Engineering Group completed an underwater inspection and structural assessment of the timber piles.

1998 Reid Middleton, Inc prepared a timber pile repair project specification and drawings for procurement and execution.

1999 Navy workforces wrapped 191 piles under Pier Delta.

2000 Navy workforces wrapped 266 piles under Pier Echo.

2002 Repairs to conduits and wiring under Pier Echo.

2003 Repairs to Pier Echo power distribution system.

2003 Berger/Abam Engineers, Inc completed an underwater inspection and comprehensive evaluation of the piers.

2004 Repairs to Pier Delta water supply.

2005 Installation of a non-slip surface on the deck of Pier Echo.

The remainder of this section presents the conclusions and recommendations, as well as pertinent details, of each of the studies. A cursory review will point out consistent facts, conclusions, and recommended actions of the studies as well as trends of decreasing structural capacity and mission capability of the piers.

Study: Blaylock Engineering Group (1998)

In September 1998, Blaylock Engineering Group executed a contract for NS Everett to provide underwater inspections and assessment[8] of the timber piles supporting each of the piers. Previous observations showed marine borer activity on the timber piles had deteriorated the piles and potentially reduced their structural capacity. Deterioration apparently accelerated in years leading up to the study due to increasing levels of marine borers around the piers, a result of tighter environmental controls on industrial activity and effluent discharge from the adjacent pulp mill in the East Waterway (the mill's treatment plant discharges into the East Waterway directly to the east of Pier Echo.) This study was commissioned in order to assess actual condition of the piles and the extent of marine borer activity. The study was restricted to the underwater condition of the piles and classified inspected-piles into three categories:

Type 1: No visible exterior presence of marine borers.

Type 2: Light to moderate presence of marine borers, demonstrating a *reduced* cross-section and structural capacity.

Type 3: Heavy presence and infestation of marine borers, demonstrating *significantly* reduced cross-section and structural capacity.

Blaylock recommended wrapping Type 1 piles on a non-priority basis (within 12 months) and Type 2 piles on a priority basis (within 9 months). Type 3 piles were recommended for priority replacement as soon as possible, as they offered very little structural contribution to the piers. An alarming number of timber piles fell into the latter two categories (indicated in yellow and red), as summarized in Table 4 and Figure 14 below:

[8] Blaylock Engineering Group. Underwater Inspection and Assessment of the Structural Timber Piles Supporting Pier Delta and Pier Echo at the Naval Station, Everett, WA, 22 September 1998.

Table 4 – Pile classifications from Blaylock study

Type	Pier Delta		Pier Echo	
	Number of piles	Percent of piles	Number of piles	Percent of piles
1	285	54%	292	47%
2	200	38%	297	47%
3	41	8%	37	6%
Total	*526*	*100%*	*626*	*100%*

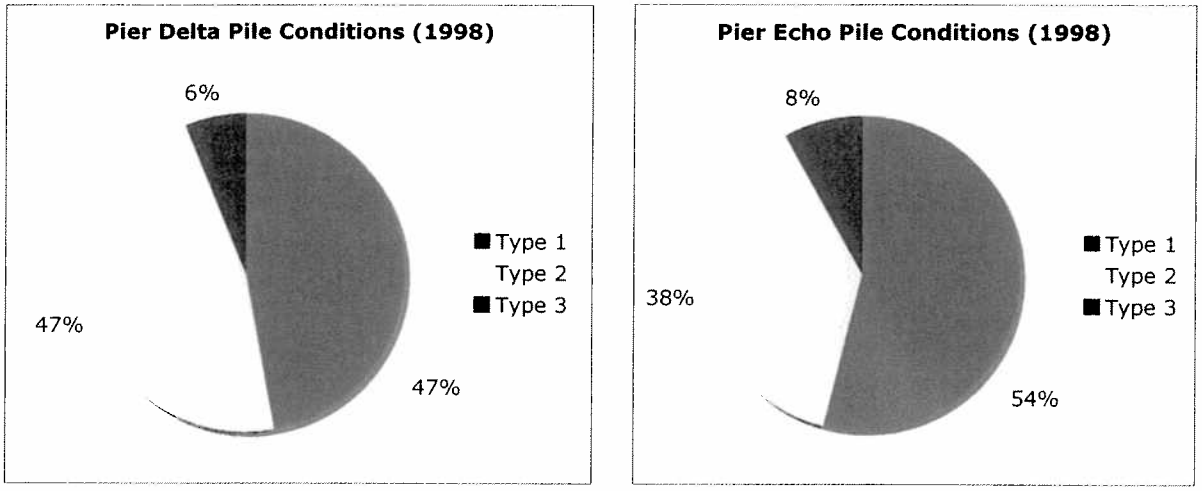

Figure 14 – Graphical representation of pile classifications from Blaylock study

The Blaylock study identified and provided drawings of individual pile conditions for both piers. For use in planning individual projects, the drawings indicate the type of each pile as well as the location of debris under the piers in need of removal. Blaylock recommended replacement of existing camels and restriction of live loads on the piers – until structural repairs were made – to foot traffic and light vehicles. These restrictions remain in place in 2007 and were confirmed in the conclusions of later studies.

Project documentation: Reid Middleton (1998)

Anticipating the results of the Blaylock study, NS Everett solicited Reid Middleton to design and prepare project documentation[9] to wrap or replace appropriate piles under each of the piers. Project scope consisted of the following:

- Critical pile replacement: Cut piles at the mudline and drive new, galvanized steel piles through cuts in the pier decking. Repair holes made in the concrete deck (Pier Delta) and replace timber deck piers (Pier Echo) as necessary following new pile installation.
- Other pile wrapping: mechanically scrape and wrap piles with 1.52 mm thick polyethylene plastic barrier to seal piles, deplete oxygen within the wraps, and prevent further marine borer action. The project documentation stated, "...it is very important to install the materials with good seals at both the longitudinal and transverse [both top and bottom] joints of the polyethylene sheeting to prevent intrusion of water." Further, wraps should "...extend to a depth of 600 mm, plus or minus 150 mm, below the mud line." (This becomes important in later discussion.)
- Camels: install new timber camels along edges of both piers at the water level.

The project specifications detailed very prescriptive materials, processes, and end results for the pile wraps, based upon specific knowledge of the East Waterway and the threats posed to the piers in that environment. The PWD executed a portion of the project with military workforces and, for environmental impact reasons, wraps were not extended below the mudline. The unfortunate result of inability to follow the specification in this detail was continued marine borer action.

[9] Reid Middleton. Repair Deteriorated Timber Piles Piers D & E at Naval Station Everett, Washington, Engineering Field Activity Northwest, 14 May 1998.

Study: Berger/Abam (2003)

In 2003, Berger/Abam Engineering, Inc – expert marine structure design firm in Washington – conducted a study[10] for EFA Northwest to establish the current condition of the piles as an assessment of the effectiveness of previous pile wrap repair projects. In addition, Berger/Abam evaluated the lateral and vertical structural capacity of the piers and provided projections for future performance.

Nondestructive inspection of the piles indicated that the wraps had been effective overall but not for the entire length of the pile behind the wrap. The effectiveness of pile wraps was assessed through the differential dissolved oxygen (DO) level inside and outside each wrap. Wrapped piles generally exhibited much lower DO behind the wrap, which is assumed to have reduced marine borer presence and action on the piles. The investigation divers, however, assessed only a slight differential in dissolved oxygen level at the *ends* of the wraps when compared to the *middle* of the wraps. Previous studies and the Reid/Middleton project specification had stated the importance of extending pile wraps below the mudline and above the high water mark. Divers in 2003 noted that the wraps not only didn't extend two feet below the mudline but frequently terminated 2-8 inches above the mudline. "The wraps decrease the DO next to the piles, but the data indicate that present levels of DO are not, in most cases, low enough to kill the marine borers." (This statement was truer for piles on Pier Delta than Pier Echo due to different wrap application procedures.) This led to higher DO levels at the end of the wraps than at the middle (see Figure 15). Further, marine borer activity had not occurred on the treated exterior surfaces of the piles, and activity was more intense inside the piles where marine borers had intruded through cracks and tears in the pile wraps. Cracks occurred at the location of the metal straps holding wraps in place and tears occurred where intruding debris

[10] Berger/Abam Engineers Incorporated. Study Evaluation of Pier Delta and Pier Echo Naval Station Everett, Washington. Engineering Field Activity Northwest, 4 June 2003.

under the piers had damaged them. Increased DO levels in the water were concluded to be the cause of increased water quality in the immediate area. Continued environmental focus in the area – while a positive trend – will continue and increase the impact DO levels have on the piles.

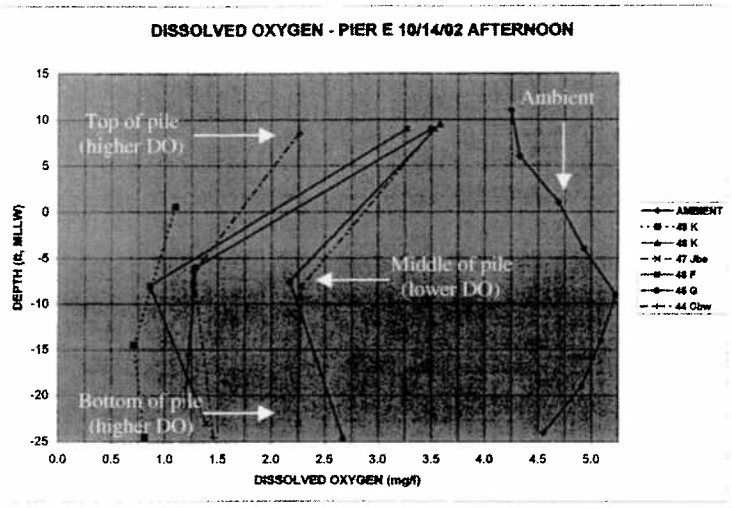

Figure 15 – Dissolved oxygen level along length of select sample piles; notice low level at middle of piles and higher levels near top and bottom of piles

Overall condition of the piers was deemed "relatively good" from a structural standpoint. Vertical and batter piles under the piers, on average, displayed a 10-15% loss of cross-sectional area. Concrete pile caps and decking on Pier Delta showed corrosion but were in overall good condition. Timber pile caps and decking on Pier Echo showed higher levels of deterioration, noted as being in "fair" condition. A number of deck timbers and pile caps on Pier Echo displayed splitting and/or dry rot that reduce structural capacity and allow rainwater intrusion, which translates to further deterioration. At a user level, the deck condition of Pier Echo contributed to tripping and other hazards.

Berger/Abam's investigation drew several important conclusions and made five primary recommendations:

1. Continued repairs were needed to maintain the piers' operational capabilities until 2008, at a cost of $365,000 ($436,000 in 2007 dollars).
2. Pier Echo could support a 30 Ton crane *only* with outriggers and proper cribbing.

3. Pier Delta could not support *any* crane operations without specific engineering guidance for outrigger placement.
4. Any future pile wrapping MUST extend two feet below the mudline and above the high water line.
5. Debris under the piers – Pier Echo in particular – should be removed, and further intrusion limited through installation of effective camels around the piers.

Berger/Abam also recommended that a representative number of pile wraps be removed to accurately determine the amount of internal deterioration that has occurred behind the wraps at mid-pile. Concern existed over the possibility of potentially higher levels of structural degradation inside wrapped piles. Destructive testing of piles was not conducted, however observations of existing piles that have been cut off above the mudline over past years show the extent of degradation that is possible (see Figure 16).

Figure 16 – Sample pile demonstrating potential for interior pile degradation

Observations: Current Condition of Piers and Piles

Extrapolating the 2003 study's conclusions to 2007, and comparing them to current observations of Piers Delta and Echo, renders the 2003 conclusions rather accurate. Overall, continued degradation is observed in below water timber members, while above water concrete components of Pier Delta remain in relatively good condition. Current observations follow, with yellow markings to indicate areas of concern:

Piles – Continuing to degrade. A number of piles are split at the interface with the pile caps and other piles demonstrate additional failure mechanisms (right pile is fully cracked and crooked).

