Wharf 6, 6 ½, and 7 Oakland Army Base

Structure Type Selection and Seismic Retrofit Report

- This Report summarizes the initial wharf structural analysis and seismic upgrade plan.

Structure Type Selection and Seismic Retrofit Strategy Report for

Wharf 6, 6 ½, and 7
Oakland Army Base

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Oakland Army Base –Wharf 6, 6 ½, and 7
Draft Type Selection and Retrofit Strategy Report

Executive Summary

This report presents the results from an evaluation of Wharf 6, 6 ½ and 7 as part of the Oakland Army Base Redevelopment project. A condition assessment of the wharves was performed to determine repairs necessary to bring the wharves to their original load capacities. In addition, a seismic assessment was performed, and retrofit schemes were prepared for each of the wharves. Presented herein are structure repair schemes, anticipated seismic vulnerabilities under earthquake loading, and retrofit strategies necessary to meet the seismic performance objectives. A summary of the current condition of the existing structures is provided along with retrofit recommendations. The proposed retrofit schemes are presented on general plan sheets provided in Appendix C.

It is anticipated that future loading conditions will require strengthening of the wharves beyond the repair to original capacity as described above. At the time this report was prepared the criteria for increased loading was not known, and the repair recommendations presented will not accommodate loading beyond the original wharf capacity.

A wharf pile testing program was performed to determine the axial capacity of the existing timber and concrete piles. The results of the on-site testing indicate that the wharf live load capacity is currently limited to the strength of the wharf deck and beams. If desired, strengthening of these controlling elements may be performed to improve the live load carrying capacity of the structures.

Introduction

The wharves at Berths 7, 8, and 9 (Wharf 7, 6 ½, and 6 respectively), located on the east end of the Oakland outer harbor and just south of the eastern entrance to the San Francisco – Oakland Bay Bridge, were originally constructed in the 1940's. As-built drawings for the structures were not available for review, however drawings dated September 1941 for the East Wharf (Wharf 5) were available. For this evaluation, it is assumed that all of the wharf structures listed above were constructed using similar details and material properties as that used at Wharf 5.

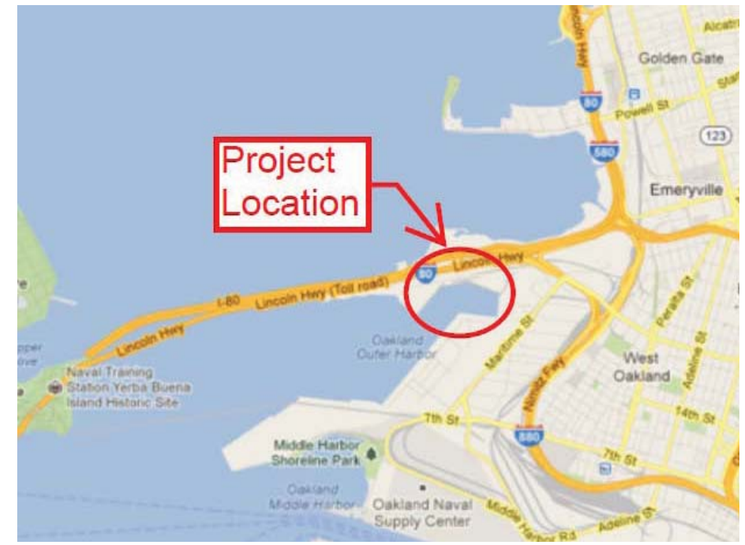

Figure 1: Project location

The original construction of the wharves consisted of a concrete deck with concrete beams and pile caps supported by a combination of timber and precast concrete piles. The wharves were damaged during the 1989 Loma Prieta earthquake, and a repair program was undertaken in the 1990's that included the addition of Cast-In-Steel-Shell (CISS) piles for lateral support and steel pipe piles to replace broken piling.

Analysis was performed to determine the level of repair necessary to bring the wharves back to their original load carrying capacity, and to determine the level of strengthening necessary to meet current seismic requirements.

It is anticipated that future loading conditions will require strengthening of the wharves beyond the repair to original capacity as described above. At the time this report was prepared the criteria for increased loading was not known, and the repair recommendations presented will not accommodate loading beyond the original wharf capacity.

Prior to conducting the structural evaluation, a structural inspection of the concrete deck, beams, and piles was performed. Inspections included visual observations and various non-destructive tests (NDTs) to determine the current condition of the structural elements and their design capacities. Approximately 30% of the wharves' piles also underwent underwater structural inspection in accordance with US Navy inspection guidelines.

A seismic analysis of the wharves was conducted for the following seismic events:

a. Operating Level Earthquake (OLE), 50% probability in 50 years event (72-year recurrence).

b. Contingency Level Earthquake (CLE), 10% probability in 50 years event (475-year recurrence).

"No Collapse" design criteria are adopted for the Contingency Level Earthquake (CLE) events, while the design criteria for the wharves to be fully operational shortly after a seismic event are used for the Operating Level Earthquake (OLE).

The scope of work for this study included the following:

- Perform a site visit to observe existing conditions of the structure
- Perform structural inspection of the wharf and various non-destructive tests (NDTs)
- Perform underwater structural inspection of approximately 30% of the wharf piles
- Review all available existing record documents and maintenance reports
- Evaluate the seismic performance and determine seismic deficiencies of the wharves and calculate structural capacity/demand ratios of the as-built and retrofit structures

The structural evaluation included two components of analysis: 1) determine earthquake force and displacement demands of structural members and, 2) determine member strength and displacement capacity. The structural evaluation includes the following:

- Preparation of a proposed seismic retrofit strategy
- Calculations substantiating structural performance

Site Visit Summary

An initial site visit was performed on Jan 7 and 8, 2013 to visually assess the physical condition of the wharves and wharf sites. During this site visit only the upper portion of the wharf deck, and underside of the wharf (behind the bulkhead wall) was observed. From March 18 to March 29, a follow up site visit was performed to observe the underside of the wharf from the water side. Significant observations from the site visits are noted below:

From behind the bulkhead wall (Wharf 6 and 7):

- Due to accessibility, only partial areas under the deck were visited.
- Pile spacing is typically 8 feet in both longitudinal and transverse directions.

- The piles appeared to be embedded into roughly 24″ x 30″ x 20″ deep slab drop caps.
- The underside of deck, where visible, seems to be in good shape, with minimal cracking.
- The dimension from bottom of concrete deck to mud line (OG) is approximately 6-7 feet.

Figure 2: Under the wharf deck behind bulkhead wall

- The timber piles measure approximately 12″ in diameter. There are batter piles as per plan which are also 12″ diameter.

Figure 3: Timber piles measure approximately 12″ in diameter

- In-place retrofit Cast-In-Steel-Shell (CISS) piles measured 42″ in diameter.
- The exposed timber piles above the high water line seem to be in good condition. Where the piles have been in contact with water, some deterioration is observed.
- Some gunite jackets show vertical and horizontal cracking, and spalling of the gunite.

- Retrofit CISS pile locations can be observed on the deck. On average, the circular deck openings were at 24 feet on center. Opening size on deck was 48 inches.

Figure 4: Existing retrofit CISS pile locations can be observed on the wharf deck

From the water side (Wharf 6, 6 ½ , and 7):

- At the East end of the Wharf 6, there are multiple locations where broken or missing piles have been replaced with steel pipe piles. Some missing piles were observed with no replacement piles installed.

Figure 5: Missing pile at the East end of the Wharf 6

- Concrete piles at Wharf 6 ½ were noted to be in good condition. No missing piles were observed.
- Several concrete piles at the Wharf 7 Extension were observed to have cracking and spalling.

Figure 6: Damage at Wharf 7 Extension pile

- Most concrete piles in the northeastern area of Wharf 7 Extension are in good condition.

Underwater Pile Inspection

DRS MARINE, Inc. performed the Type I, II & III pile inspections, in accordance with US Navy inspection guidelines, of the piles on Wharf 6, 6 ½, and 7. The inspected piles were randomly selected for each type of inspection. The following is a brief description regarding Type I, II, and III inspection:

TYPE I inspection: Visually inspect and report the observed condition of a random selected number of piles.

Type II inspection: Remove a one foot band of marine growth at three locations of a selected number of piles as follows: One foot below the waterline, one foot above the mud line and at mid section. Should the diver observe any anomalies, all marine growth adjacent to the anomaly is to be removed.

Type III inspection: Take core samples from random piles. Each core will be collected below the waterline. All wood pile cores will be 3/8″ in diameter and 6″ long. All concrete cores will be 1-3/4″ in diameter.

Figure 7: Underwater pile inspection

The findings are summarized and reported in the "Underwater Pile Inspection Report" bound separately from this report. The information in the above-mentioned report is used as the basis for the type and extent of pile repair recommendations provided in a this report.

As-Built Description

Wharf 6, 6 ½, and 7 were originally constructed in the 1940's. The wharf deck consists of concrete slab construction supported by pile systems. The concrete deck is typically 7" thick and increases to 22" thick at track areas.

Wharf 6 is supported by a combination of 12" diameter timber piles and 16" square precast concrete piles. The timber piles in the water are protected by gunite jackets. There are approximately 3,300 piles at Wharf 6. The deck is approximately 990 feet long measured at the water side face of the wharf, and is approximately 200 feet wide. Twenty-nine retrofit CISS piles were previously installed at Wharf 6.

The Wharf 6 ½ deck is approximately 1,600 feet long and about 83 feet wide. Timber piles are used only to support the bulkhead/dock wall foundation, and all other piles supporting the wharf deck are 16" square precast concrete piles. Roughly 1,750 piles support Wharf 6 ½. There is a combination bulkhead/seawall at the back of the wharf and all piles are in the water. Twenty-seven retrofit CISS piles were previously installed at Wharf 6 ½.

