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FEASIBILITY STUDY FOR SEAWALL DESIGN ALTERNATIVES FOR NAPLES ISLAND NE QUADRANT PERMANENT SEAWALL REPAIRS PROJECT

City of Long Beach, California

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1.0 INTRODUCTION

The California Coastal Commission (CCC) has requested that the City of Long Beach (City) investigate landside design alternatives for the Naples Island Northeast Quadrant (NEQ) Seawall Repair Project. Tetra Tech is pleased to submit this feasibility level evaluation of seawall design alternatives that would provide full support under static and seismic design conditions. The Rivo Alto Canal between The Toledo bridge and the Ravenna Drive bridge is referred to as the Naples Island northeast quadrant (NEQ) and is the subject area of this report. The NEQ is considered Phase I of 6 seawall repair phases identified by the City.

The main objective of landside seawall alternative is to provide a structurally independent new seawall on the landside of the existing seawall and improve the stability of the adjacent area behind the seawall on both sides of the Rivo Alto Canal between The Toledo bridge and the Ravenna Drive bridge.

Tetra Tech, Inc. and its sub-consultant Geotechnical Professionals, Inc. (GPI) have teamed on previous design efforts for the Naples NEQ Permanent Seawall Repairs Project including the Geotechnical Investigation, Naples Seawall Replacement, Phase I (North-East Quadrant), Long Beach, California in which recommendations were provided for seawalls to be constructed on the water side of the existing seawall, as documented in Reference 1. At that time, the City of Long Beach had selected the water side alternative, based on feasibility evaluations previously performed by Transystems and completed in April 2009 (Reference 2). The Transystems Feasibility evaluation outlined major structural problems with the existing seawalls and recommended immediate replacement of the NEQ seawalls, which are in imminent danger of collapse.

2.0 SCOPE OF WORK

The scope of work included in this Feasibility Study for Seawall Design Alternatives for Naples Island NEQ Seawall Repairs Project (Phase 1*)* consists of:

- A geotechnical field investigation to evaluate the existing field conditions
- An evaluation of retaining wall systems utilizing cased piles, jet grouted soil cement columns, auger-cast pressure grouted (APG) piles , steel Z-piles, and a slurry wall
- Conceptual drawings
- Constructability evaluation
- Rough order of magnitude (ROM) construction cost estimate
- Attendance of a progress meeting with the City of Long Beach
- Attendance of the December 6th, 2012 Naples Home Owners Association (HOA) meeting

3.0 FIELD INVESTIGATION/ SITE OBSTRUCTIONS

The most significant constraint in constructing new seawalls landside of the existing seawall is the likely presence of subsurface obstructions. The limited documents available from past construction activities indicated that parts of a previously existing seawall, damaged during the 1933 earthquake were left in-place. Additionally, grouting (mudjacking) was performed at various times, presumably to seal the joints of the existing seawall. Selected drawings from the documents reviewed are presented in Attachment C – Geotechnical Evaluation in Appendix A. Based on the records reviewed, these obstructions were expected to be within 4 feet landside of the existing wall. Additionally, there are several tie-back anchor rods installed at various periods, both as part of the original design and as a result of subsequent retrofits. These obstructions are key considerations for the choice and design of landside seawall alternatives.

GPI, Inc. conducted a field investigation aimed at verifying the presence or absence of obstructions that were anticipated based on a review of historical construction records and of assessing how close to the existing wall a new wall can be constructed without encountering these obstructions. This investigation was limited to accessible areas between the seawall and the sidewalk (approximately 5 feet of clear space). The investigation consisted of probing with a 6-foot long steel probe, probing with an air-jet probe, and hand auguring in areas where obstructions were detected. The results of the field investigation are discussed in the Geotechnical Evaluation, Section 3, and summarized in Appendix B of the Geotechnical Evaluation.

Available plans for a 1956 mudjacking/grouting project indicate that grout was to be pumped at 4-foot spacing's, distances of 1 to 2 feet from the wall and alternating depths of 5 and 10 feet. We understand that additional grouting was also performed in 1985, to fill voids and seal wall panel joints at one location on the north side and five locations on the south side of the canal. Relatively few (approximately 16) obstructions were encountered within 2 to 3 feet from the wall down to a depth of 6 feet using a steel probe. However, subsequent probing with an air jet tube indicated definite obstructions at depths greater than 6 feet. Based on these probings, we conclude that grouting from previous mudjacking has resulted in obstructions within at least 3 feet from the landside face of the existing wall.

Plans related to the construction of the existing seawall indicate that a previously existing wall, located landside of the existing wall was left in-place at most locations and removed at others (see plan in Appendix A of the Geotechnical Evaluation). Probing performed in areas where this wall was expected, confirmed the presence of obstructions at distances of 3 to 4 feet from the landside face of the pile cap (see Table in Appendix B of the Geotechnical Evaluation). Hand auguring at several of these locations produced chunks of wood and, in one case, chips of concrete. Based on the documents reviewed and confirmation by our field investigation, it can be concluded that the previously existing wall has remained in-place at distances 3 to 4 feet from the landside face of the pile cap of the existing seawall, except in localized areas where it was removed.

4.0 CONSTRUCTABILITY EVALUATION

In evaluating seawall design alternatives for the project, we considered constraints related to the site conditions as well as the objective of providing adequate support under static and seismic conditions, without relying on support from the existing seawall.

The three significant site-specific constraints include subsurface obstructions, site access conditions, and the need to limit vibrations during construction. An evaluation of construction methods is also provided below to outline possible construction techniques.

4.1 SUBSURFACE CONDITIONS

Our review of historical construction data and the results of our field investigation clearly indicate that there are significant buried obstructions within approximately 4 feet from the landside face of the seawall pile cap (about 5 feet from the waterside face of the seawall). These obstructions, which include irregular-surfaced grout masses, remnants of a previously existing seawall and other debris, combined with the soft soils surrounding the debris make it practically impossible to construct a new wall within 4 feet of the existing wall, because it is very difficult to drive or drill piles for a new wall into irregular-surfaced grout masses that are supported on soft soils. **Therefore, in our opinion a landside seawall would need to be constructed at least 4 feet (preferably 5 feet) beyond the inside face of the existing seawall pile cap.**

4.2 SITE ACCESS CONDITIONS

Site access is a significant constraint with respect to the choice of construction equipment and, to some extent, even affects the choice of seawall design alternatives. The site is located in a highly developed residential area with very limited access.

Landside site access is currently limited to an 11 foot wide area (work area) between the existing seawall and the brick wall adjacent to the yard of private properties which may be insufficient for construction of a landside seawall. Since the City owns the property located within 20 feet of the wall, it is highly recommended that the entire 20 foot wide area be made available for a new landside seawall replacement. This will require the removal of all the hardscape and landscape improvements within 20 feet of the existing wall. Access to this work area differs on the north and south side of the Rivo Alto Canal. The north side is accessible from the terminus of Loreta Walk, Cordova Walk and Syracuse Walk. The south side has no streets to provide direct access to the work area. Landside access is limited by the following factors:

- Street width with parking along both sides of the street.
- Overhead obstructions including utilities, power lines and trees
- Street pavement capacity
- Bridge capacity
- Narrow public access route between seawall and private properties
- Limited and narrow utility easement between residential properties

Low overhead bridges over the Rivo Alto canal are located on either end of the project site. In addition, the location of the project in the northeast portion of the Rivo Alto canal requires passage under a minimum of 2 of the 5 brides leading to Naples Island. The bridge overhead clearances are presented in Attachment D - Figure 1. The values shown are referenced to Mean Lower Low Water (MLLW) and are measured to the center of the arched bridge support. The maximum clearance under all the bridges is 12 feet at MLLW water.

The depth of the channel ranges from -6.5’ MLLW to -7.3’ MLLW along the centerline of the channel in the Northeast quadrant. Similar depths can be expected in the access routes to the project site, but have not yet been confirmed.

The Rivo Alto Canal is 69’ to 70’ wide from seawall to seawall in the project site. Private boats and docks line the channel on both sides of the project area and the water access routes. The effective navigational width of the channel and access routes is approximately 40 feet.

The storm drain outfall at the end of Cordova Walk will interfere with the seawall installation due to the elevation of the outfall cap being approximately 2 feet higher that the existing seawall on each side.

In addition to the storm drain outfall, several gravity feed drainage outfall exist within the site. The seawall design will need to account for these structures. Due to the elevation of these outfalls, it is anticipated that flap gates will need to be installed.

A Los Angeles County pump station exists on the adjacent and under western end of The Toledo Bridge. The outfall of this pump station is located underneath The Toledo Bridge and should not interfere with the seawall replacement. However, grading the hardscape area on the landside of the existing seawall will need to account for this pump station.

A City utility vault exists under the north end of the Ravenna Bridge that must be protected in place.

All landside options will require the complete removal of all trees, landscaping, utilities and hardscape improvements for construction.

4.3 VIBRATION

The alternatives considered are aimed at limiting vibrations during construction. The soils at the site to depths ranging between 15 and 24 feet are highly susceptible to vibration-induced liquefaction and settlement. Therefore, impact or vibratory equipment cannot be used at the site without risking damage to the existing structures due to vibration induced differential foundation settlement. This precludes the use of driven piles or any construction method that causes high levels of vibration.

4.4 CONSTRUCTION METHODS

Based on significant site constraints and discussion with specialty contractors it is anticipated that the drilled piers, steel sheet pile and slurry wall options would require use of barges on the canal to allow the use of larger equipment that will increase production and help reduce costs. The barge approach will also help avoid site access constraints and minimize impacts to residents.

Construction of the jet grouted secant wall from the landside is feasible, but, it would require the use of smaller equipment to access the work zone. A contractor would have to remove railings and build ramps to gain access to the work zone for equipment on the south side or utilize a crane on a barge or a very large crane on land to lift the equipment into place. Another significant consideration of concern is the surcharge on the existing wall due to high equipment loads on the landside. Some landside equipment may be too heavy to mobilize directly adjacent to the existing wall without causing deflection or failure of the existing seawall.

Delivery of materials such as structural steel and Z-piles is best accomplished by trucking the materials to the north side of the project site on North Loreta Walk or North Syracuse Walk and unloading the trucks with a barge mounted crane. The materials can be stored on site on a barge or on land.

Concrete or grout delivery can be made utilizing concrete pumps and hoses. A concrete pump on the north side can be set up to receive concrete at the end of North Loreta Walk or North Syracuse Walk and pumped to the required location. Concrete can be delivered to the south side utilizing the same pump layout, but the concrete hoses would have to be “bridged” across the channel, possibly across barges.

A Gieken silent piler hydraulic press method is the recommended installation method for Option 1 – Z-Pile Wall. The silent piler is a compact, but heavy piece of equipment. It is recommended that this equipment be trucked to the site and set into place utilizing a barge mounted crane.

Waterside access is complicated by low overhead bridges, shallow channel depth and narrow channel width. It is suggested that Flexi-floats be used to create the required barge size. Flexi floats come in a variety of sizes and shapes to allow for the assembly of the floats on site. The floats can be individually floated to the site and assembled in the project area on the canal between The Toledo Bridge and the Ravenna Bridge.

A barge mounted crane can be utilized to complete any of the design options. It is estimated a crane in the order of 100 tons would be required. It is impossible to mobilize a crane of this size to the site via water. It is anticipated the crane will be delivered to the site via truck to North Loreta Walk or North Syracuse Walk. The crane can be mounted on a flexi-float barge of sufficient size by building a bridge over the existing pile cap and at high tide, drive the crane on to the barge without applying load to the existing pile cap.

5.0 SEAWALL DESIGN ALTERNATIVES

5.1 SEAWALL DESIGN RATIONALE

This report is separated into three options:

Option 1 – Installation of a waterside steel sheet pile wall:

This option involves installation of a steel sheet pile wall on the waterside of the existing wall. Option 1 design concept does not involve removal of the existing wall, will be the least expensive option, require the least amount of time to install, not require the removal of all existing hardscape and have the least risk of damaging adjacent homes. In addition, because this new seawall would no longer depend on tie backs, it will make it easier for a future wall to be constructed on the landside by acting as a shoring system.

Options 2 and 3 – Installation of a landside retaining wall system and replacing the existing wall:

These options involve the installation of a retaining wall system on the landside of the existing retaining wall and removing the existing retaining wall and cap. New wall panels (fascia) could then be attached to the new piles and a new pile cap installed. The evaluation of these options includes landside jet grouted secant piles and landside cased secant piles. Augercast pressure grouted piles (APG), steel sheet pile and a slurry wall were also considered as other landside options.

5.2 LATERAL LOADS

Our geotechnical investigation for the water side sheet pile wall concept included a comprehensive evaluation of lateral earth pressures under static and seismic load conditions. These pressures were related to the lateral displacement of the wall. In general, the lateral earth pressures would be less for a wall that could displace under load than a wall that would be rigid. The calculated lateral loads per foot of wall and compatible lateral displacements calculated for the AZ-28 sheet pile wall were as follows:

LOADING CONDITION	PEAK GROUND ACCELERATION	LATERAL LOAD (kips/foot)	DISPLACEMENT AT ELEV. +7 (inches)
Static	0	4.1	<1.9
Operating Level Earthquake (OLE)	0.17g	5.7	3.1
Design Earthquake (DE)	0.40g	7.6	4.6

The tabulated loads are not factored. Appropriate factors need to be used for structural design. The OLE has a return period of 72 years, while the DE is equal to two-thirds of the maximum considered earthquake acceleration, which has a return period of 2,475 years.

For the feasibility-level geotechnical evaluations presented in Attachment C, the same lateral loads were considered for all options and calculated deflections were compared to the values tabulated above.

5.3 OPTION 1 – WATERSIDE STEEL SHEET PILE WALL

A cantilevered sheet pile wall installed on the waterside continues to be the preferred seawall repair alternative (see Attachment A – Option 1). Installation by a hydraulic press method, such as the GIEKEN Silent Piler is the recommended installation method (see Attachment D - Figure 3).

Advantages:

- Installation of a new wall without removing the existing wall or its tie-back anchors, which minimizes potential damage to the residential properties
- Minimizes vibration during construction
- Minimizes noise during construction
- Minimizes existing hardscape and landscape impacts
- Provides a near watertight seal
- Construction method is “cleanest” of all options considered

- Most cost-effective with the shortest construction period
- Minimizes the impact to existing mature trees

Disadvantages:

- Requires “fill” within coastal waters related to the narrowing the channel by 3 to 4 feet, and thus would require offsite mitigation (potentially at Colorado Lagoon)
- Requires coating or cathodic protection of the steel sheet pile
- Appearance of steel sheet piles may be of concern

The calculated lateral loads per foot of wall and compatible lateral displacements calculated for the AZ-28 sheet pile wall were as follows:

LOADING CONDITION	PEAK GROUND ACCELERATION	LATERAL LOAD (kips/foot)	DISPLACEMENT AT ELEV. +7 (inches)
Static	0	4.1	<1.9
Operating Level EQ (OLE)	0.17g	5.7	3.1
Design EQ (DE)	0.40g	7.6	4.6

The tabulated loads are not factored. Appropriate factors need to be used for structural design. The OLE has a return period of 72 years, while the DE is equal to two-thirds of the maximum considered earthquake acceleration, which has a return period of 2,475 years.

It is recommended to install filter fabric behind the Z-pile wall to prevent fine earthen materials from escaping the sheet pile joints due to tidal flow.

To increase the service life of the sheet pile for this project, marine grade steel (A690) is recommended for the manufacture of the sheet piles. Marine grade steel is more resistant to corrosion and section loss especially in the splash and intertidal zones.

It is recommended to utilize a sheet pile coating to extend the service life of the wall. Coal Tar Epoxy has been used in marine construction for many years and offers the best protection and repair options. The epoxy coating is installed offsite prior to the sheet pile installation. The sheet pile will be driven and the soil and obstructions removed from the waterside of the new wall. Damage to the epoxy coating will occur during the installation process. The ability of coal tar epoxy to be repaired and maintained makes it a more appealing for use on this project.

A shotcrete facia or concrete panels can be attached to the face of the steel sheet pile wall if the steel wall appearance is not acceptable. These costs have not been included in the cost estimate.

It is anticipated that a contractor utilizing a barge and a Gieken Silent Piler rig will be able to complete the pile installation portion of the project in 120 working days. See Attachment B – Option 1 for construction cost estimate.

This option is not recommended as a landside option primarily because the existing tie-backs will need to be cut as the sheet pile installation is completed. This method will involve lateral movement of the existing wall during construction on the order of several inches and pose a significant risk to adjacent private properties.

5.4 OPTION 2 – LANDSIDE JET GROUTED SECANT PILE WALL

This option involves creating a continuous (secant) soil-cement wall by the jet grouting method and reinforcing the wall with steel reinforcement at 5-foot spacing (See Attachment A – Option 2). This method allows maximum flexibility in avoiding existing tie-back rods while creating a continuous wall and allows for the installation of the secant wall without removal of the existing tie-backs. High velocity jets at the end of a rotating drill stem mix cement grout with soil (See Attachment D – Figure 2 for an illustration of the jet grouting pile process). The mix initially has the consistency of thick slurry allowing the insertion of steel reinforcement. Once the cement cures, the mix has the strength of hard soil to bedrock. The 28-day unconfined compressive strength of the soil-cement mixture should be at least 100 psi. The steel reinforcement is designed to provide the full lateral support, like soldier piles in a cantilevered shoring system, while the soil cement mix is designed to work like lagging.

Advantages:

- Allows for the installation of the new wall without cutting existing tiebacks
- Utilizes the existing tie backs to support the existing wall during construction of the new wall, temporary tie backs not required
- Minimizes vibration during construction
- Minimizes noise during construction
- Can be installed from the landside or waterside
- No fill of coastal waters

Disadvantages:

- “Messy” construction process
- Requires removal of existing seawalls and tiebacks
- Higher construction costs and longer construction period
- Requires installation of a shotcrete fascia or concrete panels
- Increases impact to landside hardscape
- Increases potential damage to residential properties
- Requires removal of existing palm trees (67 total)
- Requires removal of existing planter areas in front of residences, thus significantly changing the unique character of the Naples canal area

Tetra Tech evaluated the lateral deflection and bending moments for a preliminary design with W14x193 steel beams providing full support for the wall. The calculations were performed using the computer program LPILE Plus 5.0 and lateral loads ranging from 20 kips to 60 kips. For comparison, the unfactored lateral loads for a pile spacing of 5 feet are 20.5 kips for static, 28.5 kips for OLE and 38 kips for DE.

Preliminary analyses indicated that a total depth of 44 feet below the current ground surface, corresponding to a pile tip elevation of -37 feet, would provide adequate fixity. For these analyses, the load was applied at elevation -2 feet (9 feet below the ground surface). The results of the analyses are presented below:

LATERAL	LATERAL DEFLECTION (inches)		MAXIMUM BENDING MOMENT (inch-kips)
LOAD (kips)	@Elev. -2'	@Elev.+7'	
20	1.3	2.2	2865
40	3.2	5.2	6250
60	6.0	9.4	9885

One major advantage to this option is that the installation method is flexible enough to avoid the need to cut the existing tiebacks during construction. The existing tiebacks will be left in place during construction to support the existing wall and then removed once the new wall is in place.

Installing a jet grouted secant pile wall and replacing the existing wall will require an exposed wall face on the waterside and the installation of a shotcrete fascia or concrete panels. To accomplish this, anchor rods can be installed in the jet grouted secant piles and a permanent shotcrete fascia or concrete panels can be structurally attached to the beams. The removal of the existing seawall, soil and obstructions is required to install the new panels. It is recommended the contractor remove the obstructions and soil between the existing wall and the new wall prior to removing the existing wall. The existing wall will act as a barrier or curtain to contain construction debris and reduce turbid waters escaping the work zone.

Waste handling is a major concern during jet grouted secant pile projects, especially given the location of this project in tidal waters. It will be challenging and costly to prevent spoils from the construction operation from entering tidal waters. If this option is selected, it is imperative that the contractor be equipped to capture, contain, load, transport and dispose of excess grout, dirt and soil cuttings. This can be accomplished by the continuous use of vacuum trucks with snorkels to remove excess grout, dirt and soil cuttings.

Option 2 will include obstruction and soil removal that will present a water quality issue if not correctly managed. It is recommended the contractor remove the obstructions and soil between the existing wall and the new wall prior to removing the existing wall. The existing wall will act as a barrier or curtain to contain construction debris and reduce turbid waters escaping the work zone. The contractor will need to utilize BMP's such as silt curtains to control water quality issues.

It is anticipated that a contractor utilizing a barge and a crane mounted jet grout secant pile rig or a landside rig will be able to complete the pile installation portion of the project in 120 working days. The removal of the existing seawall could add up to 60 working days to the project. See Attachment B – Option 2 for construction cost estimate.

