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November 29, 2017

Jessica LaClair
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New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, New York 12233-7016

RE: Preliminary Design Submittal for OU-1 and OU-2
Former Anaconda Plant (a.k.a. Harbor at Hastings Site) Site No. 3-60-022
Hastings-On-Hudson, New York

Dear Ms. LaClair:

Please find attached the Preliminary Design for Operable Unit 1 (OU1) and Operable Unit 2 (OU2) (PD) as requested in your conditional approval letter dated May 5, 2017 and our responses provided to the New York State Department of Environmental Conservation (Department) on June 2, 2017. The attached document provides the Department with the preliminary design of the selected remedy for the Harbor at Hastings Site (former Anaconda Wire & Cable Plant site), NYSDEC Site #360022 located in Hastings-on-Hudson, New York.

This PD has been prepared pursuant to the NYSDEC's OU1 Amended Record of Decision (ROD) and OU2 ROD; (NYSDEC 2012a 2012b), as well as the Amended Order on Consent dated November 6, 2013 (AOC); the Remedial Design Work Plan (RDWP; Haley & Aldrich of New York [H&A] 2014); and the Pre-Design Investigation Data Summary Report (PDI Report; H&A 2015a) with additional data that was conditionally approved in a NYSDEC letter dated July 21, 2017. The PD and has been prepared in substantial conformance with the NYSDEC Department of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10; NYSDEC 2010a).

We appreciate your time in this matter and look forward to your review. If you have any questions or comments on this submittal, please feel free to contact me at 832-619-5825.

Sincerely,



Paul G. Johnson
Operations Project Manager

ecc: Jacquelyn Nealon, New York State Department of Health
Maureen Schuck, New York State Department of Health
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ARCADIS Design & Consultancy for natural and built assets

Atlantic Richfield Company

PRELIMINARY DESIGN REPORT

Harbor at Hastings Site
(Former Anaconda Wire & Cable Plant Site)
Hastings-On-Hudson, New York
NYSDEC Site #3-60-022

November 2017

Certification Statement:

I, Mark O. Gravelding, certify that I am currently a New York State registered Professional Engineer and that this Preliminary Design Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10).

Mark O. Gravelding, P.E.
Engineer-of-Record/Senior Vice President

Raymond M. Kapp
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OU2 Design Lead/Principal Engineer

PRELIMINARY DESIGN REPORT

Harbor at Hastings Site
(Former Anaconda Wire & Cable Plant Site)
Hastings-On-Hudson, New York
NYSDEC Site #3-60-022

Prepared for:

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Date:
November 29, 2017

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ACRONYMS AND ABBREVIATIONS

ARC	Atlantic Richfield Company
Arcadis	Arcadis of New York, Inc.
ASCE	American Society of Civil Engineers
bss	below sediment surface
BMP	best management practices
BOD	basis of design
CD	Consent Decree
CERP	Community and Environment Response Plan
CFR	Code of Federal Regulations
cm/sec	centimeter per second
COC	contaminant of concern
CPP	Citizen's Participation Plan
CQAPP	Construction Quality Assurance Project Plan
cy	cubic yards
DER-10	Division of Environmental Remediation-10
DNAPL	dense non-aqueous phase liquid
FD	Final Design
FER	Final Engineering Report
fps	feet per second
GAC	granular-activated carbon
GPS	global positioning system
H&A	Haley & Aldrich of New York
HASP	Construction Health and Safety Plan
JPA	Joint Permit Application
ksi	kips per square inch
LPGAC	liquid-phase granular-activated system
mg/kg	milligrams per kilogram
MHW	mean high water
MLW	mean low water

MOTEMS	Marine Oil Terminals Engineering and Maintenance Standards
N-Value	Penetration resistance of the soil
NAVD88	North American Vertical Datum of 1988
NCHRP	National Cooperative Highway Research Program
NEA	Northwest Extension Area
NOAA	National Oceanic and Atmospheric Administration
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	State of New York Department of Transportation
OU1	Operable Unit 1
OU2	Operable Unit 2
OMM	operation, maintenance, and monitoring
OWS	oil-water separator
PCB	polychlorinated biphenyl
PD	Preliminary Design
PDI	Pre-Design Investigation
PDI Report	Pre-Design Investigation Data Summary Report
RD Work Plan	Remedial Design Work Plan
PD Report	Preliminary Design Report
POTW	publicly owned treatment works
ppm	parts per million
RAMP	Remedial Action Monitoring Plan
RAO	remedial action objective
RCP	reinforced concrete pipe
RDWP	Remedial Design Work Plan
RI	remedial investigation
Riverkeeper	Riverkeeper, Inc.
ROD	Record of Decision
SCO	soil cleanup objective
site	Harbor at Hastings Site (Former Anaconda Wire & Cable Plant Site),

	NYSDEC Site #360022 located in Hastings-on-Hudson, New York
SMP	Site Management Plan
SPDES	State Pollutant Discharge Elimination System
SPT	standard penetration test
SUG	Seismic Use Group
TSCA	Toxic Substance Control Act
TSS	total suspended solids
UFC	Unified Facilities Criteria
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Village	Village of Hastings-On-Hudson

1 INTRODUCTION

1.1 General

On behalf of Atlantic Richfield Company (ARC), Arcadis of New York, Inc. (Arcadis) has prepared this *Preliminary Design Report* (PD Report) for submittal to the New York State Department of Environmental Conservation (NYSDEC) to provide the preliminary design of the selected remedy for the Harbor at Hastings Site (former Anaconda Wire & Cable Plant site), NYSDEC Site #360022 located in Hastings-on-Hudson, New York (Cover Sheet, Appendix A; site). This PD Report, including the Preliminary Design (PD) drawings (Appendix A), has been prepared pursuant to the NYSDEC's Operable Unit 1 (OU1) Amended Record of Decision (ROD) and Operable Unit 2 (OU2) ROD; (NYSDEC 2012a 2012b), as well as the Amended Order on Consent dated November 6, 2013 (AOC); the Remedial Design Work Plan (RDWP; Haley & Aldrich of New York [H&A] 2014); and the Report on Pre-Design Investigation Data Summary Report (PDI Report; H&A 2015a) with additional data that was conditionally approved in a NYSDEC letter dated July 21, 2017. The PD and has been prepared in substantial conformance with the NYSDEC Department of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10; NYSDEC 2010a).

Principal additional stakeholders involved include the New York State Department of Health (NYSDOH); United States Environmental Protection Agency (USEPA), pursuant to the Toxic Substance Control Act (TSCA); and the Village of Hastings-On-Hudson (Village), including the Hudson Riverkeeper Fund, Inc., now known as Riverkeeper, Inc. ("Riverkeeper"), pursuant to a Consent Decree (CD) v. ARC (Consent Decree 2016).

1.2 Purpose of Remedial Design

The remedial design for the site will incorporate the elements of the NYSDEC-selected remedy, as defined in the OU1 and OU2 RODs, RDWP (H&A 2014) and NYSDEC's ongoing approvals of removal boundaries into a set of biddable quality plans and specifications in the Final Design (FD), prepared in accordance with DER-10. Design submittals include:

- Preliminary Design (PD), including basis of PD and design plans (this submittal).
- Final design (future submittal), including:
  - A 95% completion submission of the design plans and specifications for stakeholder review
  - A FD submission of the plans and specifications, signed and stamped by a Professional Engineer licensed to practice in New York State and will include the required certification set forth in DER-10, Subdivision 1.5(b).

The future 95% design submittal will also include the following:

- Citizen's Participation Plan (CPP) – update to existing plan
- Community Air Monitoring Plan (CAMP)
- Community and Environmental Response Plan (CERP)

- Remedial Action Monitoring Plan (RAMP)
- Habitat Mitigation Plan
- Construction Health and Safety Plan (HASP)
- Construction Quality Assurance Project Plan (CQAPP)
- Final Remedy Performance Monitoring Plan
- Site Management Plan (SMP)
- Applicable permits and permit equivalencies for remedial construction.
- Updated Remedial Cost Estimate
- Construction Schedule

This PD Report summarizes the requirements and restrictions included in the RODs issued by the NYSDEC for OU1 and OU2 in March 2012 as well as the AOC., and the additional terms outlined in the CD entered into by Riverkeeper, the Village, and ARC in 2003, as modified in 2016. The Parties – Village, Riverkeeper, and ARC – entered into the 2016 CD, which supersedes and replaces the 2003 CD and sets forth the final obligations of the Parties. Table 1 provides an integrated summary of the requirements and restrictions set forth in the RODs, AOC and CD.

This PD Report includes the design-related assumptions for each OU specified in the relevant controlling documents (OU1 ROD, OU2 ROD, AOC, RDWP and CD). Other assumptions are based on design references, accepted practice, site knowledge, and previous experience. Decommissioning, demolition, or alternative disposition of the water tower is not part of the PD, although the OU1 design includes remediation of soil underneath the tower. Elements of potential redevelopment contained in the CD and summarized in Table 1 are incorporated in the remedial design to the extent practicable.

1.3 Description of Selected Remedy

The selected remedies for OU1 and OU2 are described in the OU1 and OU2 RODs. Subsequent approval of removal limits is being accomplished for OU1 and OU2 areas through NYSDEC approval of the Pre-Design Investigation (PDI) work plans and data reports to confirm the removal limits in OU1 and OU2. This PD includes the removal limits approved by NYSDEC, by letter of July 21, 2017, and will be amended for the FD based on the remaining limits currently being verified in accordance with the most recent NYSDEC-approved PDI Addendum Work Plan (approved October 27, 2017). Requirements of the CD are also being integrated into the selected remedy in this PD.

An integrated summary of the NYSDEC-selected remedies for OU1 and OU2 combined, from construction through post-construction phases, includes:

- Green remediation principals and techniques will be implemented to the extent feasible in the design, implementation, and site management of the remedy per DER-31, in accordance with the OU1 ROD (Amended 2012) and OU2 ROD (2012).
- Installation of a sheet pile wall (bulkhead) within the Hudson River to provide containment and allow for the recovery of PCB dense non-aqueous phase liquid (DNAPL) onshore and offshore of the northwest

corner of the site (if found in post-construction investigation). The newly created Northwest Extension Area (NEA) will create approximately 0.87 acres of new land, requiring mitigation for the aquatic habitat taken (the bulkhead alignment was subsequently approved by NYSDEC as of July 21, 2017).

- The area behind the sheet pile wall will be filled with appropriate aggregate as approved by the Department. The sheet pile wall will include sealed joints, installation of tie-rods, upland anchors, and corrosion protection. The wall system will also include groundwater filtration units to adsorb contaminants that may be present in groundwater discharging to the river.
- At the Northwest Corner of the site and along the Northern Shoreline, excavation of surface soil (0-12 inches) containing greater than 1ppm PCB and subsurface soil containing greater than 10 parts-per-million (ppm) PCB to a maximum depth of 9 feet. Outside of the Northwest Corner and the Northern Shoreline areas, excavation of surface soil (0-12 inches) containing greater than 1ppm PCB and subsurface soil containing greater than 10 ppm PCB, to a maximum depth of 12 feet ppm (removal boundaries have been approved by NYSDEC, as of July 21, 2017). Note that the 2-foot site cover that is part of the upland capping eliminates the requirement for the excavation of greater than 1 ppm in surface soils (0-12 inches) as agreed with NYSDEC and outlined in the PDI Report and subsequent approvals.
- Outfalls and associated pipe bedding from Building 52 that are potential PCB source areas will be excavated, sampled and removed, or decommissioned as approved by the Department (these areas are currently being investigated to establish removal boundaries under a sampling plan approved by NYSDEC on October 27, 2017.
- Excavation of shallow soils from the southern portion of the site that are identified as "lead hotspots". These correspond to lead levels between 2,160 ppm and 43,200 ppm (removal boundaries have been approved by NYSDEC as of July 21, 2017).
- The shoreline south of the NEA will either be a steel bulkhead or construction of a sloped shoreline cover system (this PD contains the sloped shoreline option). The sloped shoreline cover system will be designed and constructed such that no additional fill material will be placed into the Hudson River, and will require the removal of sediment or fill below the current sediment or water elevation for placement of a cover system.
- The sloped shoreline cover system will be designed with the following layers: an isolation layer of soil or geotextile designed to prevent the migration of contaminated soil particles into the Hudson River; an erosion protection layer; and a habitat/surface substrate layer.
- As part of the upland capping, a site cover will be required to allow for restricted residential use of the site. The cover will consist either of the structures such as buildings, pavement, sidewalks comprising the site development and/or a soil cover in areas where the upper two feet of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where the soil cover is required, it will be a minimum of two feet of soil, meeting the SCOs for cover material as set forth in the New York Codes, Rules, and Regulations (NYCRR), specifically 6 NYCRR Part 375-6.7(d) for restricted residential use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer with appropriate natural species (this PD assumes that a soil cover system will be constructed).

- Pile supported structures will not be permitted in any areas where PCB material (PCB DNAPL) is potentially present (this will be managed as an institutional control as described in the RODs).
- Removal of nearshore sediment and fill that contains PCB concentrations greater than 1 ppm and/or copper, zinc and lead concentrations above the background concentrations listed in the OU2 ROD, to a maximum excavation depth of 6 feet within the area where sediment resuspension controls, such as a fixed silt curtain, are feasible. This area generally corresponds to a water depth of <15 feet and a distance from the shoreline into the river of approximately 60 to 80 feet and along approximately 2,000 feet of shoreline (the limits of removal and effective resuspension controls have been approved by NYSDEC as of July 21, 2017 in all nearshore and backwater areas, with the exception of ongoing PDI sampling, which will confirm the limits of removal in the vicinity of the Old Marina and Kinnally Cove.
- Removal of deepwater sediments from a targeted area outside the northwest extension area in deeper than 15 feet of water that is defined by PCB concentrations greater than 50 ppm, to a maximum depth of 6 feet. During the design, sampling was performed to determine whether additional areas of PCBs greater than 50 ppm exist. The limits of deepwater area removal have been approved by NYSDEC as of July 21, 2017.
- On-site dewatering of dredged and excavated sediments for off-site transportation and disposal or onsite reuse, as appropriate. On-site reuse of sediments is planned and will be finalized during the FD, as discussed in Section 4.14. Water removed from the sediment will be treated and likely discharged back to the river in compliance with regulatory permit requirements.
- Backfill of dredged areas with NYSDEC-approved material. Dredged areas within the nearshore areas will be backfilled with clean material to isolate remaining contamination, prevent erosion of cap materials, restore bathymetry, and provide a habitat layer. In nearshore areas which have contamination remaining above background concentrations, isolation capping will be placed following dredging. The isolation cap will consist of a sand isolation layer; armoring layer; and a minimum of a 24-inch habitat layer. The isolation and armoring layer thicknesses and materials of the cap will be established in the remedial design. As part of the design, a river flow and deposition study will be conducted to determine approximate sedimentation rates and the acceptability that up to 12 inches of the habitat layer may fill in by natural deposition within a reasonable duration of time after installation of the isolation cap. Additional backfill needed to reach bathymetry requirements will be placed between the erosion protection layer and habitat layer. The habitat layer will be designed to restore aquatic habitat.
- Dredged areas that are deepwater areas (>15 feet in depth) will be backfilled with appropriate river substrate to pre-dredge elevation, or to within 12 inches of the pre-dredge elevation, provided that the sedimentation study demonstrates that sufficient deposition will occur within a reasonable time frame. All activities associated with the excavation and restoration of Hudson River sediments will meet the requirements of 6NYCRR Part 608.
- Imposition of an institutional control in the form of an environmental easement for the controlled property (including the newly created NEA), that will:
    - require the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8(h)(3);

  - allow the use and development of the controlled property for restricted-residential, uses as defined by Part 375-1.8(g) which are consistent with the remedial elements, although land use is subject to local zoning laws;
  - restrict the use of groundwater and/or surface water as a source of potable or process water, without necessary water quality treatment as determined by the Department, NYSDOH or Westchester County DOH;
  - prohibit agriculture or vegetable gardens on the controlled property with the exception of community gardens with the approval of the Department; and
  - require compliance with the Department approved Site Management Plan.
- A Site Management Plan (SMP) is required for the post remedial construction life of the remedy, for OU1 and OU2, as outlined the 2012 RODs. The SMP will describe the engineering and institutional controls, soil and sediment management plans, OMM plans for engineering controls, and post-remediation recovery and performance monitoring.

1.4 Site Location and Description

The site is located at One River Street, Hastings-on-Hudson, New York on the eastern bank of the Hudson River within the confines of the Hudson River Valley (Cover Sheet, Appendix A). It consists of a 28-acre property that was man-made land developed for industrial uses and home to a former wire and cable manufacturing facility operated by the Anaconda Wire & Cable Company, which ceased operations in 1974. It is also known that there are anthropogenic and regional background contaminant conditions, including but not limited to historic site fill and upstream sources to the Hudson River that have been considered in the investigations completed at the site. The NYSDEC designated the site as Class 2 Inactive Hazardous Waste Site #3-60-022. Refer to the PDI Report for additional background information (H&A 2015a).

1.5 Operable Units

The Site consists of two Operable Units, defined as OU1 and OU2. OU1 is an upland area approximately 2,400 feet long by 500 feet wide. OU2 is the area that extends westward into the Hudson River approximately 400 feet from the western OU1 boundary, north into the Old Marina (approximately 300 feet north of the northwestern corner of OU1), and approximately parallel to the southern property boundary (Drawing G-2, Appendix A). OU1 and OU2 boundaries are described in their respective RODs.

OU1 is divided into two sections for the purposes of this PD:

- OU1 North
- OU1 South.

OU2 is the offshore portion of the site that extends west from the shoreline approximately 700 feet and 300 feet north to the Old Marina. OU2 is divided into four sections for the purposes of this PD:

- Near Shore Area – North
- Near Shore Area – South
- NEA
- Deepwater Area.

Kinnally Cove and the Old Marina would be considered a fifth section of OU2 to the extent of any remediation required in these areas.

1.6 Physical and Environmental Setting

The physical and environmental setting for OU1, OU2, and the surrounding area is described in terms of regional and site geology and hydrology, including specific information about soils in OU1 and the Hudson River and sediments within OU2.

1.6.1 Regional and Site Geology

OU1, OU2, and the surrounding area are situated in an area of unconsolidated sedimentary deposits of glacial, marine, and alluvial deposits, with underlying bedrock that consists of unconsolidated deposits of crystalline metamorphic rocks of the Manhattan Prong (H&A 2008).

In the mid- and late 1800s, the current site was constructed by filling the river bottom behind a series of bulkheads in an east to west direction into the Hudson River. During remedial investigation (RI) activities performed from 1996 to 2000, the site geology was evaluated based on the collection of soil boring data. These data show that the surficial geology at the site consists of three units: man-made Fill Unit, Marine Silt Unit, and Basal Sand Unit. Within OU1 and OU2, the Fill Unit is the uppermost portion of the site and extends from ground surface to approximately -14 to -35 feet North American Vertical Datum of 1988 (NAVD88). The Fill Unit consists of a combination of silt, sand, gravel, ash, cinders, and rubble. Along the northwestern portion of the site, the Fill Unit extends into the Hudson River 25 to 75 feet offshore. The Fill Unit in OU2 is currently overlain by a thick layer of riprap and accumulated river sediments.

Below the Fill Unit is the Marine Silt Unit, which extends from the Fill Unit boundary to approximately -70 feet to -80 feet NAVD88 (northwestern corner area to the southern half of OU2). The Marine Silt Unit consists of silts, silty sand, silty-clay, and clays.

Lastly, the Basal Sand Unit is below the Marine Silt Unit. The Basal Sand Unit extends from the Marine Silt Unit boundary down to bedrock and consists mostly of medium to very dense sand and fine gravel. Intermittent lenses of stiff silt and clay are present within the Basal Sand Unit.

The physical characteristics of the site shoreline consist of timber pilings and bulkheads, riprap slopes, dock platforms, and two boat slips. In general, the shoreline is steeply sloped and lined with riprap throughout, which is approximately 10 to 20 feet thick and extends up to 100 feet offshore.

1.6.2 Regional and Site Hydrology

The Hudson River is approximately 315 miles long from its source at Lake Tear-of-the-Clouds in the Adirondack Mountains to the Battery in New York City. At the federal dam in Troy, New York, the total drainage area is approximately 8,000 square miles. The Hudson River is considered a drowned-river estuary with a mean tidal range of 5.5 feet. The river is approximately 4,700 feet wide at the site, with a maximum depth of 50 feet at mid-stream. Based on historical studies, the average tide range is 5.1 feet at the site. Depending on wind direction and velocity, up to 5-foot-high waves are generated on the river, with wakes of passing vessels up to 2.5 feet. During the winter, ice pack flows up along the eastern shore with a strong west wind (H&A 2008). Typical river velocities in the offshore areas vary from approximately 2.2 feet per second (fps) on the flood tide (flowing upstream) to approximately 2.9 fps on the ebb tide (flowing downstream) (H&A 2015a). As stated in the Conceptual Site Model (H&A 2008) mean high water and mean low water are estimated to be at El. 2.2 and El. -2.0, respectively according to historical Site reports. Extreme periods of record at the United States Geological Survey (USGS) Station 01376269 Hudson River at Piermont, New York, 14 miles upstream, include a maximum elevation of 6.40 feet NAVD88 on August 28, 2011 and a minimum of -2.43 feet NAVD88 on January 20, 2016. The October 29, 2012 flood reached an elevation of 10.68 feet from flood mark (9.68 feet NAVD88) at Piermont.