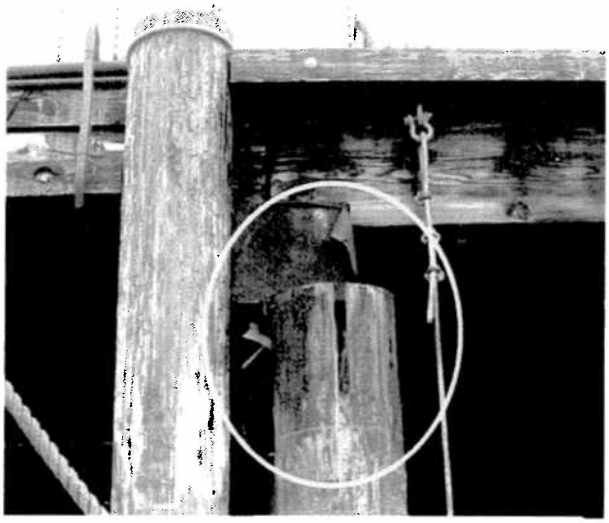

Figure 17 – Split pile

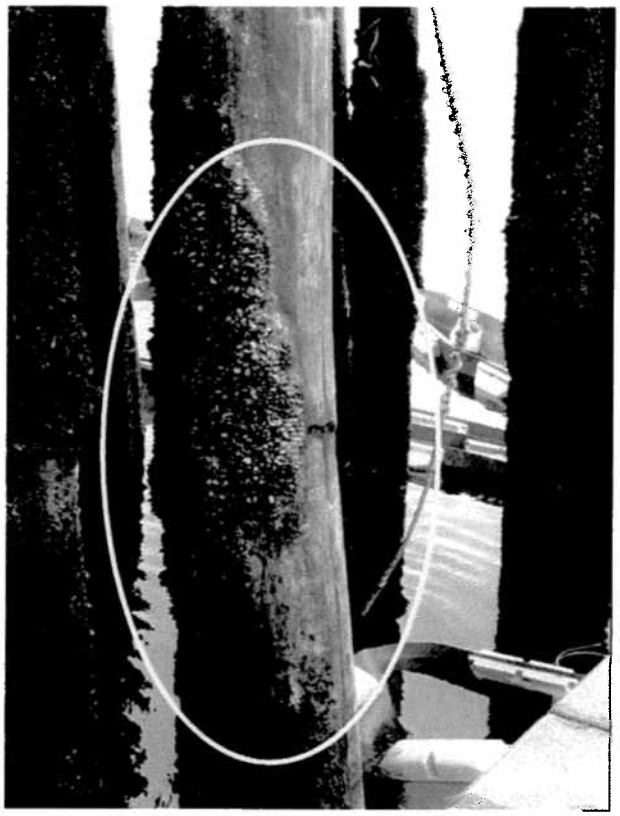

Figure 18 – Cracked pile

Wraps – Appear to be in similar condition as described in the 2003 report, though no investigation into conditions behind the wraps has been completed. Some wraps on Pier Echo are ripped all the way through, damaged by intruding debris.

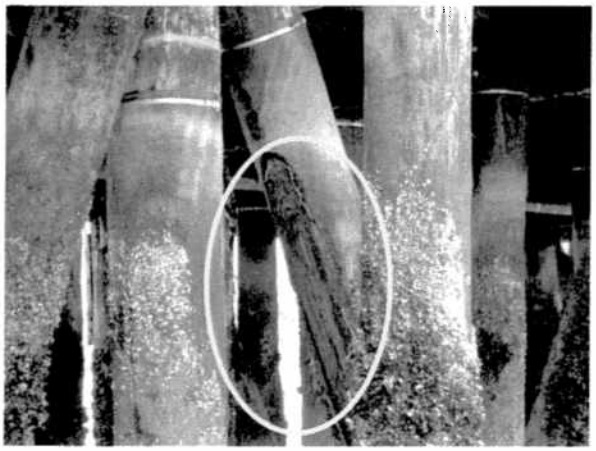

Figure 19 – Pile wrap ripped by debris intrusion

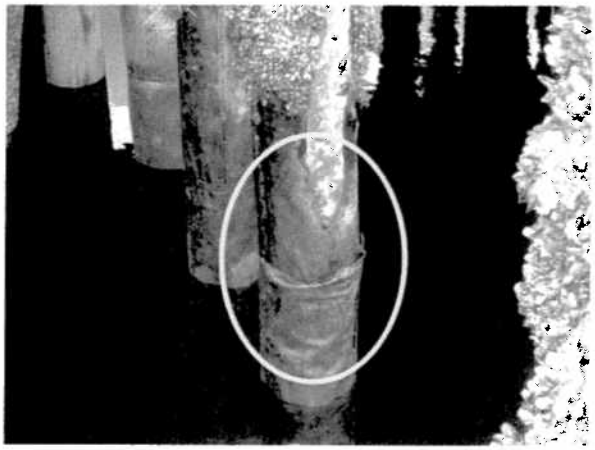

Figure 20 – Damaged, loose pile wrap

Timber decking (Echo) – Similar condition as described in 2003 report, though continued dry rot has required several metal plates over particularly weak and rotted deck timbers. Additionally, a non-slip walkway was installed to address the slippery conditions of worsening deck timbers.

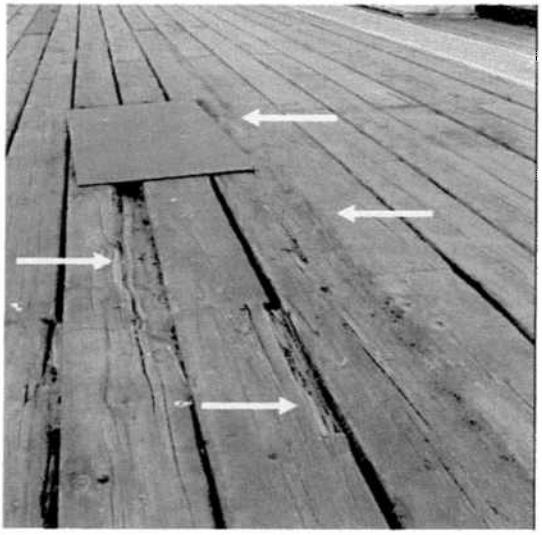

Figure 21 – Dry rot requiring metal plate covers

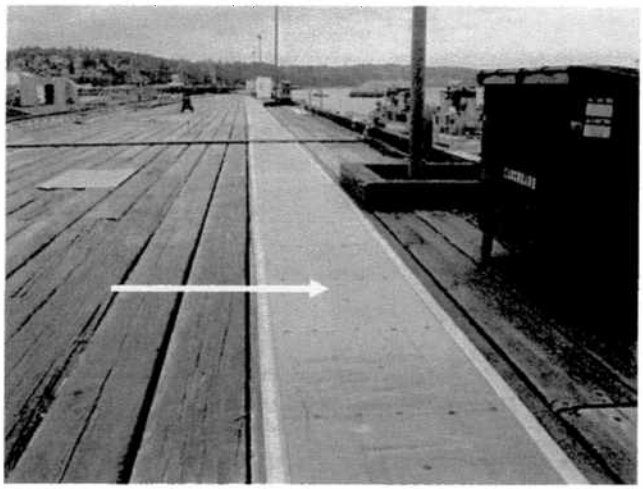

Figure 22 – Non-slip walkway over slippery deck timbers

Concrete decking (Delta) – Overall good condition with minor surface cracks/defects.

Figure 23 – Concrete surface cracks

Timber pile caps (Echo) – Clearly deteriorating, with many misaligned piles and pile caps.

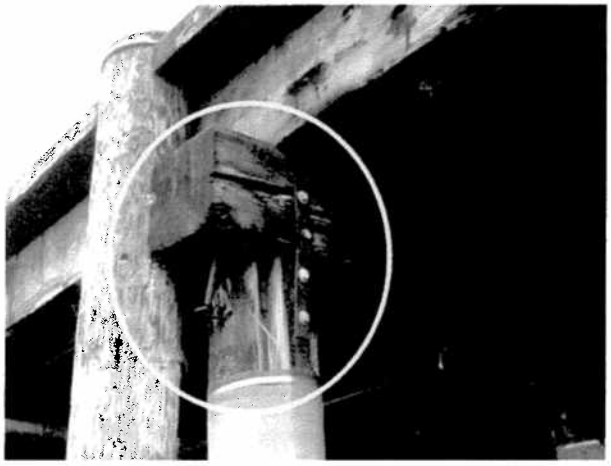

Figure 24 – Splintered pile at pile cap interface

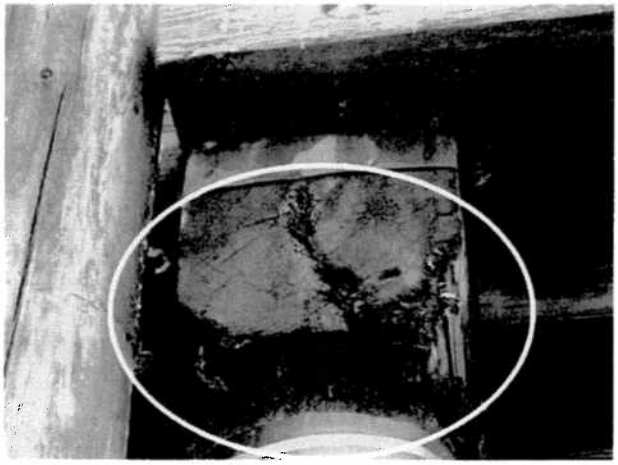

Figure 25 – Misaligned piles and pile caps

Concrete pile caps (Delta) – Overall good condition.

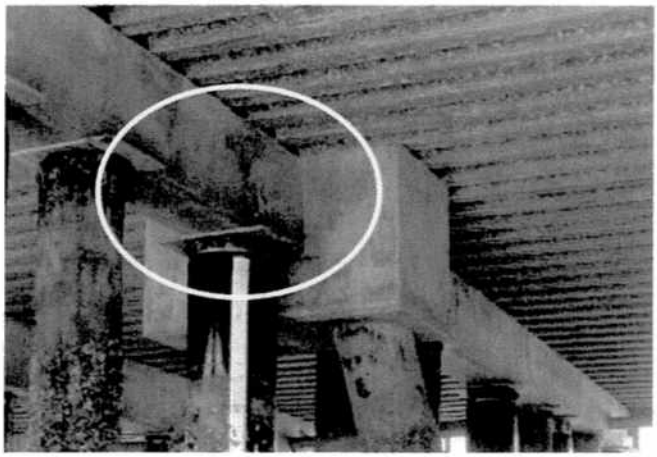

Figure 26 – Concrete pile caps and composite metal decking

Camels and debris – Camels installed in past years have been ineffective and allowed debris into the pile network, causing damage to piles and wraps. All installed camels have sunk or otherwise no longer serve their intended purpose.

Figure 27 – Debris under Pier Echo

Figure 28 – Missing camels along pier exteriors

Utilities – Virtually nonexistent on the pier, forcing Port Operations to emplace temporary water lines and other utilities, as necessary. Functional electrical power runs to the office YFN on Pier Echo.

Figure 29 – Temporary utilities on pier deck

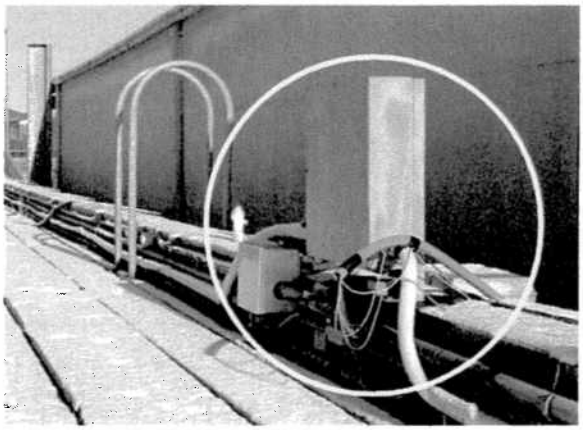

Figure 30 – Current electrical utility on Pier Echo

Section 5: Repair Alternative

Since their construction, repair has been the only executed means of maintaining operational status of Piers Delta and Echo. As presented in Section 4, a series of repair projects over the past 10+ years has forced the piers to operate at a decreasing level of service when compared to that required by the end users. At a minimum, based on recommendations of past studies, the piers require several major repair/upgrade projects and studies in the near future, including:

- Reassess timber pile conditions to identify critical piles and extent of continued decay. This requires destructive testing beyond non-destructive inspections of the past to assess actual conditions of piles *inside* the wraps.
- Replace critical piles that no longer contribute structurally to the piers. This remains an option only for Pier Echo. It is not feasible to make necessary cuts through the reinforced concrete deck of Pier Delta to replace piles without compromising the structural integrity of the concrete deck.
- Wrap piles that would benefit from application of a wrap. Wrapping should be executed in accordance with procedures similar to those outlined in Reid Middleton's Specification Section 02487, extending below the mudline and above the high water mark.
- Rewrap piles with damaged wraps, as illustrated in Section 4.
- Consider rewrapping previously wrapped piles that have displayed continued decay, in spite of the wrap.
- Install new camels around both piers at the water level to prevent debris intrusion under the piers. If effective camels cannot be installed, continuous debris removal should be expected and executed.

- Replace decking timbers on Pier Echo.
- Repair assorted connections at the pile/pile cap interface. This applies primarily to Pier Echo, though Pier Delta should be inspected for proper connections at the interface.

Additionally, load limitations must continue on the piers and likely become increasingly restrictive with time:

- Restricted live loads.
- HS20 trucks only.
- Crane use only on Pier Echo, with advisement for outrigger placement.

Berger/Abam estimated the cost of minimum repair efforts from the time of their 2003 study to 2008 at $365,000 (2003 dollars). Several projects were initiated, though few were executed, during this timeframe. Given the amount of repair on the piers compared to estimated repair requirements for the 2003-2008 timeframe – using this as an indication of the level of future repair execution – it is unlikely NS Everett will be able to apply sufficient attention to sustain the piers in their inadequate, status quo condition.

A cost projection associated with exercising a repair alternative for the piers through 2033 is presented below in Table 5. This projection is based on a recurring five-year inspection and repair schedule.[11] In every fourth year of the cycle, an inspection is conducted to establish specific requirements for programming projects executed in the fifth year. Given the estimated cost of projects required in each 5-year cycle (greater than the Military Construction threshold of $750,000) a lengthy 4-5 year planning process will ensue for each project. Hence, funding the execution timeline presented in Table 5, while necessary, is unrealistic for the early years and marginally realistic for years 2013 and beyond. Furthermore, the high cost of this program

[11] Costs based on Berger/Abam study of 2003 and escalated with NAVFAC Northwest Cost Indices.

merely represents sustaining the piers at their current level of service, which, when compared with NAVFAC pier criteria and end users' needs, maintains the piers at an unacceptable level.