5.5 OPTION 3 – LANDSIDE CASED SECANT PILE WALL

This option (see Attachment A – Option 3) involves drilling cantilevered cased piles to form a continuous wall. The piles will be placed at 2 foot spacing between the existing tie-backs. The primary secant pile option considered are drilled cased piles, which allow construction in soft soils below the groundwater level. This concept involves construction of overlapping concrete piles installed by using a combination of steel casing and mud to the full depth of each pile. The steel casing is equipped with cutting elements at the tip to allow cutting into partially hardened concrete in order to overlap the piles. Typically, the individual pile diameters for a project of this size would be about 30 inches. The piles would be installed in segments, initially between the tie-back anchors and after the concrete of the initial segments harden and tie-back anchors are removed, at the tie-back locations.

Advantages:

- No "fill" of coastal waters required
- Provides a watertight seal
- Steel corrosion protection not needed

Disadvantages:

- Greater noise impact
- Greater vibration impact
- Requires optional shotcrete or concrete panel "fascia" if rough concrete finish of cased piles is not desired
- "Messy" construction process that requires removal of soil and debris associated with the cased pile installation
- Greater potential for existing wall failure during construction
- Requires removal of existing seawalls and tiebacks
- Higher construction cost and longer construction period
- Requires removal of existing palm trees (67 total)
- Requires removal of existing planter areas in front of residences, thus significantly changing the unique character of the Naples canal area

One major drawback to this option is the need to cut the existing tiebacks to install the cased piles. This will require the installation of new tie-backs from the new cased piles to the existing panels and phasing the installation of the cased pile in conflict with the existing tie-back until after the adjacent cased piles are installed. The proposed phasing method is shown in Attachment A – Option 3.

Installing a cased secant pile wall and replacing the existing wall will require an exposed wall face on the waterside and the installation of an optional shotcrete fascia or concrete panels if the appearance of the rough finished concrete of the drilled piles is not desirable. To accomplish this, anchor rods can be installed in the cased secant piles and a permanent shotcrete face or concrete panels can be structurally attached to the piles. The removal of the existing seawall, soil and obstruction is required to install the new panels. It is recommended the contractor remove the obstructions and soil between the existing wall and the new wall prior to removing the existing wall. The existing wall will act as a barrier or curtain to contain construction debris and reduce turbid waters escaping the work zone.

Waste handling is a major concern during cased secant pile projects, especially given the location of this project in tidal waters. It will be challenging and costly to prevent spoils from the construction operation from entering tidal waters. If this option is selected, it is imperative that the contractor be equipped to capture, contain, load, transport and dispose of excess grout, dirt and soil cuttings. This can be accomplished by the continuous use of vacuum trucks with snorkels to remove excess grout, dirt and soil cuttings.

Option 3 will include obstruction and soil removal that will present a water quality issue if not correctly managed. It is recommended the contractor remove the obstructions and soil between the existing wall and the new wall prior to removing the existing wall. The existing wall will act as a barrier or curtain to contain construction debris and reduce turbid waters escaping the work zone. The contractor will need to utilize BMP's such as silt curtains to control water quality issues.

It is anticipated that a contractor utilizing a barge and a crane mounted cased secant pile rig will be able to complete the pile installation portion of the project in 320 working days. It is anticipated that a contractor will be able to install 3 cased secant piles per day. The removal of the existing seawall could add up to 60 working days to the project. See Attachment B – Option 3 for construction cost estimate.

5.6 OTHER LANDSIDE SEAWALL DESIGN ALTERNATIVES CONSIDERED

5.6.1 OPTION 4 - AUGER CAST PRESSURE GROUTED (APG) PILE WALL

This option involves installing two sets of drilled piles to form a continuous wall. The primary piles will be placed at 3.3- or 5-foot spacings between the tie-backs; the piles will be designed to provide full support. The secondary, shorter piles will mainly fill the space between the primary piles and extend to a depth of 20 feet. The primary drilled pile option considered are augercast pressure grouted piles, which allow construction in soft soils below the groundwater level, and provide undisturbed soil to concrete contact at depths where lateral resistance is required.

One major drawback to this option is the need to cut the existing tiebacks to allow for the installation of the APG piles. This will require the installation of new tie-backs from the new APG piles to the existing panels. Unlike the jet grouted secant wall, the option does not have the same flexibility to avoid existing tie backs.

Advantages:

- Provides only full strength piles
- Provides undisturbed soil to concrete contact
- No fill of coastal waters

Disadvantages:

- "Messy" construction process
- Requires optional shotcrete or concrete panel "fascia" if rough concrete finish of APG piles is not desired
- Does not provide a water tight seal between piles
- Requires cutting existing tie backs
- Increases impact to landside hardscape and residential properties
- Higher construction costs

5.6.2 OPTION 5 – HYBRID SEAWALL OPTION

The hybrid seawall option includes installation of a steel sheet pile wall on the south side of Rivo Alto canal and a landside wall on the north side utilizing the jet grouted secant pile, cased secant pile or APG methods. A steel sheet pile wall could also be installed landside on the north side of the canal, but a support system will need to designed to support the existing wall while the new sheet pile wall is installed, which requires existing tie backs to be cut. This approach would allow for the installation of new seawalls with zero net impact to the soft bottom habitat. The landside construction difficulties associated with each of the construction methods listed above would apply to the landside portion of this project. Utilizing two types of construction methods would increase costs because the scale of each method would be smaller and the need for an additional mobilization and demobilization.

One major drawback to this option is the need to cut the existing tiebacks to allow for the installation of a new seawall on the north side of the canal, unless a jet grouted wall is installed on the north side. This will require the installation of new tie-backs from the new seawall system to the existing panels.

Advantages:

- Channel width is unchanged
- No fill of coastal waters
- Increases the “usable” landside public area on the south side

Disadvantages:

- Increased cost to implement two construction techniques
- Channel alignment issues introduced at the bridges and the existing utility structures
- “Messy” landside construction process
- Requires cutting existing tie backs, increasing the risk of damaging residential properties (unless a jet grouted wall is used on the north side)
- Increases impact to landside hardscape and residential properties on the north side
- Reduces the “usable” landside public area on the north side
- Requires additional costly shoring or installation of temporary tiebacks to support the existing wall during construction

5.6.3 OPTION 6 – SLURRY WALL

A sixth option, Slurry Wall, was also considered as a seawall replacement option. Upon investigation, the slurry wall option was deemed not feasible due to the following factors:

- Cost
- Project footprint for hydromill slurry wall is too large for this site
- Site obstructions would complicate use of hydromill
- Use of Hydromill in this setting is not applicable due to:
    - project depth to shallow
    - restricted access
    - restricted work areas
- Need for temporary shoring of upper 15 feet to get Hydromill started
- Significant risk of private property damage
- Increases impact to landside hardscape and residential properties

This option involves construction of a reinforced concrete wall, cast within a trench excavated using bentonite slurry as a stabilizing agent. The original concept involved construction of the wall in segments using "Hydromill" type excavation equipment. The initial 8-foot wide segments would be constructed between the tie-back rods. In each segment, the trench would be excavated first using bentonite or similar stabilizing mud (slurry). The reinforcement and edge forming panels would then be installed. Then concrete would be tremmied from the bottom up displacing the mud. Once the concrete in the initial segments hardens, the tie-back anchors would be removed and replaced with temporary anchors, transferring all of the lateral load to the completed panels. Finally, the spaces between the completed panels would be filled with additional concrete panels, installed using the same method as the original panels. The completed concrete wall could be used as the exposed new wall by cutting the temporary tie-backs and removing the existing wall and obstructions.

6.0 CONSTRUCTION COST ESTIMATE

Rough order of magnitude (ROM) construction costs were developed by consulting with our design team, specialty drilling contractors and pile manufactures. The construction cost estimate considers the possible construction difficulties associated with the project site's limited access and challenging subsurface conditions. The ROM cost estimates are intended to provide budgetary cost estimates for planning purposes and for comparison to existing cost estimates.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The waterside Z-pile option (Option 1) continues to be the recommended seawall replacement option. This waterside option eliminates the complications that arise when trying to replace the seawall on the landside. This option could also be used as shoring for a future seawall replacement on the landside.

8.0 LIMITATIONS DISCLAIMER

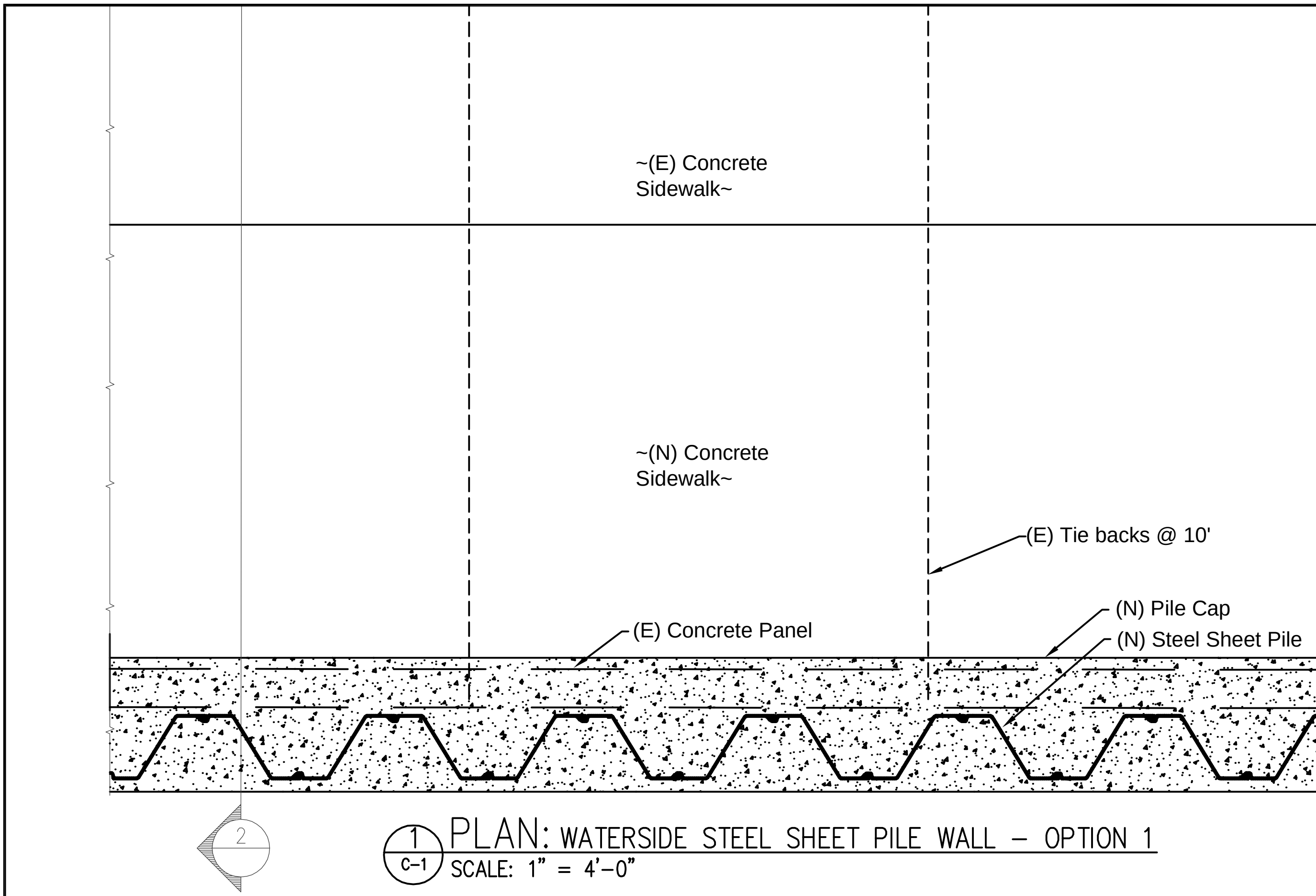
If the landside design is selected for the project, further investigation during the detailed design work will be required to accurately detail the subsurface conditions of the project area.

9.0 REFERENCES

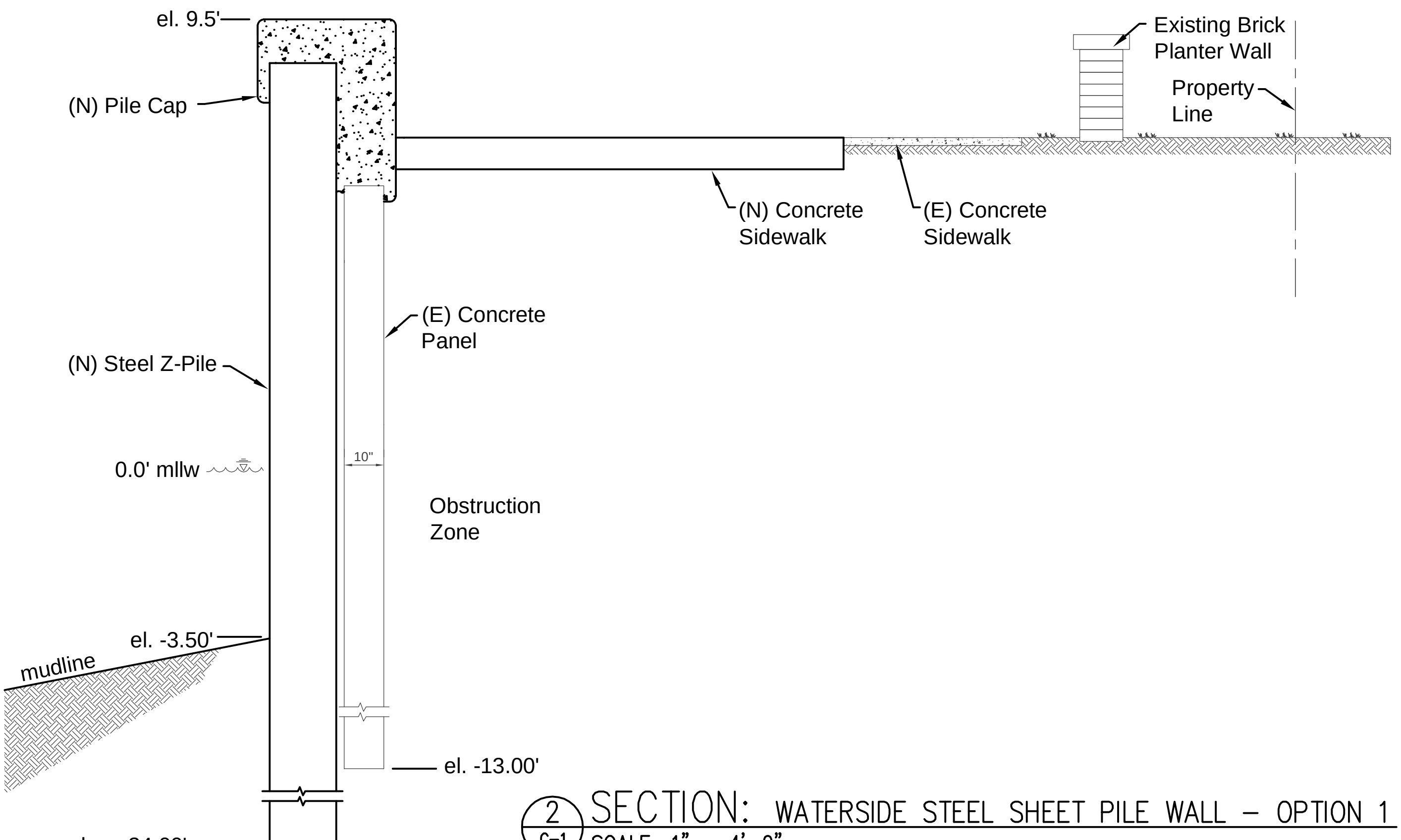
1. Geotechnical Professionals Inc., "Geotechnical Investigation, Naples Seawall Replacement, Phase I (North-East Quadrant), Long Beach, California," GPI Project No. 2359.I, dated February 14, 2011 (Revised April 19, 2012).

2. Transystems Corporation, "Naples Seawall Stability Investigation and Repair Recommendations, Long Beach, California," Transystems Project No. P506080037, February 25, 2009" – (Document includes geotechnical report by AESCO).

Attachment A..Design Alternative Figures



1 C-1 PLAN: WATERSIDE STEEL SHEET PILE WALL – OPTION 1
SCALE: 1" = 4'-0"



2 C-1 SECTION: WATERSIDE STEEL SHEET PILE WALL – OPTION 1
SCALE: 1" = 4'-0"

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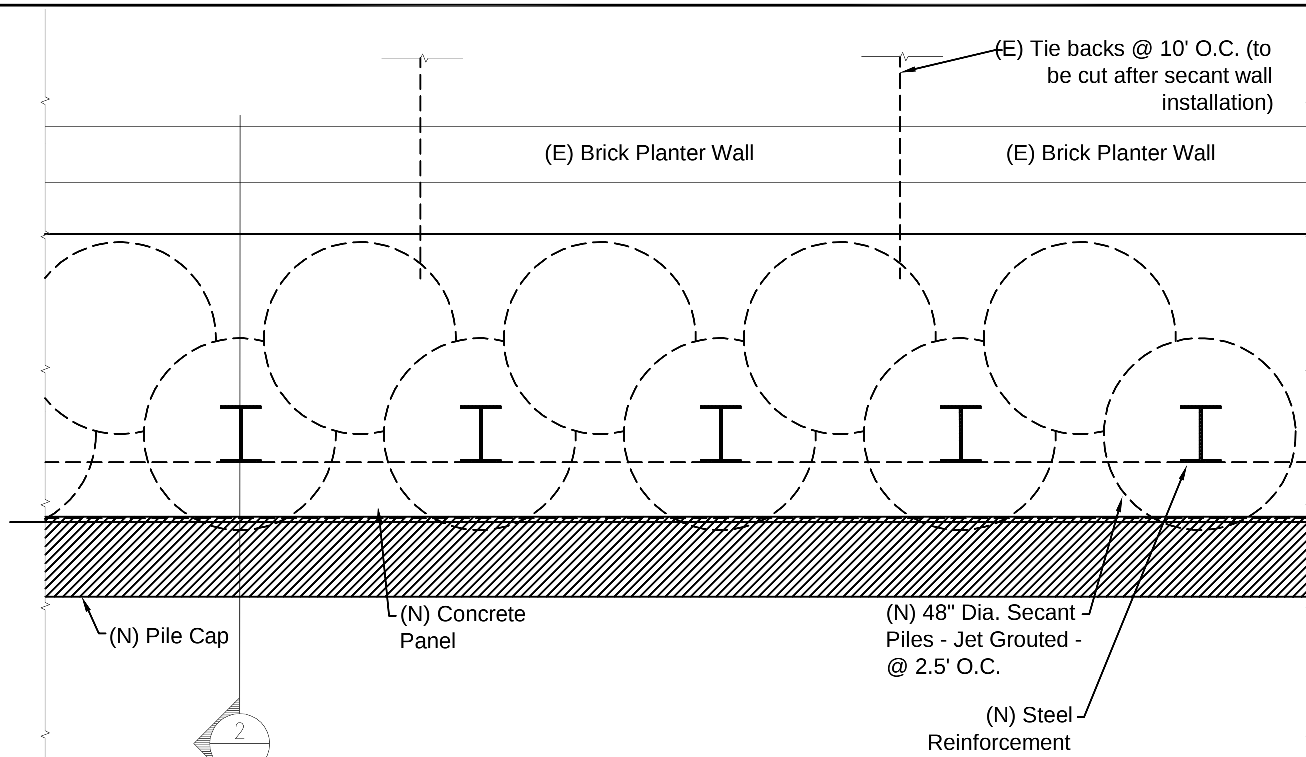
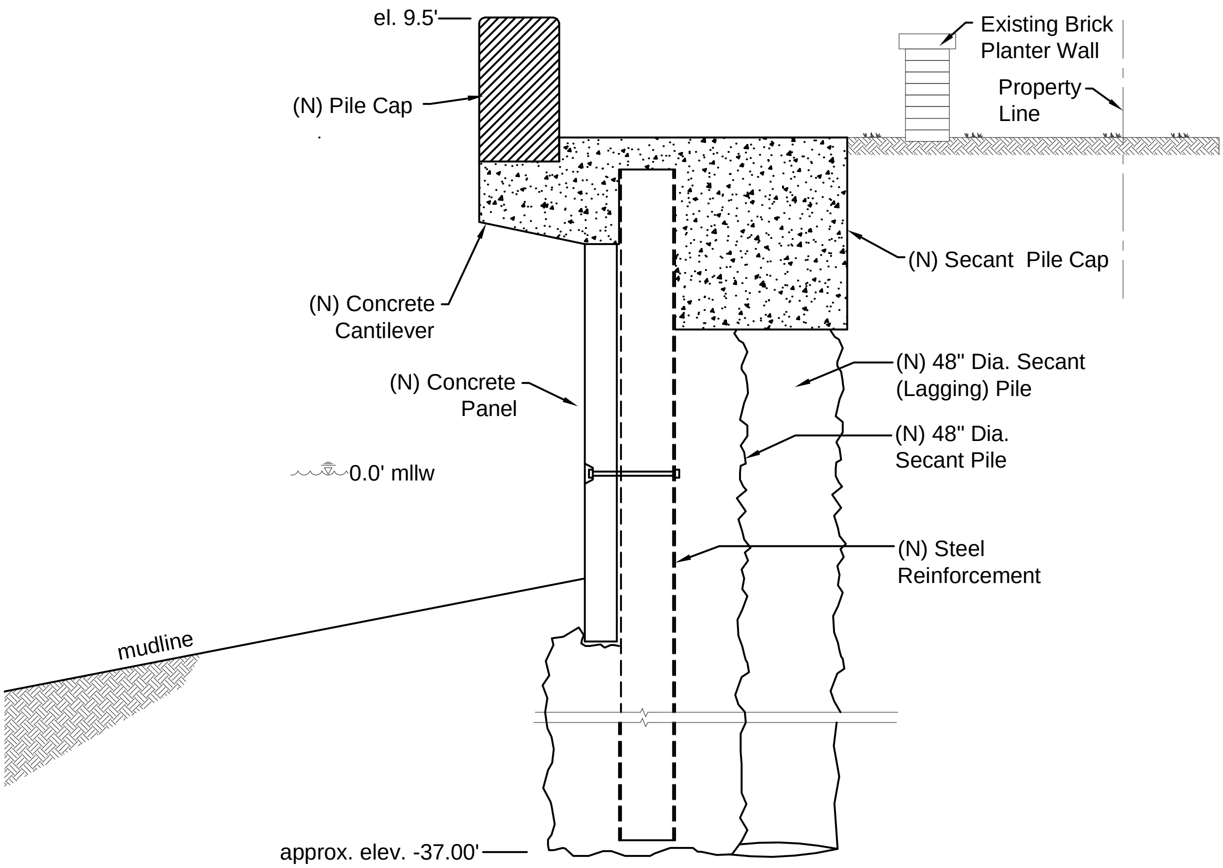
TETRA TECH KFM 401 East Ocean Blvd., Suite 420 Long Beach, CA 90802	NAPLES SEAWALL DESIGN ALTERNATIVES OPTION 1 - WATERSIDE STEEL SHEET PILE WALL	DRAWN: R.J.H DATE: Feb 201 PROJECT #:



1 C-2 PLAN: LANDSIDE JET GROUTED SECANT PILE WALL – OPTION 2
SCALE: 1" = 4'-0"



2 C-2 SECTION: LANDSIDE JET GROUTED SECANT PILE WALL – OPTION 2
SCALE: 1" = 4'-0"

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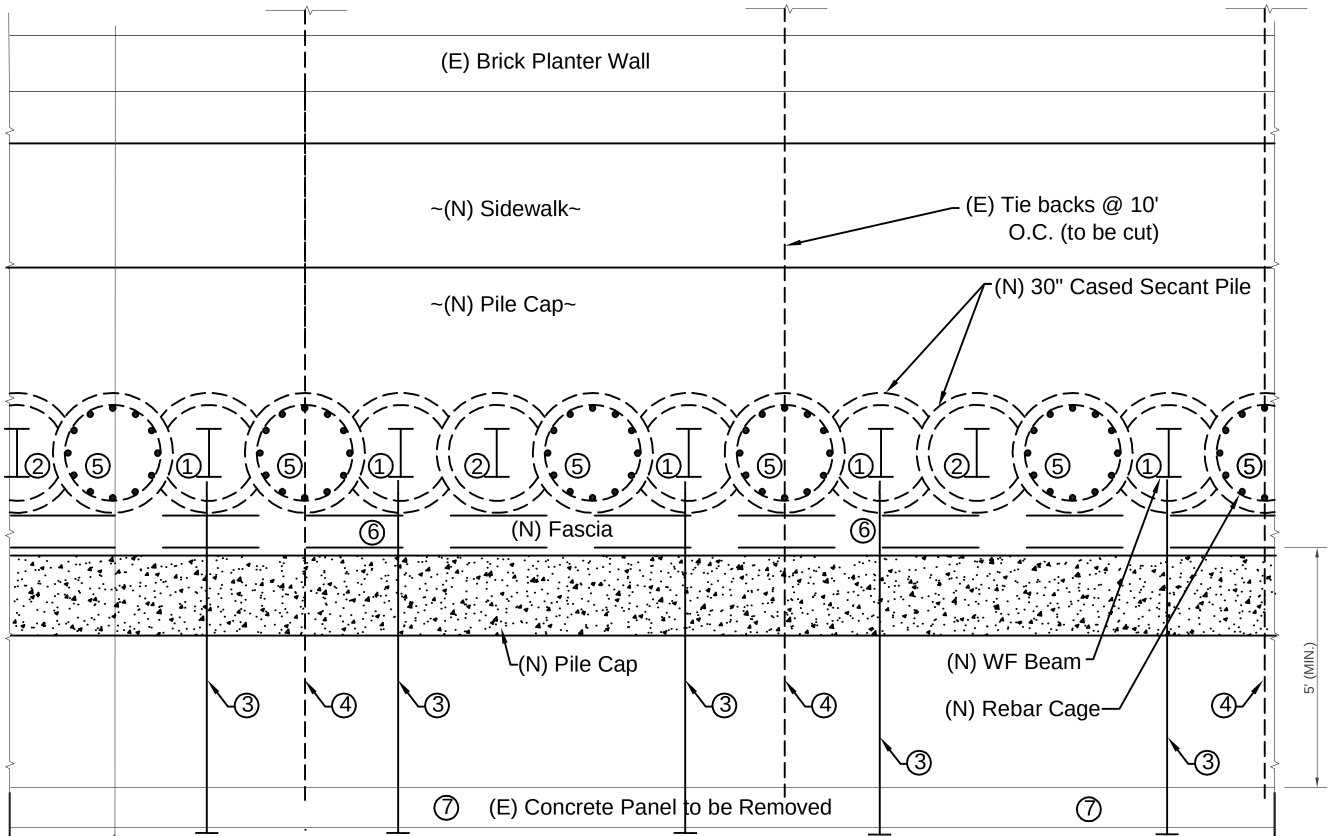
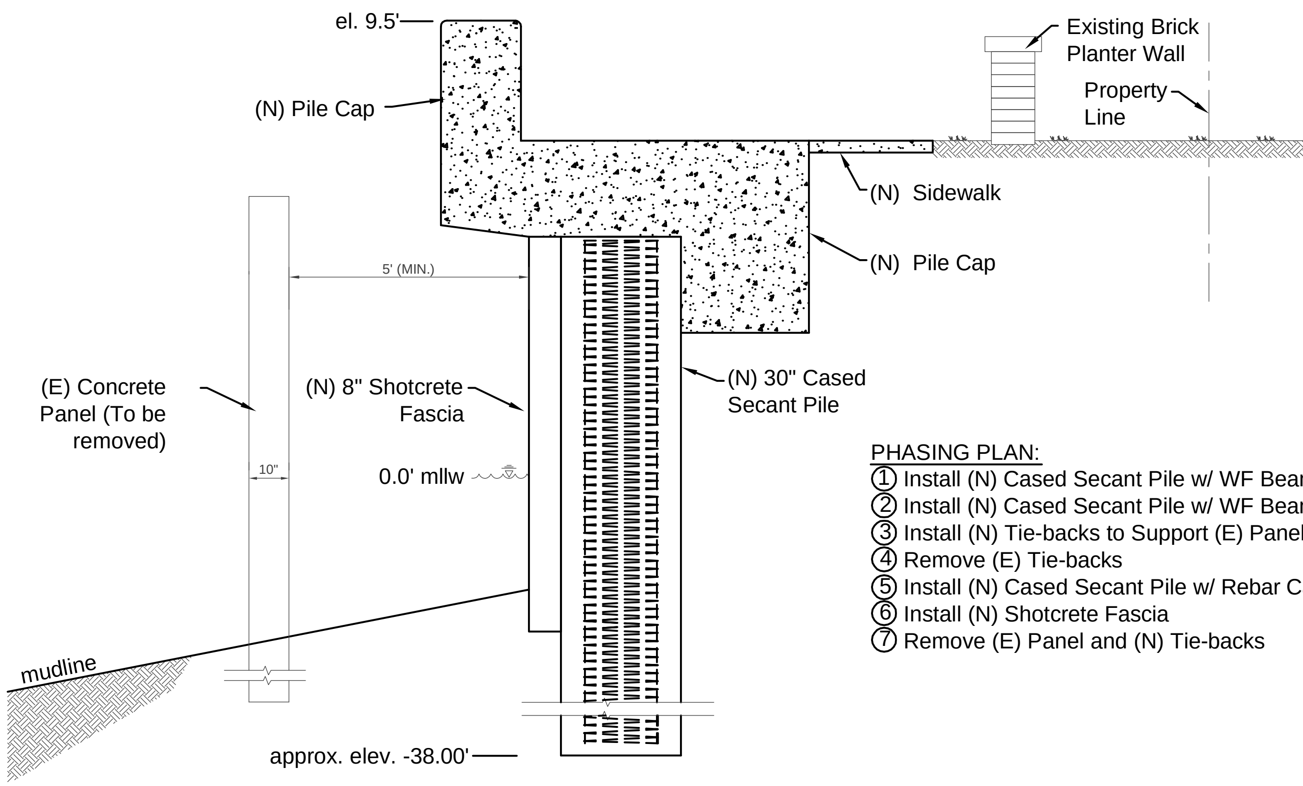
401 East Ocean Blvd., Suite 420
Long Beach, CA 90802

NAPLES LANDSIDE SEAWALL DESIGN ALTERNATIVES
OPTION 2 - LANDSIDE JET GROUTED SECANT PILE WALL

DRAWN: R.J.H
DATE: Feb 201
PROJECT #:



1 C-3 PLAN: LANDSIDE CASED SECANT PILE WALL – OPTION 3
SCALE: 1" = 4'-0"



PHASING PLAN:

1. Install (N) Cased Secant Pile w/ WF Beam
2. Install (N) Cased Secant Pile w/ WF Beam
3. Install (N) Tie-backs to Support (E) Panel
4. Remove (E) Tie-backs
5. Install (N) Cased Secant Pile w/ Rebar Cage
6. Install (N) Shotcrete Fascia
7. Remove (E) Panel and (N) Tie-backs

2 C-3 SECTION: LANDSIDE CASED SECANT PILE WALL – OPTION 3
SCALE: 1" = 4'-0"

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Long Beach, CA 90802

NAPLES LANDSIDE SEAWALL DESIGN ALTERNATIVES
OPTION 3 - LANDSIDE CASED SECANT PILE WALL

DRAWN: R.J.H
DATE: Feb 201
PROJECT #: T27046.1

Attachment B...Cost Estimates

Option 1 - Waterside Steel Sheet Pile Wall								
			Material Cost		Labor Cost		Engineering Estimate	
	Quantity	Unit	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
Mobilization	1	ls	$0.00	$0	$350,000.00	$350,000	$350,000.00	$350,000
Docks/Gangways/Ladders								
Remove existing docks and guide piles	51	EA			$1,000.00	$51,000	$1,000.00	$51,000
Reinstall docks w/ new guide piles	51	EA	$1,000.00	$51,000	$2,000.00	$102,000	$3,000.00	$153,000
Remove and Reinstall gangways and platforms	33	EA	$1,500.00	$49,500	$2,300.00	$75,900	$3,800.00	$125,400
Remove and Reinstall Ladders	18	EA	$500.00	$9,000	$800.00	$14,400	$1,300.00	$23,400
Install new staircases to docks	51	ea	$500.00	$25,500	$600.00	$30,600	$1,100.00	$56,100
Sheet Piles								
New Sheet Pile (AZ28) - Marine Grade A 690 Steel	1462	ton	$2,500.00	$3,655,974			$2,500.00	$3,655,974
Install new steel sheet pile (Giken)	86175	sf	$0.00	$0	$7.00	$603,225	$7.00	$603,225
Marine Contractor (Barges, crane, crew)	180	day			$10,000.00	$1,800,000	$10,000.00	$1,800,000
Epoxy Coating	28725	sf	$5.00	$143,625	$5.00	$143,625	$10.00	$287,250
Modify existing storm drains	5	ea	$1,000.00	$5,000	$3,500.00	$17,500	$4,500.00	$22,500
Grout Fill								
Power wash existing seawall	28725	sf	$0.00	$0	$1.00	$28,725	$1.00	$28,725
Place Concrete Grout	890	cy	$125.00	$111,250	$125.00	$111,250	$250.00	$222,500
Guard Rail								
Install new guard rail	1915	lf	$200.00	$383,000	$100.00	$191,500	$300.00	$574,500
Cantilevered Concrete Slab and Cap								
Remove existing cap/guard rail	1915	lf			$80.00	$153,200	$80.00	$153,200
Cantilevered Concrete Slab/Cap	1915	lf					$416.00	$796,640
Landside Hardscape								
Remove existing sidewalk and hardscape	22980	sf	$0.00	$0	$4.00	$91,920	$4.00	$91,920
Tree Removal	33	ea	$0.00	$0	$500.00	$16,500	$500.00	$16,500
Plant Trees	20	ea	$750.00	$15,000	$500.00	$10,000	$1,250.00	$25,000
Relocate Trees	9	ea	$0.00	$0	$1,500.00	$13,500	$1,500.00	$13,500
Regrade, add and compact soil as needed	19150	sf	$1.00	$19,150	$2.00	$38,300	$3.00	$57,450
Construct new sidewalk	11490	sf	$2.00	$22,980	$4.00	$45,960	$6.00	$68,940
Install new landscape	7660	sf	$2.00	$15,320	$6.00	$45,960	$8.00	$61,280
Install new staircases to docks	51	ea	$200.00	$10,200	$600.00	$30,600	$800.00	$40,800
Construct new light pole foundations	10	ea	$300.00	$3,000	$800.00	$8,000	$1,100.00	$11,000
Install existing light poles on new foundations	10	ea	$0.00	$0	$1,500.00	$15,000	$1,500.00	$15,000
Environmental BMP's								
Silt Curtain (movable)	1000	lf	$1.00	$1,000	$15.00	$15,000	$16.00	$16,000
Bird/Nesting Survey and Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
Vibration and Noise Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
Storm Drain								
PVC Storm Drain Pipe	1845	lf	$5.00	$9,225	$30.00	$55,350	$35.00	$64,575
RCP Storm Drain Pipe	65	lf	$50.00	$3,250	$200.00	$13,000	$250.00	$16,250
Catch Basins	52	ea	$300.00	$15,600	$300.00	$15,600	$600.00	$31,200
Raw Cost								$9,496,829
Contractor Overhead and Profit	15%							$1,424,524
SUBTOTAL								**$10,921,354**
Construction Contingency	25%							$2,730,338
Burdened Cost Total								**$13,651,692**

Option 2 - Landside Jet Grouted Secant Pile Wall								
			Material Cost		Labor Cost		Engineering Estimate	
	Quantity	Unit	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
Mobilization	1	ls	$0.00	$0	$500,000.00	$500,000	$500,000.00	$500,000
Docks/Gangways/Ladders/Staircases								
Remove existing docks and guide piles	51	EA			$1,000.00	$51,000	$1,000.00	$51,000
Reinstall docks w/ new guide piles	51	EA	$1,000.00	$51,000	$2,000.00	$102,000	$3,000.00	$153,000
Remove and Reinstall gangways and platforms	33	EA	$1,500.00	$49,500	$2,300.00	$75,900	$3,800.00	$125,400
Remove and Reinstall Ladders	18	EA	$500.00	$9,000	$800.00	$14,400	$1,300.00	$23,400
Install new staircases to docks	51	ea	$500.00	$25,500	$600.00	$30,600	$1,100.00	$56,100
Secant Wall								
Jet Grouting of Secant Piles	16068	cy	$100.00	$1,606,800	$200.00	$3,213,600	$300.00	$4,820,400
New Steel Beam (W14x193)	3326355	lbs	$0.90	$2,993,720			$0.90	$2,993,720
Install New Steel Beams	383	ea			$200.00	$76,600	$200.00	$76,600
Marine Contractor (Barges, crane, crew)	190	day			$10,000.00	$1,900,000	$10,000.00	$1,900,000
Waste Management and Disposal	1	ls					$800,000.00	$800,000
Cap Beam for New Wall	1915	lf					$175.00	$335,125
Epoxy Coating	48000	sf	$2.00	$96,000	$4.00	$192,000	$6.00	$288,000
Modify existing storm drains	5	ea	$1,000.00	$5,000	$3,500.00	$17,500	$4,500.00	$22,500
Demo and Disposal of (E) panels and obstructions	143625	cf					$10.00	$1,436,250
Install Precast Concrete Panels	1915	lf					$900.00	$1,723,500
Guard Rail								
Install new guard rail	1915	lf	$100.00	$191,500	$100.00	$191,500	$200.00	$383,000
Cantilevered Concrete Slab and Cap								
Remove existing cap/guard rail	1915	lf			$80.00	$153,200	$80.00	$153,200
Cantilevered Concrete Slab	1915	lf					$616.00	$1,179,640
Landside Hardscape/Landscape								
Remove existing sidewalk and hardscape	21065	sf	$0.00	$0	$4.00	$84,260	$4.00	$84,260
Tree Removal	25	ea	$0.00	$0	$500.00	$12,500	$500.00	$12,500
Plant Trees	0	ea	$750.00	$0	$500.00	$0	$1,250.00	$0
Relocate Trees	14	ea	$0.00	$0	$1,500.00	$21,000	$1,500.00	$21,000
Regrade, add and compact soil as needed	21065	sf	$1.00	$21,065	$2.00	$42,130	$3.00	$63,195
Install new landscape	7660	sf	$2.00	$15,320	$6.00	$45,960	$25.00	$191,500
Construct new light pole foundations	10	ea	$300.00	$3,000	$1,500.00	$15,000	$1,800.00	$18,000
Install existing light poles on new foundations	10	ea	$0.00	$0	$1,500.00	$15,000	$1,500.00	$15,000
Environmental BMP's								
Silt Curtain (movable)	1000	lf	$1.00	$1,000	$15.00	$15,000	$16.00	$16,000
Bird/Nesting Survey and Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
Vibration and Noise Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
New Storm Drain								
PVC Storm Drain Pipe	1845	lf	$5.00	$9,225	$30.00	$55,350	$35.00	$64,575
RCP Storm Drain Pipe	65	lf	$50.00	$3,250	$200.00	$13,000	$250.00	$16,250
Catch Basins	52	ea	$300.00	$15,600	$300.00	$15,600	$600.00	$31,200
Raw Cost								$17,618,315
Contractor Overhead and Profit	15%							$2,642,747
SUBTOTAL								**$20,261,062**
Construction Contingency	25%							$5,065,265
Burdened Cost Total								**$25,326,327**

Option 3 - Landside Cased Secant Pile Wall								
			Material Cost		Labor Cost		Engineering Estimate	
	Quantity	Unit	Unit Cost	Total	Unit Cost	Total	Unit Cost	Total
Mobilization	1	ls	$0.00	$0	$500,000.00	$500,000	$500,000.00	$500,000
Docks/Gangways/Ladders/Staircases								
Remove existing docks and guide piles	51	ea			$1,000.00	$51,000	$1,000.00	$51,000
Reinstall docks w/ new guide piles	51	ea	$1,000.00	$51,000	$2,000.00	$102,000	$3,000.00	$153,000
Remove and Reinstall gangways and platforms	33	ea	$1,500.00	$49,500	$2,300.00	$75,900	$3,800.00	$125,400
Remove and Reinstall Ladders	18	ea	$500.00	$9,000	$800.00	$14,400	$1,300.00	$23,400
Install new staircases to docks	51	ea	$500.00	$25,500	$600.00	$30,600	$1,100.00	$56,100
30" Cased Secant Piles								
Cased Piles	1	ls					$15,500,000.00	$15,500,000
Epoxy Coated Steel								
Surveyor								
Marine Contractor (Barges, crane, crew)	255	day			$10,000.00	$2,550,000	$10,000.00	$2,550,000
Waste Management and Disposal	1	ls					$800,000.00	$800,000
(N) Tie-backs	383	ea					$1,000.00	$383,000
Demo and Disposal of (E) panels and obstructior	143625	cf					$10.00	$1,436,250
Install Precast Concrete Panels	1915	lf					$900.00	$1,723,500
Cantilevered Concrete Slab and Cap								
Remove existing cap/guard rail	1915	lf			$80.00	$153,200	$80.00	$153,200
Cantilevered Concrete Slab/Cap	1915	lf					$416.00	$796,640
Install new guard rail	1915	lf	$100.00	$191,500	$100.00	$191,500	$200.00	$383,000
Landside Hardscape/Landscape								
Remove existing sidewalk and hardscape	21065	sf	$0.00	$0	$4.00	$84,260	$4.00	$84,260
Tree Removal	25	ea	$0.00	$0	$500.00	$12,500	$500.00	$12,500
Plant Trees	0	ea	$750.00	$0	$500.00	$0	$1,250.00	$0
Relocate Trees	14	ea	$0.00	$0	$1,500.00	$21,000	$1,500.00	$21,000
Regrade, add and compact soil as needed	21065	sf	$1.00	$21,065	$2.00	$42,130	$3.00	$63,195
Install new landscape	7660	sf	$2.00	$15,320	$6.00	$45,960	$25.00	$191,500
Construct new light pole foundations	10	ea	$300.00	$3,000	$1,500.00	$15,000	$1,800.00	$18,000
Install existing light poles on new foundations	10	ea	$0.00	$0	$1,500.00	$15,000	$1,500.00	$15,000
Environmental BMP's								
Silt Curtain (movable)	1000	lf	$1.00	$1,000	$15.00	$15,000	$16.00	$16,000
Bird/Nesting Survey and Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
Vibration and Noise Monitoring	32	weeks			$1,000.00	$32,000	$1,000.00	$32,000
New Storm Drain								
PVC Storm Drain Pipe	1845	lf	$5.00	$9,225	$30.00	$55,350	$35.00	$64,575
RCP Storm Drain Pipe	65	lf	$50.00	$3,250	$200.00	$13,000	$250.00	$16,250
Catch Basins	52	ea	$300.00	$15,600	$300.00	$15,600	$600.00	$31,200
Raw Cost								$25,231,970
Contractor Overhead and Profit	15%							$3,784,796
SUBTOTAL								**$29,016,766**
Construction Contingency	25%							$7,254,191
Burdened Cost Total								$36,270,957

Attachment C .... Geotechnical Evaluation

GEOTECHNICAL EVALUATION
OF LANDSIDE ALTERNATIVES
FOR REPLACEMENT OR REINFORCEMENT
OF SEAWALLS AT NORTHEASTERN QUARTER
OF RIVO ALTO CANAL
NAPLES AREA OF
LONG BEACH, CALIFORNIA

Prepared for:
Tetra Tech, Inc.
401 E. Ocean Boulevard, Suite 420
Long Beach, California 90802

Prepared by:
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5736 Corporate Avenue
Cypress, California 90630
(714) 220-2211

Project No. 2359.02

November 20, 2012 (Revised February 19, 2013)

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents a geotechnical evaluation of landside seawall alternatives for reinforcement or replacement of the existing seawalls on both sides of the Rivo Alto Canal, between the bridges at Ravena and The Toledo, in the Naples area of Long Beach, California.