The Hudson River flows in a southerly direction across OU2. This portion of the Hudson River is brackish water and tidally influenced (tidal influence extends up to the Federal Dam at Troy, New York). According to NYCRR Title 6 Part 858.64 Table 1 (6 NYCRR 858.64), the Hudson River estuary near the site (from New York-Bronx county line within boundaries of New York State to Bear Mountain Bridge) is Saline Classification B (SB) water. The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival (6 NYCRR 701.11).

The 2007 Flood Insurance Rate Map (FIRM) for the Village of Hastings on Hudson shows that the base flood elevation (100-year flood) is +7 ft. NAVD88. Most of the current site elevation, except for building slabs, is within this defined floodplain (Zone AE). The flood elevation is subject to change based on potential FIRM mapping changes under review by the affected municipalities (Westchester County 2017).

NYSDEC reports that in 2011, Responding to Climate Change in New York State (ClimAID) provided the first projections of sea-level rise specifically along New York's coastlines and estuaries. The ClimAID 2014 Supplement refined these projections to take into account all known components of sea-level rise, based on advances in physical understanding, climate modeling and computing and reflecting observational data that include Hurricane Irene and Superstorm Sandy. NYSDEC considers these projections to be the best available at this time for New York planners (http://www.dec.ny.gov/energy/45202.html). Projected sea level rise, based on the ClimAid projections, has been incorporated into 6NYCRR Part 490.4, which lists sea level rise projections for the New York City/Lower Hudson River (up to Kingston NY) ranging from 15 inches to 75 inches by 2100.

1.7 Report Organization and Structure

The organization of this PD Report is as follows.

Section	Description
1 – Introduction	Presents the purpose of remedial design, the remedial action objectives, site location and description, definition of operable units, physical and environmental setting, and summarizes the report organization.
2 – Basis of Design	Presents a summary of pre-design investigation activities, lists key design elements, and summarizes the basis of preliminary design for each major component
3 – Pre-Remedial Activities	Describes the activities to be completed before implementation of the remedial activities.
4 – Remedial Activities	Summarizes the remedial activities to be conducted as part of the selected remedy.
5 – Summary of Green Remediation Practices	Describes green remediation practices and principles considered in the development of the remedial design to meet the objectives of green remediation.
6 – Post-Remedial Activities	Describes the reporting, monitoring, and administrative activities to be completed following remedial construction.
7 – Remedial Quantities, Cost, and Schedule	Presents the anticipated schedule for the remedial design and implementation of the remedy.
8 – References	Lists sources used to prepare this PD Report.

The following appendices are included to supplement the contents of this PD Report. These appendices provide additional information related to the implementation of the remedial:

- Design Drawings (Appendix A)
- Remedial Design Calculations (Appendix B)
- List of Technical Specifications (Appendix C)
- Hastings on Hudson Remedial Construction Concepts (Appendix D)
- Cost Estimate (Appendix E)

2 BASIS OF DESIGN

Per the NYSDEC, the OU1 remedial design addresses remediation of the upland portions of the site (onshore), and the OU2 remedial design addresses the Hudson River sediments (offshore). Areas addressed by OU2 include the future NEA that will be created by installation of a sheet pile wall within the Hudson River to provide containment and allow for the potential recovery of liquid PCB DNAPL offshore of the northwestern corner of the site.

For practical and constructability reasons, design of the NEA wall and backfill, as well as construction of onsite habitat mitigation measures, will be integrated with and made part of the OU1 upland design. The OU2 design will address sediments in the Hudson River by removing and/or capping, including backwater areas. The OU2 design will be integrated with the OU1 design for shoreline reconstruction and habitat features during the 95% design phase.

Based on requirements outlined in the 2012 RODs, the following removals will be implemented during the remedial action:

OU1:

- At the Northwest Corner of the site and along the Northern Shoreline, excavation of subsurface soil containing greater than 10 ppm PCB to a maximum depth of 9 feet.
- Outside of the Northwest Corner and the Northern Shoreline areas, excavation of subsurface soil containing greater than 10 ppm PCB, to a maximum depth of 12 feet.
- Outfalls and associated pipe bedding from former Building 52 that are potential PCB source areas will be excavated, sampled, and removed, or decommissioned as approved by the Department.
- Excavation of shallow soils from the southern portion of the site that are identified as "lead hotspots". These correspond to lead levels between 2,160 ppm and 43,200 ppm.

OU2:

- Sediment and fill (0- to 6 feet) in the Nearshore Area within water depth up to 15 feet containing greater than 1 ppm and/or copper, zinc, and lead concentrations above background concentrations. This area includes the North and South Boat Slips, the Old Marina, and Kinnally Cove.
- Sediment (0 to 6 feet) in the Offshore NEA containing concentrations greater than 50 ppm.
- Sediment (0 to 6 feet) in the Deepwater Area containing concentrations greater than 50 ppm.

Beneficial onsite reuse of sediments and soils with concentrations below OU1 required clean-up levels (<10 ppm of PCB's) are planned, , and will be finalized prior to completion of the FD .

2.1 Summary of Pre-Design Investigation Activities

Subsequent to the 2012 RODs for OU1 and OU2, the final RDWP (H&A 2014) was prepared and included a Remedial Design Work Plan (RDWP). The RDWP was prepared in accordance with the OU1 ROD Amendment and OU2 ROD, as well as the Amended Order on Consent dated November 6, 2013. Specifically, the onshore (OU1) subsurface delineation program was designed in accordance with the

OU1 ROD Amendment and NYSDEC DER-10. The offshore (OU2) sediment delineation program was designed in accordance with the OU2 ROD. Other aspects of the pre-design investigation (PDI) (e.g., geotechnical investigations, utility surveys) were completed in accordance with the RDWP.

As described in the PDI Report (H&A 2015a), environmental and geotechnical data were required to form the basis for and complete the design of the remedy. Historical pre-design data were generated and documented in the following documents:

- Conceptual Site Model (H&A 2008)
- 50% Design Report for Operable Unit No. 1 (H&A 2006)
- Supplemental Northwest Corner Investigation Findings Report (H&A 2009)
- DNAPL IRM Recovery Well Installation (H&A 2010a)
- Data Report on Riprap Field Investigation (H&A 2010b)
- Geotechnical Data Report (H&A 2011b).

H&A (2015a) concluded that existing data were not sufficient to complete a detailed design of the remedy. Specifically, results of historical investigations did not provide adequate data to:

- Define excavation or dredge extents
- Design the NEA bulkhead wall or select its final alignment
- Design the sloped shoreline
- Evaluate site features that will impact design and constructability (e.g. obstructions, outfalls, former sumps).

Therefore, based on historical site investigations and the remedy described in the RODs, the PDI was completed to collect detailed site data to support completion of the design. The scope of the PDI was developed based on environmental and geotechnical data generated and reported in the documents referenced above, documented in the RDWP (H&A 2014), and the body of historical investigation documents.

Data collected as part of the 2015 PDI activities include the following:

- Phase 1 PDI Investigation:
  - Geophysical survey
  - Survey updates – topographic and bathymetric
  - Groundwater level data logging
- OU1 Supplemental Investigation:
  - Groundwater levels (new monitoring wells)
  - Groundwater sampling
  - Void assessment
  - Subsurface anomalies
  - Outfall investigations
  - Existing underground utilities

- OU1 excavation pre-delineation
- Extension alignment investigation
    - Offshore probes
    - Onshore probes
- Deepwater investigation
- Offshore pre-delineation
- Geotechnical exploration
- Bench testing:
    - Solids Dewatering: Methods and basic design parameters for the dewatering of water-laden excavated soils and dredged sediments
    - Stabilization: Methods and basic design parameters for the stabilization of onsite excavated soils/sediment to be reused onsite for various purposes
    - Construction Water Treatment: Methods and basic design parameters for the potential treatment of various metals and PCBs in water generated during construction activities (e.g., solids dewatering supernatant and onshore excavation dewatering)
    - Groundwater Treatment: Initial testing of treatment methods for activities to support screening technologies and provide basic design parameters for groundwater generated during the remedial execution.

The PDI results were provided to the NYSDEC in the 2015 PDI Report (H&A 2015a). Draft supplemental data from additional deepwater and backwater sampling conducted in 2015 and 2016 were submitted to the NYSDEC in January 21, 2017 (ARC 2016).

The combination of historical data and PDI data, remedial excavation, and sediment removal boundaries were confirmed and presented on the figures included in the 2015 PDI Report (H&A 2015a) and subsequent January 2017 submittals. Additional delineations and boundary confirmation work have been initiated in November 2017 and reporting will be completed in 2018 per NYSDEC's July 21, 2017 approval.

2.2 Key Design Elements

Key design elements for the FD will include:

- Site layout and logistics
- Bulkhead and funnel and gate system
- Removal of shoreline structures and related demolition, excavation, and grading
- OU1 soil excavation
- Removal of former Building 52 outfalls, subsurface piping, and pipe bedding
- OU2 dredging and in-water excavation
- Turbidity controls for nearshore dredging
- Dredged material management
- Dewatering treatment system
- Backfill, capping, and shoreline stabilization
- Habitat mitigation
- Upland capping (Land cover and grading)
- Construction and operating permits or permit equivalencies.

This PD Report and PD drawings include details on drawings. Habitat mitigation options are being developed for further discussion with the NYSDEC and will be incorporated into the 95% design. In addition, sampling results scheduled to be collected in 2017 will be incorporated as agreed with the NYSDEC in the July 21, 2017 approval. Anticipated construction and operating permits or permit equivalencies listed in this PD Report will be developed further during the FD phase.

2.3 Refinement of Dredge Limits

The dredge boundaries presented in the RODs for OU1 and OU2 were defined using a combination of analytical results and field observations from the RIs performed between 1996 and 2011.

During the 2015 and 2016 PDI, additional NYSDEC-approved pre-design confirmation sampling was performed to further refine the horizontal and vertical extents of the sediment removal limits within OU2 from what was presented in the OU2 ROD (NYSDEC 2012b). The additional data were obtained in areas where PCBs exceeding 50 milligrams per kilogram (mg/kg) were known or suspected to be present. In 2016, supplemental sampling took place to further understand and confirm the extent of the COCs within OU2. PCB detections and observations from the 2015 PDI, 2016 supplementary sampling event, and previous investigations were evaluated to assign bottom of PCB elevations for each sediment sample location within OU2 to achieve the applicable ROAs for the selected remedy.

Following the 2016 supplementary event, further adjustments were made to removal areas within OU2. The proposed removal areas presented in the 2015 PDI Report (H&A 2015a) were modified to include additional removal areas offshore of the NEA, the addition of targeted removal locations in deep-water

areas south of the NEA, and adjustments to dredge depths in the Nearshore Area. The modification of the dredge depths was approved by the NYSDEC in a conditional approval of the PDI Report dated May 5, 2017 letter and were further presented to the NYSDEC in a July 27, 2017 meeting. These modifications are shown on Design Drawings D-4 through D-9 (Appendix A).

The actual volume to be removed will need to account for operational considerations, such as allowances for sloping that may be necessary to stabilize deeper excavations and methods of dredge operations (Palermo et al. 2008). The design of the dredge prism has accounted for sloping and actual dredge operations. The dredge prism includes, at a minimum, the removal elevation defined by sampling. In addition, the dredge prism accounts for the general assumptions/boundary conditions listed below:

- Along the perimeter of removal areas, the removal will be tapered to limit side slope sloughing to transition to the existing grade outside of the sediment removal area limit.
- The dredge prism has been designed with consideration for constructability (e.g., range of accuracy of dredging equipment, reasonable tolerances, dredge slope stability).

The resulting dredge prism provides the areal extent and elevations that would need to be achieved during dredging activities and is used to determine the resulting removal volumes. The anticipated volume based on the proposed dredge prism is presented in Section 7.1.

2.4 Determination of Appropriate Resuspension Controls

Parameters for the design of the turbidity control systems will be developed following the NYSDEC's final determination of all removal areas and based on the ongoing hydrodynamic study. Additional investigations have been commenced to determine the effectiveness of the turbidity control system, particularly in deeper water located in the NEA. Flow monitoring and river information were evaluated to determine the design of a suitable turbidity control system. Based on water depth and river velocities, fixed sediment resuspension controls will be used and are shown to be feasible within dredging of the Nearshore Areas in OU2.

2.5 Assessment of Geotechnical Characteristics of Soil and Sediment

Site geology near OU1 and the NEA consists of the following:

- Fill extending from ground surface to approximately -14 to -35 feet NAVD88. Composed mostly of ash, cinders, and rubble with a preliminary hydraulic conductivity (K) of $1.0x10^{-2}$ centimeters per second (cm/sec) to $5.0x10^{-4}$ cm/sec (H&A 2016).
- Marine silt typically extending from the fill to approximately -70 feet NAVD88 to -80 feet NAVD88 (northwestern corner area to the southern half of OU2, respectively) and composed of alluvial deposits, including silts, silty sand, silty-clay, and clays with a preliminary hydraulic conductivity (K) of $5x10^{-3}$ to $1x10^{-5}$ cm/sec in the horizontal direction and $1.0x10^{-7}$ cm/sec in the vertical direction (H&A 2016).

- Basal sand that lies below the Marine Silt and extends to bedrock, consisting of medium to very dense sand and fine gravel with occasional lenses of stiff silt and clay. The basal sand is estimated to have a hydraulic conductivity (K) of $3.0x10^{-3}$ cm/sec to $8.0x10^{-3}$ cm/sec (H&A 2016).
- Gneiss – Bedrock encountered at approximately -130 feet NAVD 88 near the bulkhead alignment (based on PD2-GR-001, PD2-GR-003, and PD2-GR-004 borings).

For this PD, soil descriptions and the standard penetration resistance (N-value) were determined using standard penetration tests (SPTs) and laboratory test data (H&A 2006, 2011b, 2015a). Boring locations are shown in Appendix B. Additionally, in-field vane testing performed in 2008 and reported in the 2011 Geotechnical Data Report was used to determine soil strengths for the Marine Silt layer (H&A 2011b).

The N-values were corrected to $(N_1)_{60}$ values to account for overburden pressure. The $(N_1)_{60}$ values were calculated using the following formula (Youd et al. 2001):

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S \quad (1)$$

Where

N_m = measured standard penetration resistance

C_N = correction for effective overburden stress = $2.2 / (1.2 + \sigma'_{vo} / P_a) \leq 1.7$

C_E = correction for hammer energy ratio = 1

C_B = correction factor for borehole diameter = 1.05

C_R = correction factor for rod length = 0.95

C_S = correction for samplers with or without liners = 1.1

These $(N_1)_{60}$ values and field vane shear tests were used in conjunction with engineering judgment to estimate the engineering properties of the soil layers. Laboratory testing data from the PDIs and 2011 Geotechnical Data Report (H&S 2011b) were also considered in determining soil layer properties; however, for the Marine Silt layer, a greater weight was given for in-situ vane shear testing results considering the very soft consistency and difficulty of collecting non-disturbed samples. The estimates were based on information found in Design of Sheet Pile Walls (U.S. Army Corps of Engineers [USACE] 1994) and Soil Mechanics in Engineering Practice (Terzaghi 1996).

2.6 Northwest Extension Area Basis of Design Assumptions

Per the OU1 ROD, the bulkhead extension in the northwestern portion of the site will allow for the investigation of the potential presence of PCB DNAPL offshore of the existing shoreline that will serve as the basis for determining the appropriate remedial action necessary. The bulkhead will consist of steel sheet piles with sealant applied to the interlocks. The wall system will also include the ability to install groundwater filtration units to adsorb contaminants that may be present in groundwater before discharge to the river, depending on the results of post-construction PCB DNAPL investigation. Corrosion protection is also planned for the NEA FD to control metal corrosion for a design life of 100 years. Specific corrosion protection details will be provided in the FD submittal, but will include an evaluation of the following types of corrosion protection systems and selection of one or multiple systems for use during construction:

- Cathodic protection, which controls corrosion of a metal surface by connecting the metal to be protected (cathode) to a more easily corroded "sacrificial metal" to act as the anode.
- Coatings or paints for NEA piles, along with consideration of hot-dipped galvanization for specific structural components to prevent exposure to the environment, mitigating the effects of corrosion.
- Use of Marine grade steel, or increased steel section to mitigate structural effects of corrosion (e.g. stability of wall)

The upland and in-water geotechnical design sections, which vary in-line with the existing bulkhead types, were interpreted using topographic survey data (Wendel 2014), bathymetry data (Ocean Surveys 2012), and soil boring data from H&A (2015a) and historical investigations by Parsons (2006).

Upland groundwater within the bulkhead extension was assumed for the basis of design (BOD) to remain consistent with upland measurements, with highs near elevation 2.0 feet NAVD88 (H&A 2015a).

River water elevations will be based on assumptions that the local mean high water (MHW) tide elevation is 2.2 ft. NAVD88, mean low water (MLW) tide elevation is -2 ft. NAVD88 and mean water elevation is 0.1-foot NAVD88 (USGS Station 01376269 Hudson River at Piermont, New York). These elevations are based on correlating information collected from NOAA stations in Tarrytown, New York 8518919 and 8530095 in Alpine, New Jersey. These elevations were used for NEA bulkhead wall analyses, including the following preliminary hydrodynamic river assumptions, which will be updated in the FD after completion of the updated hydrodynamic modeling to be completed by Stantec:

- Wave heights are typically 3 feet trough-to-crest (H&A 2015a). Wave action will only affect temporary conditions before filling of the NEA. For long-term cases, wave action is not considered a critical loading case.
- Typical river velocities in the offshore areas vary from approximately 2.2 fps on the flood tide (flowing upstream) to approximately 2.9 fps on the ebb tide (flowing downstream) (H&A 2015a).
- Ice loading is considered separate from wave loading and related with construction sequencing.
- The critical water differential case is based on high groundwater elevation with an MLW tide elevation of -2 feet NAVD88 during OU2 dredging.
- The wall will accommodate high water peaks in relation to the associated rise in groundwater near the shoreline based on groundwater modeling.

For bulkhead design, the following list of BOD assumptions were used in the PD of the NEA bulkhead. Calculations for the bulkhead design are provided in Appendix B:

- A conservative water differential outboard to inboard was assumed, and verified with preliminary groundwater modeling. Surface water elevation is assumed to be -2.0 feet NAVD88 in the Hudson River for low-low tide conditions, and the groundwater elevation is assumed at 2.0 feet NAVD88 near the northwestern corner at high tide (H&A 2016) for a 4-foot water differential.
- The earth pressures acting on the walls were determined with the computer program ProSheet (ProfileARBED 2009), which uses the Coulomb theory to calculate passive earth pressure coefficients. Both fully undrained and drained conditions were analyzed for each wall type to determine the governing state.

- The sheet pile designs and anchor load calculations were performed using the Shoring Suite The sheet pile designs and anchor load calculations were performed using the Shoring Suite computer program (Civil Tech Software 2010). Shoring Suite requires soil properties, surcharge loading, and water level conditions to be input, and then determines moment, shear, deflection, minimum required section modulus (e.g. pile size), and embedment based on force equilibrium.
- A uniform surcharge load of 250 pounds per square foot was assumed to be applied to the upland side of the bulkhead, as recommended in the New York State Department of Transportation (NYSDOT) Geotechnical Design Procedure for Flexible Wall Systems (NYSDOT 2015) for construction loading for the tieback wall analysis sections. Due to sequencing, it is assumed that the temporary cantilever analysis section will not experience surcharge loading on the onshore side of the wall.
- Properties for the sheetpile evaluated in the PD were assumed based on the Skyline Steel database (Skyline Steel 2014).
- The minimum acceptable factor of safety for passive pressures for geotechnical integrity (rotation) is 1.5 for free-draining soils and 2.0 for clay (NYSDOT 2015; USACE 1994).
- The minimum acceptable factor of safety for structural integrity (yielding) is 2.0 (USACE 1994). The yield strength of the sheet pile is assumed to be 50 kips per square inch (ksi) or 50 ksi.
- To avoid compounding factors of safety in the PD, the geotechnical integrity of the wall was based on a safety factor applied to passive pressures. Structural components were designed using a factor of safety applied to structural strengths, but with no safety factor applied to passive pressures.

Arcadis developed a three-dimensional groundwater flow model to evaluate site-wide groundwater flow conditions to support design of NEA reactive gates for passive groundwater treatment. Groundwater numerical modeling was developed with MODFLOW to estimate the number and rate of groundwater extraction locations. Site-specific hydrogeologic data previously provided by H&A was used to define the model layers in the model, and the calibrated flow model was utilized to determine the number, placement, and corresponding flow rate needed to provide sufficient water treatment to prevent groundwater mounding. The approach utilized represented an estimate of steady-state flow from upland flow into the NEA area.