The northeastern part of Wharf 7 is supported by 12" diameter timber piles with gunite jackets, while the southwestern extension is mostly supported by 16" or 18" square precast concrete piles. Approximately 4,250 piles support Wharf 7. The deck of Wharf 7 is approximately 1,190 feet long and typically about 210 feet wide. The width at the Wharf 7 extension is approximately 260 feet wide. Forty-nine retrofit CISS piles were previously installed at Wharf 7.

Vertical Capacity

Existing design drawings with material properties and original design loading information were not available for the wharves. The original live load capacity was estimated based on design information obtained from Wharf 5 drawings and from information obtained during our site visits and a material testing program. Material testing of the concrete and reinforcement in the wharf slabs and beams was conducted by Testing Engineers, Inc. (TEI) to estimate the in-situ strength of existing materials. The testing reports are provided in Appendix D. Capacities were calculated for the concrete slabs and concrete beams, both in shear and flexure. The following dimensions and design parameters were used to calculate vertical capacity:

Minimum Slab depth	7 in
Minimum Beam depth	12 in below slab
Cap depth	20 in below slab
f'c	4000 psi
fy	40 ksi

Calculation results indicate that the controlling live load is approximately 600 psf, which is the same as the specified live load on the existing East Wharf (Wharf 5) as-built drawings prepared by Bechtel – McCone – Parsons Corporation Engineers, dated September 1941.

The structural capacity of the existing piles was checked for the 600 psf live load determined above. The analysis indicates that the vertical demand is much lower than the pile structural capacities. A pile testing program performed by Kleinfelder indicates that the maximum allowable axial compression capacities of existing piles are 90 kips for timber piles and 180 kips for concrete piles. Refer to Appendix E for the "Geotechnical Report for Existing Pile Foundation Capacity, Oakland Army Base – Wharves 6, 6½, and 7, (Berths 9, 8, and 7)" by Kleinfelder, dated January 24, 2014. The capacity determined through this testing program is sufficient to support the controlling wharf live load identified above. The typical timber pile spacing varies from 8'x8' to 8'x11.5' and the typical concrete pile spacing ranges from 9.5'x9.5' to 12'x12'. The estimated live load capacity based on allowable axial compression capacities of existing piles, not including any additional weight necessary for strengthening the deck and beams, is between 750 to 1050 psf and 900 to 1350 psf respectively. Therefore, the existing live load capacity for the wharf is currently estimated to be 600 psf, and it is possible to increase the live load by strengthening the wharf deck and beams.

Structure Repair to Original Condition

Data from several site visits and inspections from both land side and water side, including underwater pile inspections, have been collected and summarized to estimate the repair quantities for all types of existing structural elements. Material sampling tests have also been done at selected locations throughout Wharf 6, 6 1/2, and 7.

From the land side inspections, deterioration of the deck slab, under-deck timber piles, pile caps, and beams have been observed. From the water side, two types of inspection have been carried out: 1) underwater pile inspections for randomly selected piles, and 2) visual inspection of the underside of deck slab, beams, pile caps, and piles above water line. A small percentage of missing or seriously damaged piles were observed at Wharf 6 and 7. Minor to moderate spalling and cracking of concrete piles and timber piles with gunite jacket were observed at all three wharves.

Based on the information gathered from the inspections, repair details and estimated quantities for various types of repairs were prepared and provided on the 35% design drawings provided in Appendix C. For missing piles or severely damaged concrete piles, new concrete pile replacements will be needed. For severely damaged timber piles, pile stubbing or new replacement piles will be required. Repair details of slabs, beams, pile caps, and piles with moderate to minor spalling and cracking are provided.

Proper repair of the existing components within the structures is crucial to maintain the wharf vertical capacities described in the previous section.

Site Seismicity

The project site is located in a region of relatively high seismicity. Two acceleration response curves with peak ground accelerations of 0.878g and 1.126g were provided by the geotechnical engineer, Berlogar Stevens & Associates. The two curves were used for evaluation of the performance under the Operating Level Earthquake (OLE) and Contingency Level Earthquake (CLE), respectively. The Acceleration Response Spectrum used is 50% probability of exceedance in 50 years (72-year recurrence) for OLE and 10% probability of exceedance in 50 years (475-year recurrence) for CLE, and both are with 5% damping.

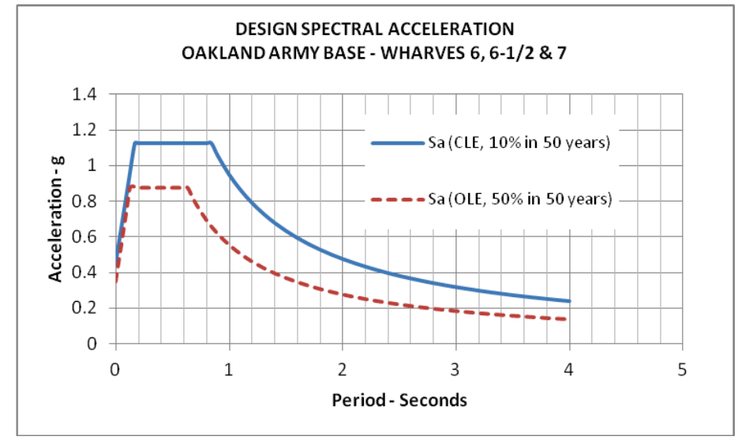

Figure 8: Design spectral acceleration curves

Seismic Evaluation Criteria

Based on "California Building Code, Chapter 31F, MARINE OIL TERMINALS", two levels of seismic performance were considered. These levels are defined as follows:

Level 1 Seismic performance:

- Minor or no structural damage
- Temporary or no interruption in operations

Level 2 Seismic performance:

- Controlled inelastic structural behavior with repairable damage
- Prevention of structural collapse
- Temporary loss of operations, restorable within months

The Level 2 evaluation follows the "No Collapse" design criteria using a seismic event with a return period of approximately 475 years which is the "Contingency Level Earthquake" or CLE. The Level 1 evaluation follows the "Operational Level Earthquake" or OLE design criteria, where the wharves are assumed to be fully operational shortly after a seismic event with a return period of approximately 72 years.

Material Properties

Based on the materials investigation reports by TEI (Appendix D), the available information from the 1941 Wharf 5 as-built drawings, and three previous reports listed below:

"Piling Condition Report & Preliminary Design Repair at Wharf 7" by Tudor Engineering Company, dated 08/1977.

"Concept Study Report to Identify Structural Repairs & Modifications to Wharf 7" by Earl & Wright, dated 10/1990.

"Preliminary Condition Assessment & Evaluation of Army Wharves 6.5 & 7" by Jacobs, dated 08/30/2011.

The following materials properties for existing materials are used in our analysis:

Timber:
- E = 1,500 ksi
- w = 32 pcf

Concrete:
A. Placed prior to 1980
- f'_c = 4,000 psi
- f'_{ce} = 5,000 psi
- w = 150 pcf

B. Placed after 1980 and new concrete
- f'_c = 4,000 psi
- f'_{ce} = 5,000 psi
- w = 150 pcf

Reinforcing Steel:
A. Placed prior to 1980
- f_y = 40,000 psi
- E = 29,000,000 psi

B. Placed after 1980
- f_y = 60,000 psi
- E = 29,000,000 psi

Structural Steel:
- f_y = 36,000 psi

Design Loads

Loads used in the evaluation include dead load, live load, and seismic loads.

Dead Load
- Self weight

Live Load
- 400 psf for general wharf area
- 600 psf or Cooper E60 at track area

Seismic Loads for CLE and OLE
- Load case 1 (LC1): DL + 1.0*Long + 0.3*Trans
- Load case 2 (LC2): DL + 0.3*Long + 1.0*Trans

In each of the above load cases, the same ground motion is input for the longitudinal and transverse directions.

References/Codes

- California Building Code, 2010 Edition
- American Concrete Institute, Building Code and Commentary, 318-08
- American Institute of Steel Construction, Manual of Steel Construction, ASD/LRFD 13th Edition
- American Society of Civil Engineers, Seismic Rehabilitation of Existing Buildings, 41-06

As-Built Model Approach and Seismic Assessment

This section describes the general approach used for the evaluation of the Wharf 6, 6 ½, and 7 structures and the manner in which the structures were analyzed. The various analysis tools that were used are described herein. Simplifications and assumptions made to facilitate the modeling of this structure are also described.

The wharf structure between expansion joints was modeled in SAP2000. All original timber piles, precast concrete piles, and in-place 42" retrofit CISS piles are modeled, and soil springs for nodes below the mudline are specified to provide boundary conditions of the system. A linear elastic dynamic seismic analysis (response spectrum analysis) of each wharf structure was performed in order to obtain the seismic displacement demands on the structural elements. Refer to the Site Seismicity section of this report for the Acceleration Response Spectrum used in the seismic analysis.

Soil springs for use in the SAP2000 model were prepared by generating p-y curves using the LPile program. In the SAP2000 models, nodes with soil springs were placed at 2 feet intervals. A secant stiffness method was used to estimate the linear soil springs from the nonlinear p-y curves provided by LPile. To obtain more accurate linear soil springs for corresponding displacements, iterations of the spring stiffness were performed based on initial SAP2000 results. The pile tops are assumed to have a "pinned" connection to the deck as no positive connection between the two elements was provided. Diaphragm

constraints were applied to the top nodes of all piles at deck level to model the in-plane stiffness of the deck. The self weight of the structures and 10% of live load on deck as seismic mass are applied to the top nodes of piles. P-delta effects on the pile with lateral displacement are considered if appropriate.