In 2011, Geotechnical Professionals Inc. (GPI) performed a geotechnical investigation and provided recommendations for seawalls to be constructed water side of the existing seawall, as documented in Reference 1. At that time, the City of Long Beach had selected the water side alternative, based on feasibility evaluations previously performed by Transystems (Reference 2). However, we understand that after meetings with the California Coastal Commission, it became apparent that construction of seawalls waterside of the existing seawalls on both sides of the canal would not be approved. The design team lead by TetraTech was instructed to re-evaluate the feasibility of constructing seawalls on the landside of the existing seawalls.

From a geotechnical point of view, the most significant constraint in constructing new seawalls landside of the existing seawall is the likely presence of subsurface obstructions. The limited documents available from past construction activities indicated that parts of a previously existing seawall, damaged during the 1933 earthquake were left in-place. Additionally, grouting (mudjacking) was performed at various times, presumably to seal the joints of the existing seawall. Selected drawings from the documents reviewed are presented in Appendix A. Based on the records reviewed, these obstructions were expected to be within 4 feet landside of the existing wall. Additionally, there are several tie-back anchor rods installed at various periods, both as part of the original design and as a result of subsequent retrofits. These obstructions are key considerations for the choice and design of landside seawall alternatives.

2.0 SCOPE OF WORK

The scope of the geotechnical services covered by this report included a limited scope field investigation, geotechnical analyses, consultations, and preparation of this report. The objective of these services was to provide adequate geotechnical input for evaluating the feasibility of constructing seawalls landside of the existing seawall. The three general seawall concepts considered included:

a. A secant wall of jet-grouted soil-cement with steel beams;

b. A drilled pile wall;

c. A steel sheet pile wall installed by a hydraulic press method;

d. A concrete slurry/diaphragm wall; and

e. A concrete secant wall.

The field investigation was aimed at verifying the presence or absence of obstructions that were anticipated based on a review of historical construction records. This investigation was limited to accessible areas between the seawall and the sidewalk (approximately 5 feet of clear space). The investigation consisted of probing with a 6-foot long steel probe, probing with an air-jet probe, and hand augering in areas where obstructions were detected. The results of our field investigation are summarized in Appendix B and discussed in Section 3 of this report.

The geotechnical analyses consisted of evaluating the deflections and bending moments induced by static and seismic lateral loads and determining the depth of embedment needed for adequate fixity. The lateral response of the first two options was evaluated using the computer program LPILE Plus 5.0. The lateral response of the sheet pile wall was evaluated using the computer program PYWALL 2.0. The results of our analyses are discussed in Section 4 of this report. Plots for the various analyses are presented in Appendix C.

3.0 FINDINGS RELATED TO OBSTRUCTIONS

The historical documents we reviewed (see Appendix A) indicated the potential presence of grout from past mudjacking and an abandoned seawall within the space between the existing seawall and the sidewalk.

Plans for mudjacking/grouting project in 1956 indicate that grout was to be pumped at 4-foot spacings, distances of 1 to 2 feet from the wall and alternating depths of 5 and 10 feet. We understand that additional grouting was also performed in 1985, to fill voids and seal wall panel joints at one location on the north side and five locations on the south side of the canal. Our initial probing with the steel probe indicated obstructions at some locations within 2 to 3 feet from the seawall. At most probed locations, obstructions were not encountered within 2 to 3 feet from the wall down to a depth of 6 feet. However, subsequent probing with an air jet tube indicated definite obstructions at depths greater than 6 feet. Based on these probings, we conclude that grouting from previous mudjacking has resulted in obstructions within at least 3 feet from the landside face of the existing wall.

Plans related to the construction of the existing seawall indicate that a previously existing wall, located landside of the existing wall was left in-place at most locations and removed at others (see plan in Appendix A). Probing performed in areas where this wall was expected, confirmed the presence of obstructions at distances of 3 to 4 feet from the landside face of the pile cap (see Table in Appendix B). Hand augering at several of these locations produced chunks of wood and, in one case, chips of concrete. Based on the documents reviewed and confirmation by our field investigation, we can conclude that the previously existing wall has remained in-place at distances 3 to 4 feet from the landside face of the pile cap of the existing seawall, except in localized areas where it was removed.

4.0 GEOTECHNICAL EVALUATION OF LANDSIDE SEAWALL OPTIONS

4.1 OVERVIEW

In evaluating landside seawall alternatives for the project, we considered constraints related to the site conditions as well as the objective of providing adequate support under static and seismic conditions, without relying on support from the existing seawall.

4.2 CONSTRAINTS

The three significant site-specific constraints include subsurface obstructions, site access conditions, and the need to limit vibrations during construction.

Our review of historical construction data and the results of our field investigation clearly indicate that there are significant buried obstructions within approximately 4 feet from the landside face of the seawall pile cap (about 5 feet from the waterside face of the seawall). These obstructions, which include irregular-surfaced grout masses, remnants of a previously existing seawall and other debris, combined with the soft soils surrounding the debris make it practically impossible to construct a new wall within 4 feet of the existing wall. Therefore, a landside wall would need to be constructed at least 4 feet beyond the inside face of the existing seawall pile cap. The existing seawall can be left in-place and structurally tied at the top to the new wall. Alternatively, at a much higher cost, the existing seawall and obstructions could be removed after the new seawall is constructed, and the new wall can be retrofitted with appropriate facing, as needed.

Site access is a significant constraint with respect to the choice of construction equipment and, to some extent, even affects the choice of seawall options.

Finally, the options considered are aimed at limiting vibrations during construction. The soils at the site to depths ranging between 15 and 24 feet are highly susceptible to vibration-induced liquefaction and settlement. Therefore, impact or vibratory equipment cannot be used at the site without risking damage to the existing structures due to vibration induced differential foundation settlement. This precludes the use of driven piles.

4.3 LATERAL LOADS

Our geotechnical investigation for the water side sheet pile wall concept included a comprehensive evaluation of lateral earth pressures under static and seismic load conditions. These pressures were related to the lateral displacement of the wall. In general, the lateral earth pressures would be less for a wall that could displace under load than a wall that would be rigid. The calculated lateral loads per foot of wall and compatible lateral displacements calculated for the AZ-28 sheet pile wall were as follows:

LOADING CONDITION	PEAK GROUND ACCELERATION	LATERAL LOAD (kips/foot)	DISPLACEMENT AT ELEV. +7 (inches)
Static	0	4.1	<1.9
Operating Level EQ (OLE)	0.17g	5.7	3.1
Design EQ (DE)	0.40g	7.6	4.6

The tabulated loads are not factored. Appropriate factors need to be used for structural design. The OLE has a return period of 72 years, while the DE is equal to two-thirds of the maximum considered earthquake acceleration, which has a return period of 2,475 years.

For the feasibility-level geotechnical evaluations presented in this report, the same lateral loads were considered for all options and calculated deflections were compared to the values tabulated above.

4.4 OPTION A – SECANT WALL WITH JET GROUTING AND STEEL BEAMS

This option involves creating a continuous (secant) soil-cement wall by the jet grouting method and reinforcing the wall with steel beams at 5-foot spacings. This method allows maximum flexibility in avoiding existing tie-back rods while creating a continuous wall. High velocity jets at the end of a rotating drill stem mix cement grout with soil. The mix initially has the consistency of a thick slurry allowing the insertion of steel beams. Once the cement cures, the mix has the strength of hard soil to bedrock. The 28-day unconfined compressive strength of the soil-cement mixture should be at least 100 psi, although typically higher strength can be achieved. The steel beams are designed to provide the full lateral support, like soldier piles in a cantilevered shoring system, while the soil cement mix is designed to work like lagging.

If the landside wall needs to have an exposed face, the soil-cement mix can be trimmed, as needed; to expose the steel beams and a permanent face can be structurally attached to the beams.

We evaluated the lateral deflection and bending moments for a preliminary design with W14x193 steel beams providing full support for the wall. The calculations were performed using the computer program LPILE Plus 5.0 and lateral loads ranging from 20 kips to 60 kips. For comparison, the unfactored lateral loads for a pile spacing of 5 feet are 20.5 kips for static, 28.5 kips for OLE and 38 kips for DE.

Preliminary analyses indicated that a total depth of 44 feet below the current ground surface, corresponding to a pile tip elevation of -37 feet, would provide adequate fixity. For these analyses, the load was applied at elevation -2 feet (9 feet below the ground surface). The results of the analyses are presented below:

LATERAL LOAD (kips)	LATERAL DEFLECTION (inches)		MAXIMUM BENDING MOMENT (inch-kips)
	@ Elev. -2'	@ Elev. +7'	
20	1.3	2.2	2865
40	3.2	5.2	6250
60	6.0	9.4	9885

The calculated deflections are valid up to the yield bending moment capacity of the piles. The deflections will be much greater once the yield moment is exceeded.

4.5 OPTION B – DRILLED PILES

This option involves installing two sets of drilled piles to form a continuous wall. The primary piles will be placed at 3.3- or 5-foot spacings between the tie-backs. These piles will be designed to provide full support. The secondary, shorter piles will mainly fill the space between the primary piles and extend to a depth of 20 feet. The primary drilled pile option considered is augercast pressure grouted piles, which allow construction in soft soils below the groundwater level, and provide undisturbed soil to concrete contact at depths where lateral resistance is required.

We evaluated the lateral response of augercast pressure grouted piles with a diameter of 24 inches and length of 45 feet (tip elevation -38 feet). For comparison with Option A lateral loads of 20, 40, and 60 kips, applied at elevation -2 feet were considered. Structural parameters for 24-inch piles, provided by Berkel and Company, one of the specialty contractors for augercast pressure grouted piles, were as follows:

Elastic Modulus:	3824 ksi
Moment of Inertia:	19,900 in^4
Concrete Compressive Strength:	4500 psi
Reinforcement:	12 #11 bars longitudinal and #4 spirals at 4-inch pitch

The results of the analyses are summarized below:

LATERAL LOAD (kips)	LATERAL DEFLECTION (inches)		MAXIMUM BENDING MOMENT (inch-kips)
	@ Elev. -2'	@ Elev. +7'	
20	1.2	2.1	2775
40	3.1	5.0	6070
60	5.4	8.4	9640

The calculated deflections are valid up to the yield bending moment capacity of the piles. The deflections will be much greater once the yield moment is exceeded.

4.6 OPTION C – STEEL SHEET PILE WALL

A sheet pile wall installed by a hydraulic press method (such as the GIKEN Silent Piler) was the preferred alternative for the waterside option. It allowed installation of a new wall without removing the existing wall or its tie-back anchors, and involved minimal vibration during construction.

This option is less desirable as a landside option primarily because the tie-backs will need to be cut as the sheet pile installation is compiled. This method will involve lateral movement of the existing wall during construction on the order of several inches. Therefore, this method is not recommended as a landside alternative if the existing wall is to be left in-place. This option could be considered if the sheet pile wall on the south side of the canal can be installed waterside (without removing the existing wall), the sheet pile wall is installed landside on the north side of the canal and the existing wall is removed.

The analyses performed for the waterside alternative with AZ-28 piles would be also applicable in this case.

4.7 OPTION D – CONCRETE SLURRY WALL

This option involves construction of a reinforced concrete wall, cast within a trench excavated using bentonite slurry as a stabilizing agent. The original concept involved construction of the wall in segments using "Hydromill" type excavation equipment. The initial 8-foot wide segments would be constructed between the tie-back rods. In each segment, the trench would be excavated first using bentonite or similar stabilizing mud (slurry). The reinforcement and edge forming panels would then be installed. Then concrete would be tremmied from the bottom up displacing the mud. Once the concrete in the initial segments hardens, the tie-back anchors would be removed and replaced with temporary anchors, transferring all of the lateral load to the completed panels. Finally, the spaces between the completed panels would be filled with additional concrete panels, installed using the same method as the original panels. The completed concrete wall could be used as the exposed new wall by cutting the temporary tie-backs and removing the existing wall and obstructions.

We evaluated the deflections, bending moments and fixity requirements for a 3-foot wide concrete wall using the computer program PYWALL Version 2.0, and a lateral load of 9 kips/foot representing the design earthquake condition. The results of our analyses are as follows:

Maximum bending moment:	1820 in kips/foot
Maximum deflection:	<1-inch
Tip below top ground:	44 feet
Tip elevation:	- 37 feet (MLLW)

As our analyses for this option were completed, we understand that this option was dropped from further consideration mainly due to constraints related to site access for the relatively large and heavy equipment that would need to be used.

4.8 OPTION E – CONCRETE SECANT WALL

This concept involves construction of overlapping concrete piles installed by using a combination of steel casing and mud to the full depth of each pile. The steel casing is equipped with cutting elements at the tip to allow cutting into partially hardened concrete in order to overlap the piles. Typically, the individual pile diameters for a project of this size would be about 30 inches. Either all or alternating piles would be reinforced with wide flange beams. The piles would be installed in segments, initially between the tie-back anchors and after the concrete of the initial segments harden and tie-back anchors are removed, at the tie-back locations. Depending on the reinforcement and concrete strength used in the design, the stiffness of the wall and deflections can be expected to be comparable to those of the concrete slurry wall (Option D). The concrete strength may need to be lowered to allow cutting into completed piles, when the "closure" piles at the tie-back locations are installed. Alternatively, a "tangent" pile system can be used that will allow pile installation without cutting into the previously installed piles. While a concrete secant pile system theoretically could be used without a smooth concrete facing, for aesthetic reasons, we understand that a smooth concrete face (either shot-creted or pre-cast panels) will be used for this project. The concrete facing will be installed after the secant wall is completed and the existing wall and obstructions between the existing and new wall are removed.

For preliminary structural evaluation, the maximum bending moment and depth of embedment considered for the concrete slurry wall (Option D) can be used for the concrete secant wall.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Of the three landside alternatives considered, the first two options would be best suited if the existing wall were to remain. These two options would have comparable lateral displacements under static and seismic loads and could be constructed without removing the tie-back anchors. From a geotechnical point of view, Option A offers one significant advantage over Option B. This option will be much less impacted by obstructions extending beyond the 4-foot exclusion zone and will provide a more continuous soil cement zone between the structural piles.

Option C is a viable and desirable option only if the new wall can be constructed water side of the existing wall, on the south side of the canal, and the existing wall is to be removed on the north side of the canal.

We understand that the City of Long Beach prefers Option E, as a permanent replacement of the existing wall, if a water side alternative, as originally recommended, will not be approved by the Coastal Commission. It should be noted that this landside alternative is likely to be much more expensive and have more impact on the existing landside improvements, then the waterside alternative, previously recommended.

6.0 LIMITATIONS

The evaluations presented in this report were aimed at providing geotechnical input for assessing the feasibility and preliminary costs for the landside alternatives considered. Once a specific landside seawall concept is selected, more detailed evaluations will be needed to refine the design and develop construction specifications. The geotechnical investigation report will then need to be updated to cover the selected concept.

Respectfully submitted,
Geotechnical Professionals Inc.

Byron Konstantinidis, G.E.
Principal

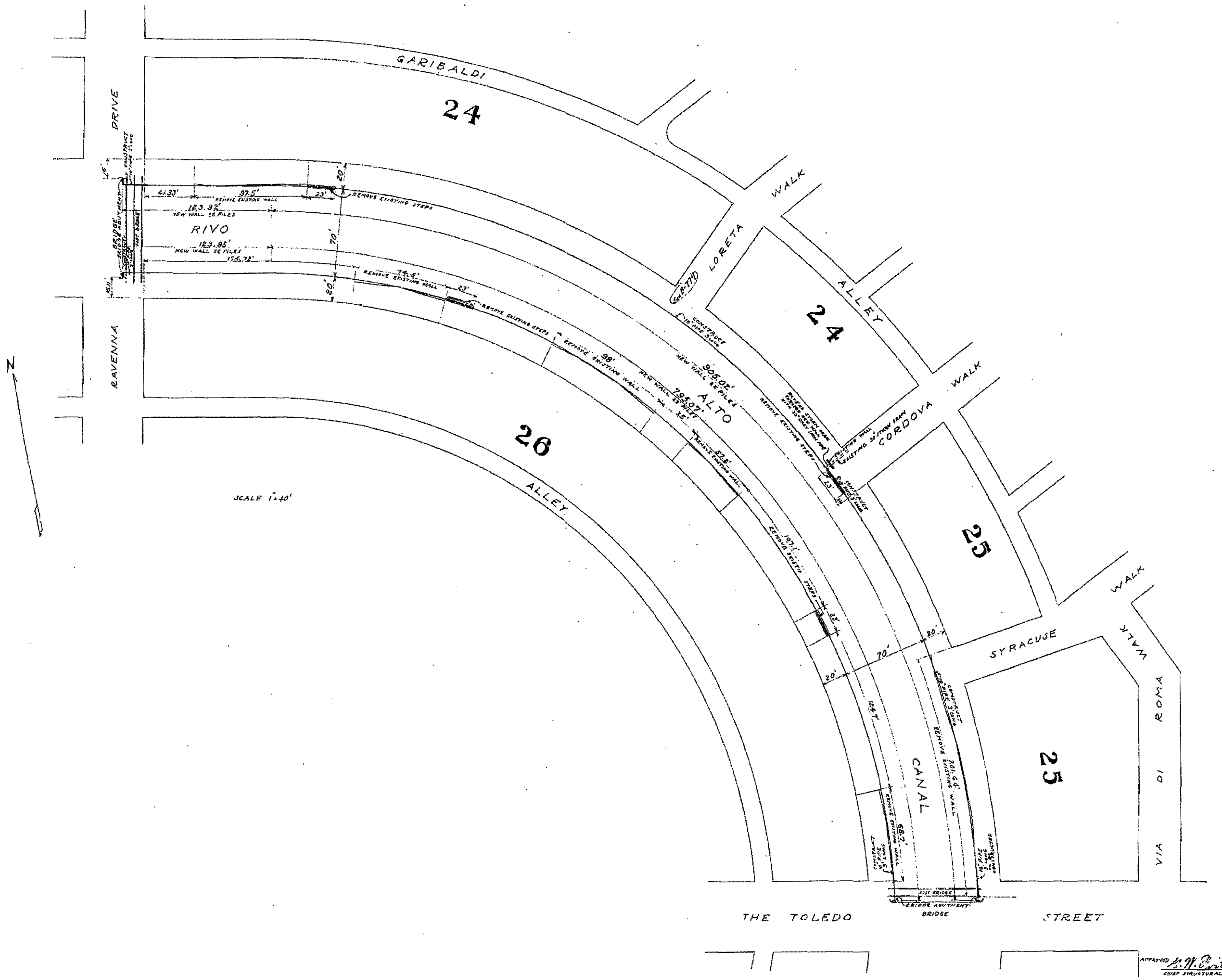
BK:sph

REFERENCES

1. Geotechnical Professionals Inc., "Geotechnical Investigation, Naples Seawall Replacement, Phase I (North-Eastern Quadrant), Long Beach, California," GPI Project No. 2359.I, dated February 14, 2011 (Revised April 19, 2012).