Arcadis initially calibrated groundwater modeling performed by H&A (H&A 2015a), using the computer program MODFLOW, and then ran steady state simulations for mean, low and high tide conditions with the NEA bulkhead installed. Two groundwater modeling scenarios were performed;

- Scenario 1 – NEA Bulkhead (Partially Enclosed); and
- Scenario 2 – NEA Bulkhead (Fully Enclosed)

Based on the results of the modeling, preliminary design of the reactive gate system in the NEA area used the following basis of design assumptions from the groundwater modeling results:

- For scenario 1, where groundwater can enter the NEA area from upgradient, groundwater flow from within the NEA area exits the NEA area to the North end of the NEA bulkhead at a rate of 0.95 to 1.25 gpm; and
- For scenario 2, where groundwater is prevented from entering the NEA area by sealing off the NEA area, 0.74 to 0.99 gpm of groundwater would need to be treated at the North end of the NEA.

Additional details on groundwater modeling performed, including calculations supporting preliminary design are provided in Appendix B. The FD will include additional groundwater modeling to refine the NEA reactive gate design.

2.7 Settlement Analysis

To support design of the NEA and OU1 restoration, which includes placement of new fill materials, settlement calculations were performed and analyzed for two conditions near the NEA bulkhead and in areas of OU1 where consolidation was considered critical for evaluation, including utility corridors and areas where final restored height was significantly greater than existing. Additional considerations will be provided in the FD in support of final grading and fill placement to allow for proper site drainage. The settlement analysis performed for the PD is included in Appendix B and included the following BOD assumptions:

- Filling of the northwestern corner to the proposed elevation (+6 feet NAVD88).
- The groundwater elevation is assumed at 1.0-foot NAVD88 for mean groundwater level at mean tide (H&A 2016).
- For secondary consolidation estimates, the total consolidation would be accessed for the design life of 100 years (parameter t).
- The analysis sections were based on the mudline elevations and variations in the upland conditions that would be retained by the shoring wall system. The soil profiles for each analysis section were correlated to the design sections for the bulkhead retaining structure.
- The basal sand is assumed to be incompressible.

The geotechnical properties of the sediments and soil to be used in the analysis are based on the results of previous geotechnical investigations and laboratory testing of samples collected (H&A 2006) as described in Section 2.5. The soil parameters of compressibility and shear strength are based on index properties and one-dimensional consolidation tests on the Marine Silt stratum. Shear strengths are also compared to in-situ vane shear test results. The Over Consolidation Ratio is based on field vane shear data and unconfined unconsolidated laboratory data correlations. Liquidity index numbers are likely influenced by organic content of sample material and difficulty in sampling soft materials.

Based on field logs and observations, the geologic units vary slightly in thickness along the bulkhead alignment. To evaluate the potential range of settlement resulting from the variations in unit thickness and the varying depths of lightweight fill material needed to reach the target elevation, three cases were evaluated for the NEA. The intent of this evaluation was to bracket the potential range of settlement that may occur and estimate the potential range for expected differential settlements.

Based on the results of PD settlement calculations, the expected magnitude of primary consolidation is expected to range from 1.9 to 4.1 feet depending on the thickness of the compressible marine silt. To reach 95% of the expected primary consolidation, it is expected to take approximately 6 to 8 years to achieve, with no additional engineering measures.

Given the expected magnitude and duration of settlement of the marine silt, engineering controls to reduce time for consolidation have been and will continue to be evaluated for the FD. Based on the initial evaluations completed to date, one option includes installation of potential wick or sand drains to decrease the time required for consolidation. It was determined that wick drains (or similar) installed into the Marine Silt at a spacing of 8 feet would decrease the time required for 95% consolidation to approximately 7 to 8 months. Preliminary wick drain calculations are also included in Appendix B.

As part of the FD, further evaluation and engineering will be completed to determine the final NEA Bulkhead construction details, sequencing and engineering controls to manage settlement.

2.8 Seismic Analysis

The NEA bulkhead is being designed as a non-building structure and will not support buildings. Although Section 1613.1 of the New York City Building Code generally requires structures to be designed to resist the effects of earthquake motion in accordance with the American Society of Civil Engineers (ASCE) standard ASCE 7-10 (ASCE 2010), it allows for certain exceptions. Exceptions listed include vehicular bridges, electric transmission towers, hydraulic structures, buried utility lines, and nuclear reactors.

Waterfront structures, such as piers, wharfs, and bulkheads, are not typically designed in accordance with ASCE standard ASCE 7-10 (ASCE 7). The Unified Facilities Criteria (UFC 4-152-01) published by the Department of Defense (2005), provide guidelines for the seismic design of piers and wharfs, including design of bulkheads. Because UFC 4-152-01 is one of the few, or perhaps the only, guideline document that includes seismic design of bulkheads (including selection of the design seismic event), it was used as a guideline for selection of the design seismic event for the site.

Based on the Seismic Use Groups (SUGs) defined in the UFC, the bulkheads should be SUG I – “low risk” because the bulkheads could be “out of operation” for some time without significant economic impact. The use of SUG I would result in seismic performance criteria associated with a relatively low seismic hazard. While this hazard is relatively low, the deformation will be limited in the design to maintain interlock integrity and maintain the structural integrity of the wall, considering the risk that if the bulkhead fails or yields significantly, impacted soils or groundwater could be released to the river.

Per UFC 4-152-01, the seismic performance criteria in terms of the level of seismic shaking are based on the Marine Oil Terminals Engineering and Maintenance Standards (MOTEMS), provided in the California Building Code (California Building Standards Commission 2013). MOTEMS defines two seismic performance levels:

- 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
- For “low-risk structures”, this would result in the following selection of design seismic events:
  - Level 1: 75% probability of exceedance in 50 years (return period of 38 years)
  - Level 2: 20% probability of exceedance in 50 years (return period of 224 years).

The most severe design event under MOTEMS is an event with a 10% probability of exceedance in 50 years (corresponding to a return period of 475 years).

For bulkheads, it seems inappropriate to use two levels of seismic performance for design. Controlled inelastic structural behavior or significant seismic deformation could render the bulkhead “unsafe”, particularly for a cantilevered bulkhead. Additionally, considering the relatively low seismicity at the site, the design seismic events suggested by MOTEMS for “low-risk structures” would result in a relatively low seismic hazard for design. Instead of strictly following UFC/MOTEMS, a single-level seismic design will be used for the bulkheads at the site using the following design criteria:

- 10% probability of exceedance in 50 years (return period of 475 years)
- Limit permanent seismic deformation such that the bulkhead remains intact with no need for significant repairs. Deformations will be limited to maintain sheet pile interlock integrity.

This approach will result in a more conservative bulkhead design than using the UFC in conjunction with MOTEMS.

The site class for the site was determined in accordance with ASCE Standard ASCE 7-10. Based on the available SPT resistance data, N-values (H&A 2006, 2011b, 2015a), and cross-hole shear wave velocities (H&A 2011b), the site was classified as Site Class E. The subsequent seismic design parameters are calculated assuming Site Class E.

The seismic hazard associated with the design seismic event was calculated using the 2008 National Seismic Hazard Mapping Project Probabilistic Seismic Hazard Analysis Interactive Deaggregation website (USGS 2013). Approximate coordinates for the new bulkhead are as follows:

- Latitude: 40.996112° N
- Longitude: 73.886377° W.

Site coefficients for adjusting Site Class B spectral accelerations to Site Class E were determined in accordance with ASCE 7-10. The seismic design parameters for the site are presented in the table below.

Probability of Exceedance	10% in 50 years
Return Period	475 years
Mean Moment Magnitude	5.56
Mean Site-to-Source Distance (km)	72.8
PGA –Site Class B (g)	0.03883
S_1 - Site Class B (g)	0.072
Site Coefficient F_{PGA} (Site Class E)	2.5
Site Coefficient F_V (Site Class E)	3.5
PGA - Site Class E (g)	0.0971

Notes S_1 = spectral acceleration at the 1-second period

The spectral acceleration at the 1-second period and Site Coefficient F_V are provided here for completeness. These parameters are used for the calculation of the seismic coefficient for calculation of dynamic active earth pressures.

The seismic stability of the bulkheads and structural demand during strong seismic activity was calculated based on a mix of limit equilibrium analysis and Composite Log-Spiral Method. Values of earthquake-induced active wall loads (P_{AE}) induced by retained soils can be computed from a limit equilibrium stability analysis by calculating the maximum equivalent external load on a wall face corresponding to a safety factor of 1.0. This concept is referred to as the generalized limit equilibrium method. Passive seismic loads will be calculated by the Composite Log-Spiral Method as outlined by Shamsabadi et al. (2007). Both anchored and cantilever wall options were analyzed in accordance with the methodology provided in National Cooperative Highway Research Program (NCHRP) Report 611 (NCHRP 2008) and calculations are provided in Appendix B.

2.9 Backfill and Capping Materials

The basis of design for the backfill materials included the following considerations/assumptions for the PD. Final design will include materials specifications and placement considerations (e.g. compaction) in the technical specifications.

- Lightweight backfill was assumed to be required for the NEA fill construction to mitigate the settlement magnitude (and overall fill volume) of the Marine Silt in the NEA area.
- OU1 excavations are assumed to be backfilled with existing materials as available, deemed acceptable for re-use, removed primarily from sloped shoreline outside of remedial excavation areas, and treated sediment meeting less than 10ppm PCB, pending BUD requirements (discussed in Section 4.14).

- Additional fill materials required to bring OU1 excavations to grade, as well as extend the site to the final developable limits, are assumed to be clean imported general or structural fill (granular material) depending on area of site, free of deleterious materials, suitable for and meeting minimum compacted permeability to not impede groundwater flow (e.g. cause mounding or flooding) at the site after restoration.
- Backfill materials for OU2 will vary from backfill to a multi-layer isolation cap. Additionally, areas that are in depositional zones of the river may be restored to within 12 inches of the pre-removal grade, which will allow restoration via natural means. Determination of depositional zones is underway through a river hydraulic analysis. Results of this analysis also will be used to determine appropriate material types and sizes for both the backfill and isolation cap materials in the FD.

Additionally, the following backfill design assumptions will be included in the FD of backfill materials for the sloped shoreline restoration, discussed in Section 4.8

Acceptable fill placed as part of the sloped shoreline will consist of either clean soils or gravel, stone, or other armoring materials meeting the criteria of Section 3.1(a)(ii) of the CD. “Acceptable Fill” means: (i) soil or topsoil that meets the NYSDEC’s restricted residential use soil cleanup objectives (SCOs) as set forth in 6 NYCRR Part 375-6.4(b)(2) and 375-6.7(d) and NYSDEC Technical Guidance DER-10; (ii) uncontaminated gravel, stone, or other armoring material; (iii) uncontaminated construction and demolition debris from the site consisting of recognizable concrete and concrete products, asphalt pavement, brick, glass, and/or rock or (iv) OU1 soils or OU2 sediments that may be solidified or stabilized and either meet the NYSDEC’s restricted residential use SCOs set forth in 6 NYCRR Part 375-6.4(b)(2) and 375-6.7(d) and DER-10 or are approved by the NYSDEC pursuant to a beneficial use determination pursuant to 6 NYCRR Part 360 and applicable NYSDEC policies. Upland Capping backfill for the site assumes including a minimum 2 feet of cover soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for restricted residential use. The soil cover will be placed over a demarcation layer, with the upper 6 inches of the soil of sufficient quality to maintain a vegetation layer with appropriate natural species.

3 PRE-REMEDIAL ACTIVITIES

ARC and/or its representatives will implement the following pre-remedial activities:

- Preparation of Construction Monitoring Plans
- Preparation of pre-mobilization submittals
- Obtaining appropriate permits and access agreements
- Pre-construction conference.

Additional information regarding each of these pre-remedial activities is provided below.

3.1 Construction Monitoring Plans

Construction monitoring plans will be developed during the FD phase and performed during construction by a third party (i.e. ARC or its subcontractors or assigned agent approved by NYSDEC), independent of the Remedial Contractor. The Selected Remedial Contractor will be provided with these plans and be obligated to adhere to the performance, environmental management and corrective action requirements specified in these plans. The construction monitoring plans include the following deliverables prepared in accordance with DER-10:

- Remedial Action Monitoring Plan (RAMP) generally will include:
  - Real time turbidity monitoring during sediment dredging
  - Regular inspection of turbidity and habitat protection controls
  - Regular monitoring and inspection of storm water management and pollution prevention controls
  - Construction treatment water discharge quality
  - Construction performance inspection and monitoring
  - Limits and corrective actions
  - Sampling and analysis procedures
  - Reference to applicable quality assurance/quality control plan for environmental sampling
  - Data reporting methods and data access
  - Reference to separate required monitoring plans
- Community Air Monitoring Plan (CAMP)
  - In accordance with the requirements of the New York State Department of Health (DOH), a Community Air Monitoring Plan (CAMP) will be prepared. The purpose of the CAMP is to monitor for airborne contaminants (i.e., PCBs, volatile organic compounds (VOCs), respirable dust) released from the Site as a direct result of the remedial actions. The CAMP for remedial construction will be consistent with NYSDEC/NYSDOH-approved and implemented CAMP for the RDWP activities and the recent demolition of Building 52.

- Community and Environmental Response Plan (CERP) will address monitoring or work practices to address the potential for short-term impacts to the surrounding community or environmental resources. The CERP generally will include:
  - Public protection, signage and site security
  - Odor, vapor and dust mitigation, control, and monitoring
  - Construction noise mitigation and monitoring
  - Construction traffic management
  - Waste management and transportation
  - Community Air Monitoring: The CAMP, to monitor airborne contaminants, will be referenced in the CERP
- HASP: A plan applicable to all onsite work, with safety protocols for authorized visitors. Contractors, construction managers and consultants will prepare their own HASP for their respective work tasks to meet the specifications outlined in Site HASP and bid documents as specified in the FD.

Additional technical performance plans to be prepared for inclusion with the FD include a Construction Quality Assurance Project Plan, Performance Monitoring and Inspection Plan and storm water pollution prevention plan (SWPP)

3.2 Preparation of Pre-Mobilization Submittals

The selected Remedial Contractor (Contractor) will be required to prepare certain pre-mobilization submittals. The purpose of these submittals is to gauge the Contractor's understanding of the FD and its construction, objectives, procedures, and outcomes, and to identify potential misunderstandings and provide clarifications before the start of remedial action construction activities. The Contractor will not be allowed to mobilize to the site before review and approval of all required pre-mobilization submittals.

These submittals generally will include the following:

- *Site Operations Plan* – The Site Operations Plan will present the Contractor's detailed approach for implementing pertinent work activities (incorporating, as necessary, specifications, site maps, details, flow diagrams, charts, and schedules), including contingency measures required by the Technical Specifications (Appendix C).
- *HASP* – The Contractor will be required to prepare and submit a project-/site-specific HASP (for use by the Contractor's onsite personnel during remedial action construction activities) to provide a mechanism for establishing safe working conditions at the site. The HASP will be prepared in accordance with all applicable rules and regulations, including Parts 1910 and 1926 of Title 29 of the Code of Federal Regulations (29 CFR 1910 and 29 CFR 1926), and will be certified by a Certified Industrial Hygienist. The Contractor is required to take all necessary precautions for the health and safety of all onsite Contractor employees in compliance with all applicable provisions of federal, state, and local health/safety laws and the provisions associated with the HASP. The Contractor will assume sole responsibility for the accuracy and content of its HASP.

- *Contingency Plan* – The Contractor's Contingency Plan will detail (at a minimum) the following procedures for emergency preparedness and contingencies: emergency access/egress, emergency evacuation of personnel from the work site, and methods to contain gasoline/diesel fuel or hydraulic oil spills. The Contingency Plan also will include a listing of all contact personnel and emergency phone numbers. Construction-related contingencies will be included in the Contractor's Site Operations Plan.

Additional information regarding the required contents of these submittals and overall submittal process will be presented in the FD, specifically in the technical specifications and CERP. Once reviewed, select pre-mobilization submittals will be provided to NYSDEC for review. Other submittals required before Contractor mobilization will be coordinated with the Contractor.

3.3 Permits and Authorizations

Certain federal, state, and local permits and other authorizations will be required for the implementation of the remedial action. A table summarizing these permits and other authorizations, based on a review of pertinent local, state, and federal regulations, will be included in the FD. ARC will obtain applicable permits, except those required to comply with local ordinances, which will be obtained by the Contractor.

The remedial action will be designed to comply with applicable federal, state, and local laws; regulations; requirements; and SCGs applicable to the site. Permits or other authorizations necessary to implement the remedial program, or for which the permit exemption provision of DER-10, Section 1.10 apply, will be identified in the PD and FD, as well as with any information necessary for demonstrating compliance with the substantive permit or other authorization requirements.

Permits (or authorizations) currently identified for consideration during the design are:

1. Joint Permit Application (JPA). A JPA will be made that addresses requirements of the USACE, National Marine Fisheries, and the New York State Department of State. Initial discussions will continue following approval of this PD Report.
2. State Pollutant Discharge Elimination System (SPDES) equivalent or Publicly Owned Treatment Works (POTW). Construction dewatering effluent will be discharged either to the Hudson River or to the POTW. Once the discharge is determined during the review of the PD, the appropriate submittals will be initiated.
3. General Permit for Stormwater Discharges from Construction Activity under SPDES program.
4. Resources. The substantive technical requirements of applicable resource-related permits (e.g., 6 NYCRR Parts 608, 661, 663) will be identified and appropriate submittals will be initiated.
5. Permit Exemptions. Exemptions from the following permit programs will be reviewed as described in DER-10, Section 5.1(c)(6):
    - Air – Title 5 permits - Not applicable
    - Air – State permits - Not applicable
    - Air – Registrations - Not applicable
    - Ballast Discharge - Not applicable
    - Chemical Control - Not applicable

- Coastal Erosion Hazard Areas - Joint Permit Application will address
- Construction of Hazardous Waste Management Facilities Not applicable
- Construction of Solid Waste Management Facilities-Not applicable
- Dams – Not applicable
- Excavation and Fill in Navigable Waters (Article 15) - Joint Permit Application will address
- Flood Hazard Area Development - Joint Permit Application will address
- Freshwater Wetland - Joint Permit Application will address
- Hazardous Waste – Applicable for generation, storage, transportation and disposal
- Long Island Wells - Not applicable
- Mined Land Reclamation - Not applicable
- Navigation Law – Docks - Joint Permit Application will address
- Navigation Law – Floating Objects- Joint Permit Application will address
- Navigation Law – Marinas - Joint Permit Application will address
- Non-Industrial Waste Transport - Applicable for generation, storage, transportation and disposal
- Operation of Solid Waste Management Facilities - Not applicable
- Operation of Hazardous Waste Management Facilities
- SPDES- Permit Equivalency Required (as noted above)
- Stream Disturbance - Joint Permit Application will address
- Tidal Wetlands - Joint Permit Application will address
- Water Quality Certification - Joint Permit Application will address
- Water Supply – Not applicable
- Wild, Scenic, and Recreational Rivers - Joint Permit Application will address.

6. TSCA. The USEPA will be consulted with respect to TSCA.

The Contractor must meet the requirements of applicable environmental permits and/or regulations, and all other permits that may be required under local jurisdictions. All appropriate permits must be maintained, and a copy must be at the site throughout the duration of the project.

ARC will be responsible for obtaining access agreements with affected property owners. The Contractor will be expected to abide by provisions of the access agreements once in place.

4 REMEDIAL ACTIVITIES

This section describes the PD associated with the remedial activities to be performed for both OU1 and OU2.

4.1 Construction Sequencing

The work will be sequenced/phased based on the Contractor's approach, design constraints, and in consideration of weather/climatic conditions and any permit requirements or other regulatory conditions. The PD has assumed the following construction sequencing:

- Erosion and sedimentation control and resuspension control installation for nearshore dredging.
- NEA construction and Deepwater Area dredging/backfill during schedule TBD for fish window
- Nearshore dredging/isolation cap and sloped shoreline
- Upland excavation and backfill
- Upland capping and final site restoration.

One additional constraint that will be considered in the FD is the likelihood of a seasonal restriction on in-water activities outside of contained areas (i.e., inside the bulkhead wall or turbidity curtain) for protection of aquatic wildlife. Potential biological impacts resulting from remedial construction, particularly regarding fish habitat, are being assessed separately. A Biological Assessment and Essential Fish Habitat Assessment have been initiated in support of further design and permitting. Further discussion of these studies and their effects on remedial activities, cost, and schedule will be included in the FD. The restrictions will be determined as part of the FD and permitting process.