In developing the cost estimate in Table 5, the following assumptions were applied to inspection, structural, and utilities (electrical and mechanical) areas of continuing maintenance:

Inspection: Two weeks of a 2-person field crew, 4-person office crew, and dive team.
Structural: Pile, pile caps, and deck repair costs plus 15% increase every 5 years as structural member decay continues.
Utilities: 5% of electrical replacement cost and 10% of mechanical replacement cost.

Table 5 – Recurring repair alternative cost estimate*, 2007-2033

Year	Inspection	Structural**	Utilities	Annual Cost	Cumulative Cost
2007	107,450			107,450	107,450
2008		1,643,983	37,607	1,681,590	1,789,040
2009				0	1,789,040
2010				0	1,789,040
2011				0	1,789,040
2012	107,450			107,450	1,896,490
2013		1,891,117	37,607	1,928,725	3,825,214
2014				0	3,825,214
2015				0	3,825,214
2016				0	3,825,214
2017	107,450			107,450	3,932,664
2018		2,175,262	37,607	2,212,870	6,145,534
2019				0	6,145,534
2020				0	6,145,534
2021				0	6,145,534
2022	107,450			107,450	6,252,984
2023		2,501,194	37,607	2,538,801	8,791,785
2024				0	8,791,785
2025				0	8,791,785
2026				0	8,791,785
2027	107,450			107,450	8,899,235
2028		2,876,074	37,607	2,913,682	11,812,916
2029				0	11,812,916
2030				0	11,812,916
2031				0	11,812,916
2032	107,450			107,450	11,920,366
2033		3,307,067	37,607	3,344,675	15,265,041
TOTAL	644,699	14,394,697	225,645	15,265,041	15,265,041

* 2007 dollars

** 15% increase/5 years due to degradation

Section 6: Replacement Alternatives

With primary consideration given to meeting NAVFAC pier requirements, several replacement options exist to meet NS Everett's operational requirements. Additional design/project considerations in this analysis include seismic capacity, environmental impact during construction, and continuing maintenance requirements. Given these considerations, two feasible replacement scenarios are considered, with two slightly different options for each:

- Traditional: Single, fixed concrete pier with floating "finger piers" (67 year useful life)
- Innovative: Single, floating modular hybrid pier (75-100 year maintenance-free useful life)

NAVFAC Northwest studied the finger pier option in 2005 and Berger/Abam studied both the concrete and floating pier options in 2003. Augmenting these studies with current knowledge and updating them with respect to 1) necessary scope changes and 2) changes in the construction industry in Western Washington will allow direct comparison of the options against one another. Additionally, continuing maintenance cost estimates are included with each alternative to allow comparison of the replacement alternatives against the repair alternative.[12] Follow-on commentary in Section 7 will provide conclusions and proposed actions for the recommended alternative.

[12] See Section 5.

Single, Fixed Concrete Pier with Finger Piers[13]

The first replacement option considered is to demolish both piers and replace them with one fixed, general-purpose pier and small "finger piers" protruding from the new pier's eastern and/or western edges (see Figures 31 and 33). The pier will occupy the existing Pier Echo footprint but extend an additional 34 feet to the west. This yields pier dimensions of 580 feet by 80 feet, expanding width from the existing 46 feet to align with NAVFAC requirements. The pier will consist of precast, prestressed concrete piles and pile caps, supporting a deck

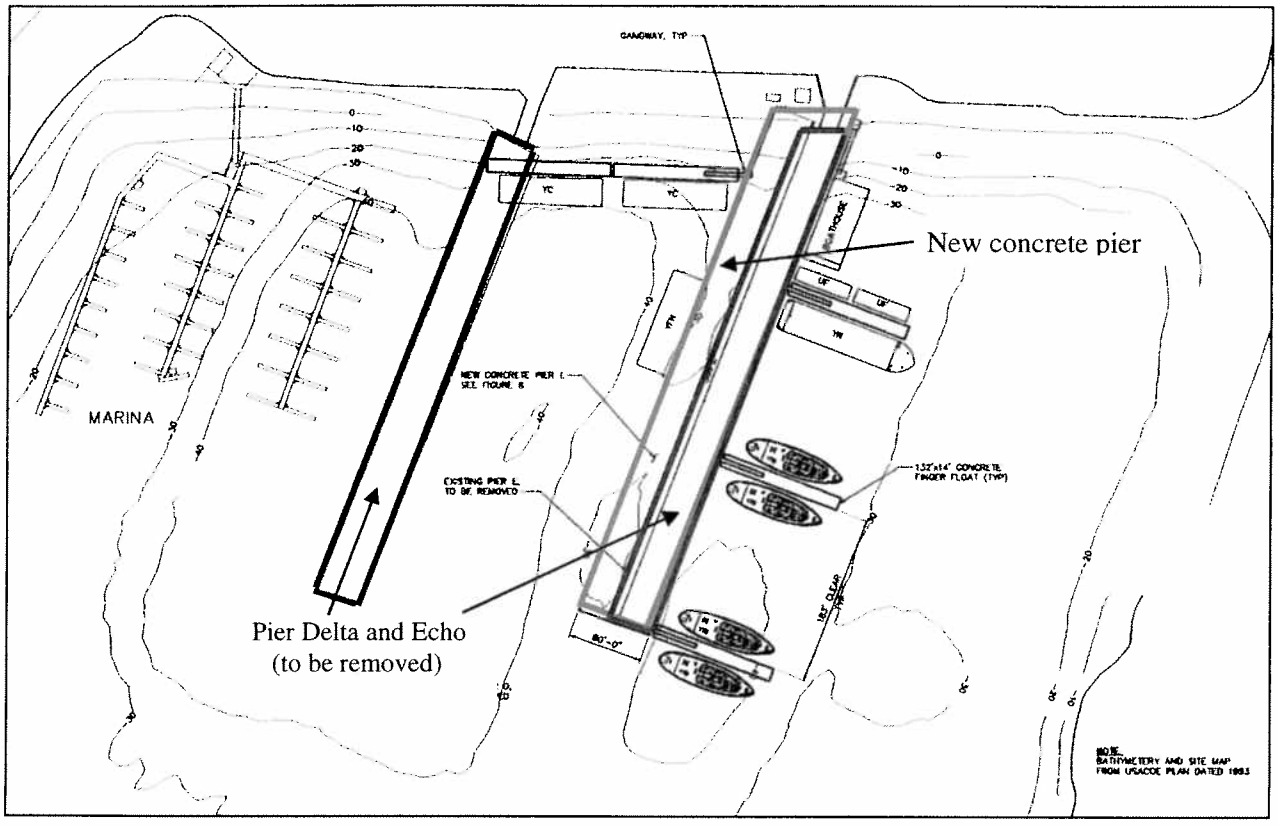

Figure 31 – Layout #1 of concrete pier with finger piers on current Pier Echo footprint (Berger/Abam, 2003)

constructed of precast, prestressed concrete panels and complimented by a steel brow. The new pier structure will be designed to withstand the displacements imposed by a design level earthquake and all service loads. The deck surface will be sloped for drainage into longitudinal trenches along the exterior longitudinal pier edges. New electrical and mechanical systems will

[13] Jurcak, T. P163A – Construct Small Craft Berthing Pier, Everett, Washington, Naval Facilities Engineering Command Northwest, 31 March 2006.

be provided on the pier and remedy current deficiencies. A utility trench along the exterior of the pier (see Figure 32) covered with removable, rain-tight hatch covers will remedy two current deficiencies; the covers provide protection from the elements, and location of all utilities above the high-water mark precludes debris damage noted in past studies. Utilities on the pier will consist of electrical (includes fire alarm and communications systems), potable/fire water, steam, and compressed air. Electrical service will be 480-volt, three-phase power, as required by NAVFAC and the individual end users. Streetlight style light poles along both sides of the pier

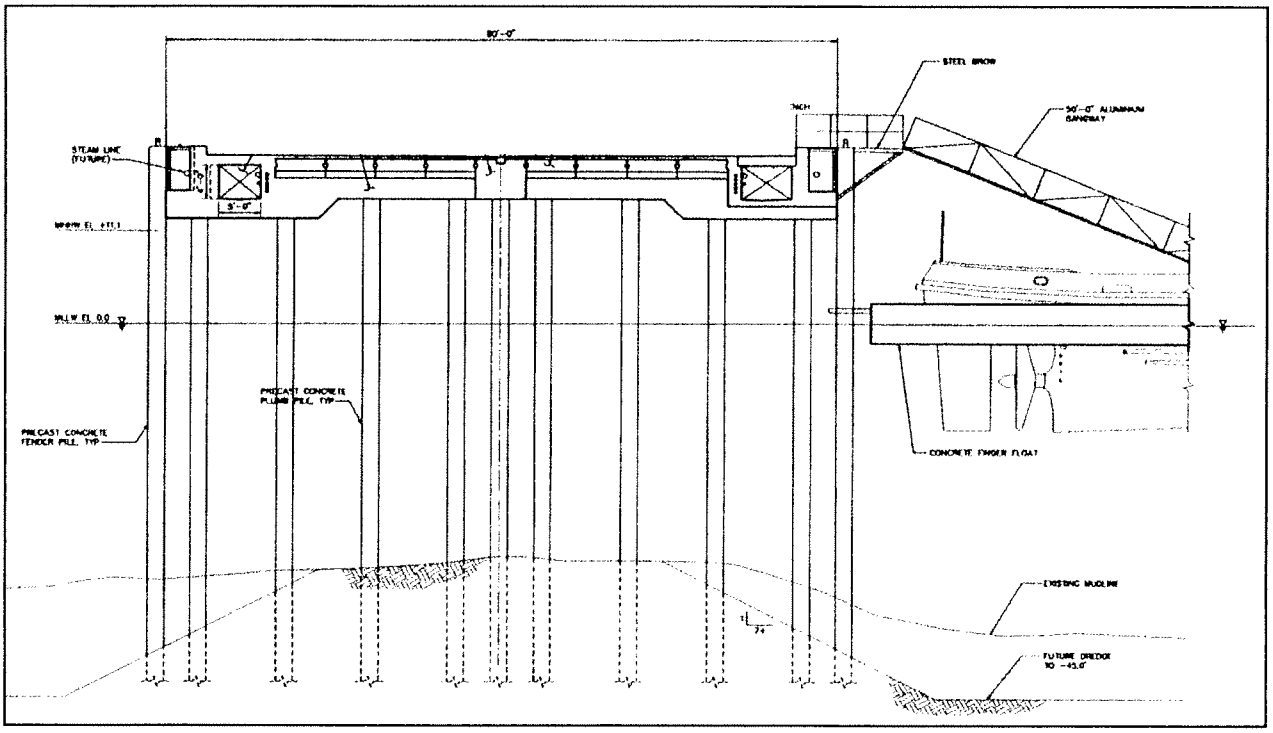

Figure 32 – Cross-section of concrete pier with floating finger piers

will provide security and lighting coverage throughout the immediate pier area as a proactive antiterrorism/force protection measure. Additional surveillance monitoring and under deck lighting will further enhance pier security. A ledge around the exterior of the pier will allow effective steam service to berthed boats.

In order to maintain a similar mooring capacity to Piers Delta and Echo, portable concrete finger pier floats will increase overall pier efficiency and provide space to moor smaller

vessels and barges. Each finger pier will measure approximately 130 feet by 15 feet and consist of a foam-filled concrete material designed to support the berthing of two YTBs or barges.[14] Fixed to the pier at the inboard end, a steel or concrete guide pile at the outboard end of each finger pier will fix each one's position. Additional floats could be added or removed, or existing ones reconfigured, to adjust to changing small craft mission requirements or introduction of a larger vessel. The use of portable floats allows shifting of positions from the pier and is more cost effective and versatile. A portable aluminum 50-foot gangway will attach to the steel brow and allow access from the fixed pier to the level of the floating finger piers and boats moored to them.

Depending on environmental considerations, the specific operational desires of Port Operations and ATG, and other factors considered during the design phase of the project, several finger pier configurations are possible. Figure 31 shows a configuration of five total finger piers; three along the east side at the pier's outboard end and two along the western side at the inboard end. This configuration allows utilization of the existing boathouse and mooring of boats to the finger piers, while providing an ideal location to berth the *Mariposa* for training operations.

An alternate layout for the finger piers is presented in Figure 33. This configuration details a straight line of five finger piers along the western edge toward the outboard end of the pier. This will provide berthing space for small craft along a concentrated portion of the pier, leaving space for the *Mariposa* and the existing boathouse. Arranging finger piers in this fashion also reduces the necessity for daily operations on the eastern side of the pier near the Kimberly-Clark paper mill.

[14] Section 3 contains operational requirements and description of YTBs/barges.