2. Transystems Corporation, "Naples Seawall Stability Investigation and Repair Recommendations, Long Beach, California," Transystems Project No. P506080037, February 25, 2009" – (Document includes geotechnical report by AESCO).

APPENDIX A



NOTE:-

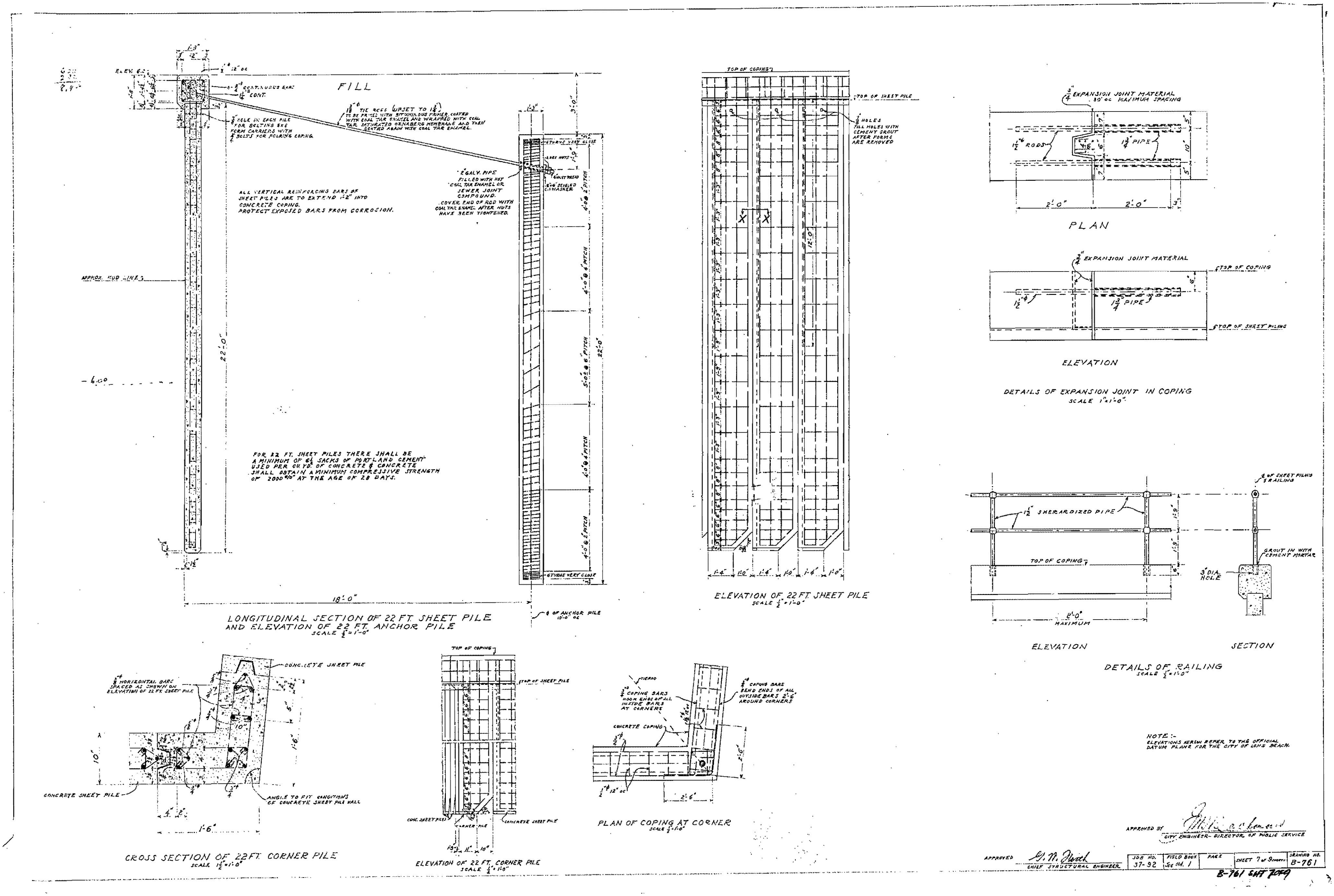
RAILING ON THE NEW WALL SHALL EXTEND FROM A POINT 6" NORTH OF THE RAILING OF THE TOLEDO STREET FOOT BRIDGE TO A POINT 6" EAST OF THE RAILING OF THE RAVENNA DRIVE FOOT BRIDGE. CONSTRUCT RAILING ON THE NEW WALL BETWEEN THE RAVENNA DRIVE BRIDGE AND THE RAVENNA DRIVE FOOT BRIDGE LEAVING A 6" CLEARANCE BETWEEN THE NEW RAILING AND THE EXISTING BRIDGE RAILINGS.

APPROVED BY [signature]
CITY ENGINEER – DIRECTOR OF PUBLIC SERVICE

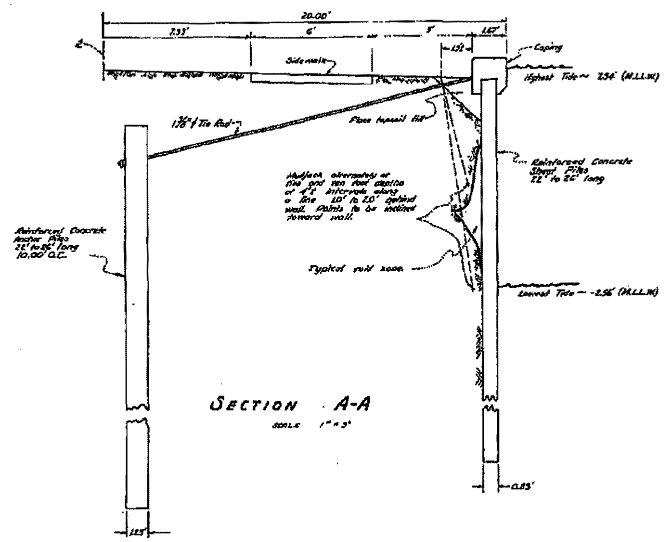
APPROVED [signature]
CHIEF STRUCTURAL ENGINEER

JOB NO.	FIELD BOOK	PAGE	SHEET	DRAWING NO.
37-92	See Sht 1		SHEET 4 of 9 SHEETS	B-761

B-761 SHT 4 of 9 F

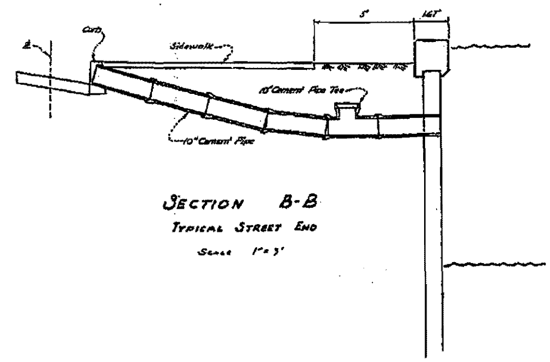


FILL
ALL VERTICAL REINFORCING BARS OF SHEET PILES ARE TO EXTEND 1'-2" INTO CONCRETE COPING. PROTECT EXPOSED BARS FROM CORROSION.
FOR 22 FT. SHEET PILES THERE SHALL BE A MINIMUM OF 6½ SACKS OF PORTLAND CEMENT USED PER CU. YD. OF CONCRETE & CONCRETE SHALL OBTAIN A MINIMUM COMPRESSIVE STRENGTH OF 2000#/□" AT THE AGE OF 28 DAYS.
22'-0"
18'-0"
LONGITUDINAL SECTION OF 22 FT. SHEET PILE AND ELEVATION OF 22 FT. ANCHOR PILE
SCALE ½"=1'-0"
TOP OF COPING
TOP OF SHEET PILE
ELEVATION OF 22 FT. SHEET PILE
SCALE ½"=1'-0"
EXPANSION JOINT MATERIAL
PLAN
ELEVATION
DETAILS OF EXPANSION JOINT IN COPING
SCALE 1"=1'-0"
1½" SHERARDIZED PIPE
TOP OF COPING
GROUT IN WITH CEMENT MORTAR
ELEVATION
SECTION
DETAILS OF RAILING
CONCRETE SHEET PILE
CROSS SECTION OF 22 FT. CORNER PILE
ELEVATION OF 22 FT. CORNER PILE
CONCRETE COPING
PLAN OF COPING AT CORNER
NOTE:- ELEVATIONS HEREIN REFER TO THE OFFICIAL DATUM PLANE FOR THE CITY OF LONG BEACH.
APPROVED BY
CITY ENGINEER - DIRECTOR OF PUBLIC SERVICE
APPROVED
CHIEF STRUCTURAL ENGINEER
JOB NO. 37-92
SHEET 7 of 9
DRAWING NO. B-761
B-761 SHT 7 OF 9



SECTION A-A

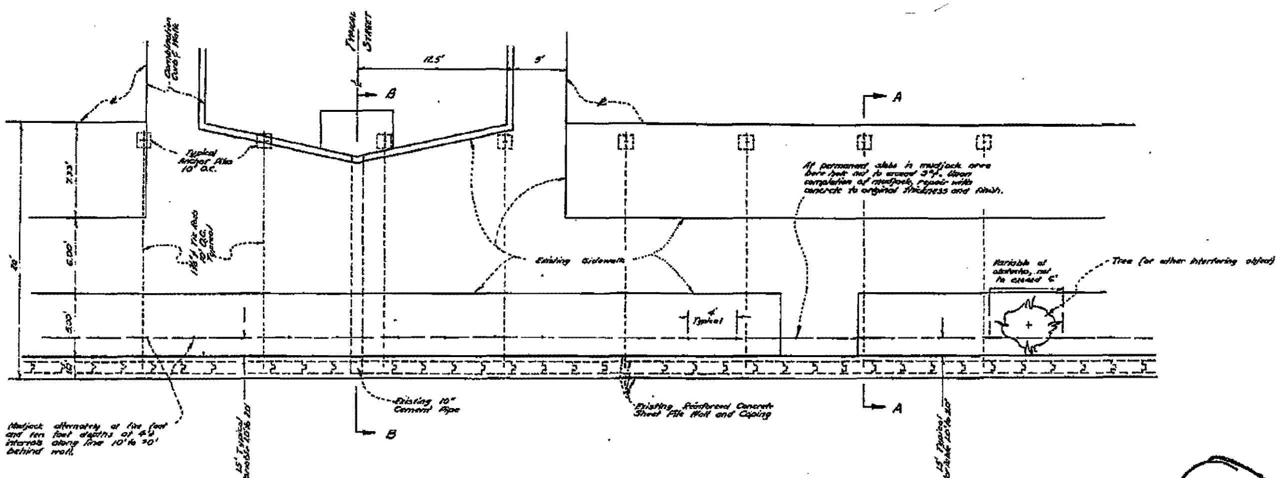
SCALE 1" = 3'



SECTION B-B

TYPICAL STREET END

SCALE 1" = 3'



- TYPICAL PLAN DETAILS -

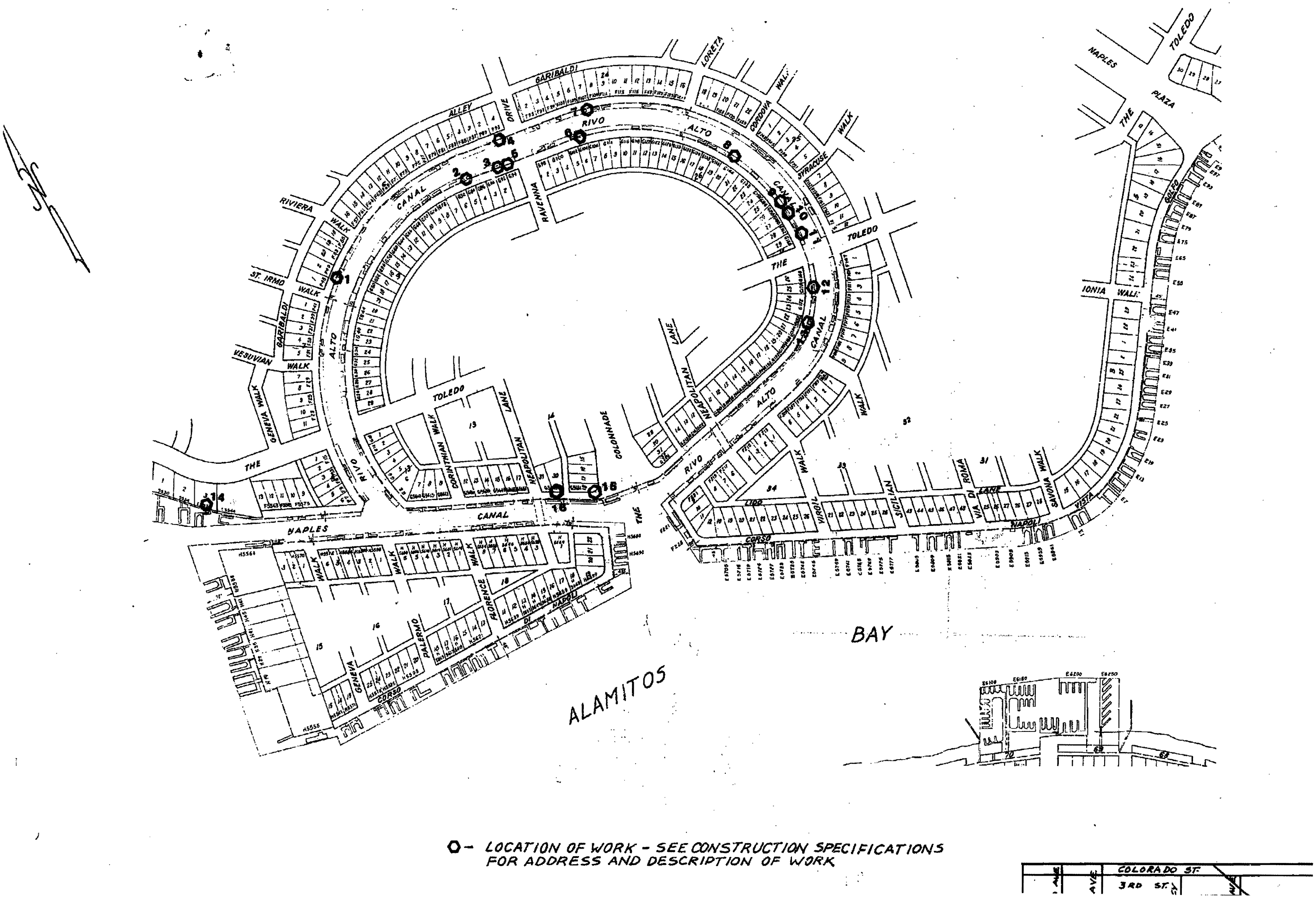
SCALE 1" = 6'