While the general construction sequence is provided above, analysis of the bulkhead sections and minimum wall requirements was completed during preliminary design assuming a construction sequence to minimize pressures on the proposed bulkhead and allow for ease of installation. Construction of the NEA is assumed to proceed with the following sequence:

- Install cantilever steel sheet pile wall along the bulkhead alignment.
- Dredge down to 6 feet below sediment surface (bss) in areas with impacted sediment on the river side of the bulkhead.
- Backfill dredged areas.
- Excavate upland areas and backfill to grade. Anchor wall will be installed during backfilling.
- Fill behind sheet pile wall with lightweight aggregate to facilitate tieback installation.
- Pre-loading and consolidation of Marine Silt within the NEA fill area (including installation of wick drains or other as determined necessary during the FD)
- Install tie-rods connected to anchor wall on existing upland portion of the site.
- Fill behind bulkhead to proposed final elevation with lightweight aggregate (to be specified in the FD).

Additional construction sequence considerations that will be evaluated during the FD will also include consideration of the consolidation estimate and timing for the NEA and potential installation of additional engineering controls before tieback anchor installation.

4.2 Mobilization and Site Preparation

Existing conditions at the site are provided on Drawing G-2. Prior to initiating construction activities, pre-construction survey data, particularly updated bathymetry, will be collected. Due to the nature of past site activities and demolition of above-grade structures, including the recent demolition of former Building 52, minimal overall subgrade preparations are needed to support site improvements for construction. PD of anticipated site preparation features is provided on Drawing C-1 and includes but is not limited to the following:

- Improving access to the site from the east along River Street at the former Building 52 area. The existing Westchester County pump house (aka lift station) will be protected and avoided. This area will serve as the main construction entrance to the property.
- Construction of lined and unlined gravel access roads for construction traffic across the site. Access roads where impacted materials may cross unimpacted areas, impermeable liners will be included in the access road design for collection of impacted soil or water from activities and will include the appropriate exclusion and contaminant reduction zones.
- A decontamination pad, anticipated to be gravel lined with impermeable liner to allow for collection of decontamination water generated, will be located near the construction entrance to facilitate cleaning of truck traffic that enters and exits the site. The PD has assumed that the primary method of sediment and soil transport will be by barge offloading; therefore, truck decontamination is not expected to be frequent.
- The construction support area is anticipated to be placed over the existing former Building 52 footprint and will provide areas for parking and support services (e.g. trailers).
- Several designated pads will be constructed across the OU1 area (tied into the proposed access roads) to support construction activities and include:
    - Soil staging and dewatering pads in proximity to both the northern and southern excavation areas. Material processing pads are anticipated to be constructed using asphalt or gravel and impermeable liner, and final details will be provided in the FD.
    - Water treatment pad to support water treatment and discharge activities.
- Construction of temporary docks for barge off-loading and load-out, assuming barge transportation from the site, and/or other facilities required based on the Contractor's means and methods. Construction of temporary docks for barge off-loading and load-out is assumed in the PD based on evaluation of available disposal options and will be determined based on the means and methods of the Contractor.

In addition to site preparation activities shown on Drawing C-1, preliminary erosion and sediment control locations are shown on Drawings C-2 and C-3. Due to the existing surfaces at the site, and minimal existing ground disturbance outside of remedial excavation areas, the erosion and sediment controls for the site include reinforced silt fencing, stabilized construction entrances, and drop inlet protection. PD details for each item are shown on Drawing C-4.

4.3 Shoreline Demolition and Riprap Removal

The areas along the shoreline consist of known debris and existing structures of varying condition, primarily consisting of timber piles and reinforced concrete and sheet piling. In accordance with the BOD, and described further in Section 4.15, the shoreline will be restored to a 3:1 sloped shoreline condition along the entire length of the site outside of the NEA. To support sloped shoreline construction, demolition of these structures is anticipated to be performed. Preliminary demolition sections showing these structures and debris along the site shoreline are shown on Drawings C-5A to C-5E. Due to the nature of the debris along the shoreline and in the nearshore area, and the lack of detail required for defining the scope of work, including anticipated volume/tonnage of demolition and surveyed extents of specific shoreline items, a detailed pre-construction survey of the shoreline and nearshore areas and associated demolition is anticipated to be performed prior to construction.

During nearshore dredging, it is assumed that other debris that will be encountered may include woody debris, scrap metal, rubbish, and other items typically found in an industrial waterway. Based on the quantity of debris anticipated, the Contractor will perform debris removal concurrently with dredging and sloped shoreline operations. Debris will be separated on the barge and disposed properly.

Shoreline demolition is expected to be performed during and following completion of near shore dredging within the resuspension controls. Following demolition of shoreline structures, the near shore dredge will continue into the 3:1 sloped shoreline area required for restoration. Demolition of structures is only anticipated above the final slope as shown on Drawings C-5A to C-5E. Further details on the sloped shoreline restoration are provided in Section 4.7.

4.4 Site Utilities

According to site records, below-grade potable water and gas utilities supplying the site were terminated at the property line in 2009. Electric service and telecommunications will be terminated at the property line as part of the remedial actions.

The proposed utility demolition and reroute plans and details are shown on Drawings C-6 through C-8, and are summarized below:

- At remediation project completion, existing onsite storm drains, abandoned water lines, and abandoned sanitary sewer lines will be decommissioned. Portions of decommissioned onsite utilities within excavation areas will be removed, but remaining portions outside excavation areas will be left in place. Pipes will be sealed, and manholes and catch basins abandoned in place. Outfalls discharged at the shoreline will be terminated and sealed at the bank or limit of sloped shoreline as applicable.
- Former Building 52 outfalls 5, 4, 3, 3A, and 1, investigated during the PDI, will be removed during remedial construction. Only portions of Outfall 2 within remedial excavations will be removed (H&A 2015a) pending additional investigation results (planned for 2017) in the former trailer area.
- The Westchester County sanitary sewer pipeline (located on the east side of former Building 52 that serves adjacent property owners to the north and conveys flow along the eastern property line of the site to the sanitary sewer pump station) will be retained and continue operation during and after remediation project completion. This sanitary sewer is located on the site between the retaining wall

that holds up the ramps to the bridge and the existing former Building 52. The existing manhole top sections and covers will be repaired and replaced with risers as required to match new grade. Any changes will be coordinated with Westchester County.

- The Westchester County sanitary sewer pump station is located approximately 350 feet south of the site entrance bridge (W. Main Street). This pump station will be retained and continue operation after remediation project completion. No modifications to the pump station are planned. Coordination with Westchester County will include:
  - Removal and replacement of line in upland excavation areas
  - Temporary bypass of line during upland excavation
  - Work on the overflow line required to repair current broken portions
  - Final grades around pump station
  - Utility corridors
  - New outfall from the pump station to the Northern boat slip, permitted by Westchester County

  Additional access requirements have not been coordinated at this point in the design.

The Westchester County pipelines will be subjected to additional overburden fill due to the requirements for elevation changes and cover soil placement, and potential settlement and pipe deformation will be calculated during the FD.

Westchester County also has a 12-inch clay sanitary sewer line that traverses the site from the southern end and exits on the eastern site boundary approximately 1,100 feet north of the southern end of the site. This sanitary sewer line is proposed to be decommissioned and replaced in a future “utilities corridor” defined on the site along the eastern site boundary from where the sewer enters the site on the southern boundary. The new sewer line will include new manholes, and approximately 980 feet of new pipe. These changes will be coordinated with Westchester County.

The Village is responsible for operating and maintaining two storm drains and the Hastings Creek conduit, which traverse the site from east to west. The following changes, as described by H&A (2006) will be evaluated and coordinated with the Village, and preliminary locations for rerouted pipes are shown on Drawings C-6A and C-7A:

- The northern 18-inch reinforced concrete pipe (RCP) storm drain originates at the Westchester County sanitary sewer pump station and discharges to the Hudson River approximately 30 feet north of the North Boat Slip. Utility survey of the discharge from the pump station indicates that portions are broken. Before construction of the NEA, the pipe will be rerouted to the south and discharged into the North Boat Slip. Replacement of this line will be coordinated with the Village and Westchester County. The new discharge will include new manholes, and approximately 420 feet of new pipe will be needed to route the pipe around the Northern OU1 excavation areas.
- The southern 18-inch steel storm drain originates approximately 400 feet south of the Westchester County sanitary sewer pump station and discharges to the Hudson River approximately 150 feet south of the North Boat Slip. This pipe conveys stormwater from the Village’s system across the site to the Hudson River. This pipeline is planned to be decommissioned with the excavation areas and sloped shoreline and then rerouted 45 feet north of the existing outfall. Approximately 475 feet of

new pipe will be needed. This pipeline will be subjected to additional overburden fill due to the requirements for cover soil placement.

- The southern 10-inch cast iron storm drain originates approximately 390 feet south of the Westchester County sanitary sewer pump station and runs approximately parallel to the 18-inch steel sanitary storm drain line and discharges to the Hudson River approximately the same location 150 feet south of the North Boat Slip. This pipe conveys stormwater from the Village's system across the site to the Hudson River. This pipeline is planned to be decommissioned with the excavation of the sloped shoreline and then rerouted 55 feet north of the existing outfall. Approximately 475 feet of new pipe will be needed. This pipeline will be subjected to additional overburden fill due to the requirements for cover soil placement.
- The Hastings Creek Conduit originates south of the Westchester County sanitary sewer pump station and discharges to the Hudson River. The conduit was confirmed by H&A to be a 48-inch RCP that has two onsite manholes. Due to the conduit's age, condition, relatively shallow existing overburden soil, and the need to place additional cover soil over the conduit, it is planned that the conduit will be replaced during the remediation project.
- A northern 30-inch RCP storm drain was identified from review of historical investigations, and the utility mapping and inspection completed as part of the PDI Report (H&A 2015). The drain originates near the Westchester County sanitary sewer pump station and discharges to the Hudson River at the northern edge of the North Boat Slip. This line is 30 inches in diameter where it enters the eastern site boundary and discharges to the river. The pipeline changes to two 30-inch pipes running parallel for 300 feet in the center of the site before combining into one 30-inch outfall at the river. A 50-foot portion of the existing storm drain pipe system will be removed during completion of excavation area N-4, including a portion of the dual 30-inch lines. Due to the age and condition of the line however, A new discharge line will be re-routed into the north boat slip and include approximately 415 feet of new line.

Rerouted pipelines will likely be subjected to differential settlement due to consolidation of the marine silt from restoration conditions (e.g., additional fill) in OU1 and will likely be handled with pre-loading or other engineering controls to mitigate the long-term effects. These details will be provided in the FD.

At remediation project completion, existing onsite storm drains, and sanitary sewer lines will be decommissioned. Portions of decommissioned onsite utilities within excavation areas will be removed, but remaining portions outside of excavation areas will be left in place.

Existing gas and water lines entering the site have been previously decommissioned (H&A2015a), however the Contractor will encounter these lines within OU1 excavation areas, and will be removed during excavation activities where encountered.

4.5 Operable Unit 1 Excavation

4.5.1 Soil and Debris Excavation

Excavation of approximately 60,800 cy of upland soils and demolition of approximately 10,000 cy of structures and debris at the site is shown on Drawings C-10 through C-13. Removal depths were

provided in the PDI Report, but to allow for efficient excavation and the use of global positioning system (GPS) machine controls on vertical excavation, it is preferred that excavation be based on elevation. Bottom elevations of excavations were determined by offsetting the elevations shown on PDI Report Figure 3.1A by the proposed removal design depth on Figure 4.2A/B/C (H&A 2015a). These elevations were compared to soil boring elevation data, where available, and removal elevations adjusted if required.

The OU1 ROD requirement to excavate surface soil (0 to 12 inches) containing greater than 1 ppm PCB will be met, alternatively, by installation of the 2-foot cover system. Soils beneath the cover system may contain up to 10 ppm PCB concentrations.

Based on high and low water level data, shallow OU1 excavations will be completed to depths of up to 4 feet along the shoreline and 6 feet in the eastern portion of the site using traditional excavation equipment (NYSDEC 2012a).

At the northwestern corner of the site and along the northern shoreline, subsurface soil containing greater than 10 ppm PCB will be excavated to a maximum depth of 9 feet for the OU1 remedy (NYSDEC 2012a). To excavate to this depth near the existing shoreline in the northwestern corner, and to manage water during excavation, a temporary proposed barrier wall likely consisting of a cement-bentonite mix and/or sheet piles will be installed around excavation N-4 and will be tied into the Marine Silt layer to minimize groundwater infiltration into the upland excavation areas. The extents of excavation N-4 are shown on page C-13 (Appendix A). The wall will be keyed into the marine silt. Due to constructability considerations installing the hydraulic barrier, specifically equipment limitations, some offset from the existing limit of removal will be needed to install the barrier. Due to this, an area of N-4 along the bank, outboard of the barrier, will be dredged in the wet as part of nearshore dredging. This approximate area is shown on Drawing C-13. Final details regarding additional measures for sloping/supporting excavation areas that may be needed to perform dredging in this area will be provided in the FD.

Additional temporary barrier walls (ex. sheet piles, slurry walls, etc.) will be evaluated during the FD to also help control groundwater and side slopes where determined necessary elsewhere onsite. These walls may also allow control of dewatering extents and facilitate excavation near the pipeline at the southern and northwestern areas in isolation. Temporary barrier walls installed to mitigate groundwater infiltration or support OU1 excavation will be penetrated or otherwise sufficiently broken up post-construction to not adversely affect any groundwater flow in the area after construction. Details for this will be provided in the FD after completion of additional groundwater modeling.

Upland excavations east of the northern shoreline area (excavation area N-4) will be completed to a maximum depth of 12 feet, as shown on Drawing C-13. To finalize excavation limits, additional pre-excavation delineation is planned for 2017in select areas which primarily include the former jobsite trailers area, former Building 52, and former Building 17.

Shallow 2-foot excavations will be performed to remove identified lead hotspots, which correspond to lead levels between 2,160 ppm and 43,200 ppm on the southern portion of the site. In area L-1, this excavation area overlaps PCB excavations, and this material will be segregated for waste management.

4.5.2 Dewatering

Dewatering at the site will be supported by installation of hydraulic barrier walls where determined necessary from groundwater modeling to mitigate groundwater infiltration during excavation activities in

OU1. The Contractor will propose and implement an excavation dewatering approach for excavating soil below the water table. Dewatering is anticipated to be necessary to complete OU1 excavations in certain areas. Dewatering will be included in the FD/construction where required for the design (e.g. NEA area); however, final dewatering means and methods will be submitted by the Contractor and will be limited to the extent needed to complete the required excavation.

Groundwater modeling during the PD was focused on calibrating the existing H&A model and modeling the NEA (Section 4.9) for modeling groundwater flow in the NEA area and potential treatment gate placement. Additional groundwater modeling will be performed during the FD to support dewatering evaluation and development of details of the proposed dewatering system that will be developed by the Contractor in accordance with performance specification requirements to be provided in the FD. The dewatering approach will include a dewatering method (such as a groundwater well point system and/or a sump network located within the excavation), pump sizing/flow rate, and proposed piping type/sizes for transporting water to the temporary water treatment system to support construction and treatment of water generated during construction, discussed in Section 4.6.

Precipitation and stormwater runoff that collects in excavations will be extracted (as necessary) and treated/discharged with the water generated by excavation dewatering activities. Perimeter grading/controls will be maintained around excavation areas to minimize the amount of stormwater surface runoff entering excavation areas. Surface drainage diversions will include rerouting of roof drain piping that discharges to the rail siding area and use of berms or other measures to limit flow of water to excavation areas.

4.5.3 Backfill of OU1

As discussed in Section 2.9, backfill of the OU1 area will be required to bring the site back to grade after remedial excavation, as well as to support restoration discussed in Section 4.7 below. Expected fill volumes are provided in Section 7.1. The anticipated fill material requirements (e.g. gradation) and placement requirements for the OU1 area will be provided in the FD. It is anticipated that fill materials to be used to backfill the OU1 excavations be comprised of the following materials:

- Concrete debris generated during excavation activities or shoreline demolition, demolished and sized to less than 24” maximum size (subject to BUD approval, as discussed in Section 4.14).
- OU1 soils, free of deleterious materials (e.g. organics, non-inert debris) that are removed outside of the remedial excavation limits as part of shoreline restoration.
- OU2 sediment treated and exhibiting total PCB less than 10 ppm (subject to BUD approval, as discussed in Section 4.14).

Following the backfill of OU1 excavations, a minimum 2 feet of cover soil), where required, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for restricted residential use, will be completed as part of the Upland capping. The soil cover will be placed over a demarcation layer, with the upper 6 inches of the soil of sufficient quality to maintain a vegetation layer with appropriate natural species. Approximately 150,000 cy of imported backfill will be placed and graded to facilitate final developable elevations in OU1.

4.6 Temporary Water Treatment

A water treatment system will be required to remove suspended solids, PCBs, and select metals from groundwater pumped from excavation areas, dewatered sediment and excavated soils, and during sediment offloading activities. As outlined in the PD, treated water from dewatering and groundwater collection will be discharged to the Hudson River via an existing outfall (to be determined), under a SPDES-equivalent permit. Monitoring/sampling will be performed in accordance with applicable permit requirements to confirm treatment is achieving required SPDES equivalence discharge limits requirements.

The treatment approach was developed based on the results from the bench-scale testing presented in Groundwater Treatment Study Pre-Design Study (H&A 2016). Bench-scale testing evaluated filtration, carbon adsorption, and metals precipitation via pH adjustment of both groundwater and water from filter pressed sediment. Water was bench-tested individually for each treatment component and then the combined groundwater and sediment pore water was tested in a full simulated treatment train. Based on the bench-scale testing, the following treatment system components are proposed. The proposed components also are shown on Drawing C-23 (Appendix A).

- Influent Equalization/Settling Tanks: Water will be pumped from the work area to several influent tanks that will serve to provide flow equalization and removal of settleable solids for initial reduction of total suspended solids (TSS). The number of tanks will be determined based on the work sequencing and expected flow rate/volumes from specific work areas.
- Oil-Water Separator (OWS): An OWS will function to remove light non-aqueous phase liquid and further reduce TSS.
- Metals Precipitation System: A pre-packaged metals precipitation system will provide metals removal by hydroxide precipitation via pH adjustment.
- Bag Filter System: Following metals precipitation treatment, step bag filters will be utilized for removal of TSS before granular-activated carbon (GAC) treatment. A variety of filter bag housing configurations are available and will be determined by the Contractor in accordance with performance-based technical specifications that will be prepared during the FD.
- Liquid-Phase GAC System (LPGAC): LPGAC adsorption units will be utilized for dissolved phase PCB removal. These units come in various sizes and configurations and will be sized based on expected flow rate and required Empty Bed Contact Time.
- Final pH Adjustment: Automated in-line pH adjustment will be performed as required to meet effluent pH discharge requirements.
- Final Polish Bag Filter System (as determined to be necessary from water quality sampling): A bag filter unit with low micron (e.g., 1 micron or smaller) bags/cartridges will provide final polishing of treated water from the LPGAC units, for removal of remaining low micron solids and PCBs potentially attached to those solids. While the prior treatment steps will remove the majority of TSS, a final filtration step may be included meet the final discharge requirements.

Treated Water Holding Tanks: Treated water will be stored prior to discharge to allow effluent testing, if required, and to provide capacity for potential upset conditions. Construction of temporary water

treatment system proposed above and included in this PD is based on data currently available and will be provided to the remedial contractor who will finalize the components of the system to meet the SPDES discharge criteria.

4.7 Sloped Shoreline and Restoration

Restoration conditions were developed in accordance with the CD, and a preliminary restoration and final grading plan is provided on Drawings C-16 and C-17. Outside of the NEA, a Sloped Shoreline will be constructed with a cover system. The Sloped Shoreline cover system will be designed and constructed, such that no additional fill material will be placed into the Hudson River and will require the removal of sediment or fill below the current sediment or water elevation. The sloped shoreline cover system will be designed with the following layers: an isolation layer of soil or geotextile designed to prevent the migration of contaminated soil particles into the Hudson River, an erosion protection layer, and a habitat/surface substrate layer. The habitat/surface substrate layer will be designed to restore aquatic, intertidal, and stream bank habitats while considering erosional forces, such as waves and currents (NYSDEC 2012a).

Per the CD, a portion of the sloped shoreline area will be designed for use as a 30-foot-wide walkway and will be graded such that the walkway grade is substantially flat. The walkway location and grade elevations will be included in the FD.

The grading plan included in the PD provides for an elevation of +11 throughout the Developable Portion of the site, defined as the area upland from approximately 80 to 100 feet from the mean low water mark (but not to exceed 110 feet from the mean low water mark) (and approximately 60 to 70 feet from the mean low water mark along the Northern Boat Slip and Southern Boat Slip), and running from the southern end of the Northwest Corner bulkhead to the Southern property boundary, inclusive of the vegetated surface layer. The sloped shoreline takes reasonable account of the possibility that some of the Developable Portion of the site (or of the base of buildings constructed on the Developable Portion of the site) may subsequently be raised to an elevation up to +14.