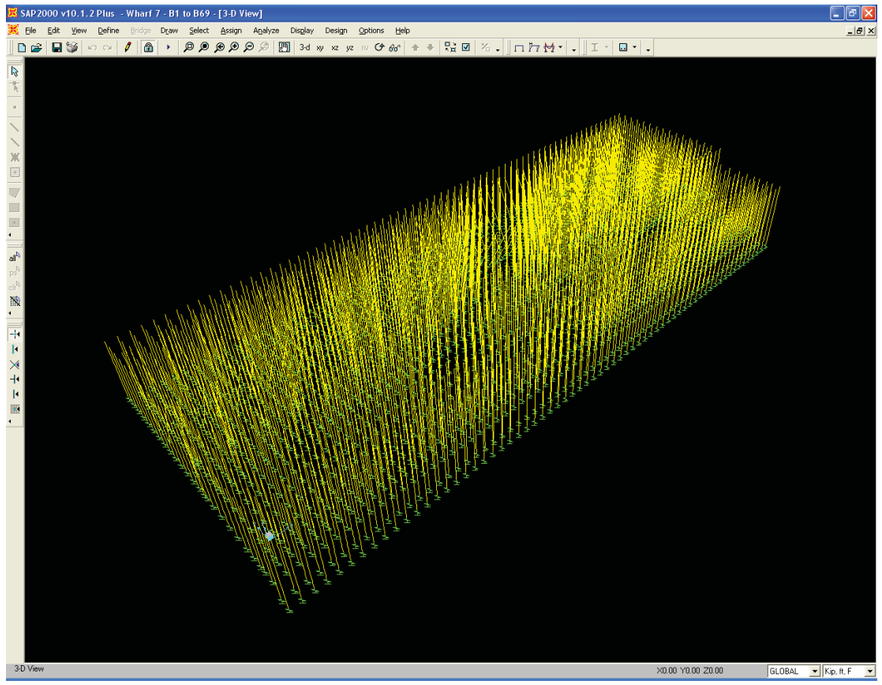

Figure 9: SAP2000 model

XTRACT was used to calculate the concrete and CISS pile section properties. Expected material properties listed in the "Material Properties" subsection of the "Evaluation Criteria" of this report were used. The section properties calculated for the piles include the effective yield and ultimate moments, the first yield and ultimate curvatures, and the cracked moment of inertia. These properties were used to determine the displacement ductility performance of the concrete and CISS piles.

Displacement capacities of timber piles were obtained from LPile models with imposed increasing lateral displacements until the timber pile reach its maximum allowable strain according to CBC code (Chapter 31F, Marine Oil Terminals).

Key Assumptions

While evaluating the structure to determine potential retrofit measures, various simplifications were necessary to model this structure. These assumptions typically do not result in a compromise to the modeling accuracy and where possible, simplifications tend to make the model results more conservative. The following is a list of key simplifications/assumptions:

- Soil springs are linear, obtained from an iterated secant stiffness using p-y curves from LPile.
- Connections between the pile and deck are modeled as pinned.
- Geometric nonlinearity is not modeled in SAP2000. P-delta effect is calculated separately when appropriate.
- Cracked properties are used for flexural elements evaluated using a displacement ductility approach; the corresponding elements in the SAP model that represent these flexural elements are elastic.

Summary of Seismic Deficiencies

The following seismic deficiencies were identified from this study. Appendix A contains tables summarizing demand to capacity ratios for timber piles, precast concrete piles, and CISS piles.

- Timber piles at Wharf 6 have inadequate displacement capacity. (D/C = 2.16 for OLE, and D/C = 1.68 for CLE)
- Timber piles at Wharf 6 1/2 have inadequate displacement capacity. (D/C = 1.42 for OLE, and D/C = 1.0 for CLE)
- Timber piles at Wharf 7 have inadequate displacement capacity. (D/C = 1.58 for OLE, and D/C = 1.22 for CLE)

All the concrete piles and previous retrofit CISS piles meet the requirements of both OLE and CLE in displacement, bending moment, and shear force. Also, no seismic deficiency in shear of timber piles is found.

Seismic Retrofit Recommendations

Considering the seismic deficiencies identified above, the retrofit philosophy is aimed at decreasing the displacement demands of the wharves. To achieve the goal, new retrofit CISS piles are proposed to reduce the fundamental vibrational periods and corresponding displacement demands of the wharves. Furthermore, retrofit CISS piles should be placed to minimize the torsional response of the wharves due to the unsymmetrical stiffness of the lateral systems. SAP2000 models including the proposed retrofit CISS piles were prepared and analyses were performed to verify the effects of the retrofit on the response of the structures. Since performance levels for the structural

elements under the OLE and CLE seismic events are different, SAP models were prepared for each separately.

The following seismic retrofit recommendations are provided to meet the seismic requirements: (See Appendix C for General Plan)

- For Wharf 6, 79 new CISS piles (48"diameter) will be needed to meet CLE requirements, and 53 additional piles will be needed for OLE.
- For Wharf 6½, 24 new CISS piles (48"diameter) will be needed to meet CLE requirements, and 8 additional piles will be needed for OLE.
- For Wharf 7, 80 new CISS piles (48"diameter) will be needed to meet CLE requirements, and 32 additional piles will be needed for OLE.

The need for additional retrofit CISS piles noted above for the Operational Level Earthquake (OLE), is primarily due to the code prescribed allowable material strains under this seismic event. In addition, the OLE ground motions are only slightly less than CLE ground motions. For the Operational Level Earthquake event, the seismic demand is 78% (0.878g/1.126g, ratio of peak ground acceleration) of the demand of Contingency Level Earthquake. The corresponding limiting timber strain values for the OLE, according to the CBC, results in a 50% reduction in capacity from the values for CLE.

Utilities and Maintenance Considerations

An analysis for future utilities was not included in the study. It is not anticipated that the retrofit construction activities will significantly impact existing utilities.

The repair and retrofit strategies described herein will not necessitate maintenance over and above what the structure already requires.

Appendix A
As-Built Demand/Capacity Tables

Table A1 Wharf 6 As-Built Condition

EXISTING TIMBER PILE - As-Built Condition

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (psi)	Capacity (psi)	D/C	OK
LEVEL I	10.60	4.90	2.16	NG	91	476	0.19	OK
LEVEL II	18.10	10.75	1.68	NG	111	476	0.23	OK

EXISTING CONCRETE PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (kip)	Capacity (kip)	D/C	OK
LEVEL I	10.30	28.20	0.37	OK	5	53	0.10	OK
LEVEL II	17.50	43.50	0.40	OK	5	53	0.10	OK

EXISTING CISS PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (kip)	Capacity (kip)	D/C	OK
LEVEL I	10.04	13.10	0.77	OK	329	981	0.34	OK
LEVEL II	17.11	26.50	0.65	OK	334	981	0.34	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

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Table A2 Wharf 6 ½ As-Built Condition

EXISTING TIMBER PILE UNDER BULKHEAD WALL (As-Built Condition)

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (psi)	Capacity (psi)	D/C	OK
LEVEL I	2.20	1.55	1.42	NG	140	476	0.29	OK
LEVEL II	3.8	3.8	1.00	NG	233	476	0.49	OK

EXISTING CONCRETE PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (kip)	Capacity (kip)	D/C	OK
LEVEL I	11.00	23.30	0.47	OK	6	53	0.11	OK
LEVEL II	18.80	34.70	0.54	OK	6	53	0.11	OK

EXISTING CISS PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (kip)	Capacity (kip)	D/C	OK
LEVEL I	10.80	18.50	0.58	OK	278	981	0.28	OK
LEVEL II	18.50	35.50	0.52	OK	279	981	0.28	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

Table A3 Wharf 7 As-Built Condition

BENT 1 TO BENT 69-EXISTING TIMBER PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (psi)	Shear Capacity (psi)	D/C	OK
LEVEL I	8.81	6.25	1.41	NG	116	476	0.24	OK
LEVEL II	15.02	13.75	1.09	NG	185	476	0.39	OK

BENT 1 TO BENT 69-EXISTING CISS PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (k)	Shear Capacity (k)	D/C	OK
LEVEL I	8.63	33.00	0.26	OK	210	981	0.21	OK
LEVEL II	14.70	74.00	0.20	OK	246	981	0.25	OK

BENT 70 TO BENT 127-EXISTING TIMBER PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (psi)	Shear Capacity (psi)	D/C	OK
LEVEL I	9.30	5.89	1.58	NG	146	476	0.31	OK
LEVEL II	15.86	13.00	1.22	NG	204	476	0.43	OK

BENT 70 TO BENT 127-EXISTING CISS PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (k)	Shear Capacity (k)	D/C	OK
LEVEL I	9.23	34.00	0.27	OK	234	981	0.24	OK
LEVEL II	15.73	78.00	0.20	OK	281	981	0.29	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

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Table A3 Wharf 7 As-Built Condition (Continued)

BENT 128 TO BENT 148-EXISTING 16" SQUARE PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (k)	Shear Capacity (k)	D/C	OK
LEVEL I	8.93	24.15	0.37	OK	16	24	0.67	OK
LEVEL II	15.23	37.00	0.41	OK	17	24	0.71	OK

BENT 128 TO BENT 148-EXISTING 18" SQUARE PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (k)	Shear Capacity (k)	D/C	OK
LEVEL I	10.00	24.61	0.41	OK	18	26	0.69	OK
LEVEL II	17.06	38.25	0.45	OK	18	26	0.69	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

Appendix B
Retrofit Demand/Capacity Tables

Table B1 Wharf 6 Retrofit Condition (132 CISS piles)

EXISTING TIMBER PILE- Retrofit Condition

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (psi)	Capacity (psi)	D/C	OK
LEVEL I	4.82	4.90	0.98	OK	91	476	0.19	OK
LEVEL II	9.68	10.75	0.90	OK	111	476	0.23	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

Table B2 Wharf 6 ½ Retrofit Condition (32 CISS piles)

EXISTING TIMBER PILE UNDER BULKHEAD WALL (Retrofit Condition)