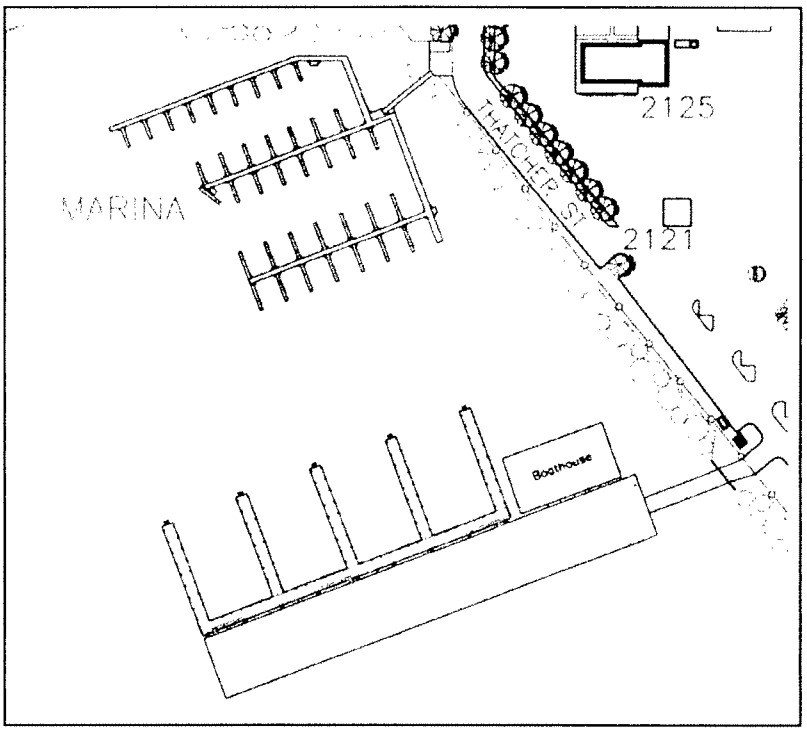

Figure 33 – Layout #2 of concrete pier with finger piers

Table 6 outlines an estimate of the construction costs to implement a fixed pier with finger piers replacement strategy. The estimate details construction costs and maintenance costs separately to draw a difference between initial and continuing capital expenditures. Maintenance costs are expected to follow a five-year cycle, similar to the cycle outlined for the repair alternative.[15] The following assumptions were applied to inspection and maintenance costs (structural, electrical, and mechanical):

Inspection: 2 weeks of a 2-person field crew, 4-person office crew, and dive team.
Structural: 2% of initial project cost plus 2% increases every 5 years.
Utilities: 2% of electrical replacement cost and 5% of mechanical replacement cost.

Summing the construction and maintenance costs provides the total cost to design, construct, inspect, and maintain the pier infrastructure through the year 2033. This analysis timeframe allows direct comparison of alternatives to one another.[16]

[15] See Section 5.
[16] See Section 7.

Table 6 - Fixed pier with finger piers (design, construction, and maintenance costs)

Item	Unit	Quantity	Unit Cost*	Total Cost*
Construct small craft berthing pier				10,330,426
Pier construction (580' x 80')	m2	4311	1,723	7,427,973
New approach and slope improvements	LS	1	2,514,096	2,514,096
Technical operating manuals	LS	1	81,759	81,759
Information systems	LS	1	40,880	40,880
Anti-terrorism/force protection	LS	1	265,717	265,717
Supporting facilities				4,532,262
Security lighting	LS	1	255,498	255,498
Electrical utilities	LS	1	537,249	537,249
Mechanical utilities	LS	1	153,299	153,299
Paving and site improvements	LS	1	715,393	715,393
Demolition	m2	4863	386	1,875,408
Floating finger piers	EA	5	179,083	895,415
Boat launch and recovery system	EA	1	100,000	100,000
Subtotal				14,862,688
Contingency (5%)				743,140
Total contract cost				15,605,828
SIOH (6%)				936,350
Subtotal				16,542,178
Design cost: design-build (4%)				661,690
Total Construction Cost				*17,203,868*
Continuing maintenance costs				
2018 - Maintenance and inspections	LS	1	435,984	435,984
2023 - Maintenance and inspections	LS	1	442,819	442,819
2028 - Maintenance and inspections	LS	1	449,655	449,655
2033 - Maintenance and inspections	LS	1	456,490	456,490
Subtotal				1,784,948
SIOH (6%)				107,097
Total Maintenance Cost				*1,892,045*
TOTAL COST THROUGH 2033				19,095,912

* 2007 dollars

Though NAVFAC pier criteria require a width of 80 feet, NS Everett does not need the full width for its small craft berthing mission. A pier of similar width will adequately serve mission requirements and reduce the initial construction cost. Table 7 displays an estimate of the construction costs to implement a modified, 50-foot-wide fixed pier with finger piers replacement strategy.

Table 7 - Modified fixed pier with finger piers (design, construction, and maintenance costs)

Item	Unit	Quantity	Unit Cost*	Total Cost*
Construct small craft berthing pier				7,544,936
Pier construction (580' x 50')	m2	2694	1,723	4,642,483
New approach and slope improvements	LS	1	2,514,096	2,514,096
Technical operating manuals	LS	1	81,759	81,759
Information systems	LS	1	40,880	40,880
Anti-terrorism/force protection	LS	1	265,717	265,717
Supporting facilities				4,532,262
Security lighting	LS	1	255,498	255,498
Electrical utilities	LS	1	537,249	537,249
Mechanical utilities	LS	1	153,299	153,299
Paving and site improvements	LS	1	715,393	715,393
Demolition	m2	4863	386	1,875,408
Floating finger piers	EA	5	179,083	895,415
Boat launch and recovery system	EA	1	100,000	100,000
Subtotal				12,077,198
Contingency (5%)				603,860
Total contract cost				12,681,058
SIOH (6%)				760,870
Subtotal				13,441,928
Design cost: design-build (4%)				537,680
Total Construction Cost				*13,979,608*
Continuing maintenance costs				
2018 - Maintenance and inspections	LS	1	371,499	371,499
2023 - Maintenance and inspections	LS	1	377,044	377,044
2028 - Maintenance and inspections	LS	1	382,590	382,590
2033 - Maintenance and inspections	LS	1	388,135	388,135
Subtotal				1,519,269
SIOH (6%)				91,156
Total Maintenance Cost				*1,610,425*
TOTAL COST THROUGH 2033				15,590,033

* 2007 dollars

Single, Floating Modular Hybrid Pier

Perhaps one of the most exciting research topics in the area of Navy pier infrastructure is the floating Modular Hybrid Pier (MHP). This section presents the ongoing MHP program, its current conclusions, and its scope. The conceptual design appropriately focuses on application to large Naval vessel berthing, not small craft berthing. However, the basic design can be modified to support smaller vessels. The conceptual design firm, Berger/Abam, confirmed this possibility.[17]

Recognizing the aging pier infrastructure across the Navy and the extraordinary maintenance costs associated with sustaining them, Naval Facilities Engineering Support Center (NFESC) embarked on a venture with Berger/Abam to develop a suitable pier to support the Naval Fleet into the future. The research program consists of utilizing emerging material technologies to develop an entirely new paradigm for Naval pier design and construction. "The purpose of the program was to develop cost competitive, long lived, lightweight, and modular structural concepts for Navy pier construction having a zero maintenance requirement for 75 years in a severe marine environment."[18] Program design criteria include the following:

- Modularity
- Operational space
- Utilities (water, electrical power, sewer, steam, compressed air, communications, and fire alarm)
- Waste handling
- Personnel transfer features
- Maintenance and repair capabilities
- Cargo transfer capability
- Access facilities
- Fendering
- Crane services ability
- Mooring devices
- Access for external transportation
- Lighting

[17] M Wernli, Interview with the author, 29 May 2007.

[18] Berger/Abam, Final Report, Phase 1 – Concept Development Modular Hybrid Pier (MHP), February 2000.

- Security provisions.

The MHP uses post-tensioned, high strength, lightweight concrete with corrosion resistant reinforcement to provide a double-deck – upper, operating deck and lower, service deck – pier for vessel berthing. The pier is fixed in place by a single steel mooring shaft per module, supported by a mooring dolphin. The mooring dolphin consists of a concrete pile cap roughly 40

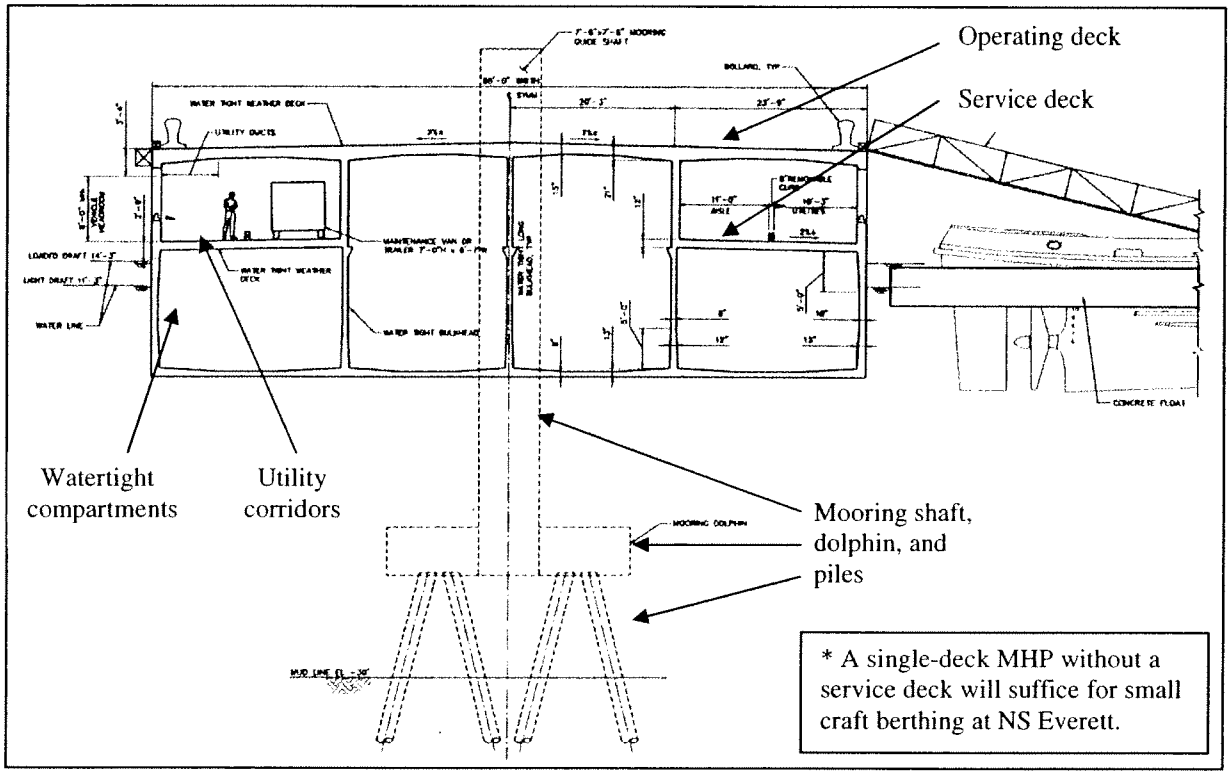

Figure 34 – Cross section of MHP with compartment, deck, and mooring indications (Berger/Abam, 2003)

feet square on a network of approximately 16 traditional piles (see Figure 34).

NFESC has conducted many load analyses of the design using finite element models. The pier modules and mooring system can sustain the impact of a drifting ship; forces applied by current, wave, and wind in a 100-year event; probable seismic events; internal flooding of a module; and loads of multiple 140 Ton cranes at maximum lift (Berger/Abam, 2003). The models remain in use to improve the design in addressing operational and performance concerns as design and testing continue.

By nature of its name, one of the pier's greatest strengths is its *modular* design. The standard individual module is 325 feet long, 88 feet wide, and 29 feet high with a draft of 14 feet. Four modules can be joined into a 1300-foot pier to berth an aircraft carrier, though the design allows assembly of anywhere from 2-5 modules. Additionally, steel mooring shafts are designed around combined loading conditions for application in any Naval port. Modules are designed for open-ocean towing and can be relocated and/or reconfigured based on mission changes at the local, regional, or global level.

Ongoing Phase 3 of the MHP study consists of smaller, operational testing of all aspects of MHP implementation: construction, open-ocean towing, mooring system construction, and operations. All structural components for two 50-foot square modules were cast and assembled into modules at a dry dock facility in Tacoma, Washington and subsequently towed 1100 nautical miles to Naval Station San Diego in October 2005. The 50-foot by100-foot test bed passed all program requirements in construction and ocean towing.

Having met initial program requirements, testing begins in June 2007 following construction of the mooring system. The test bed consists of many combinations of concrete cover, reinforcement, and post-tensioning methods. With varying concrete cover, two combinations of reinforcement were used: 1) stainless steel (outboard) and epoxy-coated (inboard) 2) MMFX (inboard and outboard). Performance testing with artificial lateral and vertical loading mechanisms will continue through October 2007, with major testing in July and August. Long-term performance testing of the test bed is not planned as part of Phase 3 and the likely next step in the MHP program is a full-scale pier that begins the implementation phase.

As earlier stated, the MHP development project is geared toward berthing for much larger vessels, to include aircraft carriers (CVN), guided missile destroyers (DDG), guided missile frigates (FFG), and cruisers (CG). For large Naval vessels, each of the operational and service capabilities the pier provides is of great importance, however they carry varying levels of importance in application to small craft berthing. Due to the decreased berthing load of small craft, when compared to Naval vessels, a MHP for this purpose could be substantially reduced in size. For application at NS Everett, Berger/Abam recommended a 552.5-foot long pier of two modules 88 feet wide as a spatially-suitable, replacement for Piers Delta and Echo (see Figure 35). The 14-foot draft of the MHP requires positioning a bit further from shore to maintain minimum vertical clearance at the Mean Lower Low Water level (MLLW). In order to maintain a target mooring capacity equal to 150% of either Pier Delta or Echo – 75% of total current capacity – concrete floats similar to the "finger pier" option are included.