Acceptable Fill placed along the shoreline will be sized and placed to provide for slope stability, protect against erosion, and allow for habitat restoration to the extent practicable. The sloped shoreline will include a riparian vegetated buffer and additional vegetative buffer that could be further installed near the sloped shoreline/Developable Area interface.

For the OU1 area restoration, a permeable demarcation layer consistent with the approved remedial design, which may consist of either a layer of synthetic material, such as Geogrid, a demarcation snow fence, or another suitable material, will be placed wherever a soil cover is placed after placement of Acceptable Fill per the 2012 OU1 ROD and CD. The uppermost 6 inches of clean soils placed on the Developable Portion of the site will consist of a 6-inch layer of topsoil that will be seeded, fertilized, and maintained to reduce sedimentation and erosion.

It is assumed that any facilities required for groundwater remedial system OMM (if determined necessary after DNAPL investigation) will not be prohibited from construction within 60 feet of the coves and/or within the northwestern corner of the site.

The general elevations and grade changes for the site are presented on Drawings C-16 and C-17 (Appendix A).

4.8 Habitat Mitigation

Compensation for the natural resource impacts within the Hudson River, associated with the construction of the NEA, is required as part of the Remedial Action. Currently, 0.87 acre of tidal wetlands, classified by the State Tidal Wetland Map as Littoral Zone, has been estimated to be impacted during the construction of the NEA. Discussion with the DEC and stakeholders indicate that the compensation for impacts will likely involve tidal marsh creation and the creation of a vegetated slope located immediately adjacent to much of the Hudson River bordering the site. Numerous concepts and approaches have been developed and are being vetted by the design team with regards to feasibility, ability to integrate the mitigation with the other components of the Remedial Action, and effects on future land use. On October 4, 2017, a mitigation meeting was held on-site with the NYSDEC to gain further insight on NYSDEC's mitigation expectations, limitations, and regulatory interpretations.

Design criteria for tidal marsh creation have been conceptually identified, such as the targeted marsh platform elevations, planting densities, and the tidal marsh tie-ins to uplands grades and the Hudson River. Design elements, including mitigation size (i.e., mitigation ratios) and the specific on-site footprint of the mitigation area(s), are still being negotiated with the NYSDEC. A final mitigation package will be developed as part of the FD

4.9 Northwest Extension Area

In the existing Northwest Corner Offshore Area, where the full depth of sediment contamination cannot be feasibly excavated without destabilizing the shoreline, the selected containment of the area using sealed sheet piles provides the greatest degree of long-term effectiveness by containing the material with the highest levels of PCBs. This extension also enables the more effective removal of potential liquid PCB material from the source area beneath the Northwest Corner Onshore and Northwest Corner Offshore areas by creating a land platform to support additional investigation and potential removal activities. The sheet piles will be driven along an alignment that is known to be free of liquid or semi-solid PCBs, confirming that drag down or migration of PCBs into the clean Basal Sand aquifer will not occur (NYSDEC 2012b). The alignment selected in the PD is based on findings from the approved PDI Report with clearing the alignment shown on S-1 per the OU2 ROD (H&A 2015a)

To meet the requirements of Article 15 and 6 NYCRR Part 608, the NEA bulkhead wall alignment will be placed to minimize filling of the Hudson River while still meeting the remedial goals. The proposed alignment is shown on Drawing S-1 and was selected to be along the toe of the riprap slope to facilitate driving of the piles and due to slope stability concerns in attempting to remove the riprap. The volume of fill needed behind the wall will be based on the final approved bulkhead alignment. The proposed NEA, as identified by the NYSDEC in their public presentation of the 2012 OU2 ROD (NYSDEC 2015), is shown on Drawings S-1 through S-10. The final alignment was approved by NYSDEC (NYSDEC 2017a; 2017b).

Although the final alignment will be supported by PDI mapping to minimize contact with existing riprap or other sheet pile obstructions, potential pre-clearing or trenching may be required if additional obstructions are observed during pile driving.

The northwest extension bulkhead wall will consist of sealed 50 ksi AZ 17-700 and AZ 46-700N steel sheet piles, 35 to 79 feet in length and will be supported by 81- to 104-foot-long, 1.75-inch to 2.25-inch-

diameter steel tieback anchors that will be connected to an AZ 17-700 anchor wall. These components are shown on Drawings S-2 through S-4.

The area behind the wall will be filled to an elevation that rises to meet the final restoration conditions shown on Drawings C-16 and C-17. Approximately 24,000 cy of lightweight fill will be used to fill the area behind the wall to reduce the loading on the bulkhead and settlement of the Marine Silt layer after construction of the NEA. The wall will also include cathodic protection for corrosion resistance and outlets for groundwater filtration units installed on the upland side of the wall for the adsorption of potential groundwater contaminants before discharging into the Hudson River.

Final ground surface elevation of the bulkhead and northwest extension outboard of the existing shoreline will be designed assuming to be at +6 feet NAVD88, approximately 4 feet above the mean high water (MHW) elevation (based on 1983 to 2001 national tidal datum epoch and NOAA Station 8530095), a 19-year National Tidal Datum Epoch with the ground surface benching up near the existing shoreline to +8 feet NAVD88 for the 2.5-acre Open Space area (30 feet wide and within 110 feet of MLW mark) and additionally sloping up to +11 feet NAVD88 at the boundary of the Developable Portion of OU1. These elevations and site areas are described in the 2016 CD, and general and proposed boundaries are shown for various alternatives on the attached figures.

Within the NEA, the backfill will likely consist of man-made lightweight fill within the area behind the extension bulkhead and up onto the upland, a far enough distance to reduce the loading on the bulkhead and settlement of the Marine Silt layer after construction of the NEA. In the remaining portion of the northwestern corner, acceptable fill will be backfilled within the upland excavation areas of OU1 and a minimum 2 feet of cover soil, where required, with a demarcation layer and upper 6 inches of the soil of sufficient quality to maintain a vegetation layer with appropriate natural species. The material requirements for both the lightweight fill and any other fill to be used in the NEA area will be provided in the FD technical specifications.

The design life of the replacement bulkhead is 100 years, including structural and cathodic protection.

4.9.1 Bulkhead Extension Funnel and Gate Treatment System

Upon completion of the bulkhead extension, an investigation will be performed to delineate the potential DNAPL within the NEA. Based on the results of the investigation, a remedial action plan will be submitted to NYSDEC. To address the potential for impacted groundwater being discharged to the Hudson River treatment gates(s) will be installed to treat groundwater passing through the NEA before entering the Hudson River. The proposed method of collection and treatment, is as follows:

- The sheet pile wall system will include sealed joints to contain and funnel groundwater to treatment gates within the wall system for passive filtration units that will adsorb/treat contaminants.
- These treatment gates will be designed to treat potentially PCB-impacted groundwater from the NEA as necessary.

The gate placement along the extension alignment is shown on S-4 in the north and southeastern corner of the NEA, and was based on preliminary groundwater modeling results provided in Appendix B. Final gate location and dimensions will be determined during the FD and after completion of the hydrodynamic and additional groundwater modeling. At this time, it is assumed the treatment media will consist of

activated carbon to remove the potential of dissolved-phase PCBs (H&A 2016, 2015b), however other media will be evaluated as part of the FD.

To determine the necessity of treating groundwater passing through the NEA before entering the Hudson River, groundwater quality monitoring will be performed on the water before and after the treatment gates. Based on the results of the monitoring a determination for continued treatment will be performed. A monitoring plan for the groundwater passing through the NEA, will be prepared as part of the FD.

4.10 Dense Non-Aqueous Phase Liquid Investigation in Northwest Extension Area

Upon completion of the bulkhead extension, an investigation will be performed to delineate and further evaluate the presence/absence of DNAPL within the NEA. Based on the results of the investigation, a remedial action plan will be submitted to NYSDEC.

4.11 Sediment Removal and Isolation Cap

Sediment generally will be removed to depths ranging from 2 to 6 feet bss based on conditions at the time of sampling, from the Nearshore Area, Offshore NEA, and Deepwater Area in accordance with NYCRR Part 608. The actual removal limits have been defined as elevations based on sample data and site bathymetry (Appendix A). It is currently anticipated that removal of sediment will be performed in the wet using GPS-guided mechanical dredging equipment with an allowable overdepth of 6 inches; however, final methods will be determined by the Contractor. Overdredging and guidance system requirements will be detailed in the technical specifications, which will be included in the FD (Appendix C). It is assumed based on experience with similar material that dredging cannot occur at a steeper cut that 2:1 (horizontal:vertical); however, this assumption will be assessed further in the FD. Dredged sediment will be transported to an onsite staging area for processing and eventual transport offsite for treatment/disposal. A potential staging area layout is shown on Drawing C1 (Appendix A), although the actual layout will be determined by the selected Contractor. If riprap removal is necessary in nearshore areas, the riprap will be stockpiled for potential reuse. Following completion of removal activities, clean river backfill and capping materials will be placed over the dredged area. Immediate backfill of completed dredge areas is not required; however, the Contractor will be required to backfill open dredge areas prior to demobilization at the end of a given construction season.

The dredging equipment will be operated to minimize resuspension of material during the remediation. Dredged materials will be transferred to scows and transported to an onsite unloading area for transfer to haul trucks for transport to an onsite temporary staging area. The specific methods will be determined by the Contractor; a portion of an existing bulkhead adjacent to the upland support area will be available for offloading the scow. The Contractor will be required to segregate TSCA-regulated, non-TSCA, and BUD material, including equipment used to handle such material, throughout the removal and handling processes. If equipment is used for multiple classifications of material, the equipment will be decontaminated using procedures detailed in the technical specifications, which will be included in the FD (Appendix C).

After the Contractor has completed sediment removal to the appropriate depth as indicated on the Design Drawings (Appendix A), the Contractor will conduct a post-dredging bathymetric survey to verify that the proposed removal limit has been reached.

The goal of river backfilling and isolation cap placement is to restore the river bottom to the approximate pre-removal elevation and composition in accordance with the Restoration Plan. The final grades also will achieve a final condition with no net fill and take into consideration material stability based on the characteristics of the fill material. Dredging will be completed before initiating isolation cap operations. Individual cells will need to be established within the larger dredge area if the Contractor prefers to initiate placement of isolation cap materials before dredging activities are complete.

River backfill and underwater capping materials will be directly placed from the barge without need for onshore offloading.

The selection and placement of underwater capping materials considered the following geotechnical and hydrodynamic parameters:

- Consolidation
- Cover stability
- Scour
- Mud-waving.

Materials that are compatible with the aquatic habitat and resistant to scour will be evaluated and selected based on the ongoing river hydrodynamic model, biological assessment, and essential fish habitat studies.

4.11.1 Deepwater Areas

The dredged areas in the Offshore NEA and Deepwater Areas are shown on the Design Drawings and will be backfilled to within 1 foot of the pre-construction elevation. The upper 1 foot will be left low to allow for natural sedimentation. The fill material will be determined during the FD and will consider river dynamics from Phase 2 of the hydrodynamic study. Monitoring of natural sedimentation will be performed at regular intervals, which will be determined based on the results of the ongoing hydrodynamic study and included in the FD.

4.11.2 Nearshore and Backwater Areas

The dredged areas in the Nearshore Area are shown on the Design Drawings and will be covered with an isolation cap. The isolation cap will consist of a sand isolation layer, armoring layer, and a minimum of a 24-inch habitat layer. Dredged areas outside the Nearshore Area will be backfilled with appropriate river substrate to pre-dredge elevations or to within 12 inches of the pre-dredge elevation. Up to 12 inches of the habitat layer may fill in by natural deposition (NYSDEC 2012b). A hydrodynamic study on river flow and deposition is underway to determine if the current sedimentation rates could produce up to 12 inches of a habitat layer within a reasonable timeframe following the installation of the isolation cap. Data from this study will also be used to size the materials in the isolation cap based on river velocity and material shear resistance.

The backfill and isolation cap materials will be placed with an acceptable tolerance over the area as measured by the bathymetric survey following placement of each layer. It is assumed that the material will be placed mechanically; however, hydraulic equipment may also be considered for sand and/or habitat layer materials. Backfill/cap placement may occur with the same equipment used for dredging following decontamination of the equipment. Construction activities and equipment operation will be managed to minimize resuspension during placement.

It is anticipated that the backfill/cap materials will be placed with engineering controls or while the engineering controls utilized for dredging, if any, are still in place. The Contractor may implement additional controls to achieve water quality requirements included in permits and/or access agreements. Backfill areas that are located in depositional zones, as determined by the ongoing hydrodynamic study, may be backfilled to within 12 inches of the pre-removal grade. Monitoring of natural sedimentation in these areas will be performed at regular intervals, which will be determined based on the results of the ongoing hydrodynamic study and included in the FD.

4.12 Turbidity Monitoring

Turbidity monitoring, including baseline monitoring before the initiation of in-water construction activities, will be performed in accordance with permit requirements during dredging and cover placement activities. It is anticipated that stationary and mobile turbidity monitoring will be performed before the start of construction activities to document pre-construction conditions and capture changing flow directions.

The locations, equipment for, and frequency of monitoring, as well as action levels, will be dictated by the permit requirements.

4.13 Material Handling and Disposition

The Contractor will be required to segregate TSCA-regulated and non-TSCA-regulated material, including equipment used to handle such material, throughout the removal and handling processes.

Kemron Environmental Services performed bench-testing and evaluated dewatering, stabilization, and construction water treatment of impacted materials from the site (H&A 2015b, Attachment D). Results from the treatability test show that gravity dewatering alone will not be sufficient, and additional dewatering using a filter press or equivalent will be required with the potential for additional stabilizing additive.

Stabilization testing was conducted with onsite sediment samples with estimated average PCB concentrations of 50 mg/kg. In addition, 25 gallons of onsite soil was obtained from ongoing test pitting operations, to determine if the highly granular onsite soils could be used as a stabilizing additive (H&A 2015b). Results of these stabilization tests indicated the following:

- Wet soils can be stabilized with Portland cement for use as onsite fill.
- Sediments were successfully stabilized with several additives (including Portland cement, cement kiln dust, and lime kiln dust) for offsite disposal.
- The addition of excess onsite soils to dewatered sediment at rates of 1:1 will allow for mixture to be transported offsite for disposal.
- Stabilization addition rates can be reduced with the addition of onsite soils.

Additional treatability studies may be performed during construction to determine other options.

The primary sources of impacted material at the site included dredge material, upland soils, and debris. Debris will be sorted from the upland soils and decanted sediments before material handling and stabilization to the extent possible.

OU1 soils initially will be dewatered in-situ as described in Section 4.5.1 using hydraulic control to cut off the Hudson River from the permeable materials to be removed. OU1 materials will be staged on staging/handling pads shown on Drawing C-1 (Appendix A) and will be used for sediment blending or conditioned for disposal.

The dredge material will be collected with an environmental bucket. Once all debris has been appropriately removed, the remaining sediment will be offloaded to staging areas onsite, where it will be blended with stabilizing agents and/or upland soils before transport and offsite disposal. It is anticipated that stabilized materials will be transported offsite for disposal via barge or rail. Trucking will be limited to normal refuse, plastic and paper for recycling, and non-hazardous scrap metal and debris.

4.14 Beneficial Use Materials

The selected remedial alternative for OU2 (Modified Remedial Alternative 6) presented in the OU2 ROD, recognizes that disposal options for removed sediments include a combination of off-site disposal and potential on-site reuse in OU1, and that the details and limitations for the on-site reuse will be developed during the remedial design. Recently revised 6NYCRR Part 360 Regulations for beneficial use (Section 360.12 Beneficial Use, effective November 4, 2017) are being evaluated. Treatability studies referenced in Section 4.13 have provided the bench scale data to demonstrate that dewatering to prepare sediments for re-use on site is feasible. The contemplated on-site re-use of sediments is general upland backfill or grade fill beneath the site cover system, and is limited to sediments exhibiting less than 10 ppm PCBs and lead at concentrations lower than the upland limits of removal for lead. Discussions with NYSDEC have been initiated and further discussions are planned to provide information in the FD,

To prepare the case-specific application for beneficial re-use of sediments, the specific areas to be segregated for re-use during dredging and the estimated volumes of segregated sediments to be removed pursuant to NYSDEC-approved removal limits, will be characterized based on existing data, including data currently being generated for the Kinnally Cove area. A performance sampling and analysis plan for dewatered sediments proposed for re-use will be included.

Crushing and onsite re-use of existing concrete slabs at the site will also be proposed. Existing concrete slabs are assumed to be an average of 8 inches (in.) in thickness. Slabs within areas that will not be excavated will be broken up into 24 in. or smaller sizes and left in place to provide Site drainage through infiltration. Slabs within areas that will be excavated, shall be pre-characterized and removed or re- used according to the results of the characterization proposed in the case-specific re-use application.

Other re-use materials under consideration are uncontaminated on-site rip-rap, existing concrete bulkheads, dock platforms, and pedestals to be similarly evaluated.

4.15 Solid Waste Transportation and Disposal

An evaluation of offsite transportation and disposal options for the remedial soils and sediments is presented in Appendix D. Based on that assessment, the FD will provide plans and performance specification for transport of sediments in covered containers, loaded at the site waterfront onto barges, and offloaded to rail cars for transportation to waste management facilities permitted and approved for the waste streams. This method was successfully used for removal of PCB-contaminated building materials and other demolition waste from Building 52 in 2017. Lessons learned from that process will be used to frame the FD details and performance specifications for offsite transportation and disposal of soil and sediment remediation waste.

Potential sources of soil and rock backfill that can be delivered to the site by barge were also identified in Appendix D. Specifications for backfill will be included in the Final design and potential sources will be considered to meet those specifications.

4.16 Water Handling and Treatment

Filtration testing conducted in 2006 show that filtration of groundwater was not successful in removing all PCBs and metals from water collected at the site. As a result, the following evaluations were conducted in 2015 and summarized in the PDI Report on samples of groundwater and pore water:

- Initial raw water testing
- Filtration testing
- Carbon adsorption testing
- Precipitation testing
- System testing (combination of filtration, carbon adsorption, and precipitation).

Results of the treatability testing show that construction waters consisting of groundwater, pore water, and/or a combined stream of water can be treated successfully as outlined in System Testing Methods of the 2015 Treatability Study (H&A 2015b, Attachment D).

4.16.1 Sources of Water to be Treated

The primary sources of construction waters that will require treatment are the sediment handling barges and groundwater and surface water runoff collected during upland OU1 excavations. Before removing sediment from the barges, free water will be pumped out, if necessary, for treatment. Upland excavations will be dewatered to facilitate soil removal to target depths below the water table. Water will also be collected from any dewatering methods performed on saturated excavated soils and sediments. Collection sumps will similarly be installed at the staging and decontamination areas to allow collection of water for treatment.

4.16.2 Treatment Assumptions

Collected construction waters will be managed at an onsite temporary water management and treatment facility. Water treatment options include several alternatives, including onsite treatment with discharge to

the river, pre-treatment for discharge to the Westchester County sewer system, and supplemental offsite treatment.

The treatment system design will be performance-based and will specify the minimum system capacity, system components, discharge location, and, sampling criteria. The selected Contractor will perform the FD of the treatment system.

4.16.3 Treated Water Discharge Limits

Construction water treatment performed onsite will be treated and monitored to meet NYSDEC wastewater discharge permit equivalent limits issued by NYSDEC. These limits are for any temporary treatment system discharge associated with the remediation project via an outfall to the Hudson River. Any construction water to be discharged to the Westchester County sanitary sewer system will be pre-treated to meet permit requirements issued by Westchester County Department of Environmental Facilities, should a permit be issued.

4.17 Site Restoration and Demobilization

A site walk will be conducted prior to final demobilization to determine that the work is complete and document tasks remaining for completion. Prior to demobilization, facilities that were constructed to support the construction will be removed. Disturbed surfaces will be restored to pre-construction conditions unless specified otherwise in the design.

5 SUMMARY OF GREEN REMEDIATION PRACTICES

Sustainable green remediation practices and principles have been considered in the development of the remedial design to be implemented. Specifically, the design considerations discussed herein meet the objectives of green remediation of DER-31/Green Remediation (NYSDEC 2011) by:

- Protecting human health and the environment
- Supporting human and ecological use and reuse of remediated land
- Utilizing technologies and practices that are sustainable, to the extent practicable, to reduce air emissions and greenhouse gas production
- Utilizing technologies and practices, to the extent practicable, to conserve natural resources and energy.

The following specific procedures and protocols will be adopted during implementation, where feasible:

- Use of solar-powered monitoring equipment and/or battery chargers
- Use of recycled materials (e.g., paper, lubrication oil) instead of virgin materials, where practicable
- Recycle all non-contaminated debris and construction waste at a site (e.g., asphalt, metals) to the extent practicable
- Use of biodegradable fluids for equipment and environmentally acceptable lubricants for oil-water interfaces, to the extent practicable
- Minimizing clearing of vegetation.