1956
1985-

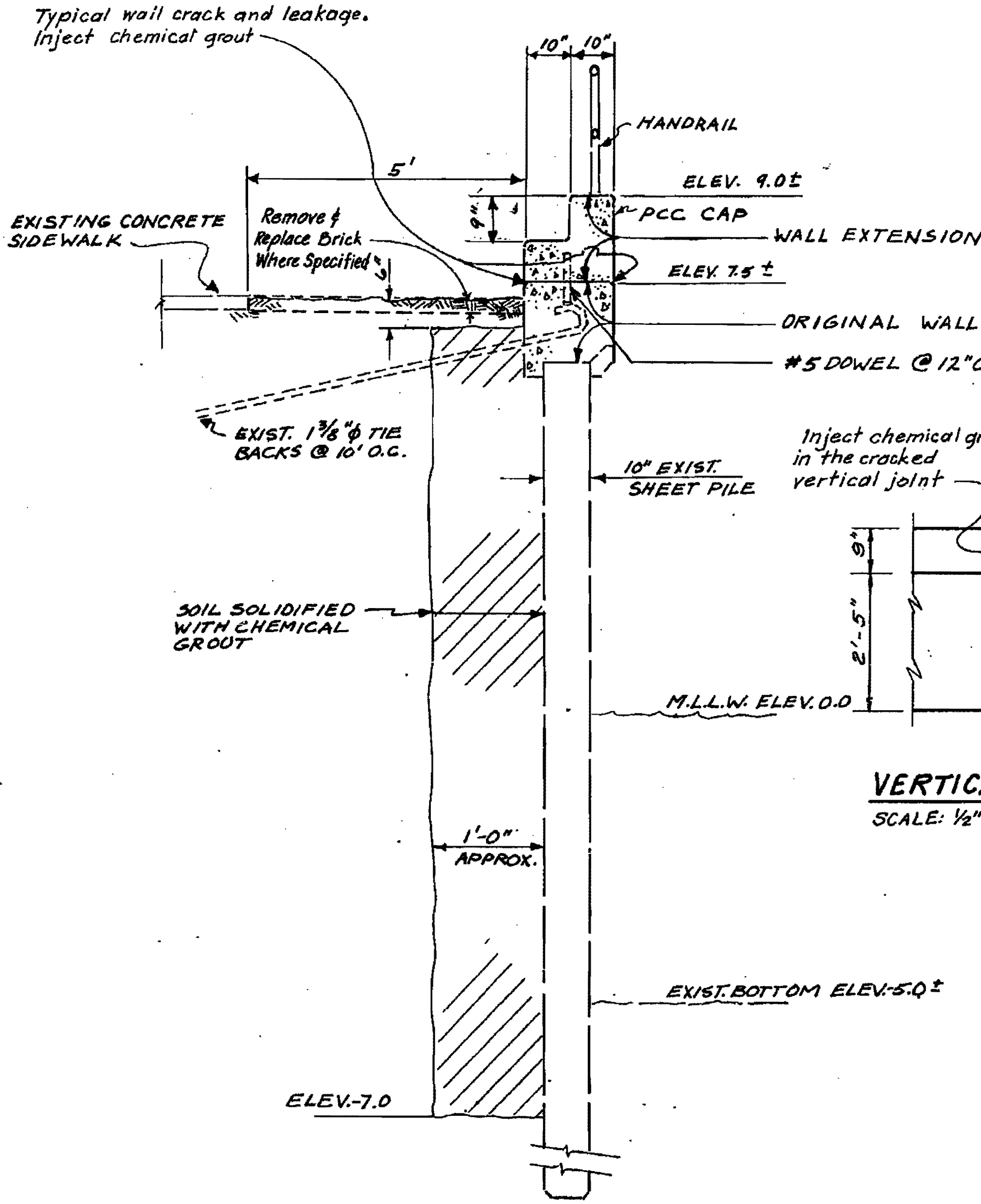
2D

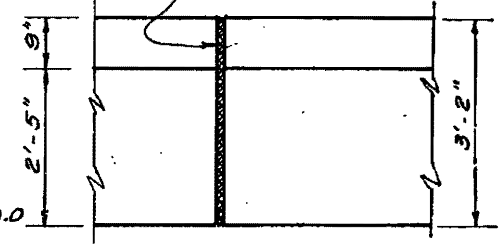
NAPLES MUDJACKING

55-160			SHEET 2 of 2	B-1327



O - LOCATION OF WORK - SEE CONSTRUCTION SPECIFICATIONS FOR ADDRESS AND DESCRIPTION OF WORK



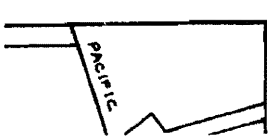


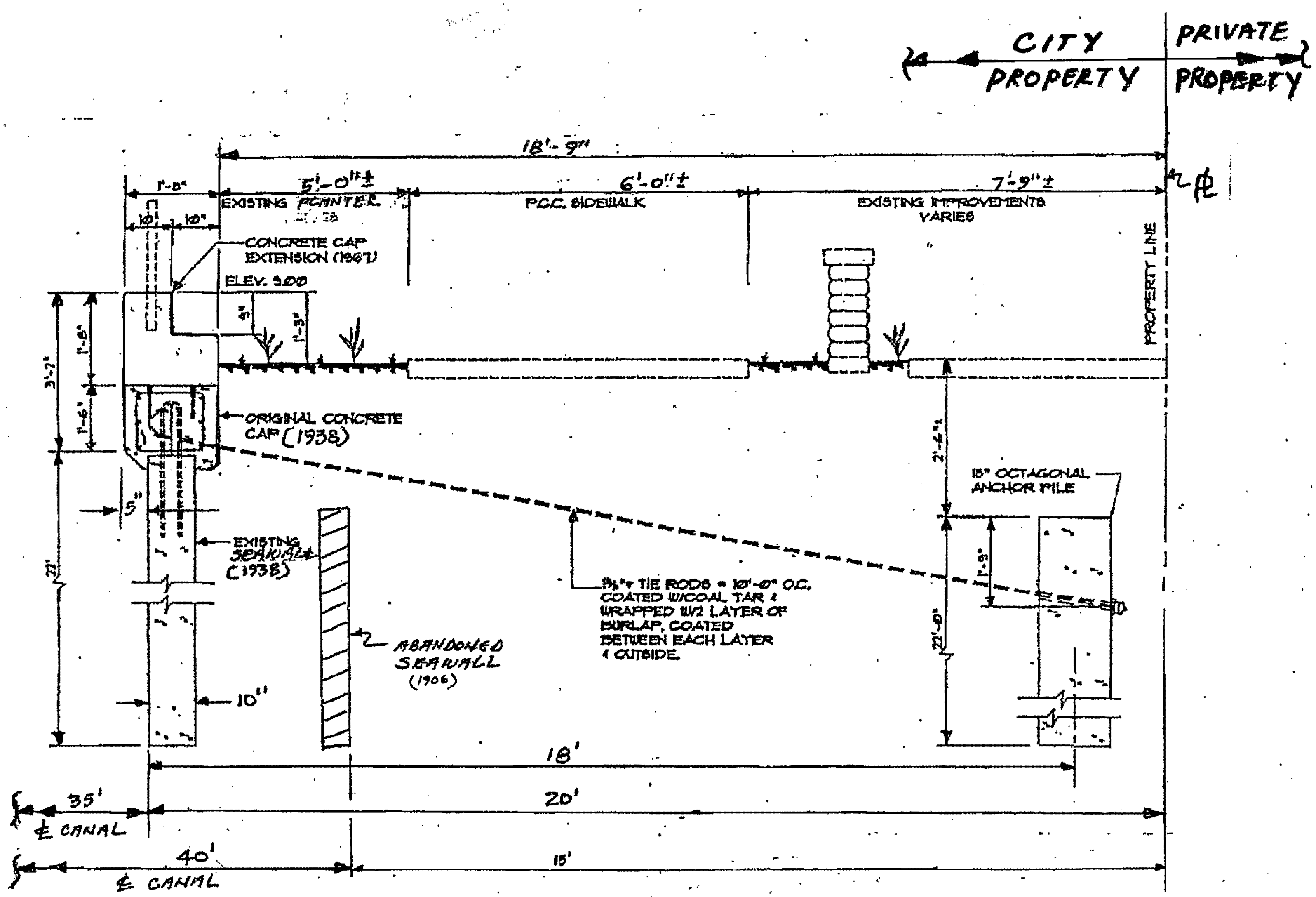
VERTICAL JOINT DETAIL

SCALE: 1/2" = 1'-0"

TYPICAL CROSS SECTION THROUGH BULKHEAD WALL

SCALE: 1/2" = 1'-0"





NAPLES SEAWALL-TYPICAL SECTION (REFERENCE: TRACT NO. 500 DRAWING NO. B-761)

APPENDIX B

APPENDIX B

RESULTS OF PROBING

Soils exposed in planter areas were probed initially with a six-foot long steel probe ½-inch in diameter. Probings were performed at 0.5-foot lateral intervals perpendicular to the wall starting with the landside face of the seawall cap. In general, the soft soils that prevail behind the wall did not offer any significant resistance and it was possible to extend the probing to the full length of the probe (6 feet), except where obstructions were encountered. The results of probing with the steel probe are summarized in the table below:

LOCATION[1] NO.	DEPTH OF OBSTRUCTION (feet) AT DISTANCES[2] (feet)								REMARKS[3]
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
South Side									
100	0.6	---	---	4.9	---	---	---	0.9-3.3	HA-concrete @ distance of 4 feet
116	1.8	1.0	0.8	0.7	0.7	0.7	2.0	4.0	
132	NP[4]	NP	0.8	0.7	4.0	1.5	0.8	1.2	refusal possibly in dense soil
148	---	1.5	2.3	---	---	1.5	3.4	---	
156									
North Side									
97 west	NP	NP	NP	NP	NP	NP	NP	---	surface improvements to 3.5' distance
97/99	NP	NP	NP	NP	5.1	5.1	5.1	5.1	surface improvements to 2.0 distance
107	1.3	1.3	0.9	0.5	0.8	1.0	1.0	0.5	
109-111	---	---	---	---	1.2	3.6	4.0	---	HA – concrete chips
119	---	---	---	---	---	3.1	1.9	NP	HA – concrete & wood @ 3' distance
125	---	---	---	0.9	0.9	---	2.1	1.5	HA – wood @t 3.5' distance
143 west	---	---	---	---	1.6	4.4	5.0	1.6	HA – concrete pieces @ 2.5' distance
143 east	---	---	---	---	1.4	3.5	NP	3.5	HA – wood @ 3.0' and 4.0' distance
149	---	---	---	---	1.1	1.1	2.5	3.4	
159	---	---	---	3.4	3.2	2.7	3.0	3.5	
Notes:									
1	Location numbers indicate house numbers								
2	Probe distances are from the landside of the seawall pile cap								
3	HA – hand augered								
4	NP – not probed (usually because surface covered with improvements)								
5	--- no obstructions to depth of 6								

At a few select locations, where low resistance to probing was detected to the full depth of 6 feet, additional probing, with small diameter (¼") copper tubing connected to an air compressor, was performed. Obstructions were detected at variable depths below 6 feet as follows:

LOCATION NO.	DEPTH RANGE OF OBSTRUCTION (feet)
119	6.1
143 west	6.2 – 7.8
143 east	6.9 – 7.8
149	6.2 – 6.7

APPENDIX C

APPENDIX C

LPILE AND PYWALL ANALYSES

C.1 SOIL PROFILE

For both LPILE and PYWALL analyses, a soil profile representative of the eastern parts of the site, with post-liquefaction residual soil strengths was conservatively used, in order to evaluate the maximum bending moments and deflections. For other parts of the site, where the weakest soils are limited to shallower depths, the lateral deflections and bending moments can be expected to be somewhat less. Preliminary lateral load analyses performed for the original seawall concept had indicated a difference of about 15 percent in deflections and maximum bending moments. Similar differences can be expected for the current concepts.

C.2 LPILE ANALYSES

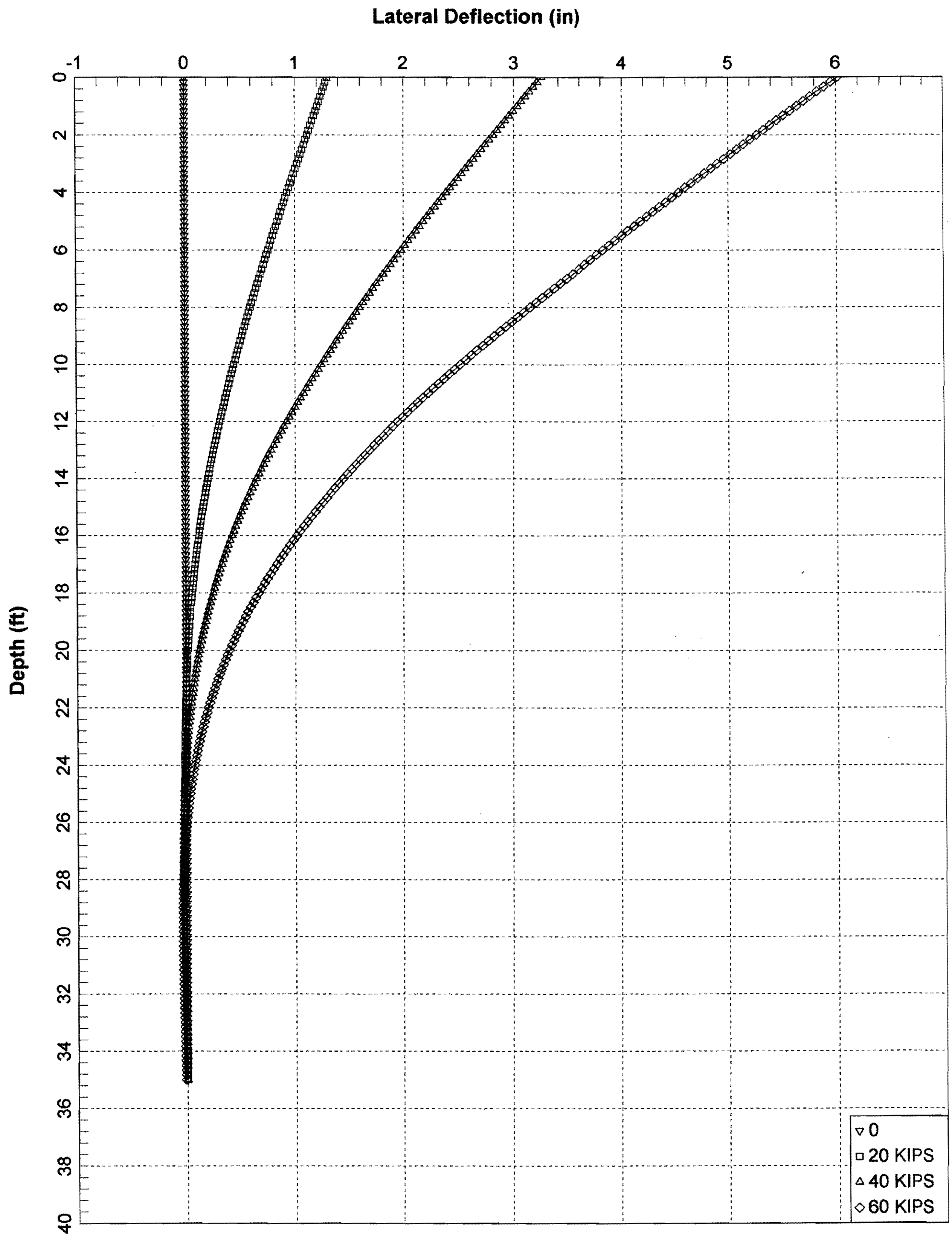
The deformations and bending moments induced by lateral loading on W14x193 steel beams and 24-inch diameter reinforced concrete piles were evaluated by the computer program LPILE Plus Version 5.0.2.4.

Parametric analyses with lateral loads in the range of 20 to 60 kips were performed. The lateral loads were applied at Elevation -2 feet (MLLW). Based on lateral stability analyses performed previously, this elevation was determined to be at the center of the loading to resist lateral spreading under seismic conditions. It should be noted that for LPILE analyses, the top of wall (zero depth on the enclosed charts) is at the point of load application (Elevation -2 feet). The deflections at the actual ground surface (Elevation +7 feet) were extrapolated from the enclosed charts.

C.3 PYWALL ANALYSES

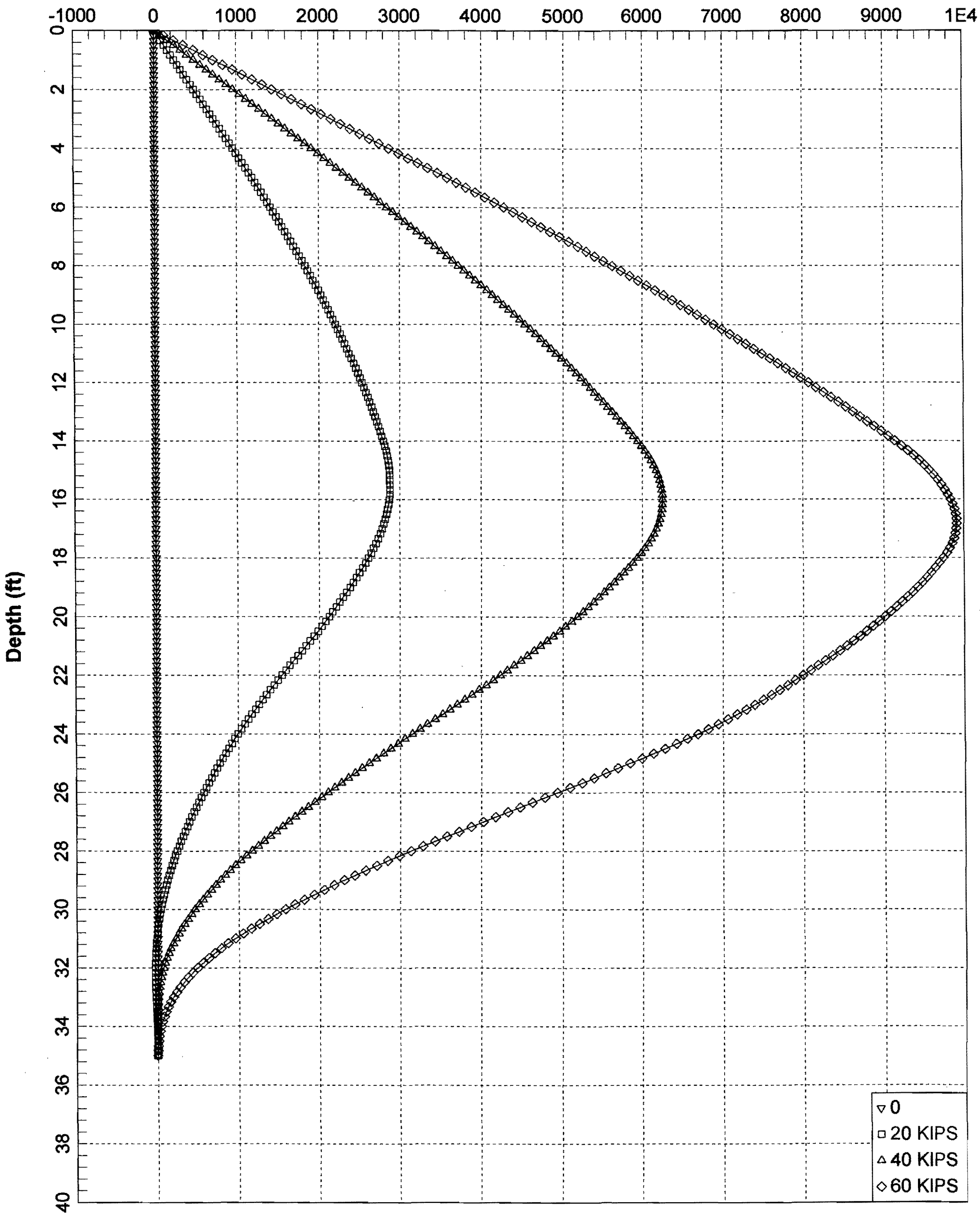
The lateral deflections and bending moments inducted by lateral loading on AZ-28 sheet piles were evaluated using the computer program PYWALL Version 2.0.

Three loading conditions, representing static loads, OLE seismic loads, and DE seismic loads were analyzed. The results of the analyses are graphically presented in the figures that follow this text. For these analyses, zero depth corresponds to Elevation +7 feet (MLLW).

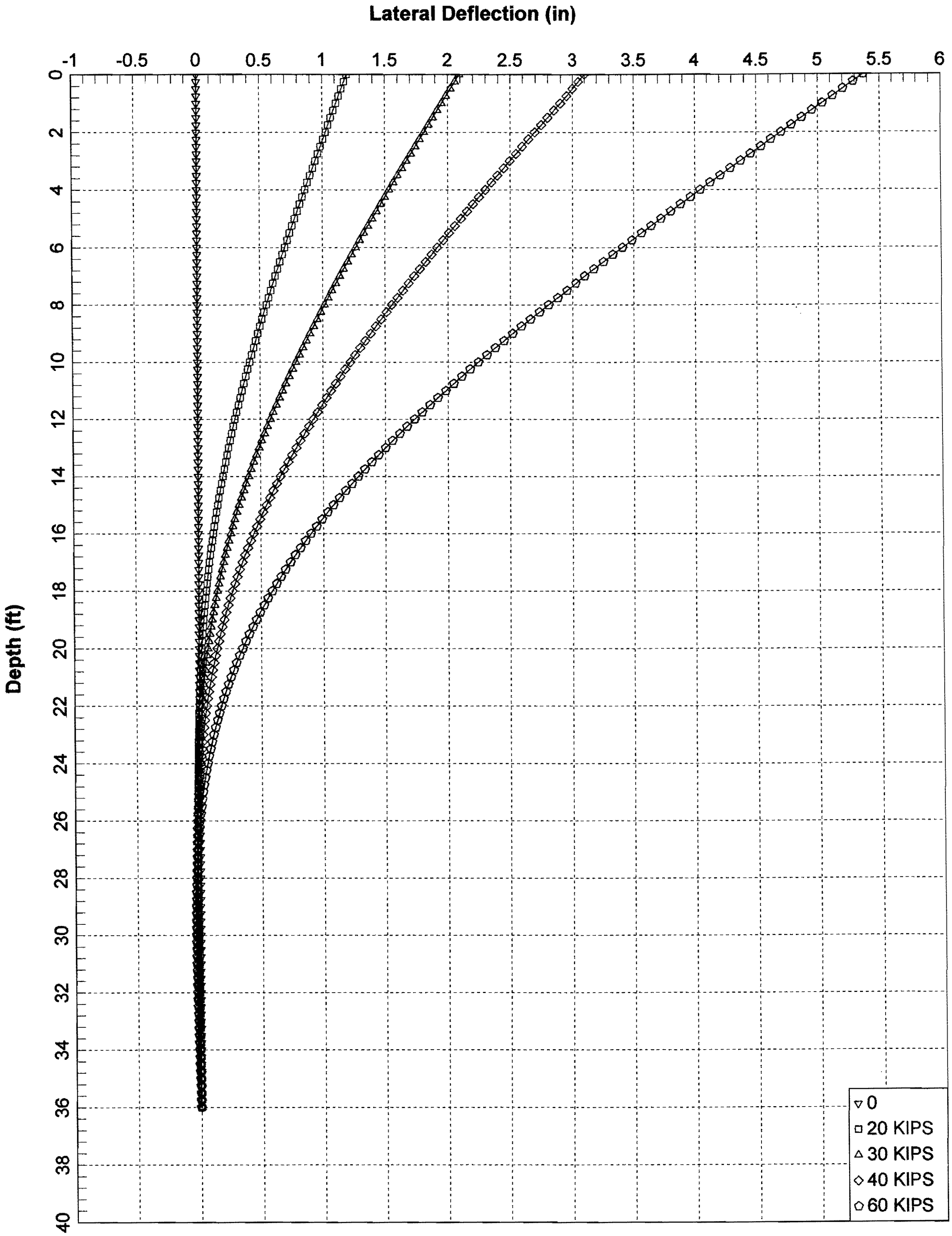


W14x193 PILE TIP AT ELEV. -37

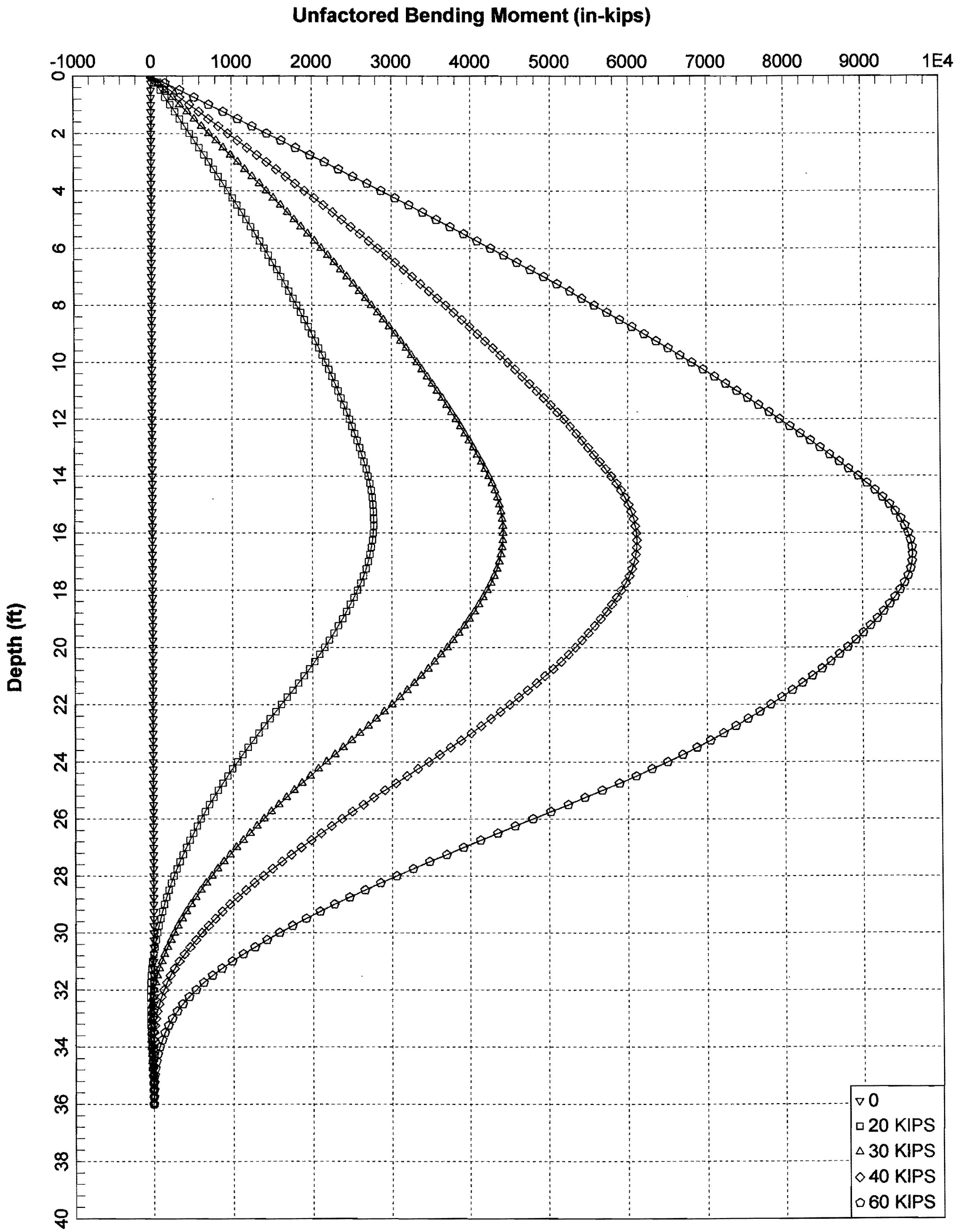
Unfactored Bending Moment (in-kips)