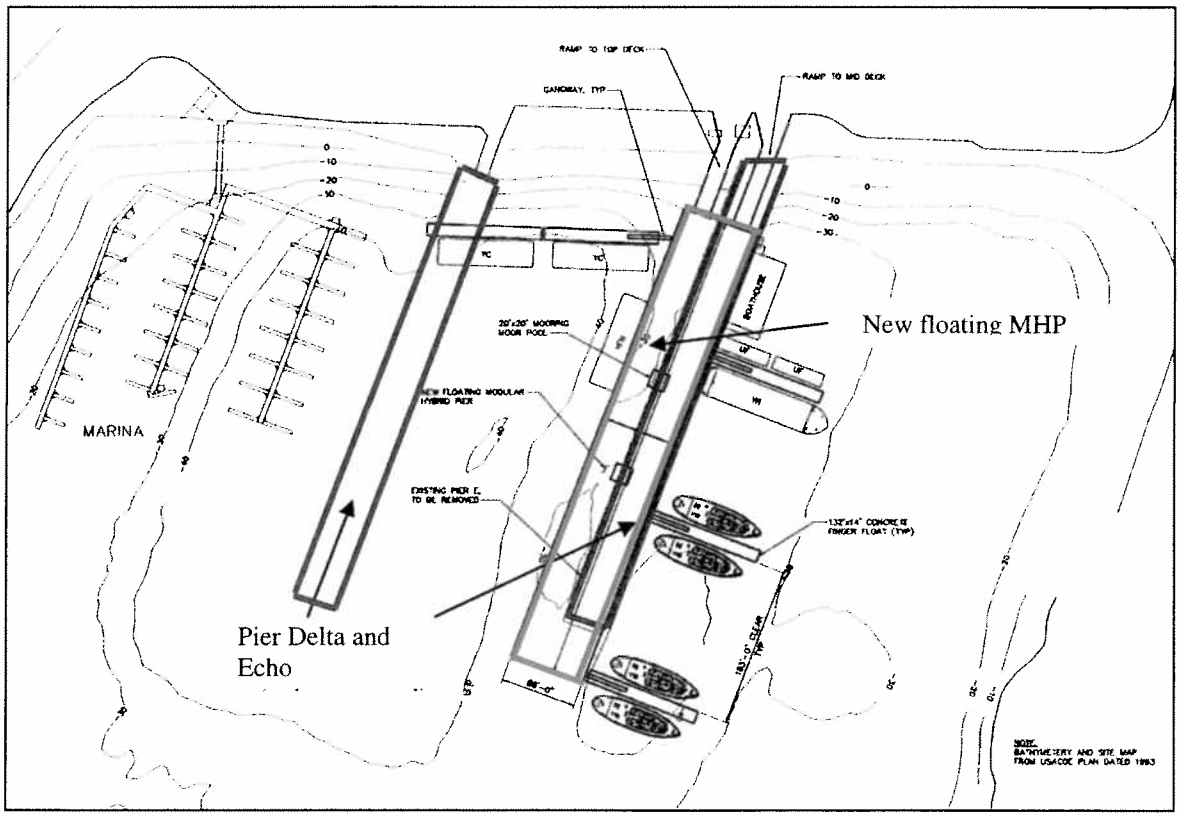

Figure 35 – Layout of 88-foot-wide MHP on current Pier Echo footprint (Berger/Abam, 2003)

Alternately, since neither 88 feet of pier width nor a service deck is necessary for small craft berthing in Everett, a slightly smaller, modified MHP would cut costs and make this a more competitive option to attain funding. The width of the concept pier is designed around ability to turn around a truck on the service deck and stability concerns over operating several 140-ton cranes simultaneously, neither of which is a driving requirement in Everett. As Figure 36 shows, one could cut out the service deck (marked in blue) and/or the inboard air voids (marked in red) to produce a single-deck pier approximately 50 feet wide. Reducing the width will reduce the loading capacity but maintain sufficient capacity for crane operations in support of small craft

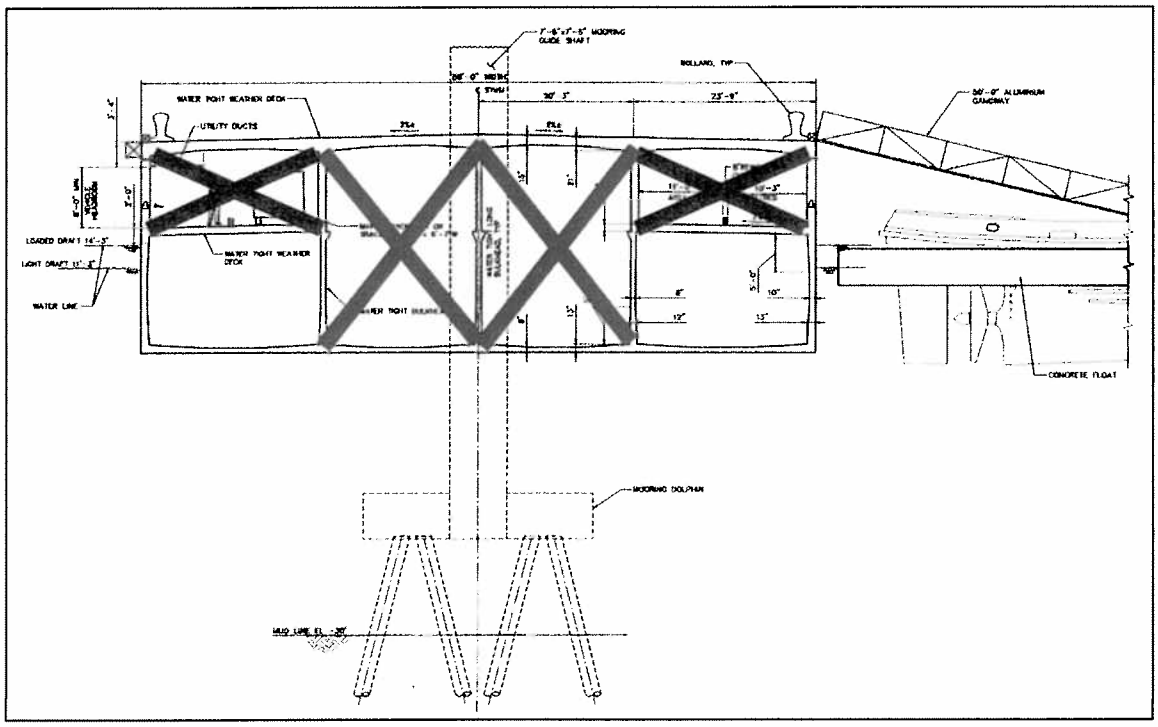

Figure 36 – Cross-section of modified, single-deck MHP

berthing. Additionally, reduction to 50 feet falls below the NAVFAC pier requirement, though NAVFAC Northwest does not anticipate that a deviation presents a problem. Modifying the conceptual design according to these parameters has not yet been explored from a technical or design standpoint. It will require specific design and analysis to ensure it will satisfy technical and operational requirements for this specific application at NS Everett.

Table 8 details the cost of an 88-foot-wide MHP with a service deck. Table 9 details a rough cost estimate of a 50-foot-wide MHP without a service deck. The following assumptions were applied to continuing inspection and maintenance costs (structural, electrical, and mechanical):

Overall: This is a "maintenance-free" pier and requires minimal continuing repairs.
Inspection: 2 weeks of a 2-person field crew, 4-person office crew, and dive team.
Structural: Minimal.
Utilities: 2% of electrical replacement cost and 5% of mechanical replacement cost.

Table 8 - Full-width MHP with floating piers (design, construction, and inspection costs)

Item	Unit	Quantity	Unit Cost*	Total Cost*
Construct small craft berthing pier				12,551,431
Demolish existing piers	m2	4,863	386	1,874,928
New modular hybrid pier (552.5' x 88')	m2	4,517	1,709	7,720,223
New approach and slope improvements	LS	1	2,158,166	2,158,166
Floating finger piers	EA	5	159,623	798,114
Supporting facilities				744,699
Electrical (power, comm, and fire)	LS	1	537,249	537,249
Mechanical (potable water only)	LS	1	107,450	107,450
Boat launch and recovery system	EA	1	100,000	100,000
Subtotal				13,296,130
Contractor overhead and profit (25%)				3,324,033
Total contract cost				16,620,163
Design and contingency (20%)				3,324,033
Subtotal				19,944,195
SIOH (6%)				1,196,652
Total construction cost				*21,140,847*
Continuing maintenance costs				
2018 - Inspections	LS	1	97,260	97,260
2023 - Inspections	LS	1	97,260	97,260
2028 - Inspections	LS	1	97,260	97,260
2033 - Inspections	LS	1	97,260	97,260
Subtotal				389,040
SIOH (6%)				23,342
Total maintenance cost				*412,382*
TOTAL COST THROUGH 2033				21,553,229

* 2007 dollars

Table 9 - Modified MHP with floating piers (design, construction, and inspection costs)

Item	Unit	Quantity	Unit Cost*	Total Cost*
Construct small craft berthing pier				9,217,698
Demolish existing piers	m2	4,863	386	1,874,928
New modular hybrid pier (552.5' x 50')	m2	2,566	1,709	4,386,491
New approach and slope improvements	LS	1	2,158,166	2,158,166
Floating finger piers	EA	5	159,623	798,114
Supporting facilities				744,699
Electrical (power, comm, and fire)	LS	1	537,249	537,249
Mechanical (potable water only)	LS	1	107,450	107,450
Boat launch and recovery system	EA	1	100,000	100,000
Subtotal				9,962,397
Contractor overhead and profit (25%)				2,490,599
Total contract cost				12,452,997
Design and contingency (20%)				2,490,599
Subtotal				14,943,596
SIOH (6%)				896,616
Total construction cost				*15,840,212*
Continuing maintenance costs				
2018 - Inspections	LS	1	97,260	97,260
2023 - Inspections	LS	1	97,260	97,260
2028 - Inspections	LS	1	97,260	97,260
2033 - Inspections	LS	1	97,260	97,260
Subtotal				389,040
SIOH (6%)				23,342
Total maintenance cost				*412,382*
TOTAL COST THROUGH 2033				16,252,594

* 2007 dollars

Section 7: Discussion and Recommendations

Presentation up to this point has provided the necessary facts and figures to facilitate recommendations provided at the end of this section. Discussion leading up to recommendations will consider the following areas as variables in the planning process:

- Federal funding processes
- Project classification
- Operational disruption during construction
- Environmental impact
- Funding solutions.

One necessary bit of presentation remains in order to establish sufficient background for overall discussion: the federal government's planning and funding processes and how the Navy executes them. One of the most significant factors is the Military Construction (MILCON) funding threshold, which lies at $750,000. MILCON projects require specific Congressional approval and funding on a project-by-project basis and are provided to all services across the Department of Defense. The planning timeline for a MILCON project, from submission of project documentation to start of construction, is generally 4-5 years. Figure 37 shows the steps in the process of acquiring appropriation (funding) for a project. A similar process occurs – through the House and Senate Armed Services Committees and Subcommittees – to produce the Authorization Bill that provides legal authority to fund and execute projects. As seen in Figure

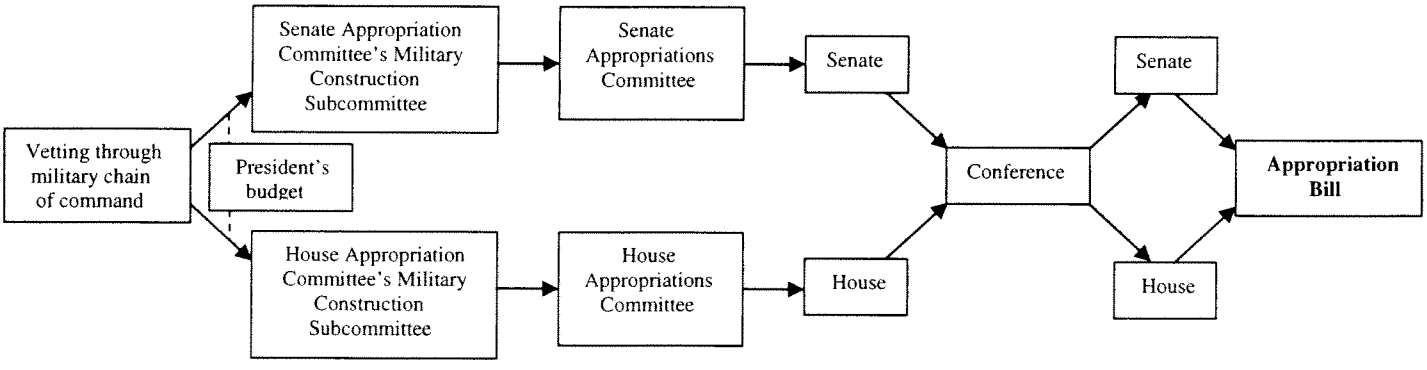

Figure 37 – Military Construction (MILCON) appropriation process

37, a project is vetted through all levels of the chain of command, through the Secretary of Defense, and on to Congress. The House and Senate Appropriation Committees and Subcommittees appropriate funds for specific projects, detailing authorized funding in the Appropriations Bill. One can see how laborious, involved, and political each step can be, so as to yield the 4-5 year process.