The Contractor will execute remediation activities to minimize the potential for negative impacts on the environment through implementation of best management practices (BMPs). Examples of such BMPs include the following:

- Minimizing access routes into the work areas and maintaining designated vehicular traffic routes onsite to protect ecosystems.
- Use of river barges for delivery and shipping where practical to minimize trucking and associated engine emissions.
- Limiting, where practical, the “footprint” of equipment staging material processing areas, remediation areas, and field offices. The footprint will be restored to original condition upon completion of the project.
- Collection and onsite treatment of all potentially impacted wastewaters encountered during operations.
- Maintaining pollution prevention and waste minimization programs from initiation of mobilization activities to project close out.
- Inspecting onsite equipment daily for clean operation.
- Maintaining good site housekeeping practices.
- Utilization of low emission diesel equipment and fuel.

Reducing project emissions by minimizing idle time for equipment by shutting down equipment not being actively used.

6 POST-REMEDIAL ACTIVITIES

A Final Engineering Report (FER), including Record Drawings and SMP, will be prepared and submitted to the NYSDEC following completion of the remedial action activities described herein. These documents are explained in this section.

6.1 Final Engineering Report

Subsequent to the completion of the remedial action activities, an FER will be prepared and submitted to the NYSDEC for review and approval. The purpose of the FER will be to document remedial action activities for the project area and note any deviations from the FD Report. The FER will be prepared under the direction of, and certified by a Professional Engineer licensed in the State of New York directly involved in the remedial action activities, and will contain the following information:

- Background, site description and RAOs
- Description of the selected remedy
- Summary of the remedial action activities performed
- Record Drawings documenting the removal limits and final configuration of installed restoration
- Copies of permits, regulatory documents, and approvals, and relevant project correspondence, as appropriate
- A description of any deviations from or modifications to the NYSDEC-approved FD
- Copies of waste manifests, bills of lading, and/or certificates of treatment/disposal, as appropriate
- Quality assurance/quality control testing results
- Summaries of monitoring results obtained during construction (e.g., water column, air)
- Representative project photographs taken during the remedial action
- Engineer's certification statement.

6.2 Site Management Plan (SMP)

In accordance with DER-10, an OU1 and OU2 SMP will be prepared and submitted to the NYSDEC that will define the institutional and engineering controls and post-remedial obligations. A draft SMP will be completed as part of the FD and will be finalized during preparation of the FER. The SMP will include the following:

- Summary of Previous Investigations and Remedial Actions
- Institutional and Engineering Control Plan
- Post Construction Monitoring Plan
- Operations and Maintenance Plan
- Periodic Assessments/Evaluations

- Reporting Requirements

7 REMEDIAL QUANTITIES, COST, AND SCHEDULE

7.1 Remedial Quantities

The following table summarizes estimated key removal, fill, and disposal quantities based on the preliminary design with allowance for two areas to be finalized by pre-design sampling. In-water quantities are listed with both neat quantities based on the extent of required work and total quantities that include anticipated sloughing of the work areas that will occur given native material conditions. Quantities listed for OU1 excavation and backfill, and Old Marina/Kinnally Cove dredging and backfill are subject to revision based on ongoing pre-design sampling. The quantities summarized in the following table were used to develop the remedial cost estimate (Appendix E).

Task	Estimated Quantity	
	Neat	Total
OU1 Excavation		112,600 cy
OU1 Backfill of Excavated Areas		112,600 cy
OU1 Backfill for Redevelopment		150,000 cy
Nearshore Dredging	30,800 cy	33,200 cy
Deepwater Dredging	6,000 cy	8,400 cy
Old Marina/Kinnally Cove Dredging		6,000 cy
Isolation Cap	27,400 cy	29,800 cy
Deepwater Backfill [1]	6,000 cy	8,400 cy
Old Marina/Kinnally Cove Cap		6,000 cy
TSCA-Regulated Material		128,000 tons
Non-TSCA-Regulated Material		110,900 tons
Debris		25,700 tons

1 - The deepwater backfill quantity shown is indicative of the anticipated quantity of imported backfill required. Up to 1 foot of material may be deposited naturally, which will be evaluated and proposed based on the results of the ongoing hydrodynamic study.

7.2 Remedial Cost Estimate

The anticipated cost of the remedial project based on the elements of this PD for both OU1 and OU2, is approximately $268,000,000. The preliminary cost estimates for each operable unit are provided in Appendix E. The cost estimate will be refined further in the FD.

7.3 Final Design and Construction Schedule

During review of this PD Report by the NYSDEC, ARC will initiate development of the FD Report. Comments provided by the NYSDEC on this PD Report will be incorporated into the FD Report. Assuming comments by the NYSDEC on the PD and approval of the final pre-design delineations are received during first quarter 2018, it is anticipated that the FD Report will be submitted to the NYSDEC in the third quarter of 2018. Following NYSDEC approval of the FD Report, pre-construction activities will be initiated (e.g., contractor procurement, submittal of permit applications, access agreements).

Barring any delays caused by approvals, permitting, or site access, it is anticipated that remedial activities will be initiated in the 2019-2020 timeframe. Further details regarding the schedule for the remedial action and sequencing of the work will be presented in the final remedial action schedule to be submitted to NYSDEC once the permits for the project have been received from the USACE and NYSDEC, and Contractor selection has been finalized. The remedial construction schedule is anticipated to range from 5 to 13 years, depending on the available in-water working time.

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TABLE

Table 1
Summary of ROD/CD Requirements and Restrictions

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Design requirements and restrictions related to site remedial construction and redevelopment are specified in the RODs and CD. Collectively, these include:

Remedial Requirements	Restrictions
Green remediation principals and techniques will be implemented to the extent feasible in the design, implementation, and site management of the remedy per DER-31, in accordance with the OU-1 ROD (Amended 2102) and OU-2 ROD (2012).	Specific green remediation elements will be identified in the remedial design. The site-specific goal will be to minimize construction impacts to the Village to the extent feasible while implementing the remedy. Green remediation components will also apply to the future site management obligations.
Installation of a sheet pile wall within the Hudson River (referred to as the NEA) to provide containment and allow for the recovery of PCB DNAPL onshore and offshore of the northwest corner of the site. The area behind the sheet pile wall will be filled with soil and/or lightweight aggregate as approved by the Department. The sheet pile wall will include sealed joints, installation of tie-rods, upland anchors, and cathodic protection. The wall system will also include groundwater filtration units to adsorb contaminants that may be present in groundwater discharging to the river.	The location and alignment of the proposed sheet pile wall will be verified during the remedial design to minimize filling into the Hudson River. Construction of pile supported structures other than the bulkhead is prohibited in the NEA.
Construction of a sheet pile wall offshore of the northwest corner of the site extending into the Hudson River with backfill, which will create approximately 0.88 acres of new land in the Northwest Extension Area (NEA).	Taking Hudson River habitat for construction of the NEA requires developing and implementing a mitigation plan to replace the aquatic habitat that will be lost. Mitigation will involve the creation and/or restoration of river habitat in accordance with an NYSDEC-approved plan.
Following the upland removal actions and for PCBs and metals specified in the OU-1 ROD, an engineering control consisting of a site cover will be required throughout the entire upland area to meet the cleanup objectives for restricted residential use of the site. The cover will consist either of the structures such as buildings, pavement, sidewalks comprising the site development or a soil cover in areas where the upper two feet of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs).	Where the soil cover is required, it will be a minimum of two feet of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for restricted residential use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer with appropriate natural species.
Additional engineering controls will consist of DNAPL recovery in the NEA and measures to provide filtration of groundwater	Upon completion of the bulkhead extension, an investigation will be performed to delineate and further evaluate the presence/absence of potential DNAPL within the NEA. Based on the results of the investigation, a remedial action plan will be submitted to NYSDEC.
PCB materials and PCB impacted soils will be removed from the upland area to target depths specified in the OU-1 ROD, as delineated in the final NYSDEC-approved Pre-Design Investigation (PDI). PCB impacted sediments will be removed from the Hudson River and the Old Marina in accordance with the OU-2 ROD, as delineated in the final NYSDEC-approved PDI.	Pile-supported structures will not be permitted for future construction in any areas where PCB material (PCB DNAPL) is potentially present after remedial construction. Per the OU-2 Responsiveness Summary, RESPONSE 54: Restrictions on the installation of piles and pile-supported structures outside of the Northwest Extension Area (NEA) are not planned. The installation of piles will not be restricted in the marina area provided that PCB DNAPL is not present. The remedial design will determine the precise boundaries of the NEA.
Disposal of Excavated Soil and Fill. Per the CD, AR shall, as appropriate, treat and dispose of any soils, fill materials, water, wastewater, or other wastes generated pursuant to activities conducted pursuant to the OU-1 ROD (2004) and OU-1 ROD Amendment (2012). Any such treatment and disposal shall comply	Design must address significant constraints regarding access to and from the site through the Village streets, in favor of rail and/or barge access. Access directly to the site via rail requires siding installation and access via barge requires temporary docking installation.

Remedial Requirements	Restrictions
with all applicable laws and regulations, and any such disposal shall occur at an appropriate off-site disposal facility in accordance with applicable laws and regulation. AR shall use all reasonable efforts to maximize the use of barges and rail to transport material excavated from the Site and to bring equipment and material to the Site (e.g., for backfill) in effectuating the remediation, as well as to transport any sediment excavated from the Hudson River pursuant to the OU-2 ROD that are placed on the Site and not used as backfill in implementing the OU-1 ROD.	
As defined by the Amended Consent Decree (CD), a finished grade contour line of +11 feet above local mean sea level (LMSL) shall be made part of the final site grade.	Such contour line, as defined by the CD, is estimated to be approximately 80 to 100 feet from the mean low water mark (but not to exceed 110 feet from the mean low water mark) (and approximately 60 to 70 feet from the mean low water mark along the Northern Boat Slip and Southern Boat Slip), and running from the southern end of the Northwest Corner bulkhead to the Southern property boundary.
Per the CD, a future developer, owner, or other party may desire to raise the elevation of a reasonable area within the Developable Portion of the Site to an elevation greater than +11 above LMSL.	Design of the Sloped Shoreline must take reasonable account of the possibility that some of the Developable Portion of the Site (or of the base of buildings constructed on the Developable Portion of the Site) may subsequently be raised to an elevation up to +14 LMSL.
Per the CD, “Sloped Shoreline” shall mean an area to become sloped shoreline and/or stable transition (including estuarine plantings and other vegetation appropriate for habitat) extending in an easterly direction inland from the mean low tide water mark of the Site to the first Site finished redevelopment grade contour line at +11 feet above LMSL as determined in an approved Remedial Design and/or redevelopment plan.	A portion of the Sloped Shoreline area shall be designed for use as a Walkway and shall be graded such that the grade is substantially flat. The Walkway location and grade elevations shall be included in the draft and final Remedial Design and shall be subject to Village approval, not to be unreasonably withheld. Any such area shall also be designed to be consistent with the designation of Open Space (2.5 acres consisting of a strip of land 30 feet in width on average and paralleling the Hudson River for the length of the Site).
Per the OU-1 ROD, the sloped shoreline cover system will be designed and constructed such that no additional fill material will be placed into the Hudson River, and will require the removal of sediment or fill below the current sediment or water elevation for placement of a cover system. The sloped shoreline cover system will be designed with the following layers: an isolation layer of soil or geotextile designed to prevent the migration of contaminated soil particles into the Hudson River; an erosion protection layer; and a habitat/surface substrate layer. The habitat/surface substrate layer will be designed to restore aquatic, intertidal and stream bank habitats while taking into account erosional forces, such as waves and currents.	Sloping from the waterfront, including the substantially flat 30-ft wide walkway/open space to the created +11 ft. contour must fit within a maximum of 110 ft. of the [existing] mean low water mark as specified in the site topographic survey. Per Comments# 8 and 67 in the OU-1 ROD Responsiveness Summary: “The DEC should consider effects of flooding and sea level rise in its site design”. Per DEC Response #67: “The remedial design will consider future storm events and rising sea level that are likely to result in more intense storms, higher water events, and greater erosive forces on the site than have been documented in the past.”
Per the CD, design the Sloped Shoreline along the Northern Boat Slip to include a concrete ramp or other similar boat launch (“Boat Launch”) suitable for launching non-motorized light recreational watercraft. AR shall establish a right of public access to the Boat Launch that runs with the land.	AR and the Village shall cooperate and coordinate regarding the design of the Sloped Shoreline to provide reasonable flexibility in design elements to accommodate potential redevelopment modifications that may correspond to reasonable future waterfront uses, including but not limited to the location of waterfront uses, the location of the Walkway, and the steepness of the slope
The OU-1 ROD Amendment allows installation of either a sheet pile wall or sloped shoreline cover system in	The NEA bulkhead design must accommodate the possible future placement of a gangway or floating

Remedial Requirements	Restrictions
areas that do not require containment of liquid PCBs. The CD requires additional considerations in shoreline and NEA bulkhead design: • Consistent with the OU-1 ROD Amendment, AR shall install a new bulkhead around the Northwest Corner. The bulkhead installed shall consist of steel sheet pile or equivalent with a design life as approved by DEC, and the bulkhead shall be installed such that a future dock or pier of suitable design and construction could be constructed by a developer, owner, or other party out to water depths greater than 15 feet off the northwest corner and connected to the Northwest Corner through a gangway, floating walkway, or other similar structure without jeopardizing the structural integrity of the Northwest Corner bulkhead or the integrity of the site remedy. • The shoreline along the Shoreline Area, Northern Remainder and Southern Portion of the Site may consist of either a steel sheet pile bulkhead or a sloped natural shoreline. • The Sloped Shoreline shall be designed to include appropriate grading and armoring to protect against erosion. AR shall also construct the riparian vegetated buffer and design the Sloped Shoreline such that an additional vegetative buffer could be further installed in the vicinity of the Sloped Shoreline/Developable Area interface, with the precise location of any such vegetative buffer to be determined in the Remedial Design. AR shall initially seed any such area of additional vegetation with grass.	walkway to a future dock or pier constructed by a developer. The sloped shoreline design must include riparian vegetative buffer and vegetated buffer between the sloped shoreline and Shoreline/Developable Area interface. Vegetated areas must meet the requirements for the 2-foot soil cover system specified in the OU-1 ROD Amendment.
Per the CD, Acceptable Fill" shall mean (i) soil or topsoil that meets DEC's restricted residential use soil cleanup objectives as set forth in 6 NYCRR Part 375-6.4(b)(2) and 375-6.7(d) and DEC Technical Guidance DER-10; (ii) uncontaminated gravel, stone, or other armoring material; (iii) uncontaminated construction and demolition debris from the Site consisting of recognizable concrete and concrete products, asphalt pavement, brick, glass, and/or rock or (iv) Operable Unit 1 soils or Operable Unit 2 sediments that may be solidified or stabilized and either meet DEC's restricted residential use soil cleanup objectives set forth in 6 NYCRR Part 375-6.4(b)(2) and 375-6.7(d) and DER-10 or are approved by DEC pursuant to a beneficial use determination pursuant to 6 NYCRR Part 360 and applicable DEC policies.	Acceptable Fill placed in the Developable Portion of the Site shall be sufficiently crushed, if necessary, so as (x) not to materially inhibit pilings or other structural support to be driven through it, (y) to inhibit subsidence that would materially impair reasonable future use, and (z) to support topsoil that would maintain vegetation placed on top of it. The Acceptable Fill should be placed in lifts and compacted such that the fill is substantially non-yielding so as not to materially create impairment to future commercial or [restricted] residential use of the Developable Portion of the Site.
Per the CD, in addition to the placement of Acceptable Fill to return the Site to grade, AR shall place two additional feet of "Clean Soils" across the entire Developable Portion of the Site, unless the placement would create significant mounding which is likely to inhibit proper drainage. The top two feet shall be Clean Soils unless the placement of other Acceptable Fill is approved in writing by the Village.	Prior to or concurrent with Site redevelopment, AR shall cause Clean Soils to be placed across the Site in accordance with the following criteria: • Clean Soils shall be placed in the Developable Portion of the Site in a volume sufficient to raise the elevation to a minimum of +11 feet above LMSL.

Remedial Requirements	Restrictions
	• The uppermost 6 inches of Clean Soils placed on the Developable Portion of the Site that will not be covered by roads, buildings, pavement, or other impermeable surfaces shall consist of a 6-inch layer of topsoil that will be seeded, fertilized and maintained to reduce sedimentation and erosion, and AR shall make any repairs necessary to maintain the Clean Soils Cover. • Both the volume and grading of Clean Soils placed in the Developable Portion may be adjusted to allow for contouring to provide for appropriate Site drainage, the placement of utilities, and the placement of roads, sidewalks, or other paved areas, subject to the approval of the Village. • Any trenches for new utilities or excavation of existing utilities shall be over-excavated to remove soils containing contaminants above the restricted residential use soil cleanup objectives as set forth in Part 375-6.7(d) on all sides to a width adequate for future maintenance without requiring future excavation of soils outside this clean corridor created for utilities. • Any new utilities shall be surveyed to identify the location thereof, which survey shall include GPS coordinates for incorporation into a Village GPS system. AR may fulfill its obligation pursuant to Section 4.9(b) of the CD by: • Placing Clean Soils on the Developable Portion of the Site; or • Causing a redeveloper or other third party to place Clean Soils on the Developable Portion of the Site in conjunction with a Village-approved and zoned redevelopment plan for the Site; or • Issuing a promissory note to a future redeveloper or, if there is no redeveloper, issuing a promissory note or other financial assurance reasonably acceptable to the Village, in an amount sufficient for the purchase and placement of Clean Soils on the Developable Portion of the Site.
Deed Restrictions: Upon completion of the remediation or prior to sale of the Site, whichever is earlier, AR shall place restrictions on the deed to the Site that restrict future use of the Site per the CD Sections 7.1(a) through 7.1(f).	Future use restrictions, as specified in (a) through (f), are: (a) The height of any buildings remaining on the Site or to be constructed on the Site in the future shall not exceed 65 feet above the finished elevation of the Developable Portion of the Site (which height the Village may further restrict consistent with applicable law), and all new buildings shall be

Remedial Requirements	Restrictions
	constructed with a minimum of a 100 foot setback from the current River low tide water line (and 60 feet from the eastern edges of the coves, unless a variance or other local land use approval from this setback has been obtained from the Village. Notwithstanding the foregoing, the restriction shall not prohibit community and/or commercial facilities, such as boathouses/boat storage building, public seating area and ancillary facilities (such as a café) for the service of light foods, restrooms and similar services, from being constructed within 60 feet of the coves and/or within the Northwest Corner. The Sloped Shoreline shall constitute part or all of the setback. (b) New pilings, pillars, or other subterranean support structures shall not be installed through the contact barrier or cover in the Northwest Corner, and this area shall be designated as open space pursuant to (f) below. (c) Utilities shall be placed through Acceptable Fill, or in appropriately designed utility corridors intended to prevent future utility workers performing maintenance or repair in these specific areas from coming into contact with any remaining contaminated soil. (d) Wells shall not be installed to make use of groundwater at the Site for drinking, irrigation, or domestic purposes. Wells may be installed for the purposes of monitoring or managing groundwater or other environmental conditions. (e) Detached single family residential homes shall not be constructed on the Site. (f) The Company (AR) shall designate as open space not to be developed ("Open Space") and allow public access to the following: (i) The Northwest Corner, including the "extension" thereof created pursuant to the OU- ROD Amendment (constituting approximately 2 acres); (ii) Approximately 2.5 acres consisting of a strip of land 30 feet in width on average and paralleling the Hudson River for the length of the Site and meeting the following criteria: 1) The 2.5-acre strip of land shall be located between the elevation LMSL+8 mark of the Sloped Shoreline and a line no further

Remedial Requirements	Restrictions
	inland than 110 feet from the mean low water mark; 2) Some or all of the 2.5-acre strip of land may be located within the area designated as the Sloped Shoreline; 3) The designated 2.5 acres of Open Space shall be substantially flat and shall be suitable for, and intended for, the future construction of a Walkway; and 4) The final location of the 2.5 acres of Open Space shall be identified in the Remedial Design, subject to the approval of the Village, not to be unreasonably withheld, and any permitting or approvals necessary from other governmental authorities. (iii) An additional 1.75 acres consistent with the location of Open Space on a development proposal for the Site formally submitted to the Village for its approval. (g) The Company (AR) may designate as Open Space and, once designated, allow public access to, up to an additional 8 acres, at such time as, and conditioned upon the agreement of AR and the Village on, a development plan for the Site. Any such Open Space that may be designated may be donated to a qualified land trust or other tax qualified recipient or to the Village. Such Open Space shall be identified and designated in accordance with future development and shall be subject to any further agreements reached between the Village and AR.
A Site Management Plan (SMP) will be required due to reliance on engineering and institutional controls to complete the remedy. The SMP will be prepared on the latest NYSDEC template.	The Site Management Plan will outline the post-remedial obligations, to be specified in: • Engineering and Institutional Control (EIC) Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the institutional controls (Environmental Easement) and engineering controls (cover system, PCB DNAPL/fluid recovery and groundwater treatment) remain in place and effective. The EIC Plan will include, but may not be limited to: o An Excavation and Sediment Management Plan which details the provisions for management of future excavations in areas of remaining contamination; o Descriptions of the provisions of the environmental easement including any land use, groundwater and/or

Remedial Requirements	Restrictions
	surface water use restrictions, which include a prohibition on pile supported structures over areas with PCB material; o Provisions for the management and inspection of the identified engineering controls; o Maintaining site access controls and Department notification; and o The steps necessary for the periodic reviews and certification of the institutional and engineering controls. • Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to: o Monitoring groundwater quality and elevation to assess the performance and effectiveness of the remedy; o Soil cover system inspection and maintenance as necessary to ensure its function is not impaired by erosion or activities at the site; o Shore protection system (sheet pile and sloped areas) will be periodically monitored for erosion, corrosion, damage or deterioration; shoreline elevation; • Within the Hudson River, measure PCB and metals concentrations and evaluate the long-term contaminant trends in the affected media (biota, sediment, water). The river monitoring plan includes, but may not be limited to: o Baseline sampling of biota; surficial sediment sampling; biota sampling in the vicinity of the site and at reference locations; porewater and surface water sampling in the vicinity of the site and at reference locations; shoreline and nearshore bathymetry; and habitat characterization; o Long-term sampling of biota; surficial sediment sampling; biota sampling in the vicinity of the site and at reference locations; porewater and surface water sampling in the vicinity of the site and at reference locations; shoreline and nearshore bathymetry; and restoration success to assess the performance and effectiveness of the remedy; and o A schedule of monitoring and frequency of submittals to the Department;

Remedial Requirements	Restrictions
	• Operation and Maintenance Plan to ensure continued operation, maintenance, monitoring, inspection, and reporting of for any mechanical or physical components of the remedy. The plan includes, but is not limited to: o Compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting; o Maintaining site access controls and Department notification; and o Providing the Department access to the site and O&M records.
An Environmental Easement (EE) will be prepared by NYSDEC following receipt of a completed Environmental Easement Checklist and the items listed in Appendix A to the checklist, including but not limited to title report and site survey meeting the EE requirements. Easements granted to the Village for the newly constructed walkway and boat slip must be included on the site survey and title documents.	The EE will be executed, recorded with Westchester County, and noticed to the affected local governments (ALGs). The EE: • Runs with the land in favor of the State; • Restricts specific land uses as specified in the Deed Restrictions required by the CD, consistent with the definition of restricted residential use in 6NYCRR Part 375; • Guarantees NYSDEC access for inspection; • Requires periodic certification of institutional and engineering controls in accordance with 6 NYCRR Part 375-1.8(h)(3); and • Requires compliance with the Department approved Site Management Plan. • In accordance with ECL 71-3607.2, ALGs who approve building permits must be able to identify real property subject to an EE and request NYSDEC review of building permit applications for consistency with the EE.