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Demand (in)	Capacity (in)	D/C	OK	Demand (psi)	Capacity (psi)	D/C	OK
LEVEL I	1.46	1.55	0.94	OK	140	476	0.29	OK
LEVEL II	3.24	3.80	0.85	OK	233	476	0.49	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

Table B3 Wharf 7 Retrofit Condition (112 CISS piles)

BENT 1 TO BENT 69-EXISTING TIMBER PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (psi)	Shear Capacity (psi)	D/C	OK
LEVEL I	6.18	6.25	0.99	OK	86	476	0.18	OK
LEVEL II	10.47	13.75	0.76	OK	135	476	0.28	OK

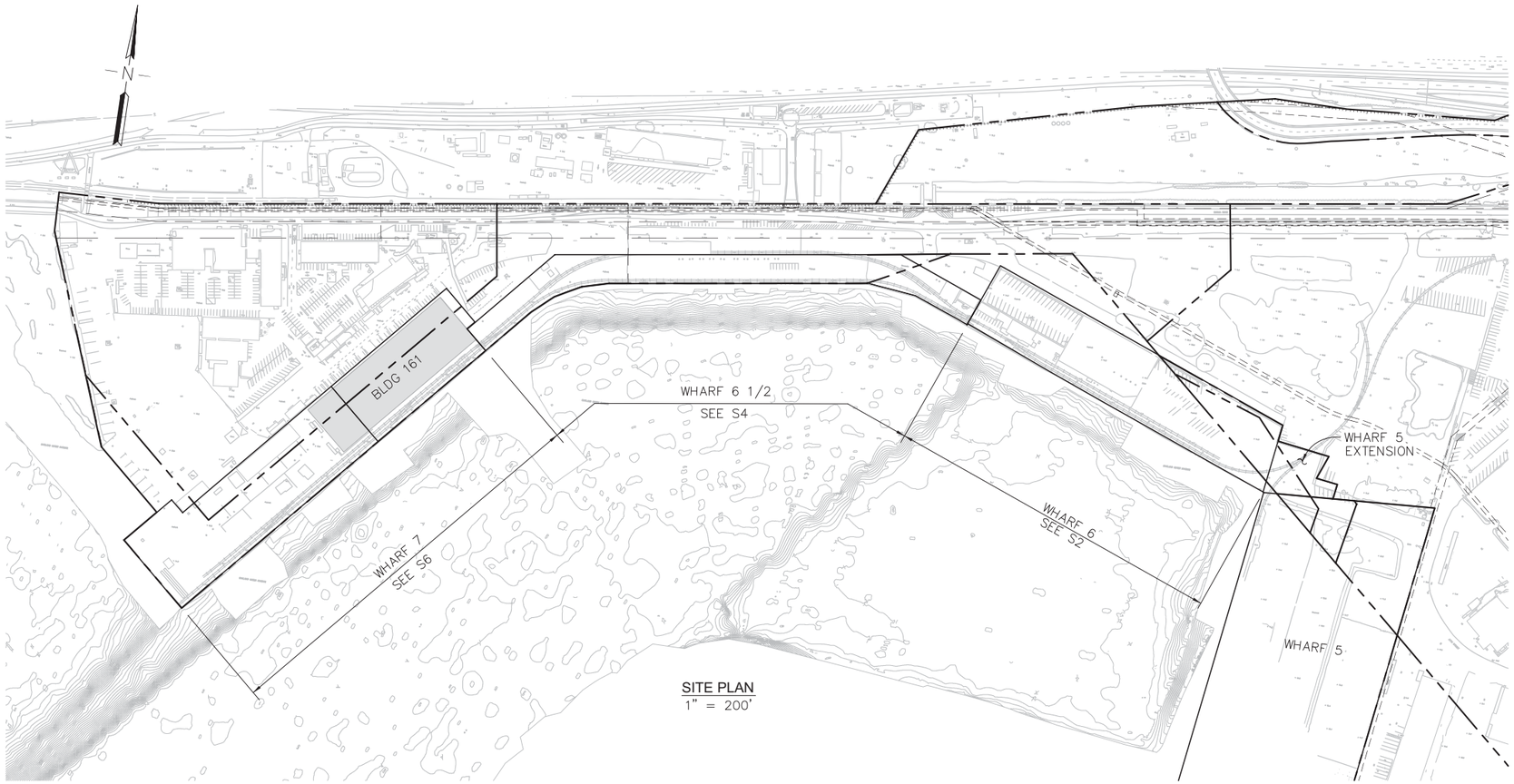
BENT 70 TO BENT 127-EXISTING TIMBER PILE

	DISPLACEMENT				SHEAR			
SEISMIC LEVEL	Disp Demand (in)	Disp Capacity (in)	D/C	OK	Shear Demand (psi)	Shear Capacity (psi)	D/C	OK
LEVEL I	5.88	5.89	1.00	OK	109	476	0.23	OK
LEVEL II	9.98	13.00	0.77	OK	152	476	0.32	OK

Note: Demand to capacity ratios greater than 1.0 indicate exceedance of allowed displacement.

Oakland Army Base – Wharf 6, 6 ½, and 7
California Capital & Investment Group (CCIG)
Final Type Selection and Seismic Retrofit Strategy Report

Appendix C
General Plans (Bound Separately)



SITE PLAN
1" = 200'

GENERAL NOTES

1. INTENT OF DRAWINGS:
   A. THE GENERAL NOTES APPLY TO ALL STRUCTURAL WORK EXCEPT WHERE THEY CONFLICT WITH DETAILS AND NOTES SPECIFICALLY SHOWN AND NOTED.
   B. THE STRUCTURAL DRAWINGS SHOW ONLY THE BASIC STRUCTURE. REFER TO CIVIL, UTILITY, R/W, AND ELECTRICAL DRAWINGS FOR THE NONSTRUCTURAL ITEMS WHICH REQUIRE SPECIAL PROVISIONS DURING THE CONSTRUCTION OF THE STRUCTURE.
   C. ALL INFORMATION SHOWN IS BASED ON LIMITED FIELD MEASUREMENTS AND OBSERVATIONS AS WELL AS WHARF 5 EXISTING DRAWINGS.
2. BASIS OF DESIGN:
   A. CALIFORNIA BUILDING CODE 2010 EDITION
   B. AMERICAN CONCRETE INSTITUTE, BUILDING CODE AND COMMENTARY, 318-08
   C. AMERICAN INSTITUTE OF STEEL CONSTRUCTION, MANUAL OF STEEL CONSTRUCTION, ASD/LRFD 13TH EDITION
   D. AMERICAN SOCIETY OF CIVIL ENGINEERS, SEISMIC REHABILITATION OF EXISTING BUILDINGS, 41-06
3. DESIGN LOADS:
   A. DEAD LOAD:
      1. SELF WEIGHT
   B. LIVE LOAD:
      1. 400 PSF GENERAL WHARF
      2. 600 PSF OR COOPER E60 LOADING AT TRACK AREA
   C. LATERAL LOADS:
      1. SEISMIC DESIGN CRITERIA:
         A. SEISMIC DESIGN CRITERIA IS BASED ON A PERFORMANCE-BASED APPROACH. TWO LEVELS OF DESIGN EARTHQUAKE ARE CONSIDERED.
            1. OPERATING LEVEL EARTHQUAKE (OLE) - AN EARTHQUAKE WITH 50% PROBABILITY OF BEING EXCEEDED IN 50 YEARS (72-YEAR RECURRENCE). UNDER THIS LEVEL OF EXCITATION THE STRUCTURE SHOULD SATISFY THE SERVICEABILITY CRITERION OF CONTINUED FUNCTIONALITY IMMEDIATELY AFTER EARTHQUAKE WITHOUT SIGNIFICANT STRUCTURAL DAMAGE. ANY REPAIRS REQUIRED SHOULD BE ESSENTIALLY COSMETIC.
            2. CONTINGENCY LEVEL EARTHQUAKE (CLE) - AN EARTHQUAKE WITH A 10% PROBABILITY OF BEING EXCEEDED IN 50 YEARS (475-YEAR RECURRENCE). UNDER THIS LEVEL OF EXCITATION THE STRUCTURE SHOULD BE CAPABLE OF RESISTING THE EARTHQUAKE WITHOUT COLLAPSE AND WITH REPAIRABLE DAMAGE.
         B. DESIGN SPECTRUM:
            1. BASED ON SITE SPECIFIC ACCELERATION AND DISPLACEMENT SPECTRA RECOMMENDED BY BERLOGAR STEVENS AND ASSOCIATES.
         C. SEISMIC DESIGN APPROACH:
            1. THE SEISMIC DESIGN APPROACH IS TO PROVIDE A DUCTILE SUBSTRUCTURE WITH PLASTIC HINGES IN PILES TO DISSIPATE THE EARTHQUAKE ENERGY. A DISPLACEMENT-BASED DESIGN APPROACH IS USED TO ENSURE THAT THE STRUCTURAL SYSTEM AND ITS INDIVIDUAL COMPONENTS HAVE ENOUGH CAPACITY TO WITHSTAND THE DEFORMATION IMPOSED BY THE DESIGN EARTHQUAKE.
            2. A SERIES OF NONLINEAR PUSH-OVER ANALYSES ON 2-D STRUCTURE MODELS WITH NONLINEAR SOIL SPRINGS WAS PERFORMED TO OBTAIN THE STRUCTURE DISPLACEMENT CAPACITY AND SHEAR DEMAND. THE DISPLACEMENT DEMAND WAS ESTABLISHED BASED ON EQUAL DISPLACEMENT METHOD WITH RESULTS FROM THE NONLINEAR STATIC ANALYSIS.
4. EXISTING CONDITIONS:
   A. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PERTINENT TO THE WORK PRIOR TO MATERIAL FABRICATION AND/OR CONSTRUCTION. FIELD CONDITIONS DIFFERENT FROM THOSE NOTED ON THE CONTRACT DOCUMENTS SHALL BE PROMPTLY BROUGHT TO THE ATTENTION OF THE ENGINEER. ITEMS TO BE FIELD VERIFIED INCLUDE BUT ARE NOT LIMITED TO:
      LOCATION, DIMENSIONS, AND ELEVATIONS OF EXISTING STRUCTURES, STRUCTURAL ELEMENTS, EQUIPMENT AND UTILITIES WHICH HAVE BEEN SHOWN AS REFERENCE ON THE DRAWINGS AND MAY AFFECT NEW CONSTRUCTION.
5. MATERIAL STRENGTHS:
   A. CONCRETE
      1. CONCRETE PLACED PRIOR TO 1980 — f'c = 2500 PSI
      2. CONCRETE PLACED AFTER 1980 — f'c = 4000 PSI
      3. NEW CONCRETE — f'c = 4000 PSI
   B. CONCRETE REINFORCEMENT
      1. REINFORCEMENT PLACED PRIOR TO 1980 — Fy = 33000 PSI
      2. REINFORCEMENT PLACED AFTER 1980 — Fy = 60000 PSI
      3. NEW REINFORCEMENT — ASTM A706 GRADE 60
   C. STRUCTURAL STEEL
      1. EXISTING STEEL — Fy = 36000 PSI
      2. W SHAPES — ASTM A992, GRADE 50
      3. HSS SHAPES — ASTM A500 GRADE B
      4. BOLTS — ASTM A325
      5. ANCHOR BOLTS — ASTM F1554 GRADE 105
      6. OTHERS — ASTM A36