In line with this reality, the reasonable planning timeline for construction of either of the presented replacement alternatives[19] is FY 2012-2013, assuming project submission this year. All initial project costs (replacement alternatives) in Table 10 and continuing project costs (repair alternative) in Table 5 are above the MILCON threshold. Regional and base commanders possess authority to fund some types of construction and maintenance projects under the MILCON threshold.

Table 10 – Summary of project alternative costs

	Repair Alternative	Concrete Pier Alternative	Modified Concrete Pier Alternative	MHP Alternative	Modified MHP Alternative
Initial Project Cost	n/a	$17,203,868	$13,979,608	$21,140,847	$15,840,212
Continuing Maintenance/ Project Costs	$15,265,041	$19,095,912	$15,590,033	$21,553,229	$16,252,594

The repair alternative becomes more and more unrealistic with exploration of government funding limitations. Recurring maintenance projects on a five-year cycle places NS Everett in the position of always having a MILCON in planning for Piers Delta and Echo. Given the competition within the Department of Defense for MILCON project funding, it is conceivable that an initial project would be funded in the planning timeline given above. It is highly unlikely, however, that MILCON funding can be secured for necessary recurring projects every five years. Altering the cycle from five years to two or three years would, in theory,

[19] See Section Six

increase the number of projects and reduce the cost of each project, perhaps below the MILCON threshold. The poor condition of the piers will realistically only benefit from projects of substantial enough scope that they fall in the realm of MILCON funding. Additionally, with the passage of time, the attainable level of service through repair has dropped while the cost of construction has continued to rise. The result of this combination? Increasingly expensive projects that are in and of themselves less effective; "less bang for more bucks." This is not a proposition that will achieve – let alone maintain – sufficient momentum to secure necessary funding for an effective repair program. Based on MILCON funding constraints and competition, I recommend exclusion of a continuing repair program as a viable alternative for Piers Delta and Echo.

Funding for any replacement alternative will be challenging and require the base commander placing this project at the top of his priority project list with NAVFAC Northwest. Given the competition for MILCON funds within the Department of Defense, the cheaper a project, the better. The likelihood of Congressional approval increases substantially for lower cost projects, and scope is frequently removed from projects to reduce their cost as they move up the military chain of command. Follow on maintenance inspections and small repair projects should fall under the threshold for the regional or base commander to approve and fund.

Complicating funding issues is the project classification. The Navy has several general definitions used to classify a project that are applicable to this discussion; repair, maintenance, and construction.

Repair: Restoration of a real property facility to such a condition that it may be effectively utilized for its designated purposes, by overhaul, reconstruction or replacement of constituent parts or materials which are damaged or deteriorated to the point where they cannot be economically maintained.

Maintenance: The labor and materials required to maintain a facility in its customary state of operating efficiency.

Construction: The labor and materials required to build a new facility or to alter an existing facility by increasing its size or adding capabilities.

"Construction" projects generally undergo greater scrutiny than "repair" or "maintenance" projects because the former are viewed as a growth in Naval infrastructure in an era when the Navy is taking every effort to *reduce* its footprint. Table 11 compares likely classification of each replacement alternative. The modified options are both classified as "repair" as they occupy the exact footprint of Pier Echo and do not represent a growth in footprint or operational capacity. The Navy facility management community refers to this as "repair by replacement."

Table 11 - Replacement alternatives and likely project classifications

	Concrete Pier Alternative	**Modified Concrete Pier Alternative**	**MHP Alternative**	**Modified MHP Alternative**
Classification	Construction	Repair	Construction	Repair/Construction

Classified as "construction," the full-width version of each alternative adds pier footprint and capacity.

One of many considerations in project planning concerns the operational disruption that construction causes. Fortunately, replacement of both Piers Delta and Echo with a single pier allows use of Pier Delta during construction, followed by movement of operations to the new pier and demolition of Pier Delta. Since all replacement alternatives benefit from intermediate use of Pier Delta, the only difference in interruption arises from the construction methodology associated with the two types of piers. The concrete pier requires sequential demolition of Pier Echo and construction of the new pier. The MHP allows concurrent construction of the pier off-

site and the two mooring shafts on-site. The MHP would then be floated over top of the mooring shafts, tested, and put into service. The operational disruption would be less for the MHP.

The same trend would be observed for the general environmental impact of pier construction operations. A fixed pier could require as many as 600 individual vertical and batter piles. A MHP only requires approximately 40 individual support piles under the mooring dolphins. During construction, therefore, the environmental impact of the MHP is less.

Several methods could be approached to reduce the cost and increase the competitiveness of the proposed project. First, inclusion of a small craft launch and recovery system in the project increased the project cost estimates. One could reasonably anticipate its removal from the project scope by higher military authorities, being viewed as a "nice to have" feature of the project. Removing it from the project scope at the base level starts the project off on a good foot with the regional engineer staff and could enhance its likelihood of success.

Second, since MILCON funding is one of the more difficult "pots of money" to access, NS Everett could attempt to fund the demolition of Pier Delta from a different pot of money. This would maintain the same overall project cost but reduce the amount requested from MILCON funds. As previously mentioned, the Navy focuses on reducing footprint and has a pot of money designated for demolition projects that have no follow-on construction. Since demolition of Pier Delta is not an integral component of the new pier being a "complete and usable facility" this should be achievable and substantially reduce overall project cost.

Third, continued use of the YFNs and UFs currently moored to the piers will maintain the project scope as is and not require inclusion of office or storage space in this project or other projects across the base. Procurement of new YFNs and/or UFs also becomes unnecessary in this project.

Lastly, NS Everett could petition NFESC to select it as a site for further testing of the MHP under operational conditions in a seismic zone. Berger/Abam explained that the greatest hurdle currently confronting the MHP's continued progress is education[20]. Owners and contractors need to be educated as to the relative simplicity of the pier compared to the piers they are used to building and operating. Engineers need education on how to design with these types of structures with these types of materials. Government officials and the public need education of the pier's sustainable nature. The best way to educate is through smaller-scale implementation such as this small craft application.

Regardless of the path chosen to remedy the impact of the deteriorating piers, several additional concerns must be addressed as planning moves forward. If one of the modified replacement alternatives is selected, it will not meet the width requirement set by NAVFAC. A variation to this effect must be approved. Environmentally, the actual cost associated with executing either a fixed or floating pier is unknown. Given the high level of environmental control in the Pacific Northwest, costs could be substantially different from those estimated. Lastly, as seen in Figure 38 the legal property line of NS Everett cuts through both Pier Delta and Pier Echo. While not an issue at present, this will need to be addressed with the City of Everett prior to any reconstruction efforts.

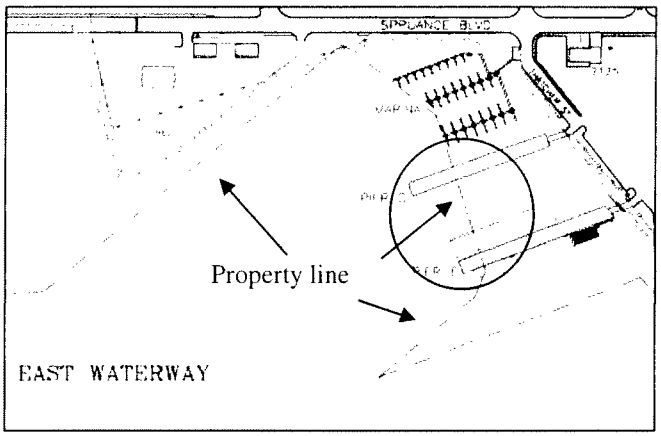

Figure 38 – Base map with marked legal property line

[20] M. Wernli, Interview with the author, 29 May 2007.

Based on this presentation and discussion, this study recommends the base pursue a single, modified fixed pier replacement alternative with a width of approximately 50 feet. The study further recommends that repair efforts be limited to those necessary to prolong pier use until the replacement project timeline. A draft DD Form 1391 – the primary project document vetted through the chain of command to Congress – is included as Appendix E. This 1391 will require refinement and inclusion of additional details and documentation as planning progresses. Consultation with regional planners at NAVFAC Northwest indicates this project will need to top the base Commanding Officer's project priority list. Placed as his #1 priority, the project could stand a chance in the competitive MILCON environment. Otherwise, the project may never gain traction and could "die at the planner's desk." For perspective, NAVFAC Northwest receives approximately $150M in annual MILCON funding, though higher amounts occasionally come to fund high-dollar projects[21]. This translates to 3-5 projects per year, depending on project value. Most of the funded projects serve new mission requirements and are highly visible, neither of which describes this project. Concerted effort from the base will be absolutely necessary to push this project through the scrutiny of the process, secure funding, and ultimately construct a new pier for its small craft mission.

[21] M. Vail, Interview with the author, 06 June 2007.

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Glossary

ATG – Afloat Training Group.

Batter pile – Diagonal pile that provides lateral structural capacity to a pier.

CG – Cruiser (Naval vessel).

CVN – Nuclear-powered aircraft carrier (Naval vessel).

DDG – Guided missile destroyer (Naval vessel).

DO – Dissolved Oxygen level in a water body/sample.

EFA Northwest – Engineering Field Activity Northwest, the regional Navy engineering command to whom NS Everett PWD reports. EFA Northwest was recently renamed NAVFAC Northwest.

FFG – Guided missile frigate (Naval vessel).

FY – Fiscal Year.

HSB – High Speed Boat. A small boat with dual outboard engines, usually employed by Navy SEAL units.

Inboard – Nautical term; located within the hull or toward the center of a vessel.

LCS – Littoral Combat Ship.

Marine borer – Organisms in water at the microbiological level that bore into wood material.

MHHW – Mean Higher High Water level at high tide.

MILCON – Military Construction project, valued at greater than $750,000.

MLLW – Mean Lower Low Water level at low tide.

MMFX – A microcomposite steel, epoxy-coated reinforcement used in place of traditional steel reinforcement bars.

NAVFAC – Naval Facilities Engineering Command.

NAVFAC Northwest – Regional Navy engineering command to whom NS Everett PWD reports. Formerly referred to as Engineering Field Activity Northwest.

NFESC – Naval Facilities Engineering Support Center, the primary construction and engineering technology development command for the Navy.

Outboard – Nautical term; located nearer or towards the outside of a ship or aircraft.

PO - Port Operations (department of NS Everett).

PWD – Public Works Department.

RHIB – Rigid Hull Inflatable Boat.

SIOH – Supervision, Inspection, and Overhead; costs charged by NAVFAC for support associated with the administration of contracts for facilities projects.

UF – Utility Float.

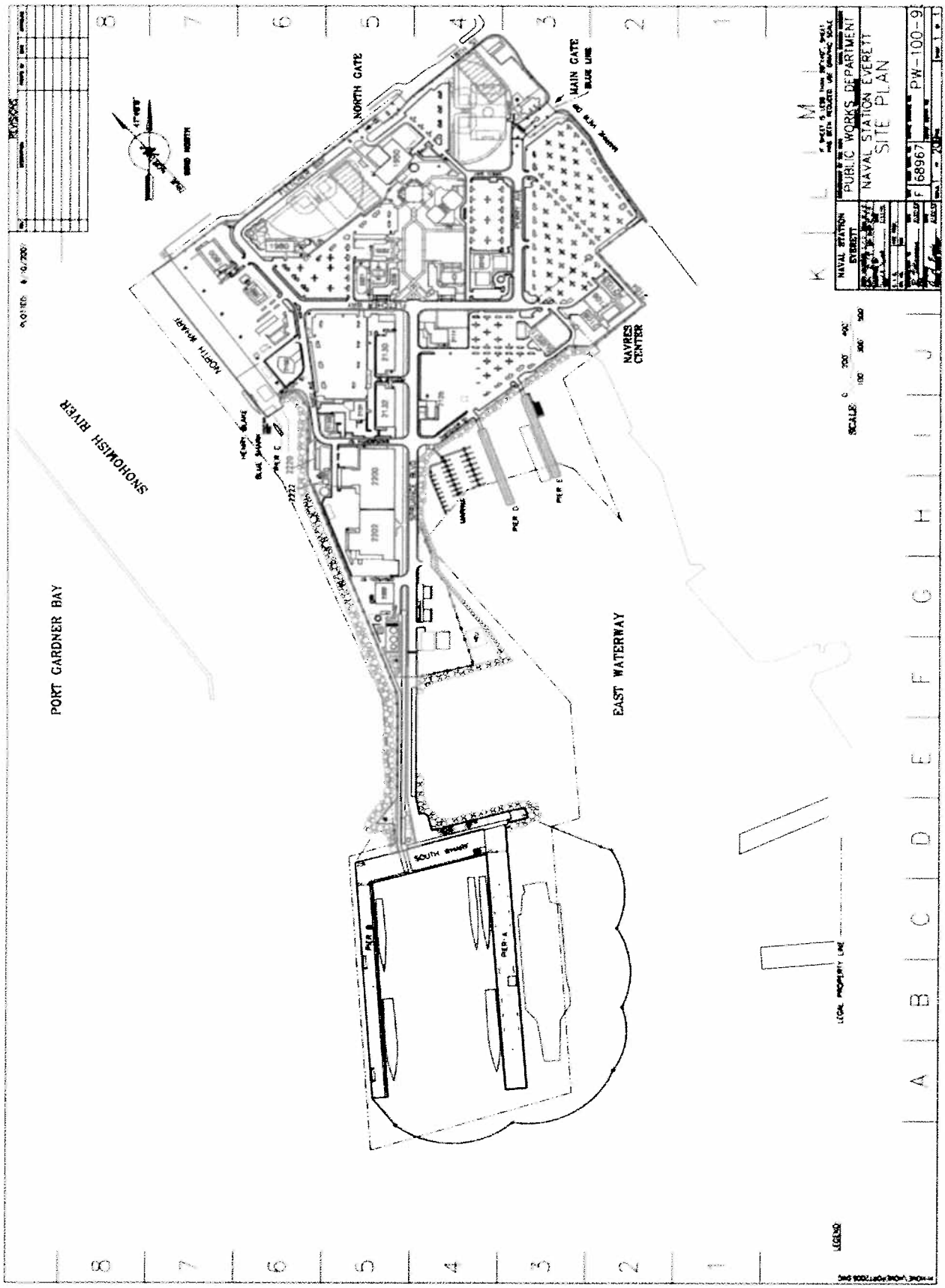
USCG – United States Coast Guard.