APPENDIX A

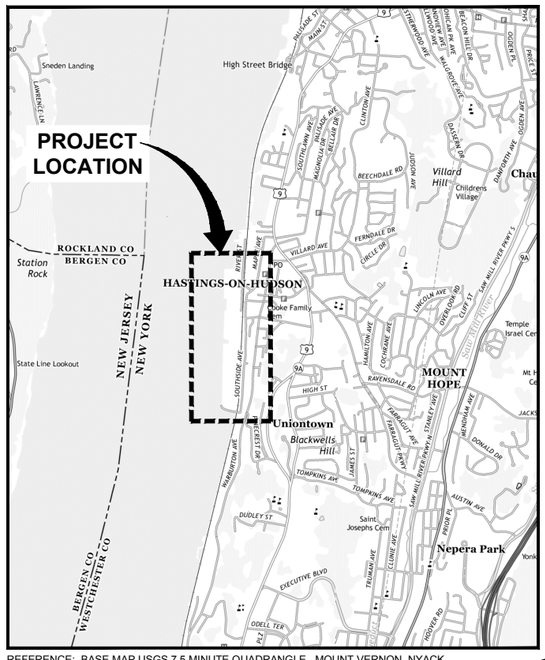
Design Drawings

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: LYR:ON=*;OFF=*REF*
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XREFS: IMAGES:
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NY_Yonkers_20130322_TM_geo.png

CONTRACT DRAWINGS

PRELIMINARY DRAFT
REMEDIAL DESIGN WORK PLAN

DISCLAIMER: THESE DRAWINGS PRESENT THE PRELIMINARY DESIGN FOR REMEDIATION OF THE HARBOR AT HASTINGS SITE AND WILL BE REVISED DURING FINAL DESIGN BASED UPON FINAL DESIGN CALCULATIONS AND ADDITIONAL INFORMATION OBTAINED.



REFERENCE: BASE MAP USGS 7.5 MINUTE QUADRANGLE., MOUNT VERNON, NYACK, WHITE PLAINS, AND YONKERS, NY-NJ, 2013.

HARBOR AT HASTINGS
SITE PRELIMINARY DESIGN
OU1 AND OU2

SITE NO: 3-60-022

NOVEMBER 2017

ATLANTIC RICHFIELD CO.
HASTINGS-ON-HUDSON, NEW YORK

NOT FOR CONSTRUCTION

ARCADIS | Design & Consultancy for natural and built assets

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- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING MEAN LOW WATER LINE
- EXISTING MEAN HIGH WATER LINE
- –24– — EXISTING MINOR BATHYMETRIC CONTOUR
- 25 — EXISTING MAJOR BATHYMETRIC CONTOUR
- 5 — PROPOSED TOPOGRAPHIC CONTOUR
- PROPOSED GRADE BREAK
- OU2 AREA
- PROPOSED GROUNDWATER TREATMENT LOCATION
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- –19– — PROPOSED BATHYMETRIC CONTOUR
- VC-102A — SAMPLE ID
- CP-11 — CONTROL POINT
- 20+00 — STATIONING LINE
- PROPOSED TURBIDITY CURTAIN
- EXISTING OU2 BOUNDARY
- EXISTING PILE FIELD

- TRUCK/VEHICLE FLOW DIRECTION
- CONSTRUCTION ACCESS ROAD
- DOCK LOADING/UNLOADING AREA
- DECONTAMINATION PAD
- STAGING AREA
- WATER TREATMENT AREA
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA
- ABANDON MANHOLE IN PLACE
- S — PROPOSED SANITARY SEWER MANHOLE
- D — PROPOSED STORM SEWER MANHOLE
- S-21 3.5' — PROPOSED PCB EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- L-1 — LEAD REMOVAL AREA
- PROPOSED NEARSHORE ISOLATION CAP AREA
- PROPOSED DEEPWATER BACKFILL AREA
- 11 — PROPOSED FINAL GRADE CONTOUR (1-FOOT INTERVAL)
- PROPOSED MEAN LOW WATER (MLW) LOCATION (–2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED BULKHEAD

GENERAL NOTES:

1. EXISTING UPLAND TOPOGRAPHIC INFORMATION OBTAINED FROM FIELD SURVEYS CONDUCTED BY Wendel WD Architecture, Engineering, Surveying and Landscape Architecture, P.C. BETWEEN 2009 AND 2014.
2. EXISTING HUDSON RIVER TOPOGRAPHIC INFORMATION BASED ON BATHYMETRIC SURVEY CONDUCTED BY OCEAN SURVEYS, INC. ON 10–16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
3. HORIZONTAL DATUM IS NAD83, NEW YORK STATE PLANE, EAST ZONE, US SURVEY FEET AS ESTABLISHED FROM MAPPING PREPARED BY BOSWELL ENGINEERING DATED: 1/27/2006, REVISED 5/04/2006. JOB NUMBER 04–209, DRAWING No. 04–209–MW.
4. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), US SURVEY FEET.
5. ACTUAL SITE FEATURES AT THE TIME OF CONSTRUCTION MAY DIFFER FROM THOSE SHOWN ON THE DRAWINGS. THE CONTRACTOR SHALL PROMPTLY NOTIFY THE OWNER AND ENGINEER (IN WRITING) OF ANY SUCH DIFFERENCES THAT MAY AFFECT PERFORMANCE OF THE WORK.
6. INFORMATION RELATED TO SUBSURFACE CONDITIONS IS APPROXIMATE AND SHOULD NOT BE RELIED UPON AS A COMPLETE DEPICTION OF THE SITE CONDITIONS.
7. THE TECHNICAL WORK AND CONTRACTOR REQUIREMENTS ARE DESCRIBED IN SEVERAL DOCUMENTS. THESE DOCUMENTS INCLUDE: THE REMEDIAL DESIGN REPORT, DRAWINGS, AND TECHNICAL SPECIFICATIONS. THESE DOCUMENTS SHOULD BE THOROUGHLY REVIEWED BY THE CONTRACTOR. ANY DIFFERENCES IDENTIFIED BY THE CONTRACTOR BETWEEN THE INFORMATION PRESENTED IN THE ABOVE-LISTED DOCUMENTS SHALL BE SUBMITTED TO THE ENGINEER (IN WRITING) FOR CLARIFICATION.

SITE MANAGEMENT/PROJECT PERFORMANCE NOTES:

1. ALL WORK SHALL BE PERFORMED IN A NEAT AN ORDERLY MANNER, IN CONFORMANCE WITH THE BEST MODERN TRADE PRACTICE, AND BY COMPETENT EXPERIENCED PERSONNEL. MATERIALS AND INSTALLATION SHALL BE IN ACCORDANCE WITH ALL CODES, REGULATIONS, AND REQUIREMENTS OF ALL APPLICABLE CITY, COUNTY, STATE, FEDERAL AND OTHER PUBLIC AUTHORITIES.
2. ALL EQUIPMENT OPERATED WITHIN THE PROJECT WORK LIMITS SHALL BE DECONTAMINATED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS PRIOR TO ARRIVING ON-SITE AND PRIOR TO LEAVING THE SITE. PROJECT EQUIPMENT THAT COMES IN CONTACT WITH EXCAVATED MATERIALS SHALL BE APPROPRIATELY DECONTAMINATED PRIOR TO HANDLING BORROW MATERIAL OR EXCAVATED MATERIAL SUBJECT TO RE-USE AS ON-SITE BACKFILL, AND PRIOR TO LEAVING THE SITE ACCORDING TO THE TECHNICAL SPECIFICATIONS.
3. EXISTING SITE FEATURES NOT SPECIFICALLY IDENTIFIED ON THE DESIGN DRAWINGS MAY REQUIRE REMOVAL BY THE CONTRACTOR TO FACILITATE CONSTRUCTION. THE REMOVAL OF SUCH FEATURES SHALL NOT BE PERFORMED WITHOUT PRIOR APPROVAL FROM THE ENGINEER.

SAFETY NOTES:

1. THE CONTRACTOR SHALL PROVIDE EVIDENCE OF ALL ON-SITE PERSONNEL COMPLETING OSHA 40-HOUR TRAINING AND 8-HOUR TRAINING PRIOR TO INITIATING REMEDIAL CONSTRUCTION ACTIVITIES.
2. THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING, MAINTAINING, AND SUPERVISING ALL SAFETY MEASURES AND PROGRAMS IN CONNECTION WITH THE PROJECT. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS FOR THE SAFETY AND PROTECTION OF SITE WORKERS, ENGINEERING PERSONNEL, AND SITE VISITORS.
3. THE MATERIALS SUBJECT TO HANDLING AS PART OF THE PROJECT MAY CONTAIN HAZARDOUS CONSTITUENTS OR CHEMICALS AND SHOULD BE HANDLED IN ACCORDANCE WITH APPLICABLE REGULATIONS. THE REMEDIATION CONTRACTOR SHALL DEVELOP AND IMPLEMENT APPROPRIATE HEALTH AND SAFETY MEASURES FOR ITS EMPLOYEES, SUBCONTRACTORS, AND SITE VISITORS, AND FOR THE PROTECTION OF THE ENVIRONMENT AND SURROUNDING COMMUNITY.
4. THE CONTRACTOR SHALL PERFORM ALL TRENCHING AND EXCAVATION OPERATIONS IN ACCORDANCE WITH THE REQUIREMENTS OF 29 CFR 1926.650. THE CONTRACTOR SHALL EMPLOY CERTIFIED/TRAINED ON-SITE PERSONNEL TO ACT AS EXCAVATION COMPETENT PERSON AND PERFORM INSPECTIONS AS DEFINED IN 29 CFR 1926.650.

UTILITY NOTES:

1. THE LOCATIONS, ALIGNMENTS, AND CONSTRUCTION OF UTILITIES SHOWN ON THE DRAWINGS ARE APPROXIMATE AND BASED ON INFORMATION READILY AVAILABLE TO THE DESIGN ENGINEER. PRIOR TO BEGINNING THE WORK, THE CONTRACTOR SHALL VERIFY THE PRESENCE AND LOCATION OF ALL UNDERGROUND SITE FEATURES AND UTILITIES RELEVANT TO AND POTENTIALLY TO BE ENCOUNTERED DURING THE WORK. ADDITIONAL SITE FEATURES AND UTILITIES MAY BE PRESENT THAT ARE NOT SHOWN ON THE DRAWINGS.
2. THE CONTRACTOR IS RESPONSIBLE FOR CONTACTING/COORDINATING WITH DIG SAFELY NEW YORK TO LOCATE AND IDENTIFY UNDERGROUND UTILITIES. THE DIG SAFELY NEW YORK PHONE NUMBER IS 811; THE WEBSITE IS WWW.DIGSAFELYNEWYORK.COM. RECORDS OF UTILITY NOTIFICATIONS SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO INITIATING INTRUSIVE WORK.
3. THE CONTRACTOR IS RESPONSIBLE FOR CONTACTING/COORDINATING WITH THE APPROPRIATE UTILITY COMPANIES FOR THE TEMPORARY BRACING, REMOVAL, RELOCATION, AND/OR REPLACEMENT OF ANY UTILITIES, UTILITY POLES, OR GUY WIRES.

SITE MANAGEMENT/PROJECT PERFORMANCE NOTES:

1. ALL WORK SHALL BE PERFORMED IN A NEAT AND ORDERLY MANNER, IN CONFORMANCE WITH BEST MODERN TRADE PRACTICE, AND BY COMPETENT, EXPERIENCED PERSONNEL. MATERIALS AND INSTALLATION SHALL BE IN ACCORDANCE WITH ALL CODES, REGULATIONS, AND REQUIREMENTS OF ALL APPLICABLE CITY, STATE, FEDERAL, AND OTHER PUBLIC AUTHORITIES.
2. ALL EQUIPMENT OPERATED WITHIN THE PROJECT WORK LIMITS SHALL BE DECONTAMINATED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS PRIOR TO ARRIVING ON-SITE AND PRIOR TO LEAVING THE SITE. PROJECT EQUIPMENT THAT COMES IN CONTACT WITH EXCAVATED MATERIALS SHALL BE APPROPRIATELY DECONTAMINATED PRIOR TO HANDLING BORROW MATERIAL, THERMALLY TREATED MATERIAL OR EXCAVATED MATERIAL SUBJECT TO RE-USE AS ONSITE BACKFILL, AND PRIOR TO LEAVING THE SITE ACCORDING TO THE TECHNICAL SPECIFICATIONS.
3. EXISTING SITE FEATURES NOT SPECIFICALLY IDENTIFIED ON THE DESIGN DRAWINGS MAY REQUIRE REMOVAL BY THE CONTRACTOR TO FACILITATE CONSTRUCTION. THE REMOVAL OF SUCH FEATURES SHALL NOT BE PERFORMED WITHOUT PRIOR APPROVAL FROM THE ENGINEER.
4. WORK ZONE AIR MONITORING SHALL BE PERFORMED BY THE CONTRACTOR IN ACCORDANCE WITH THE CONTRACTOR'S HASP, REMEDIATION DESIGN (RD) REPORT, REMEDIAL ACTION WORK PLAN (RAWP), AND TECHNICAL SPECIFICATIONS.

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS:
01701X00
IMAGES:

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.:
Designed by: | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

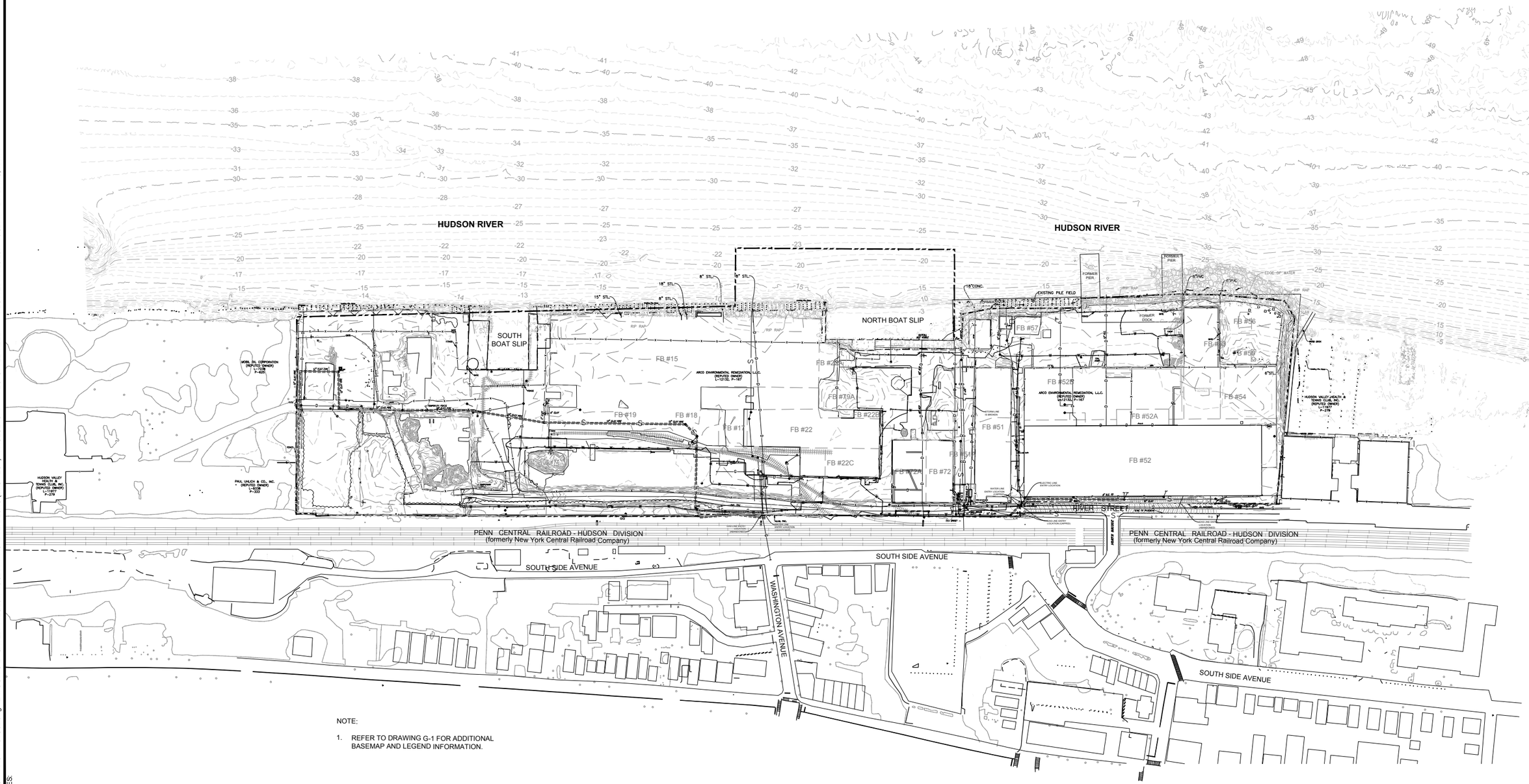
GENERAL NOTES AND LEGEND

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

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One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

G-1



NOTE:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.

XREFS:
01701X00
01701X01
01701X13
IMAGES:

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G.STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF"=REF*
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120' 0 120' 240'
1"=120'

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USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1
State: NY | Date Signed: | Project Mgr.:
Designed by: | Drawn by: | Checked by:

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXISTING SITE CONDITIONS

ARCADIS Project No.
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G-2

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G. STEINBERGER PIC:K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS:
IMAGES:
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01701X01
01701X13

APPROXIMATE SHORELINE
15" STL.
18" STL.
8" STL.
8" STL.
8" STL.
Existing Pile Fields
Existing Pile Fields
DOCK
DOCK
DOCK
DOCK
GATE
GATE
FENCE
GATE
FENCE
GATE
FENCE
12" CLAY PIPE
12" CLAY PIPE
12" CLAY PIPE
INACTIVE
TEMPORARY FENCE
12" CLAY PIPE
12" CLAY PIPE
6" CLAY
6" CLAY
8" CLAY
12" CLAY PIPE
12" CLAY PIPE
INACTIVE
INACTIVE
TEMPORARY FENCE
INACTIVE
INACTIVE
GAS LINE CUT & CAPPED (DATE UNKNOWN)
FNC. END
ALUM. FNC.
GAS LINE ENTRY LOCATION (ABANDONED)
WATER LINE ENTRY LOCATION (ABANDONED)

NOTE:
1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASEMAP INFORMATION.