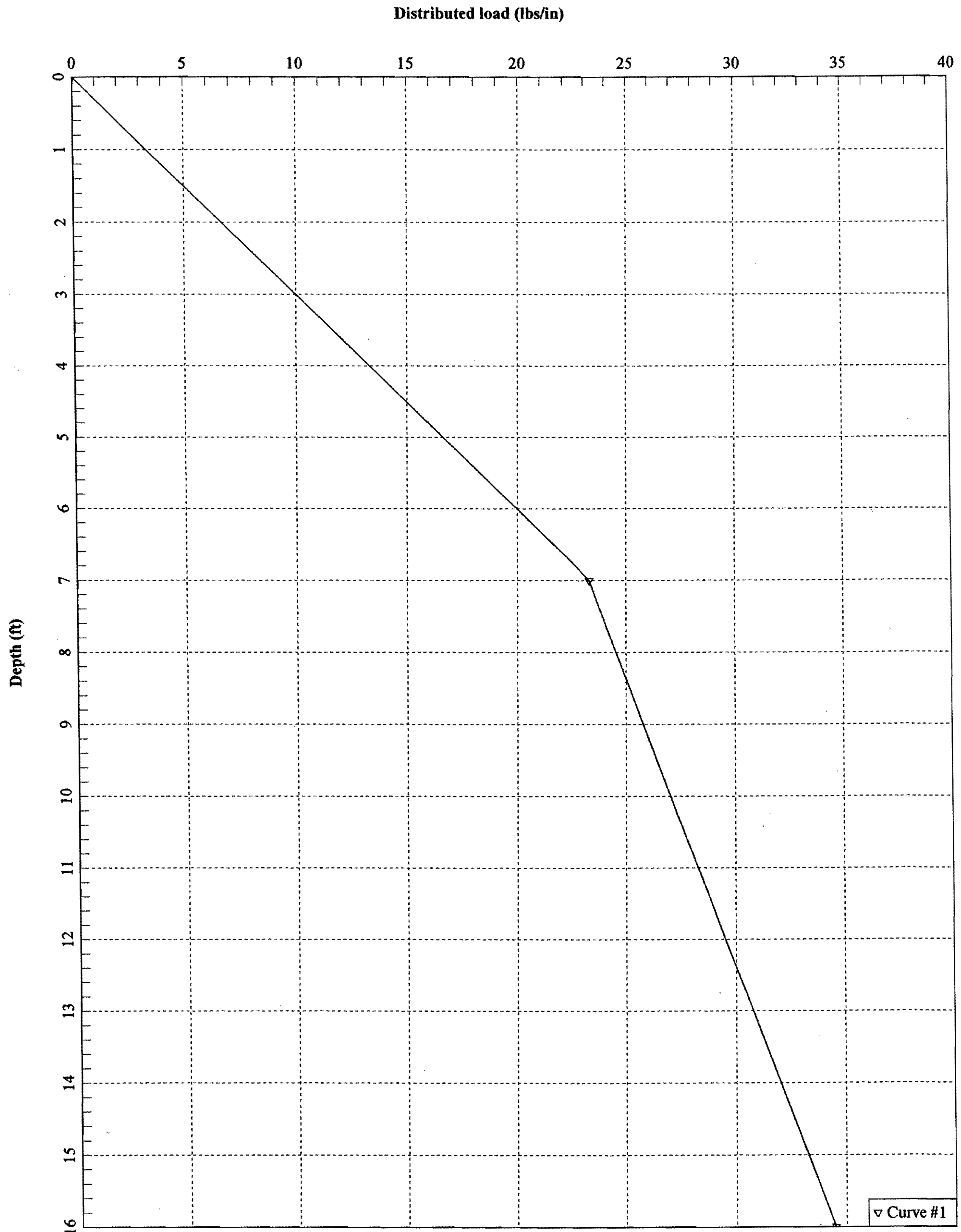
W14X193 PILE TIP ELEV -37



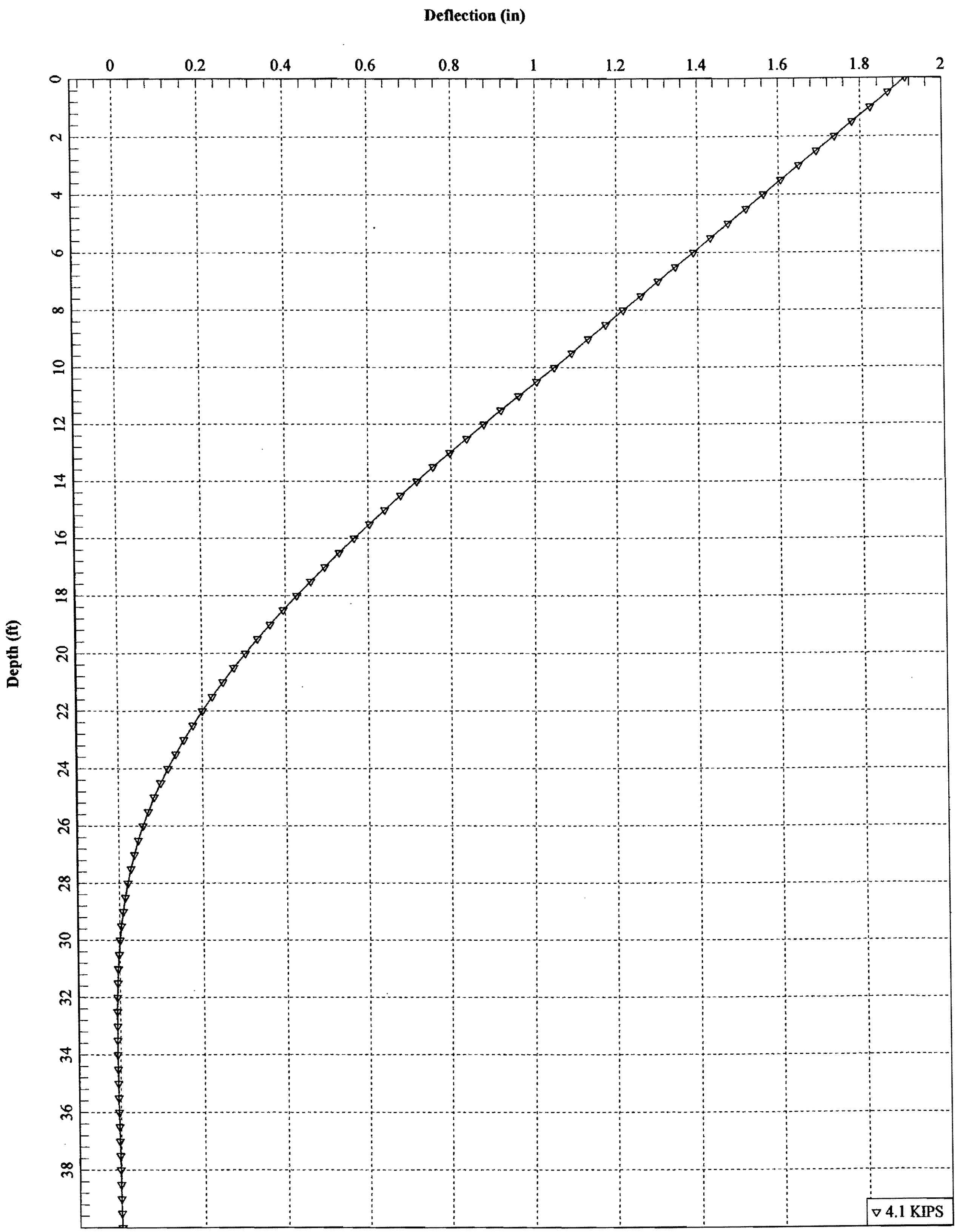
24 INCH APG PILE -38 TIP



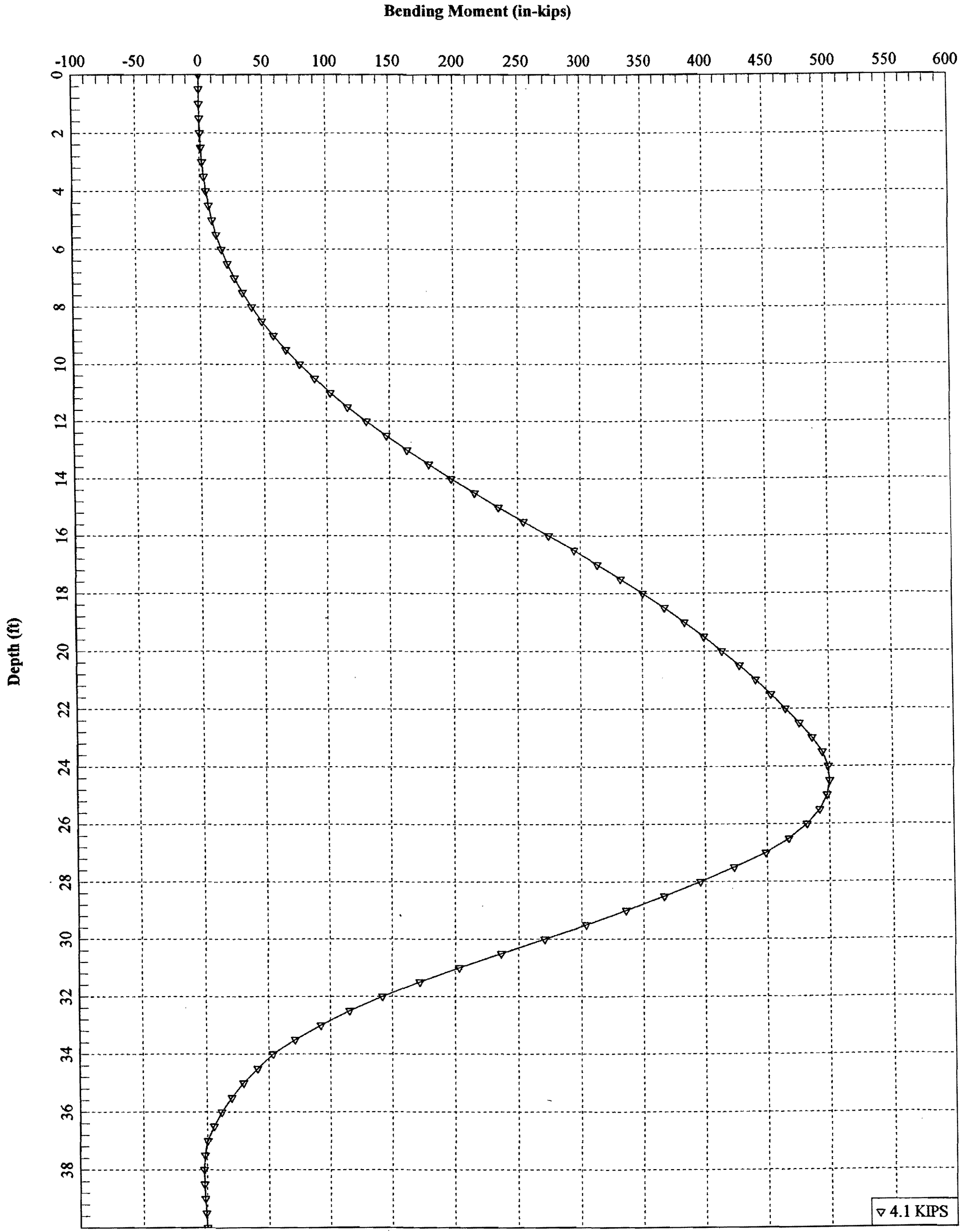
24 INCH APG PILE -38 TIP



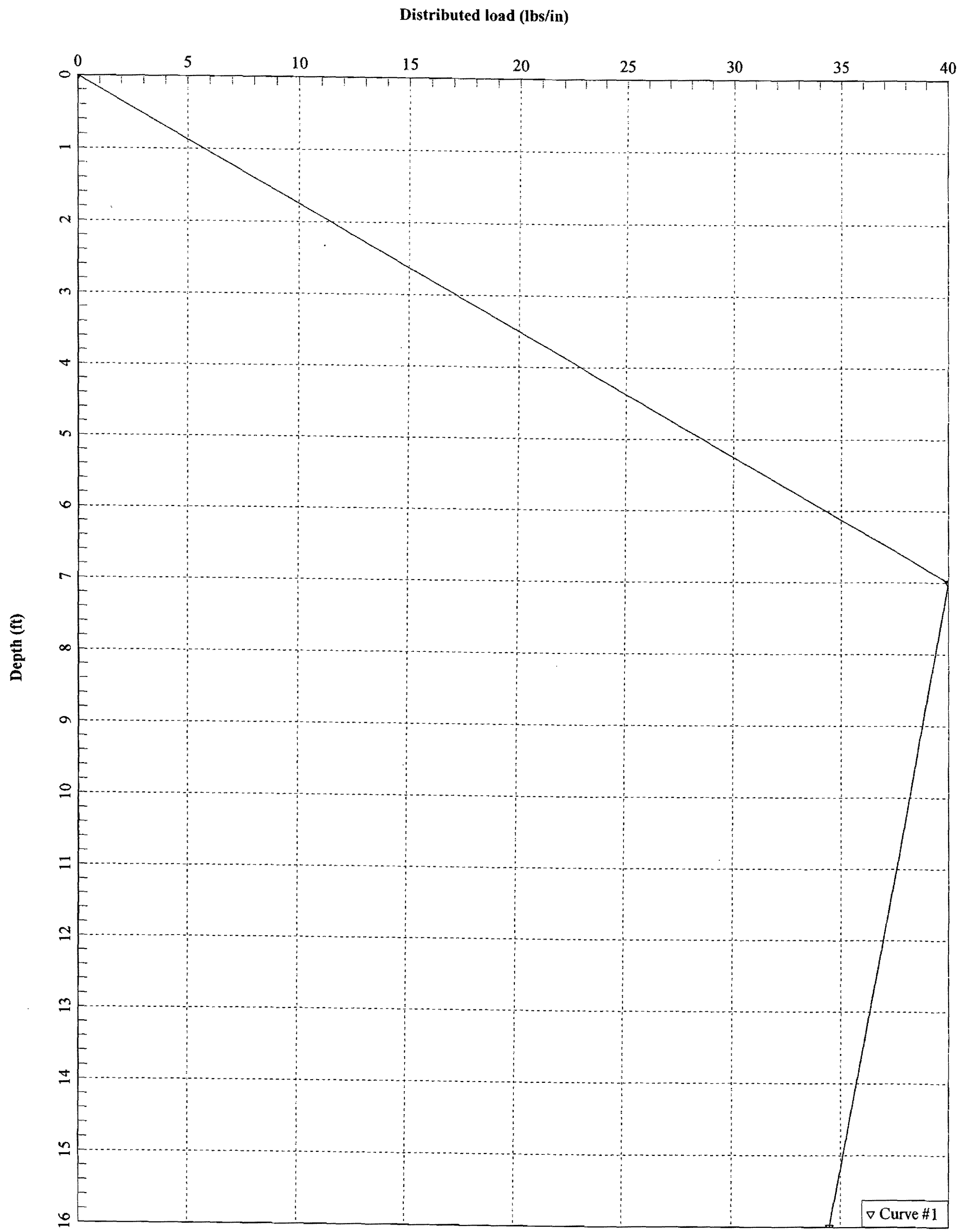
AZ-28 EARTH PRESSURE FOR 4.1 KIP STATIC LOAD



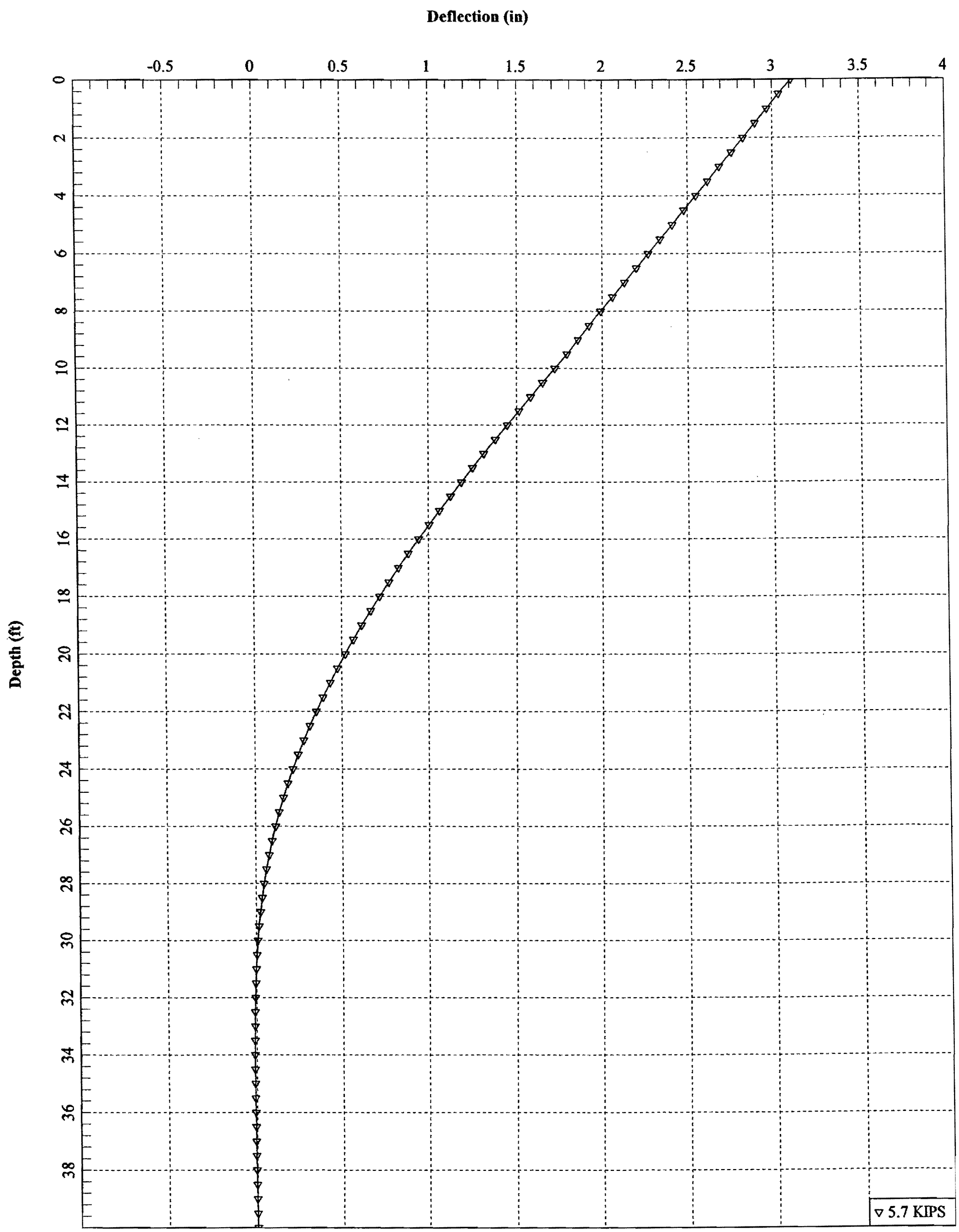
AZ-28 TIP ELEVATION AT -33 FEET (STATIC LOAD)