YFN – Yard Float Non-Nuclear Barge.

YTB – Yard Tub Boat (small craft vessel).

List of Appendices

Appendix A: Base Map



Appendix B: Official Property Record, Pier Delta

CLASS 2 PROPERTY RECORD

Report Date 03 MAY 2007 11:47

Installation	N68967	NAVSTA EVERETT WA	**Property No**	202079	
Special Area			**Facility No**	PIER D	
Instal Mgmt Clmnt	N00052	CNI	**Facility ID**	NFA100001506818	
Mission Claimant	N00052	CNI	**Facility Type**	3	STRUCTURE
Operational Claimant	N69292	CFFC	**Action Type**	3	CORRECTION
Former Installation			**Former PR No**		
Facility Name	PIER D		**Last Updated**	30 APR 2007	
			Family Housing Indicator	N	

Location

Region	N68742	CNR NORTHWEST
Country	US	UNITED STATES
State	53	WASHINGTON
County	061	SNOHOMISH
City	0690	EVERETT
Map Grid	I4	

Excess and Disposal

Excess Action	
Excess Date	
Consolidated PR	
Disposal Method	
Disposal Date	
Disp Contract No	

Acquisition

Estate Code	18 PURCHASE	**Acquisition Date**	05 MAY 1987
Land CCN	91110 LAND - PURCHASE	**Government Cost**	$ 2,461,184
Acq Contract	N6247487RP00A23	**Apr/Est Value/Date**	

Maintenance

Preponderant User	N68967	NAVSTA EVERETT WA
Prime Use CCN	15520	SMALL CRAFT BERTHING
Prime FAC Code	1551	SMALL CRAFT BERTHING
Mnt Fund Source	A	O&M, N
Mnt Responsibility	N68967	NAVSTA EVERETT WA
Eng Eval Date		
Current PRV	$ 1,458,378	**PRV at EOY 06** $ 1,458,378

Measurements

	English	Metric
Length	564.00	171.91
Width	45.00	13.72
Height		
Area	2,820.00	2,357.88
Area UM	SY	M2
Number of Stories		
Irregular Shape Ind	N	

Construction

Year Built	1941	**Original Proj No**	UNKNOWN
Year Improved		**Current Proj No**	UNKNOWN
Constr Type	P PERMANENT	**ABMP Code**	

Utilization

Fac Use CCN	15520 SMALL CRAFT BERTHING	**Min Val**	10.00	**DoD FAC**	1551
Facility Use		**Max Val**	5,500.00	**DoD UM**	FB
User Activity	N68967 NAVSTA EVERETT WA	**Otg Identifier**		**Primary UM**	FB

	Area		Other		Alternate	
	English	Metric	English	Metric	English	Metric
Adequate						
Substandard						
Inadequate			564.00	171.91		
Total			564.00	171.91		
Unit of Meas			FB	M		

Deficiencies **Adq** **Sub** **Inad**

Notes

Year built should have been 1941 not 1987. This was built before Everett

Appendix C: Official Property Record, Pier Echo

CLASS 2 PROPERTY RECORD

Report Date 03 MAY 2007 11:46

Installation	N68967	NAVSTA EVERETT WA	**Property No**	202078	
Special Area			**Facility No**	PIER E	
Instal Mgmt Clmnt	N00052	CNI	**Facility ID**	NFA100001506809	
Mission Claimant	N00052	CNI	**Facility Type**	3	STRUCTURE
Operational Claimant	N69292	CFFC	**Action Type**	3	CORRECTION
Former Installation			**Former PR No**		
Facility Name	PIER E		**Last Updated**	30 APR 2007	
			Family Housing Indicator	N	

Location

Region	N68742	CNR NORTHWEST
Country	US	UNITED STATES
State	53	WASHINGTON
County	061	SNOHOMISH
City	0690	EVERETT
Map Grid	I3	

Excess and Disposal

Excess Action	
Excess Date	
Consolidated PR	
Disposal Method	
Disposal Date	
Disp Contract No	

Acquisition

Estate Code	18 PURCHASE	**Acquisition Date**	05 MAY 1987
Land CCN	91110 LAND - PURCHASE	**Government Cost**	$ 2,526,600
Acq Contract	N6247487RP00A23	**Apr/Est Value/Date**	

Maintenance

Preponderant User	N68967	NAVSTA EVERETT WA
Prime Use CCN	15520	SMALL CRAFT BERTHING
Prime FAC Code	1551	SMALL CRAFT BERTHING
Mnt Fund Source	A	O&M, N
Mnt Responsibility	N68967	NAVSTA EVERETT WA
Eng Eval Date		
Current PRV	$ 2,978,815	**PRV at EOY 06** $ 2,978,815

Measurements

	English	Metric
Length	576.00	175.56
Width	45.00	13.72
Height		
Area	2,880.00	2,408.05
Area UM	SY	M2
Number of Stories	1	
Irregular Shape Ind	N	

Construction

Year Built	1941	**Original Proj No**	UNKNOWN
Year Improved		**Current Proj No**	UNKNOWN
Constr Type	P PERMANENT	**ABMP Code**	

Utilization

Fac Use CCN	15520 SMALL CRAFT BERTHING	**Min Val**	10.00	**DoD FAC**	1551
Facility Use		**Max Val**	5,500.00	**DoD UM**	FB
User Activity	N68967 NAVSTA EVERETT WA	**Otg Identifier**		**Primary UM**	FB

	Area		Other		Alternate	
	English	Metric	English	Metric	English	Metric
Adequate						
Substandard						
Inadequate			1,152.00	351.13		
Total			1,152.00	351.13		
Unit of Meas			FB	M		

Deficiencies Adq Sub Inad

Notes

Govt cost of $279,800 is the contributory value.

NAVFAC NW Market Analysis Workbook
Cost Indices

YEAR	SAYLOR PUBLICATIONS INC.			WASHINGTON STATE DEPARTMENT OF TRANSPORTATION			ENGINEERING NEWS RECORD		
	INDEX	PERCENT INCREASE	VALUE	INDEX	PERCENT INCREASE	VALUE	INDEX	PERCENT INCREASE	VALUE
1996	482.8		100.00	124.0		100.00			
1997	499.9	3.54	103.54	139.0	12.10	112.10			
1998	522.6	4.54	108.24	116.0	-16.55	93.55			
1999	534.3	2.24	110.67	120.0	3.45	96.77	3423.0		100.00
2000	585.0	9.49	121.17	128.0	6.67	103.23	3505.0	2.40	102.40
2001	602.7	3.03	124.83	129.0	0.78	104.03	3547.0	1.20	103.62
2002	645.4	7.08	133.68	139.0	7.75	112.10	3602.0	1.55	105.23
2003	651.6	0.96	134.96	145.0	4.32	116.94	3651.0	1.36	106.66
2004	743.2	14.06	153.94	170.0	17.24	137.10	3745.0	2.57	109.41
2005	811.8	9.23	168.14	176.0	3.53	141.94	4129.0	10.25	120.63
2006	864.3	6.47	179.02	228.0	29.55	183.87	4265.0	3.29	124.60
2007	*873.3*	*1.04*	*180.88*	*254.0*	*11.40*	*204.84*	4359.0	2.20	127.34
2008							4455.0	2.20	130.15
2009							4549.0	2.11	132.90
2010							4645.0	2.11	135.70
2011							4743.0	2.11	138.56
2012							4847.0	2.19	141.60

NOTE: 2007 data shown in *italics* represents first quarter data and is only shown for informational purposes.

Historical 7-year Average	7.11%	1.07		9.60%	1.10		3.19%	1.03
Projected 4-year Average	Based on 7-year average			Based on 7-year average			2.13%	1.02

SOURCES:

SAYLOR: http://www.saylor.com/indexes.htm
WSDOT: http://www.wsdot.wa.gov/biz/construction/constructioncosts.cfm
ENR: http://www.wbdg.org/ccb/DOD/UFC/ufc_3_701_06.pdf

Appendix E: DD Form 1391

1. Component	FY 2012 MILITARY CONSTRUCTION PROGRAM	2. Date
NAVY		19 JUN 2007

3. Installation(SA) and Location/UIC: N68967	4. Project Title
NAVAL STATION EVERETT EVERETT, WASHINGTON	Piers D and E Replacement

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
	15520	P165	15,440

9. COST ESTIMATES

Item	UM	Quantity	Unit Cost	Cost($000)
PIERS D AND E REPLACEMENT (28,998 SF)	m2	2,694		8,370
PIER CONSTRUCTION (2694 M2) (28,998 SF)	m2	2,694	1,911.39	(5,150)
NEW APPROACH & SLOPE IMPROVEMENTS	LS			(2,790)
TECHNICAL OPERATING MANUALS	LS			(90)
INFORMATION SYSTEMS	LS			(50)
ANTI-TERRORISM/FORCE PROTECTION	LS			(290)
SUPPORTING FACILITIES				5,020
ELECTRICAL UTILITIES	LS			(600)
MECHANICAL UTILITIES	LS			(170)
PAVING AND SITE IMPROVEMENTS	LS			(790)
DEMOLITION	LS			(2,080)
SECURITY LIGHTING	LS			(280)
FLOATING MOORINGS	LS			(990)
BOAT LAUNCH/RECOVERY SYSTEM	LS			(110)
SUBTOTAL				13,390
CONTINGENCY (5%)				670
TOTAL CONTRACT COST				14,060
SIOH (6%)				840
SUBTOTAL				14,900
DESIGN/BUILD - DESIGN COST (4%)				540
TOTAL REQUEST ROUNDED				15,440
TOTAL REQUEST				15,440
EQUIPMENT FROM OTHER APPROPRIATIONS (NON ADD)				(150)

Guidance Unit Cost Analysis

Cat Code	Facility	OSD Guid.	Guid. Cost	Guid. Size	Project Scope	Room Size Fctr	Area Size Fctr	Area Cost Fctr	Esc. Factor	Unit Cost
15520	PIER CONSTRUCTION (2694 M2)		1,723.00	2694 m2	2694 m2	1.0000	1.000	1.109336882		1,911.39

Currently there is no OSD guidance for small craft berthing piers. Costs were derived from a study evaluation of Pier 'D' and Pier 'E' completed 04 June 2003 by Berger/Abam Engineering Inc. All costs were escalated to FY12 using Naval Facilities Engineering Command (NAVFAC) Northwest Cost Indices.

10. Description of Proposed Construction:

The Using Activity for this project is planned to be: NAVAL STATION EVERETT.