INDEX TO PLANS

WHARF REPAIR

SHEET No.	TITLE
S1	STRUCTURE INDEX
S2	WHARF 6 GENERAL PLAN No. 1
S3	WHARF 6 GENERAL PLAN No. 2
S4	WHARF 6 1/2 GENERAL PLAN No. 1
S5	WHARF 6 1/2 GENERAL PLAN No. 2
S6	WHARF 7 GENERAL PLAN No. 1
S7	WHARF 7 GENERAL PLAN No. 2
S8	WHARF 6 STRUCTURAL PLAN No. 1 - BENTS 1 TO 50
S9	WHARF 6 STRUCTURAL PLAN No. 2 - BENTS 51 TO 124
S10	WHARF 6 1/2 STRUCTURAL PLAN No. 1 - BENTS 1 TO 99
S11	WHARF 6 1/2 STRUCTURAL PLAN No. 2 - BENTS 101 TO 211
S12	WHARF 6 1/2 STRUCTURAL PLAN No. 3 - BENTS 213 TO 333
S13	WHARF 7 STRUCTURAL PLAN No. 1 - BENTS 1 TO 56
S14	WHARF 7 STRUCTURAL PLAN No. 2 - BENTS 57 TO 112
S15	WHARF 7 STRUCTURAL PLAN No. 3 - BENTS 113 TO 148
S16	EXISTING STRUCTURAL SECTIONS AND DETAILS
S17	REPAIR DETAILS No. 1
S18	REPAIR DETAILS No. 2
S19	REPAIR DETAILS No. 3
S20	BUILDING 161 SEISMIC UPGRADE No. 1
S21	BUILDING 161 SEISMIC UPGRADE No. 2

WHARF UPGRADE

HEAVY LIFT DOCK-STRUCTURE - OPTION A

SHEET No.	TITLE
A1	SITE/DEMOLITION PLAN
A2	WHARF 6 1/2 GENERAL PLAN
A3	WHARF DECK PLAN
A4	WHARF TYPICAL SECTION
A5	TYPICAL PILE DETAILS

HEAVY LIFT DOCK-STRUCTURE - OPTION B

SHEET No.	TITLE
B1	SITE/DEMOLITION PLAN
B2	GENERAL PLAN
B3	WHARF TYPICAL SECTION
B4	WHARF DECK PLAN

LEGEND

—— – ——	RIGHT OF WAY
————	EDGE OF WHARF DECK
[ ]	BUILDING

ABBREVIATIONS

@	AT
AC	ASPHALT CONCRETE
℄	CENTERLINE
CISS	CAST-IN-STEEL SHELL
COL	COLUMN
CONC	CONCRETE
DIA	DIAMETER
EL	ELEVATION
EXIST	EXISTING
HSS	HOLLOW STRUCTURAL SECTION
MIN	MINIMUM
MLLW	MEAN LOWER LOW WATER
No.	NUMBER
NTS	NOT TO SCALE
OCT	OCTAGONAL
₱	PLATE
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE

PLAN CHECK SET/NOT FOR CONSTRUCTION (4/12/13)

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408-296-5515
BCA

JOB NO.	2011216.5
DRAWN BY:	S. HICKEY
CHECKED BY:	

REGISTERED PROFESSIONAL ENGINEER — TROY M. SWENSON — No. 4620 — Exp. 12/31/13 — STRUCTURAL — STATE OF CALIFORNIA

PROJECT INFO.

OAKLAND ARMY BASE WHARVES
STRUCTURE INDEX

REV	DATE	COMMENT	CHECKED BY	C.O.O.
	04/15/13	35% SUBMITTAL		

DRAWING NO. S1
SHEET __ OF __
SCALE: AS SHOWN
DATE: 04/15/13

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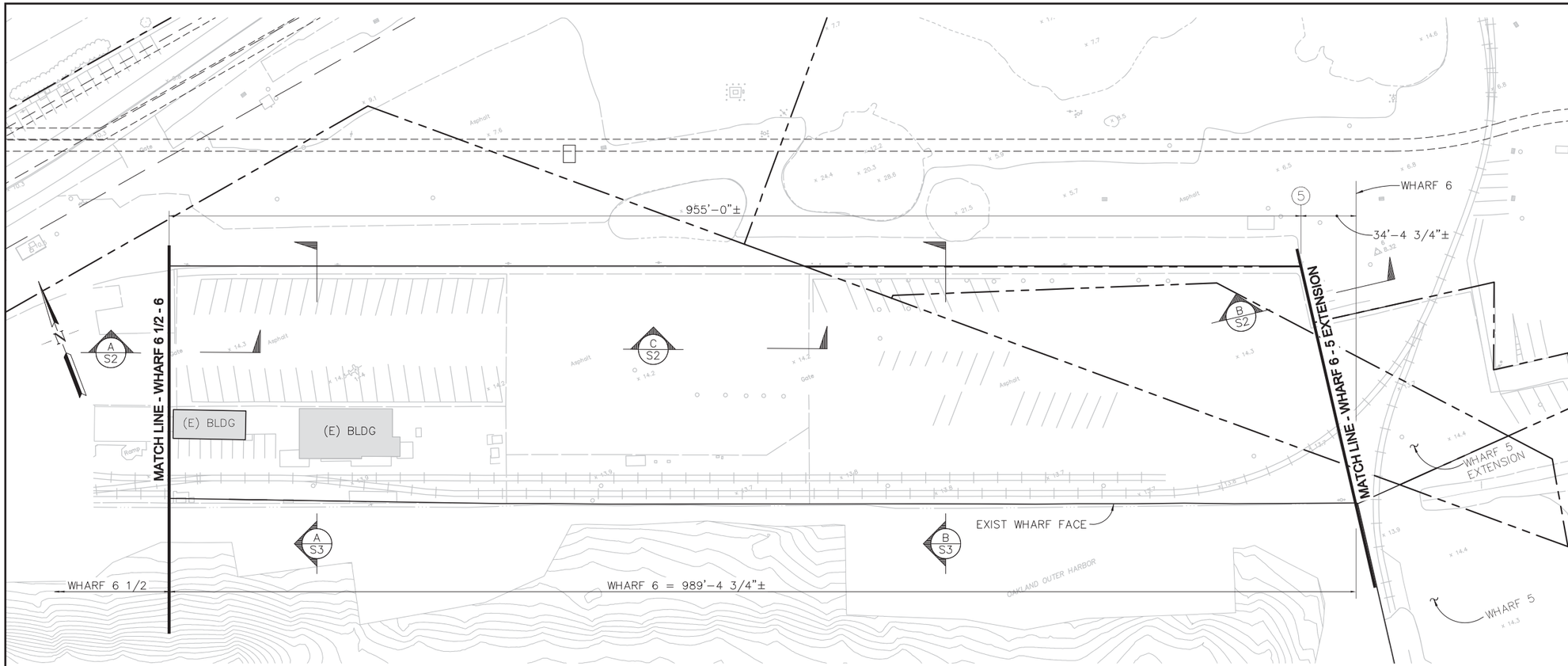
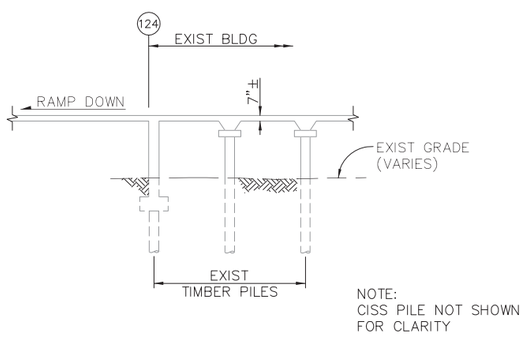


WHARF 6 PLAN
1" = 50'