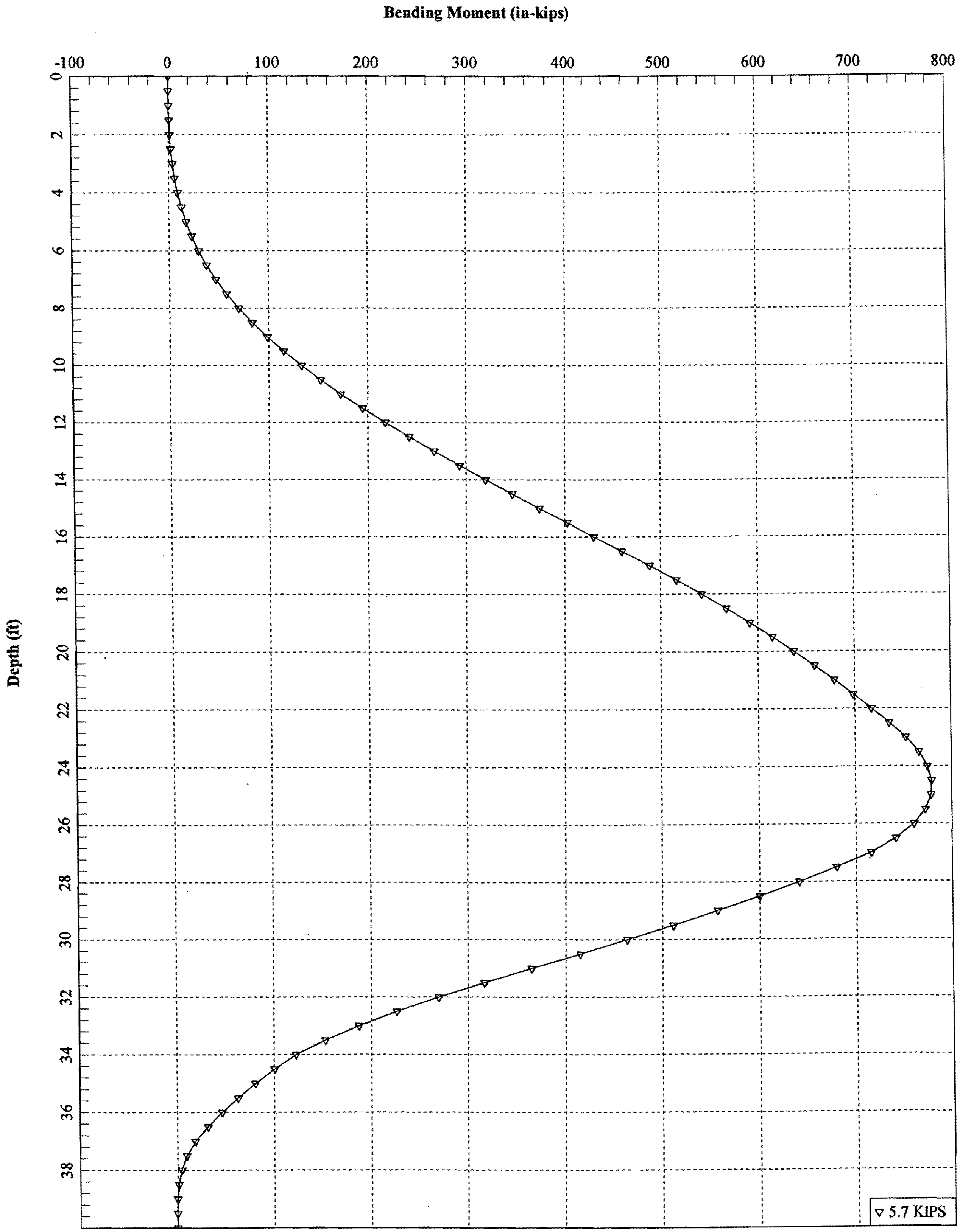
AZ-28 TIP ELEVATION -33 FEET (STATIC LOAD)



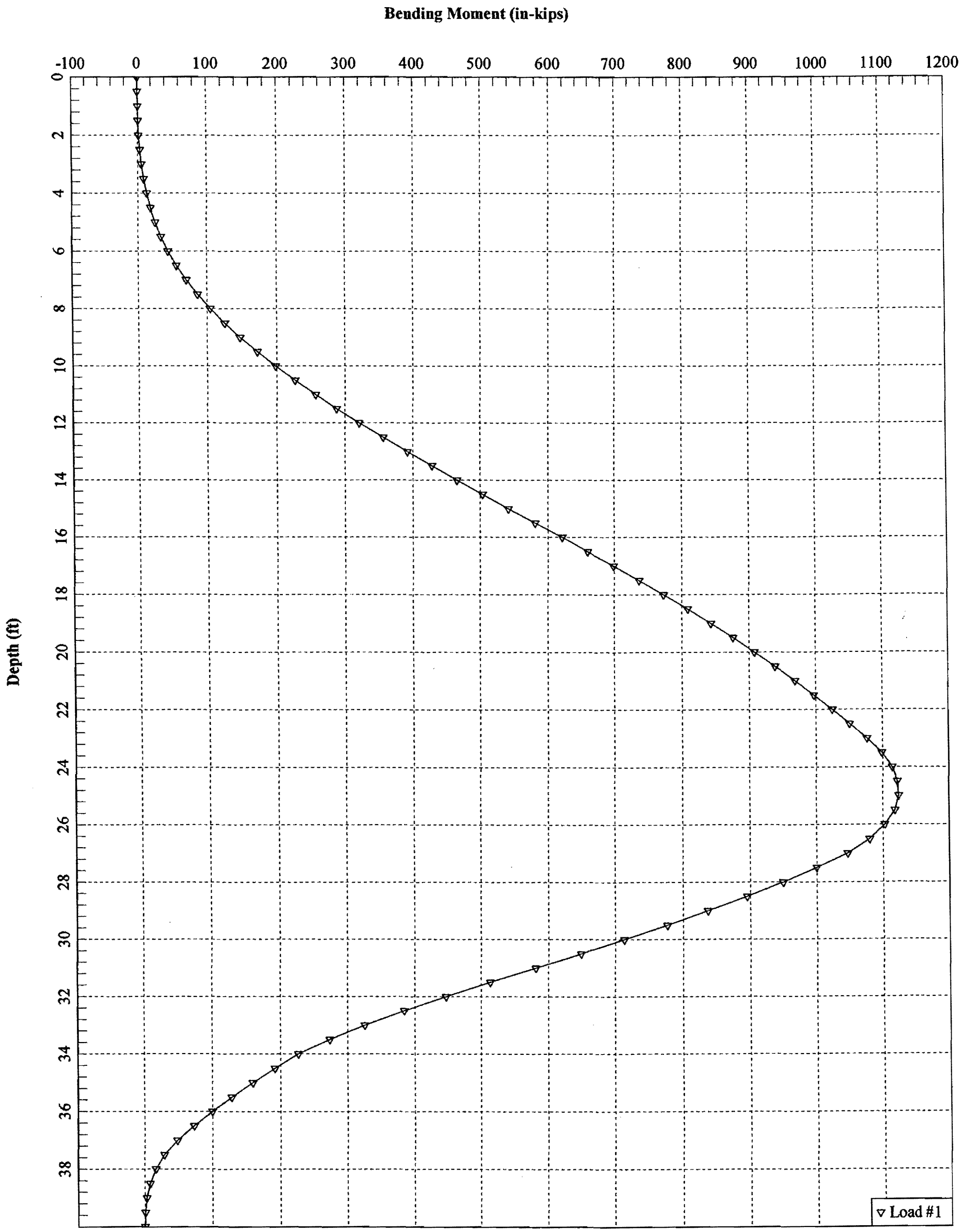
AZ-28 EARTH PRESSURE FOR 5.7 KIP LATERAL LOAD (OLE)



AZ-28 TIP ELEVATION AT -33 FEET (OLE)



AZ-28 TIP ELEVATION AT -33 FEET (OLE)



AZ-28 TIP ELEVATION AT -33 FEET (DE)

Attachment D ....Photos/Figures

Figure 1 – Naples Bridge Clearances

P:\Projects\CLB\TC27046_Naples Seawall\Submittals\Work Plan_Setp2011\Figures\Naples Seawall Figures.dwg

N

NOT TO SCALE

NOTE:

1. CLEARANCES REFERENCED TO 0' MLLW.
2. CLEARANCES SHOWN INDICATES MAX HEIGHT TO CENTER OF ARCHED BRIDGE SUPPORT.

TETRA TECH INC. ARCHITECTS, ENGINEERS & SCIENTISTS LONG BEACH, CA 562.495.0495	BRIDGE CLEARANCES		DATE: SEPT 2011
	NAPLES SEAWALL		FIGURE 1-2
	TT JOB NO.: TC-27046	DRAWN BY: NSC	NOT TO SCALE

Figure 2 – Jet Grout Rig

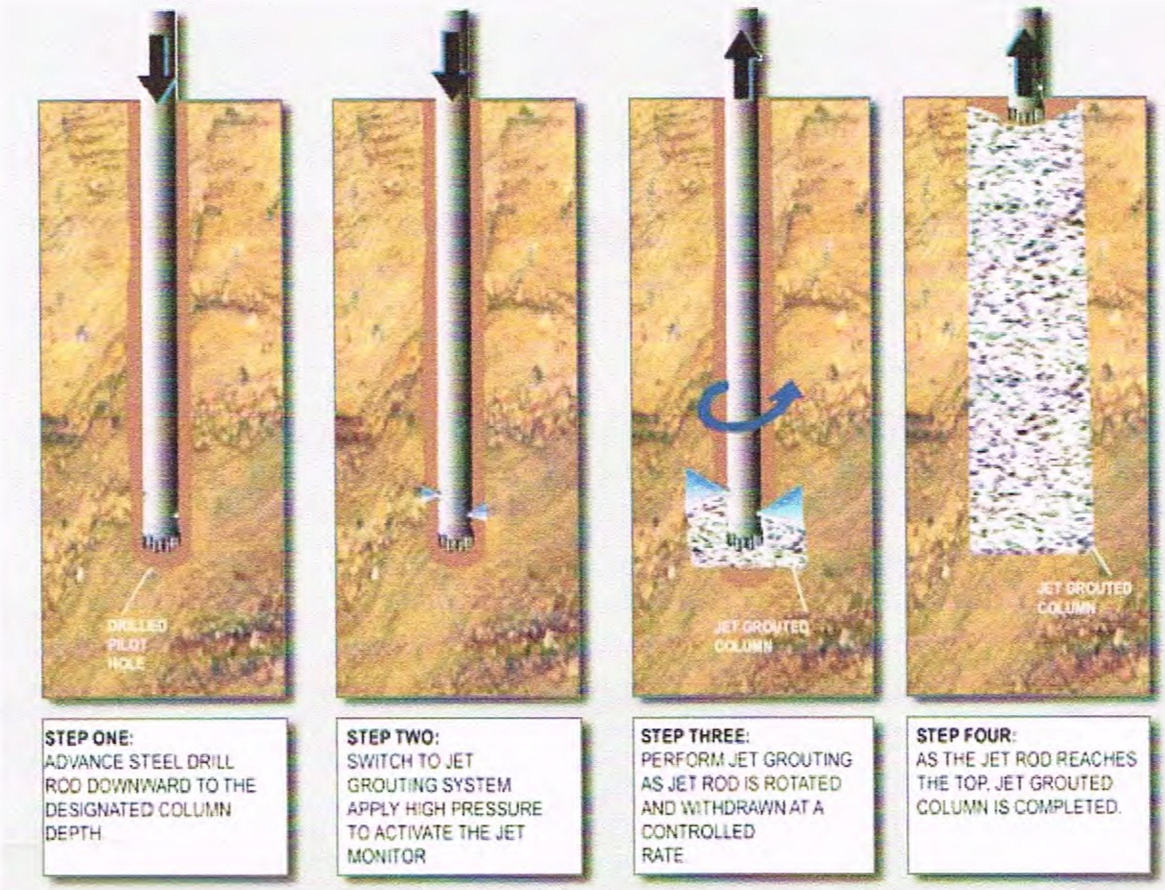

DRILLED PILOT HOLE
JET GROUTED COLUMN
JET GROUTED COLUMN
STEP ONE:
ADVANCE STEEL DRILL ROD DOWNWARD TO THE DESIGNATED COLUMN DEPTH.
STEP TWO:
SWITCH TO JET GROUTING SYSTEM APPLY HIGH PRESSURE TO ACTIVATE THE JET MONITOR
STEP THREE:
PERFORM JET GROUTING AS JET ROD IS ROTATED AND WITHDRAWN AT A CONTROLLED RATE.
STEP FOUR:
AS THE JET ROD REACHES THE TOP, JET GROUTED COLUMN IS COMPLETED.

Figure 3 – Gieken Silent Piler

BLUE IRON, INC.
SPECIALIZING IN SHEETING, SHORING AND BRACING

Giken Silent Piler

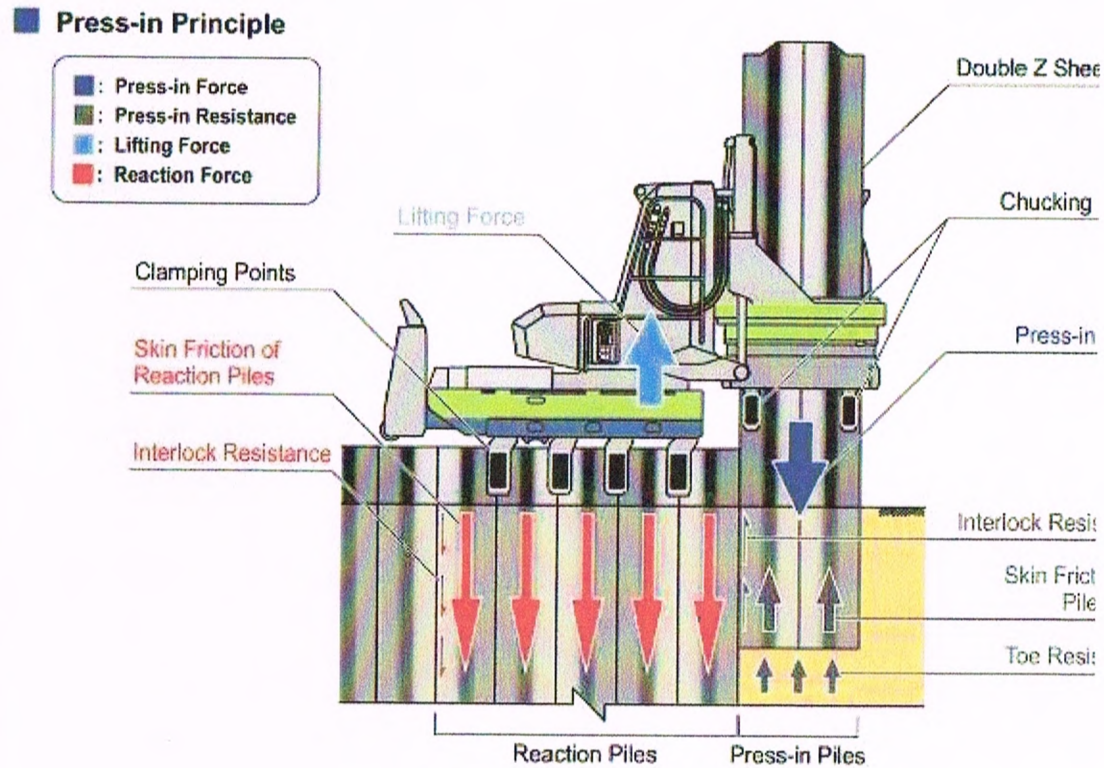
Conventionally prefabricated piles have been pounded or vibrated into the ground. Such methods inevitably generate excessive noise and vibration because of their reliance percussive or vibratory energy. Taking the initiative in solving this problem, Mr. Akio Kitamura, who had already founded Giken as his own contracting company, turned his a resistance to extraction of installed sheet piles. Thereby he discovered the press-in principle, which utilizes reaction force derived from fully installed piles as a counter weigh hydraulically press-in subsequent piles. In succeeding years, Giken developed the world\'s first SILENT PILER press-in machine to make the press-in principle practicable ir Since the piles are pressed-in, the Silent Piler does not cause any damage to the environment including neighboring structures and local residents through noise and vibrati ultimate solution for non-pollutive piling was pioneered and the Press-in Method set off on its endless innovation to establish a new standard for a true revolution in construct

The World's First Press-in Machine:

In 1975, the first operational Silent Piler was initially designed and built by Giken for its own use to provide a means of silent and vibration-free pile installation. This is the w piling equipment to hydraulically jack a pile utilizing the reaction force of fully installed piles (The PRESS-IN principle).

Continuous Development of Silent Piling Technology:

The superior press-in principle developed by the first Silent Piler has been improved on every subsequent model. Accordingly the current Silent Piler incorporating the most up to date technologies has achieved a 70% weight reduction with much higher performance.



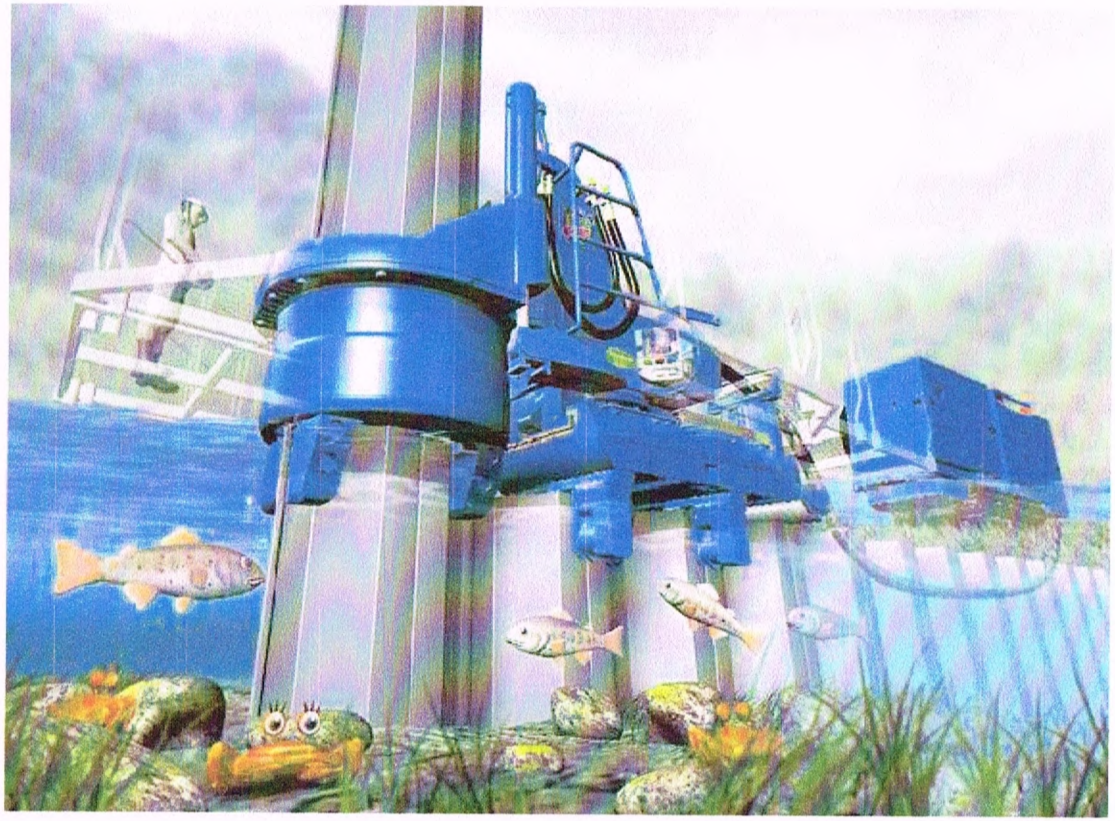
Application for Various Shapes and Materials:

Adopting the most appropriate method for the project, new types of the Silent Piler that can press-in prefabricated piles in all different shapes or materials such as tubular sheet piles and concrete sheet piles have been developed and are already in practical use.

Environment Conscious Operation and Higher Performance for Sustainable Construction:

Since development of the first Silent Piler in 1975, substantial number of projects has been completed with scientific empirical analysis and feedback collected from each project site. The newest Press-in machines adapt to the wider shapes in construction materials which have been developed to be more efficient. Such equipment uses advanced environmentally sound construction practices through systematic design while minimizing the overall environmental imp

GENERAL ENGINEERING CONTRACTO



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Attachment E…………….Naples Seawall Initial Study/Mitigated Negative Declaration