Proposed project will demolish both existing Piers "D" and "E", totaling 51,300 SF (5,700 SY/4,766 m2). Both piers will be replaced with a new small craft berthing pier. Proposed

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1. Component NAVY	FY 2012 MILITARY CONSTRUCTION PROGRAM	2. Date 19 JUN 2007
3. Installation(SA) and Location/UIC: N68967 NAVAL STATION EVERETT EVERETT, WASHINGTON	4. Project Title Piers D and E Replacement	

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
	15520	P165	15,440

pier will consist of precast, prestressed concrete piles and pile caps supporting a deck constructed of precast, prestressed concrete panels. Piles will be designed to meet dredging requirements, if required in the future. The new pier would occupy the same footprint as the existing Pier "E". Pier dimensions will be approximately 580' X 50' = 29,000 SF (3,222 SY/2,694 m2) and will include a steel brow. This new structure will be designed to withstand the displacements imposed by a design level earthquake, as well as all service loads. The deck surface will be sloped for drainage into longitudinal trenches. All utilities will be above the high-water mark enclosed in trenches. Storm water would be collected and treated through the existing storm water treatment system. Cleats will be sized and spaced to meet NAVFAC criteria of 20-ton cleats for general-purpose piers. New electrical and mechanical systems will be provided on the pier. A 4' X 5' foot utility trench will be run along the exterior of the pier with covered, removable, rain-tight hatch covers. Electrical service will consist of 480-volt, three-phase power, fire alarm, and communication systems as required by NAVFAC. Streetlight style light poles will provide security and high mast lighting to meet AT/FP proactive measures. Mechanical systems will be limited to potable/fire water. To meet NAVFAC criteria, steam and compressed air will be provided in the pier design. Space for a future compressed air system will be left in the trench, including additional space in the mechanical mounds for connections. The steam and compressed air can be hooked up at a later time, or connected to temporary systems for a specific use. A ledge would be placed around the exterior of the pier for the addition of future steam service. Conduits will be embedded in the concrete surrounding the trench for future electrical and communication needs. To increase moorage efficiency, while decreasing overall footprint, five portable concrete floating finger piers will be provided to moor smaller vessels and barges. Proposed configuration would provide approximately 1.5 "equivalent piers" of moorage, as compared to the two existing piers. Each lateral float would be 132' x 14' = 1,848 SF (205 SF/172 m2). The floats would be of foam-filled concrete material and will be designed to support two YTBs or barges. Steel or concrete guide piles will be required to moor the floats on each float's outboard end. The floats provide a cost efficient way of adding moorage without increasing the length of the pier. Additional floats could be added or removed, or existing ones reconfigured, to adjust to changing small craft mission requirements or assignment of a larger vessel. The use of portable floats will allow shifting of positions from the pier and will be the most cost effective and versatile. A portable aluminum 50' gangway will be attached to the steel brow for access to the floats. Due to the gangway and pier floats being portable in nature, funding will be through Operations Procurement Navy (OPN). New utilities will be a looped system. 22,300 SF (2,478 SY/2,072 m2) of fixed pier footprint will be demolished and not replaced. The replacement pier will be constructed of more resistant and environmentally friendly materials, meet NAVFAC pier criteria, facilitate storm water treatment, have adequate maneuvering room at the slips, have upgraded utilities, provide capabilities for enhanced future utilities, and be capable of supporting larger vessels. The existing slope adjacent to and under the piers has a marginal factor of stability against future sloughing and sliding, so a new approach and slope improvements will be constructed. To meet AT/FP requirements, metal halide lamps

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3. Installation(SA) and Location/UIC: N68967	4. Project Title
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5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
	15520	P165	15,440

and infrared lamps in environmental housings will be installed on the underside of the pier. Additional lighting mounted on aluminum posts will be placed on the pier to provide lighting coverage 150' feet beyond the pier. The perimeter of the new pier will include surveillance monitoring, and under deck lighting. The project includes small craft launch and recovery capabilities, currently lacking, to support the small craft mission.

11. Requirement: 2694 m2 **Adequate:** **Substandard:**

FACILITY PLANNING DATA:

Category Code	Requirement	UM	Adequate	Substandard	Inadequate	Deficit/ Surplus
15520 SMALL CRAFT BERTHING	2694	m2				

NOTES:

SCOPE:

Construct a fixed small craft berthing pier to replace Pier "D" and "E". (Current Mission)

PROJECT:

This project will demolish Piers "D" and "E" (51,300 SF/5,700 SY/4,766 m2) and construct a new small craft berthing pier (29,000 SF/3,222 SY/2,694 m2). Pier will be located on the existing Pier "E" footprint.

(Current Mission)

REQUIREMENT:

Adequate facilities are required to berth one USCG training cutter, two Yard Float Non-Nuclear Barges (YFN), two Utility Floats (UF), three Yard Tug Boats (YTB), and a floating boathouse. Capability is required to launch and recover small craft aboard the base. The current design for both piers cannot accommodate these berthing requirements. Due to the close proximity of the existing Marina, one side of Pier "D" cannot berth any craft. Due to structural deterioration, neither pier is capable of supporting cranes with a greater than a 30 ton capacity. Both piers are required to support a 90-ton crane under current NAVFAC criteria. The design, layout, and overall deterioration of both piers are deficient when compared to NAVFAC criteria. This impacts mission requirements for pier operations. The new pier will comply with current NAVFAC, safety, and building code standards; allow for proper slip width; and provide adequate berthing for all craft.

CURRENT SITUATION:

Piers "D" and "E" were both built in 1941. Due to the age of these piers (66 years), they are currently in a state of disrepair. Recent improvement in surrounding water quality has likely led to the increased activity of marine borers in the underwater sections of the piles, resulting in accelerated deterioration. Underwater assessments were conducted for both piers in 1996, in 1998, and again in 2003. Each study identified a number of affected piles, which led to a priority-based program of wrapping piles that exhibited light-to-moderate marine borer infestation. Repair plans for 2003 included replacing the heavily

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5. Program Element	6. Category Code 15520	7. Project Number P165	8. Project Cost ($000) 15,440

deteriorated piles and wrapping those showing little or no infestation. This work was not accomplished. The 2003 study's observed conditions reflected that Pier "D" includes a total of 532 timber piles, 341 unwrapped and 191 wrapped. Pier "E" includes a total of 626 timber piles, 360 unwrapped and 266 wrapped. The wrapped piles had a thick (40-60 mils) high-density polyethylene (HDPE) wrap application. Further inspections stated that the tidal exchange and wave action acting together as a pumping mechanism were forcing water into and out of the pile wraps. The pile wrapping did not extend below the mudline, as recommended in the previous studies. In numerous cases, the wrap stopped 4-6 inches above the mudline. Some of the heavy wraps under the piers were puckered at the upper and lower ends where the bands were cinched around them. This led to increased water and marine borer intrusion. The heavier wraps also showed some buckling in the vertical seam, leaving sizeable gaps where water can freely exchange. The exposed zones below the wrap allowed marine borers to re-infest the piles and continue to degrade them. The deck and pile caps of Pier "E" are severely degraded and rotted. The concrete deck and pile caps on Pier "D" are in good condition, but the concrete deck precludes any pile replacement projects as piles continue to degrade. The piles under Pier "D" provide a lower live load capacity than Pier "E". The decks of the piers were designed for a 250-psf live load on Pier "D" and 500-psf live load on Pier "E". A live load capacity of 600-psf is required for both piers. Both piers are required to have the capacity to support a 90-ton mobile crane. Existing piles exhibit some lateral displacement and rotation at the top. Certain pilings located near the shore below Pier "E" have moved as a result of past slope sliding. In some cases, the pilings have separated from the deck. The slopes adjacent to and under the piers are marginally stable and are susceptible to future sloughing and sliding. Any additional loading imposed on the slope from earthquake forces, vibrations, etc., could induce slope movements. The risks for future slope movements are moderate to high. In comparing the existing piers to NAVFAC criteria, it was found that a number of characteristics of the piers do not meet these criteria. NAVFAC guidance calls for slip width to be not less than 300'. The slip width between the piers is only 250', and the width to the Marina on the west side of Pier "D", is only 70'. Utilities on the pier are either not provided or in a state of major disrepair. Small craft are launched and recovered from a ramp in the civilian marina, which increases response time for hazardous material spill/force protection response and creates a liability for the government within the marina.

IMPACT IF NOT PROVIDED:

If this project is not accomplished, timber piles will continue to deteriorate due to marine borer infestation, live load pier capacity will become increasingly inadequate, and current berthing accommodations to berth small craft and vessels will be hindered. NAVFAC criteria will continue to not be met. Existing lack of structural capacity, utilities, and boat launch capability will continue to adversely impact the mission. Replacing Piers "D" and "E" by a single pier with potable floats that could be shifted to meet changing mission requirements is the most cost effective and versatile solution.

ADDITIONAL: Economic Alternatives Considered:

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NAVAL STATION EVERETT EVERETT, WASHINGTON	Piers D and E Replacement

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
	15520	P165	15,440

A. Status Quo:

B. Renovation/Modernization:

C. Lease:

D. New Construction:

E. Other Alternatives:

F. Analysis Results:

12. Supplemental Data:

Site Approval:

[ ] Yes, obtained date:
[X] No, expected date:

Issues (If yes, please provide discussion under issue):

Yes	No	
[ ]	[X]	DDESS, AICUZ, Airfield, EMR, or wetlands
[ ]	[X]	Endangered species/sensitive habitat
[ ]	[X]	Air quality
[ ]	[X]	Cultural/archeological resources
[ ]	[X]	Clearing of trees
[ ]	[X]	Known contamination at selected site
[ ]	[X]	Operational problems
[ ]	[X]	Traffic patterns impact
[ ]	[X]	Existing utilities upgrade
[ ]	[X]	Ordnance sweep required prior to Construction

Planning (If no, please provide an explanation):

Yes	No	
[X]	[ ]	Consistent w/ Master Plan or Base/Regional Dev.

Host Nation Approval: N/A

National Capital Region Approval: N/A

NEPA Documentation:

Yes	No	
[ ]	[X]	Complete

Level of NEPA:

Yes No

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	X	Categorical Exclusion
X		Environmental Assessment(EA)
	X	Environmental Impact Statement(EIS)
	X	Memorandum of Negative Decision

Mitigation Issues:

Yes	No	
	X	Wetlands replacement/enhancement
	X	Hazardous waste
	X	Contaminated soil/water
	X	Other

Environmental Cleanup: N/A

Project Issues:

Yes	No	
	X	System safety
	X	Soils - foundation and seismic conditions
	X	Construction/operational permits
	X	Local air quality/wastewater permits
	X	Complies with Final Governing Standard (Environmental standard for Spain, Italy & Greece)
	X	Land Acquisition (i.e. location, quantity)
	X	Technical Operating Manuals
	X	Feasibility/Constructibility in FY
	X	Historical Preservation
	X	Does the facility have an overhead crane requirement?
	X	Navy Crane Center contacted to assist with dev. of crane estimate (lifting capacity < 10-tons)?
	X	Navy Crane Center contacted to coord. procurement and timelines (lifting capacity >= 10-tons)?

Yes	No	
	X	Physical Security:
		Shielding
		SCIF
		Fencing
		IDS
		Other Type:

BUDGET ESTIMATE SUMMARY SHEET:

Item	UM	Quantity	Unit Cost	Total Cost
Special Construction Features:				
OTHER COSTS (other Primary Facility items)	LS			2,788,979

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1. Component	FY 2012 MILITARY CONSTRUCTION PROGRAM	2. Date
NAVY		19 JUN 2007

3. Installation(SA) and Location/UIC: N68967	4. Project Title
NAVAL STATION EVERETT EVERETT, WASHINGTON	Piers D and E Replacement

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
	15520	P165	15,440

Item	UM	Quantity	Unit Cost	Total Cost
NEW APPROACH & SLOPE IMPROVEMENTS	LS	1	2,788,979.42	2,788,979
TECHNICAL OPERATING MANUALS	LS			90,698
TECHNICAL OPERATING MANUALS	LS	1	90,698.27	90,698
INFORMATION SYSTEMS	LS			45,350
TELECOMMUNICATIONS	LS	1	45,349.69	45,350
ANTI-TERRORISM/FORCE PROTECTION	LS			294,770
ANTI-TERRORISM/FORCE PROTECTION	LS	1	294,769.67	294,770
Utilities and Site Improvements:				
ELECTRICAL UTILITIES	LS			595,990
ELECTRICAL UTILITIES	LS	1	595,990.13	595,990
MECHANICAL UTILITIES	LS			170,060
MECHANICAL UTILITIES (POTABLE/FIRE WATER ONLY)	LS	1	170,060.23	170,060
PAVING AND SITE IMPROVEMENTS	LS			793,612
PAVING AND SITE IMPROVEMENTS	LS	1	793,611.84	793,612
DEMOLITION	LS			2,082,356
DEMOLISH PIERS "D" AND "E"	m2	4863	428.20	2,082,337
SECURITY LIGHTING	LS			283,433
SECURITY LIGHTING	LS	1	283,433.35	283,433
FLOATING MOORINGS	LS			993,317
FLOATING FINGER PIERS	EA	5	198,663.38	993,317
BOAT LAUNCH/RECOVERY SYSTEM	LS			110,934
BOAT LAUNCH/RECOVERY SYSTEM	EA	1	110,933.69	110,934

A. Estimated Design Data:

1. Status:
   - (A) Date design or Parametric Cost Estimate started
   - (B) Date 35% Design or Parametric Cost Estimate complete
   - (C) Date design completed
   - (D) Percent completed as of September 2010
   - (E) Percent completed as of January 2011
   - (F) Type of design contract
   - (G) Parametric Estimate used to develop cost
   - (H) Energy Study/Life Cycle Analysis performed
2. Basis:
   - (A) Standard or Definitive Design
   - (B) Where design was previously used
3. Total cost (C) = (A) + (B) = (D) + (E):
   - (A) Production of plans and specifications
   - (B) All other design costs
   - (C) Total $0
   - (D) Contract

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1. Component NAVY	**FY 2012 MILITARY CONSTRUCTION PROGRAM**	2. Date 19 JUN 2007
3. Installation(SA) and Location/UIC: N68967 NAVAL STATION EVERETT EVERETT, WASHINGTON	4. Project Title Piers D and E Replacement	

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
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(E) In-house

4. Contract award:

5. Construction start:

6. Construction complete:

B. Equipment associated with this project which will be provided from other appropriations:

	Funding	Funding	Installation Start-End	Shakedown Start-End	IOC date	
Environmental Permits/Mitigation		CMN				150,000

JOINT USE CERTIFICATION:

The (CERTIFYING OFFICIAL) certifies that this project has been considered for joint use potential. (TYPE OF CONSTRUCTION RECOMMENDED)is recommended. (UNILATERAL STATEMENT, if Unilateral Construction is selected)

Activity POC: Phone No:

Attachments:

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