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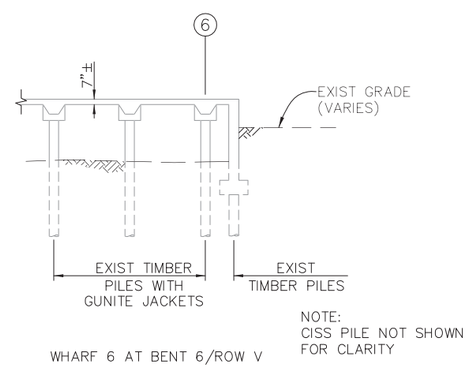
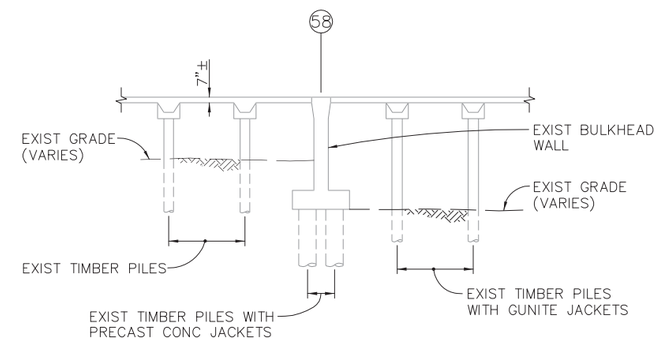
A SECTION
NTS



WHARF 6 AT BENT 6/ROW V

B SECTION
NTS



WHARF 6 AT BENT 58/ROW S

C SECTION
NTS

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OAKLAND ARMY BASE WHARVES
WHARF 6 GENERAL PLAN No. 1

REV	DATE	COMMENT	CHECKED BY	C.O.O.
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DRAWING NO. S2
SHEET ___ OF ___
SCALE: AS SHOWN
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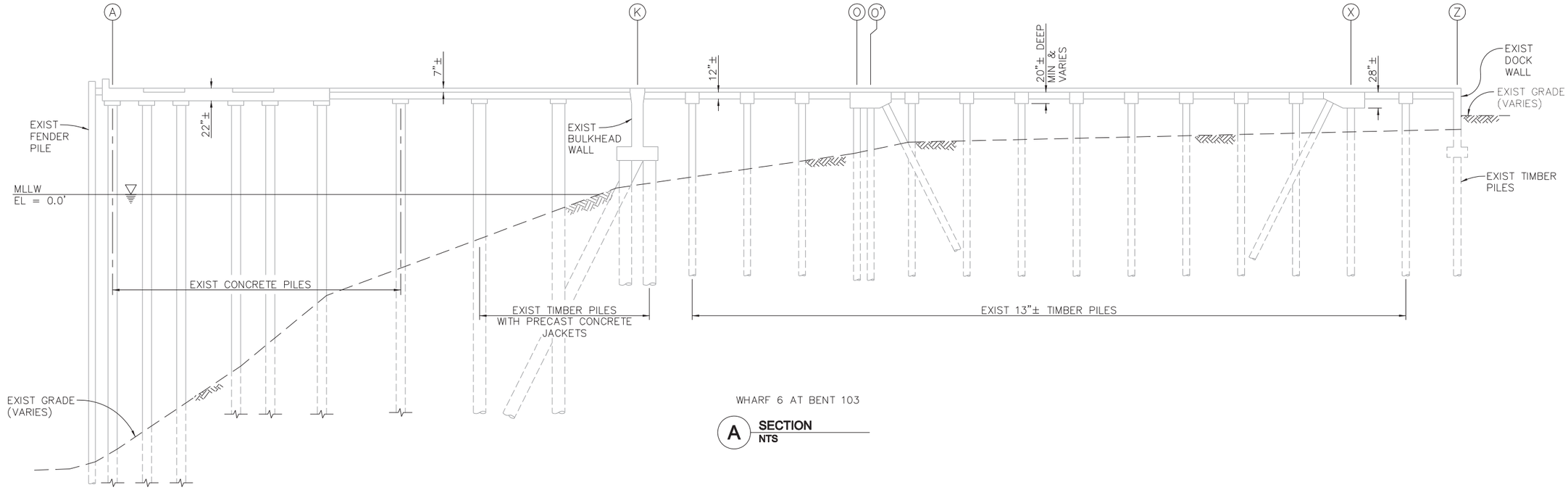
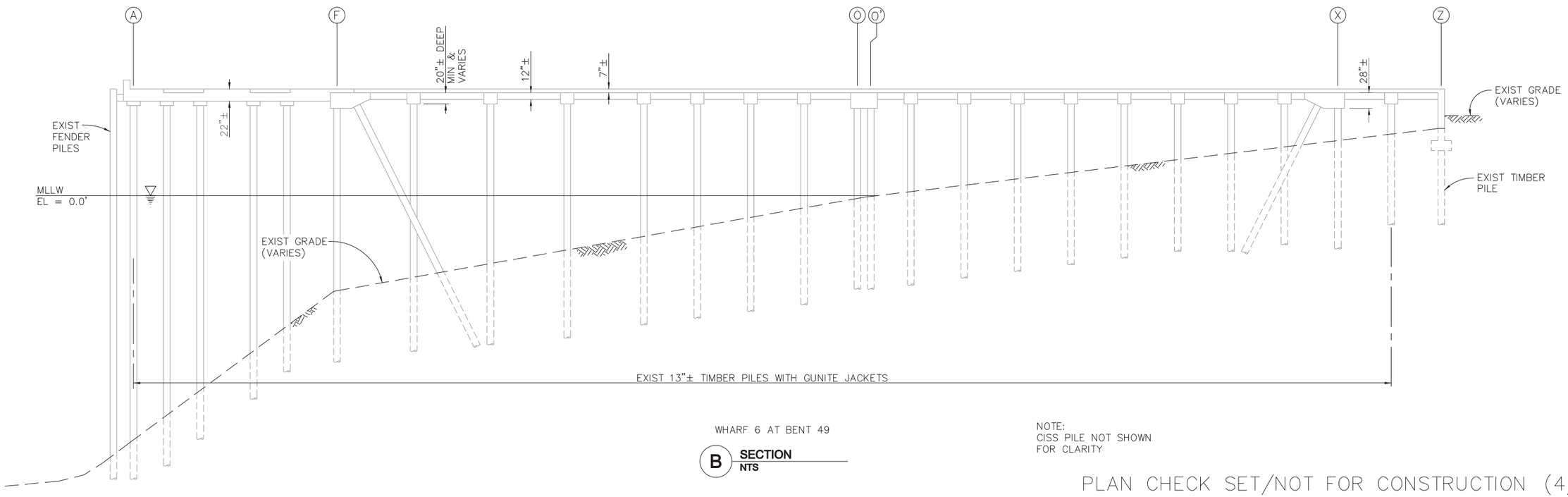


WHARF 6 AT BENT 103

A SECTION
NTS



WHARF 6 AT BENT 49

B SECTION
NTS

NOTE:
CISS PILE NOT SHOWN
FOR CLARITY

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OAKLAND ARMY BASE WHARVES
WHARF 6 GENERAL PLAN No. 2

REV	DATE	COMMENT	CHECKED BY	C.O.O.
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DRAWING NO.
S3
SHEET ___ OF ___

SCALE: AS SHOWN
DATE: 04/15/13

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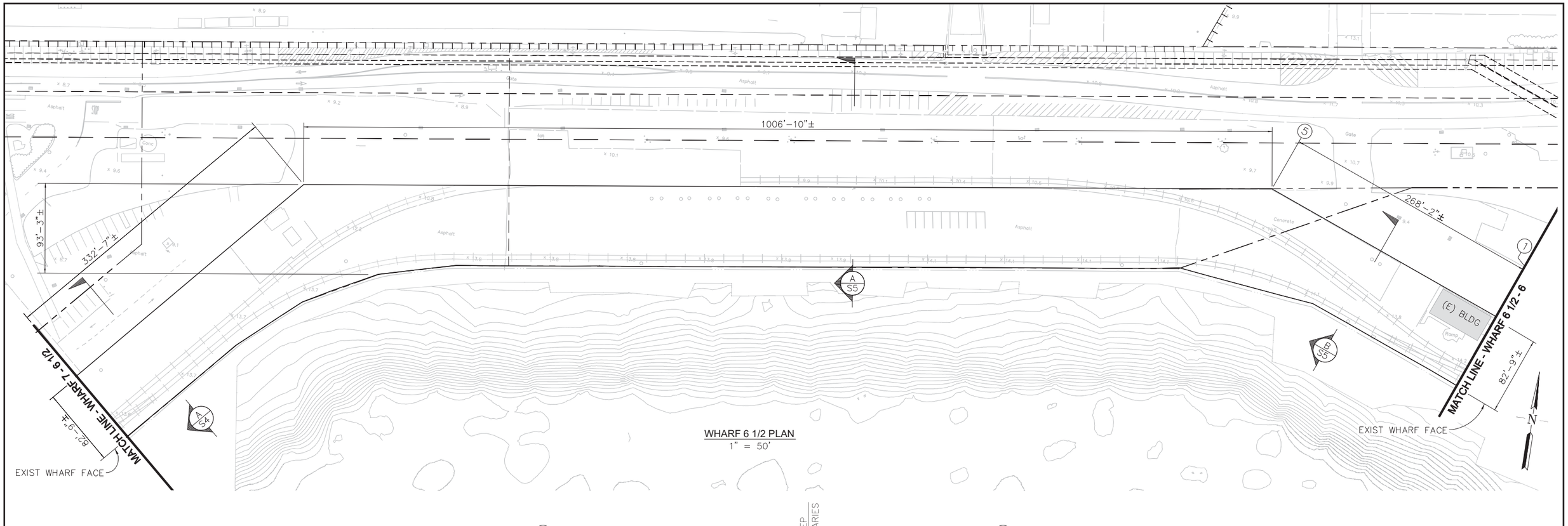
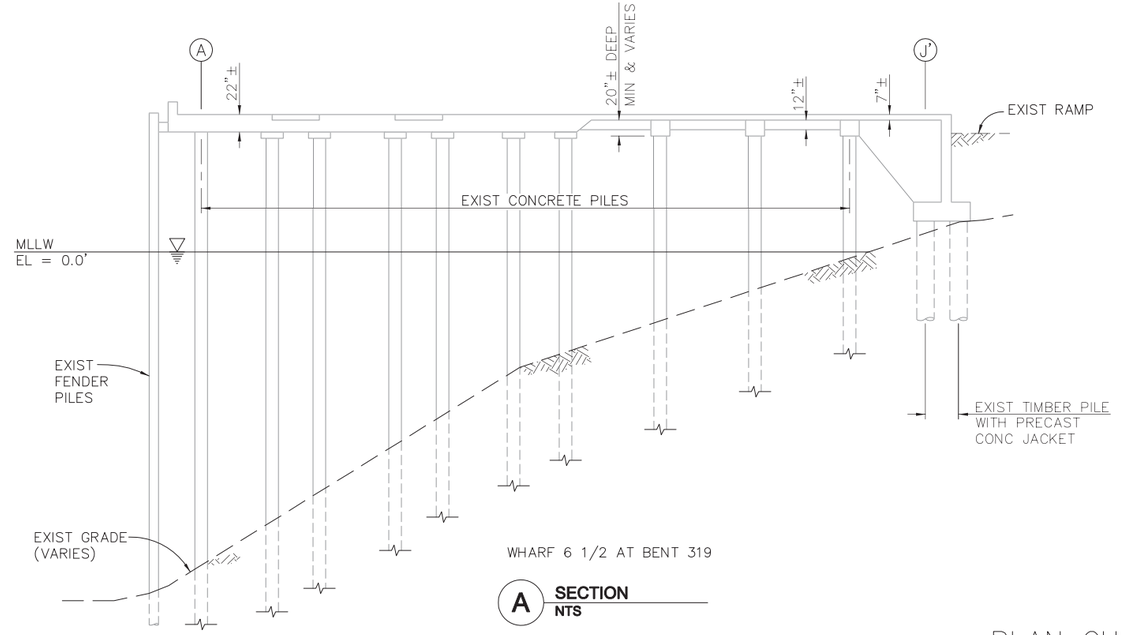


WHARF 6 1/2 PLAN
1" = 50'



WHARF 6 1/2 AT BENT 319

A SECTION
NTS

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PROJECT INFO.

OAKLAND ARMY BASE WHARVES
WHARF 6 1/2 GENERAL PLAN No. 1

REV	DATE	COMMENT	CHECKED BY	C.O.O.
	04/15/13	35% SUBMITTAL		

DRAWING NO. S4
SHEET __ OF __
SCALE: AS SHOWN
DATE: 04/15/13

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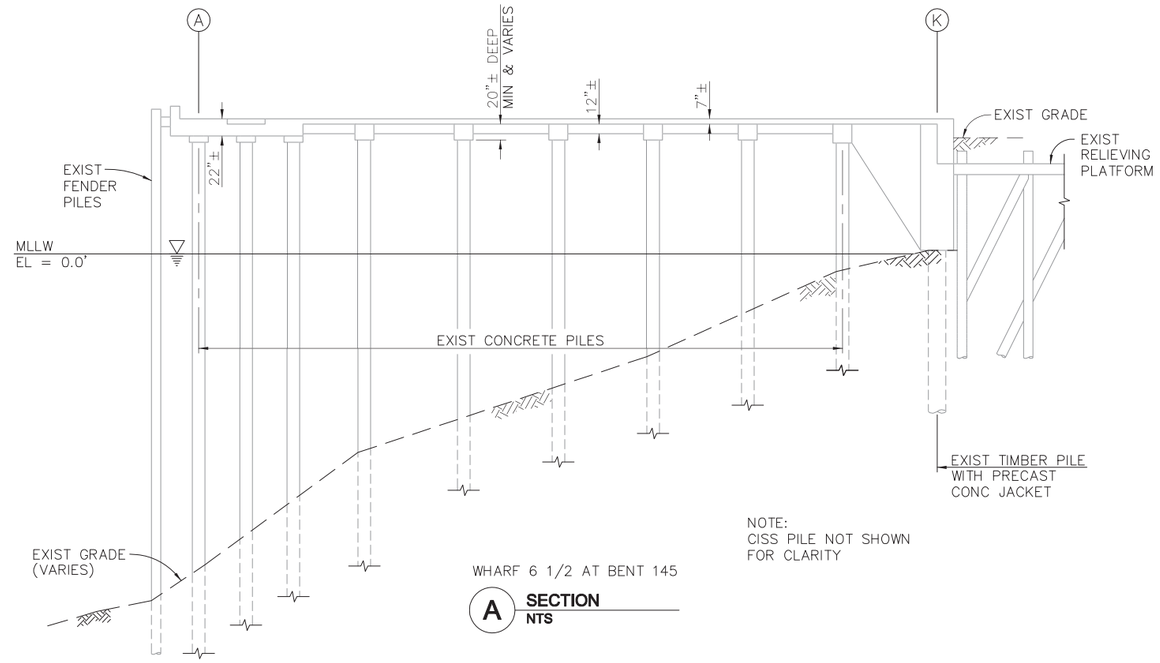
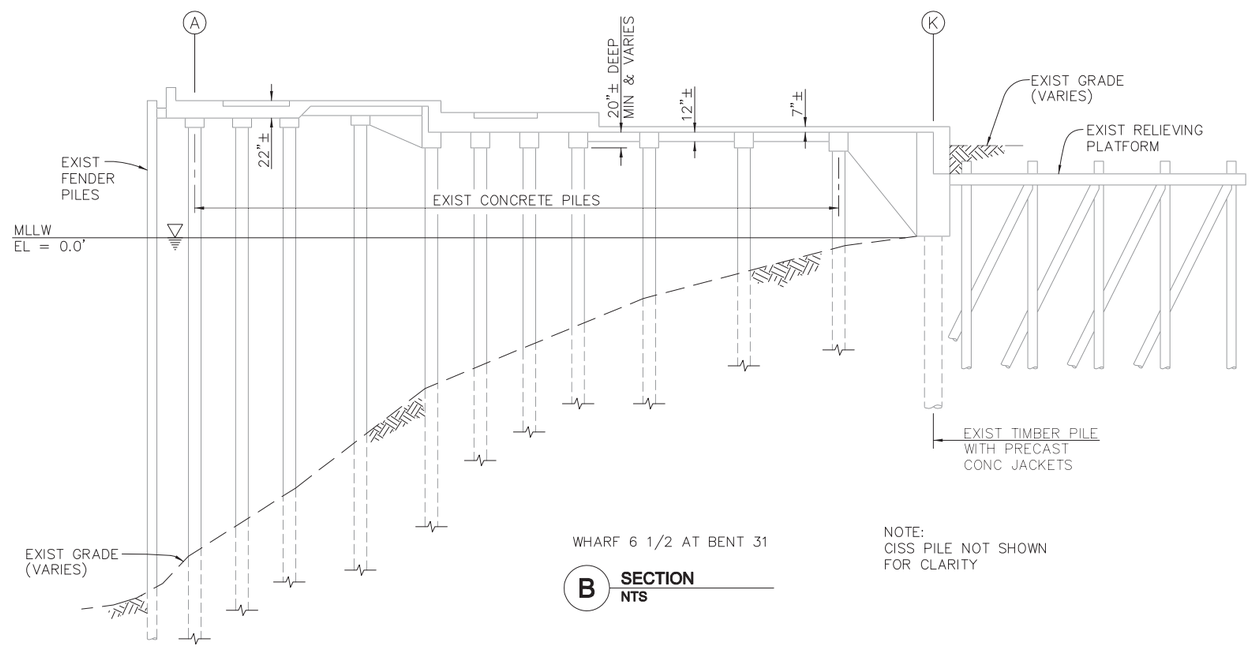


WHARF 6 1/2 AT BENT 145

A SECTION
NTS



WHARF 6 1/2 AT BENT 31

NOTE:
CISS PILE NOT SHOWN
FOR CLARITY

B SECTION
NTS

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STATE OF CALIFORNIA

PROJECT INFO.

OAKLAND ARMY BASE WHARVES
WHARF 6 1/2 GENERAL PLAN No. 2

REV	DATE	COMMENT	CHECKED BY	C.O.O.
	04/15/13	35% SUBMITTAL		

DRAWING NO.
S5
SHEET ___ OF ___
SCALE: AS SHOWN
DATE: 04/15/13

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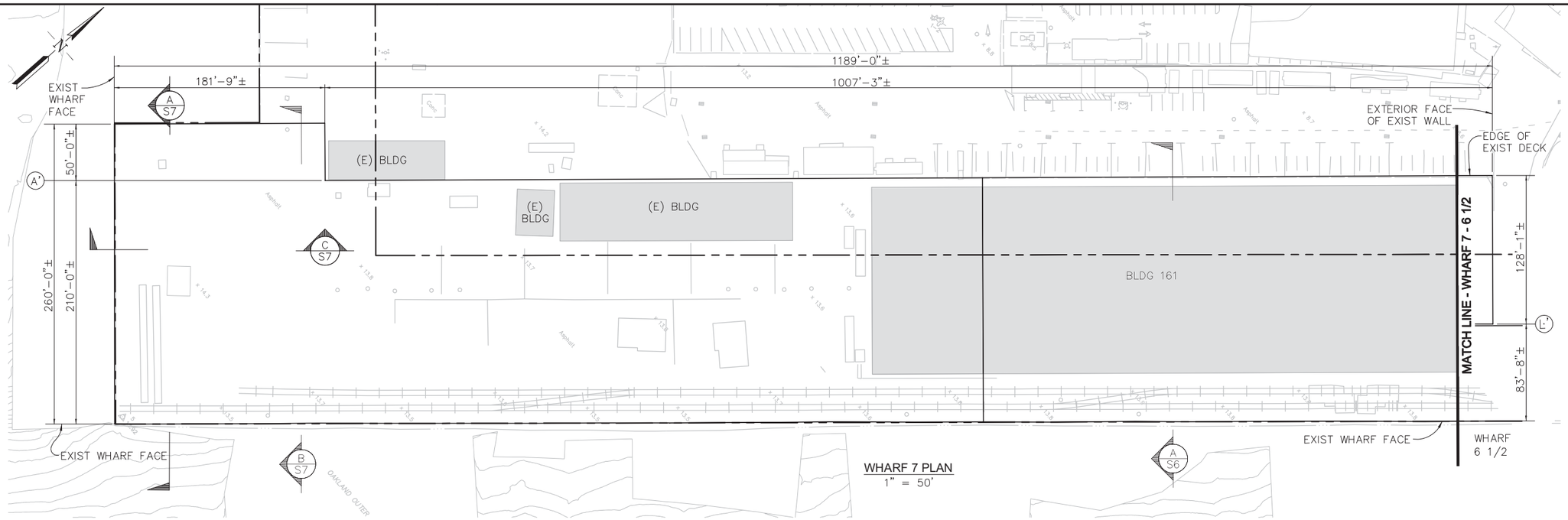
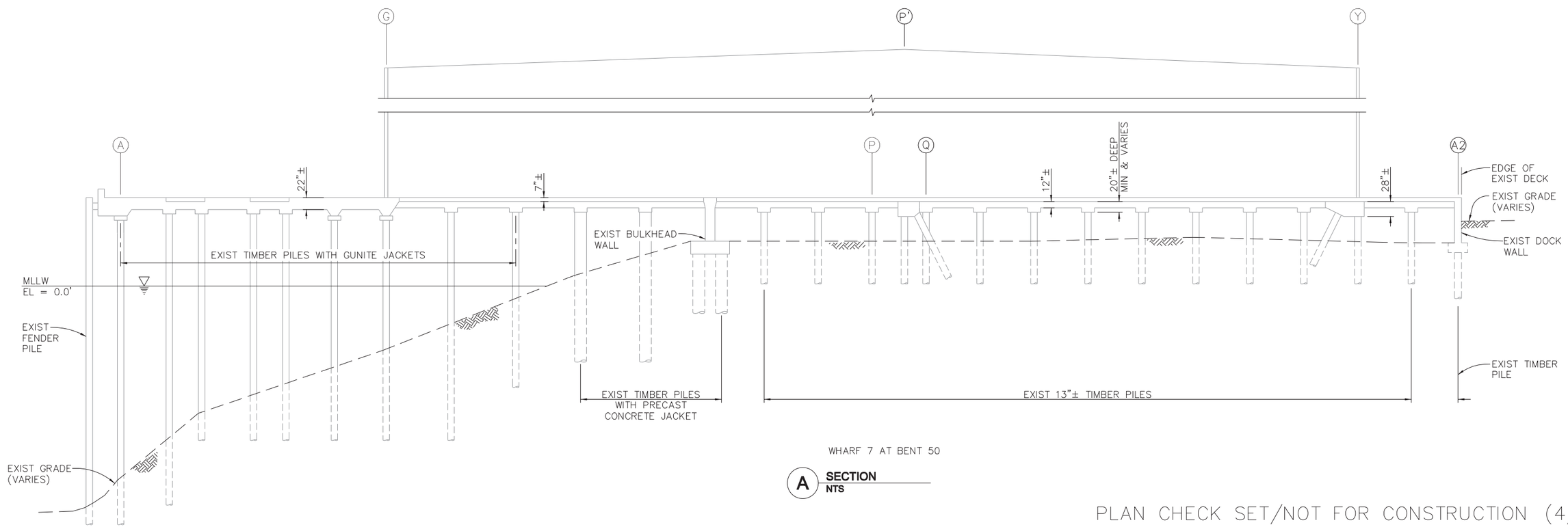


WHARF 7 PLAN
1" = 50'



WHARF 7 AT BENT 50

A SECTION
NTS

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No. 4620
Exp. 12/31/13
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STATE OF CALIFORNIA

PROJECT INFO.

OAKLAND ARMY BASE WHARVES
WHARF 7 GENERAL PLAN No. 1

REV	DATE	COMMENT	CHECKED BY	C.O.O.
	04/15/13	35% SUBMITTAL		

DRAWING NO.
S6
SHEET __ OF __

SCALE:	AS SHOWN
DATE:	04/15/13

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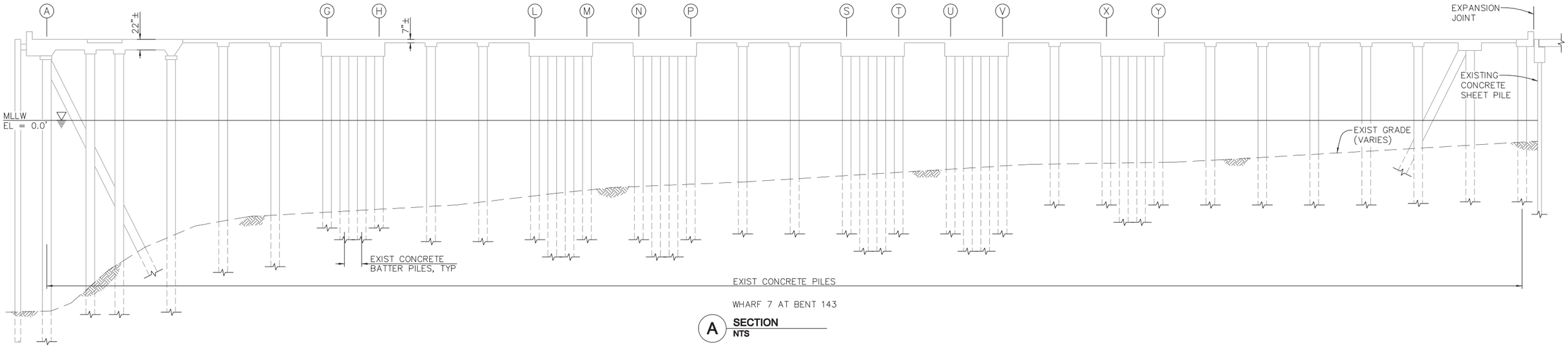
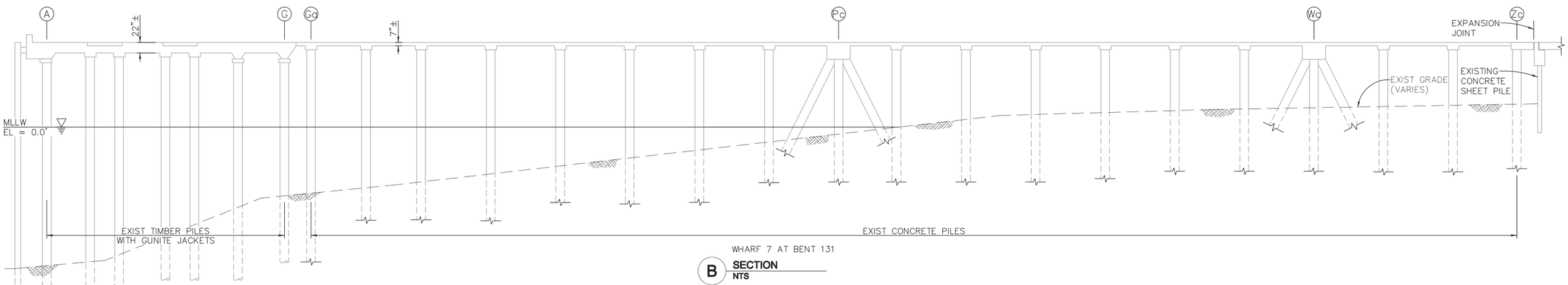
(2011216S6)
2011216.5



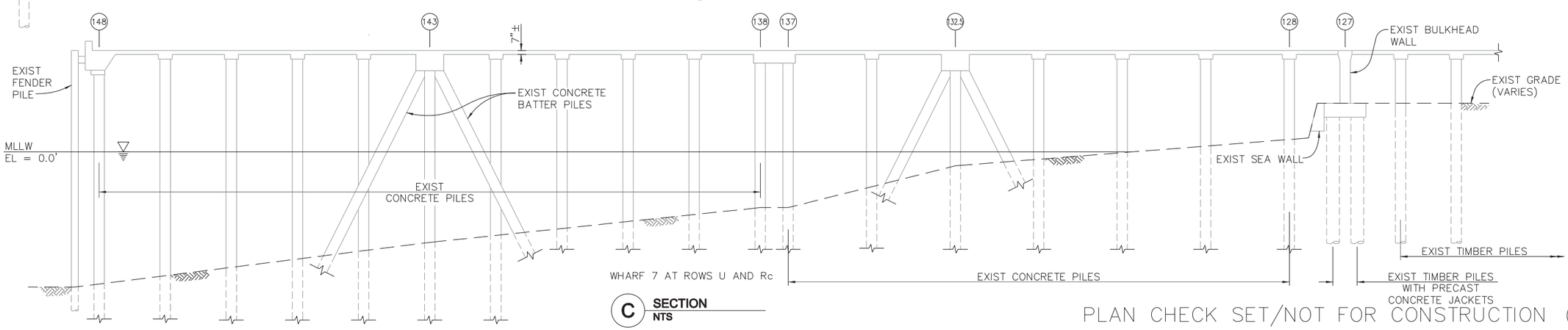
WHARF 7 AT BENT 143

A SECTION
NTS



WHARF 7 AT BENT 131

B SECTION
NTS



WHARF 7 AT ROWS U AND Rc

C SECTION
NTS

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TROY M. SWENSON
No. 4620
Exp. 12/31/13
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STATE OF CALIFORNIA

PROJECT INFO.

OAKLAND ARMY BASE WHARVES
WHARF 7 GENERAL PLAN No. 2

REV	DATE	COMMENT	CHECKED BY	C.O.O.
	04/15/13	35% SUBMITTAL		

DRAWING NO.
S7
SHEET ___ OF ___

SCALE:	AS SHOWN
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2011216.5 (2011216S7)