LEGEND:
- G — EXISTING GAS LINE (INACTIVE)
- S — EXISTING SANITARY SEWER LINE
- D — EXISTING STORM DRAIN
- W — EXISTING WATER LINE (INACTIVE)
- ⊞ EXISTING CATCH BASIN
- ⊕ EXISTING MANHOLE
- APPROXIMATE SHORELINE

1"=40' (40' 0 40' 80')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: . | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

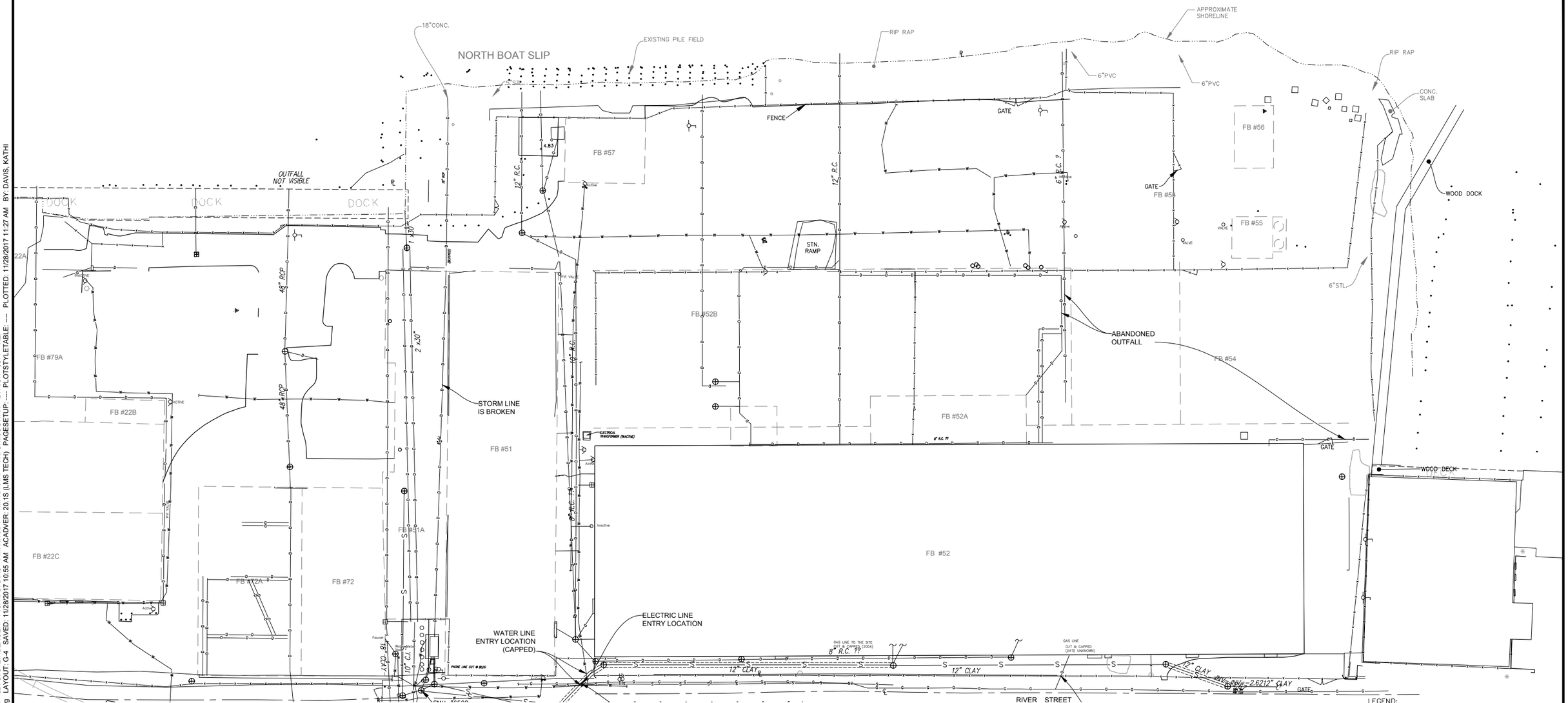
EXISTING UTILITY PLAN (SOUTH)

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

G-3



NOTE:
1. REFER TO DRAWING 1 FOR ADDITIONAL LEGEND AND BASE MAP INFORMATION.

LEGEND:

- G — EXISTING GAS LINE (INACTIVE)
- S — EXISTING SANITARY SEWER LINE
- D — EXISTING STORM DRAIN
- W — EXISTING WATER LINE (INACTIVE)
- ⊞ EXISTING CATCH BASIN
- ⊕ EXISTING MANHOLE
- APPROXIMATE SHORELINE

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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1"=40' (40' 0 40' 80')

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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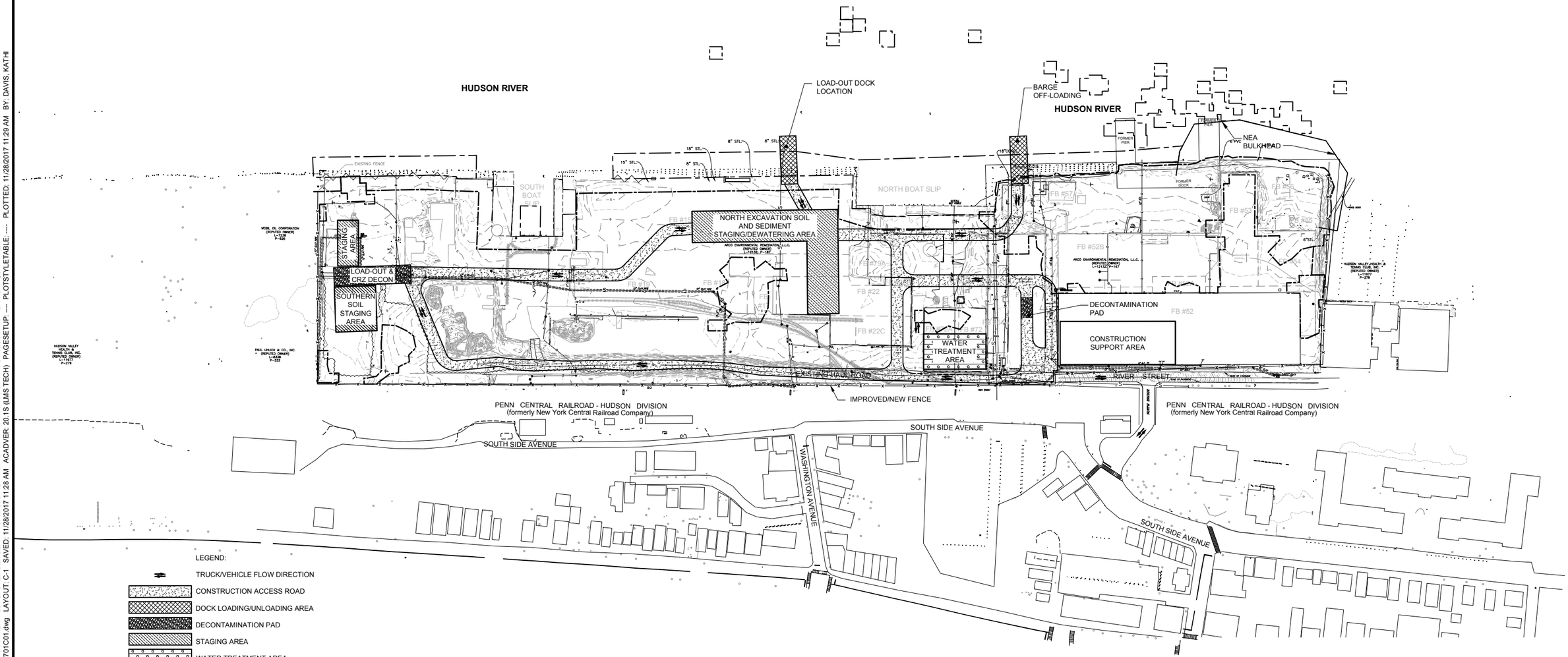
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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXISTING UTILITY PLAN (NORTH)

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G-4



LEGEND:

- TRUCK/VEHICLE FLOW DIRECTION
- CONSTRUCTION ACCESS ROAD
- DOCK LOADING/UNLOADING AREA
- DECONTAMINATION PAD
- STAGING AREA
- WATER TREATMENT AREA
- DREDGING LIMITS
- EXCAVATION LIMITS
- IMPROVED/NEW FENCING

NOTES:

1. REFER TO DRAWING G–1 FOR ADDITIONAL LEGEND AND BASE MAP INFORMATION..
2. SITE LOGISTICS AND TRAFFIC CONTROL PLAN REPRESENT A GENERAL SITE AND THE PLAN WILL BE DEVELOPED BY THE SELECTED REMEDIAL CONTRACTOR.

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="*";OFF="*REF*"
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01701X01

1"=120' (120' 0 120' 240')

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by | Drawn by | Checked by

NOT FOR CONSTRUCTION

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

SITE LOGISTICS AND TRAFFIC CONTROL PLAN

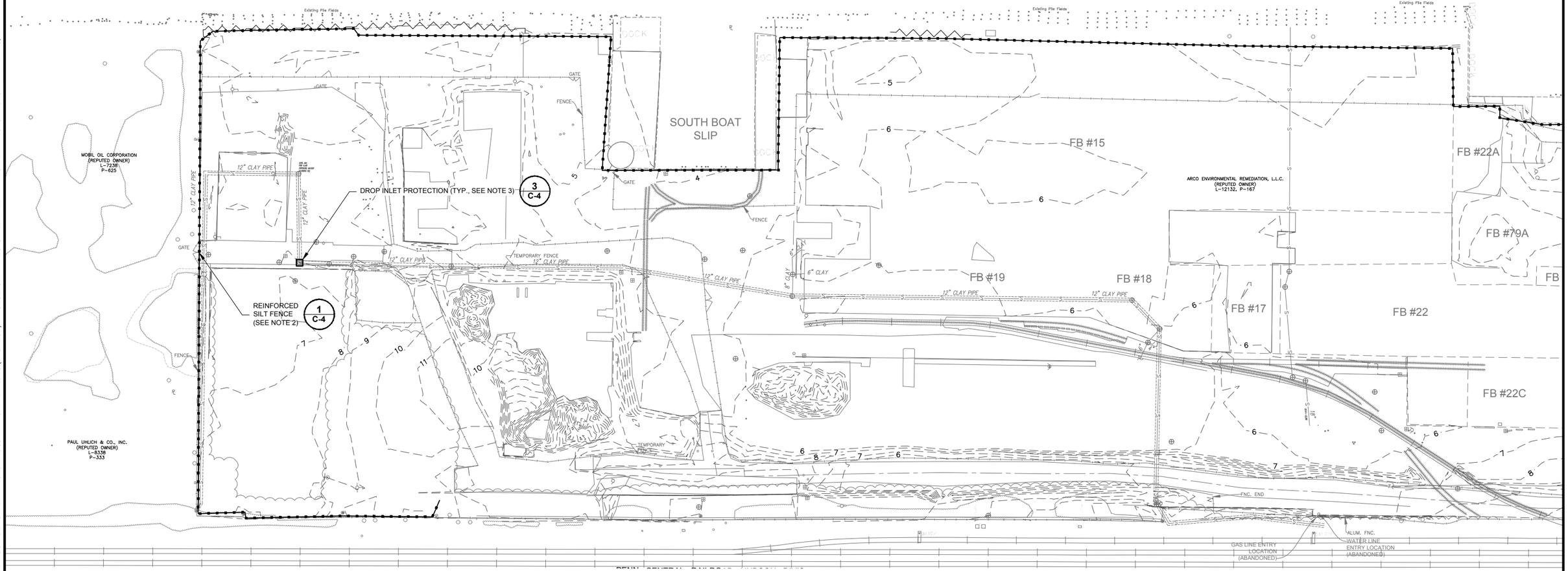
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Date
NOVEMBER 2017

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Syracuse, NY 13202
Tel: 315-446-9120

C-1

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS:
0170 1X00
0170 1X01
IMAGES:



NOTES:

1. REFER TO DRAWING G–1 FOR ADDITIONAL LEGEND AND BASE MAP INFORMATION.
2. EROSION AND SEDIMENTATION CONTROL MEASURES SHOWN ARE GENERAL LOCATIONS. LOCATIONS WILL BE MODIFIED AS NEEDED DURING EXECUTION OF THE WORK TO FACILITATE EXCAVATION, AND ACCESS ROUTES.
3. DROP INLET PROTECTION MEASURES WILL BE INSTALLED IN AREAS THAT MAY RECEIVE RUNOFF DURING THE WORK. DROP INLET PROTECTION WILL BE IN PLACE AT AFFECTED LOCATIONS UNTIL SITE STORMWATER DRAINAGE FEATURES ARE ABANDONED AS DETAILED ON THE DESIGN DRAWINGS.
4. ALL SHORELINE EXCAVATION, DREDGING AND SLOPED SHORELINE CONSTRUCTION TO ABOVE HIGH WATER MARK WILL BE DONE INSIDE THE SILT CURTAIN, AND/OR TEMPORARY SHEETING.

LEGEND:

REINFORCED SILT FENCE — 1 C-4

DROP INLET PROTECTION — 3 C-4

50' 0 50' 100'
1"=50'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EROSION AND SEDIMENT CONTROL PLAN - SOUTH

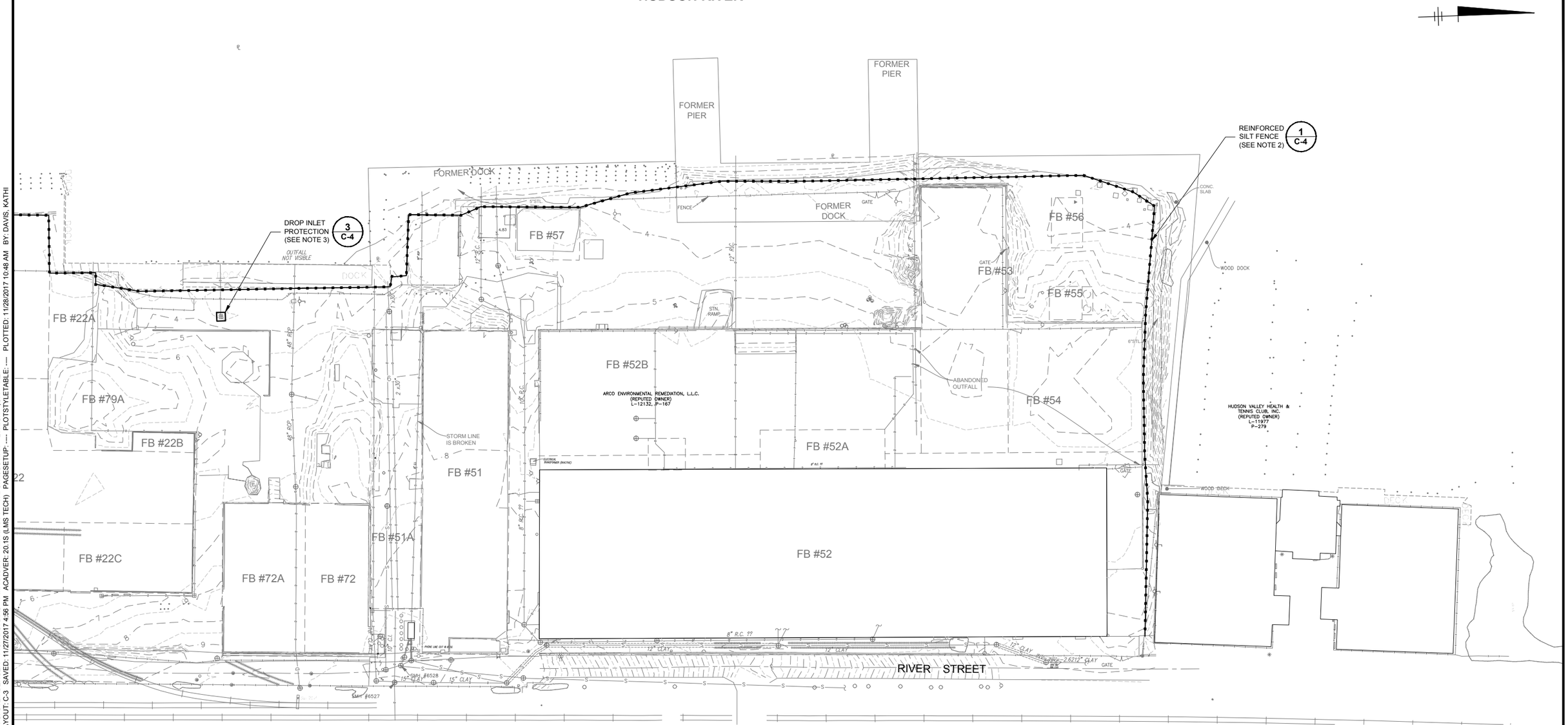
ARCADIS Project No.
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Date
NOVEMBER 2017

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One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-2

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF=*REF*
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XREFS: IMAGES:
01701X00
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NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASE MAP INFORMATION.
2. EROSION AND SEDIMENTATION CONTROL MEASURES SHOWN ARE GENERAL LOCATIONS. LOCATIONS WILL BE MODIFIED AS NEEDED DURING EXECUTION OF THE WORK TO FACILITATE EXCAVATION AND ACCESS ROUTES.
3. DROP INLET PROTECTION MEASURES WILL BE INSTALLED IN AREAS THAT MAY RECEIVE RUNOFF DURING THE WORK. DROP INLET PROTECTION WILL BE IN PLACE AT AFFECTED LOCATIONS UNTIL SITE STORMWATER DRAINAGE FEATURES ARE ABANDONED AS DETAILED ON THE DESIGN DRAWINGS.
4. ALL SHORELINE EXCAVATION, DREDGING, AND SLOPED SHORELINE CONSTRUCTION TO ABOVE HIGH WATER MARK WILL BE DONE INSIDE THE SILT CURTAIN, AND/OR TEMPORARY SHEETING. IN-WATER TURBIDITY CONTROLS ARE SHOWN ON DREDGE DRAWINGS.

LEGEND:

REINFORCED SILT FENCE 1 C-4

DROP INLET PROTECTION 3 C-4

50' 0 50' 100'
1"=50'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		.
Designed by	Drawn by	Checked by
.	.	.

NOT FOR CONSTRUCTION

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

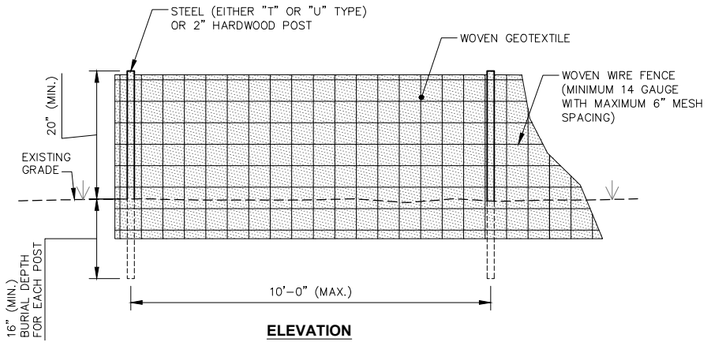
EROSION AND SEDIMENT CONTROL PLAN - NORTH

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-3



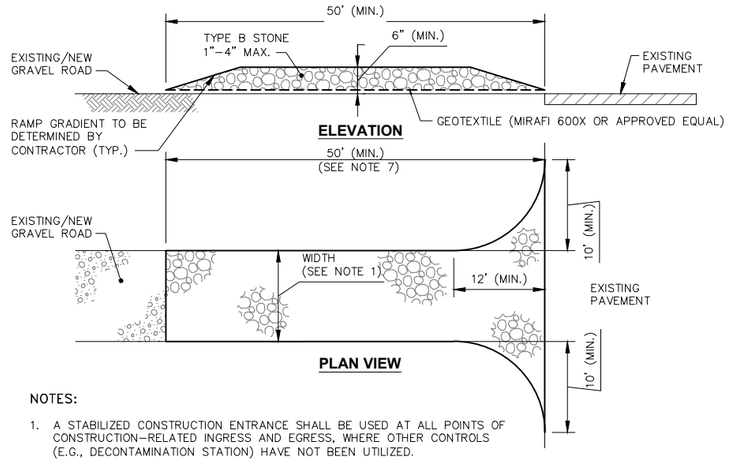
ELEVATION

NOTES:

1. SEDIMENT DEPOSITS SHALL BE REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE GEOTEXTILE.
2. WHEN TWO SECTIONS OF WOVEN GEOTEXTILE ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY 6" AND FOLDED.
3. PREFABRICATED UNITS SHALL BE GEOFAB, ENVIROFENCE, OR APPROVED EQUIVALENT.

REINFORCED SILT FENCE (1)

NOT TO SCALE

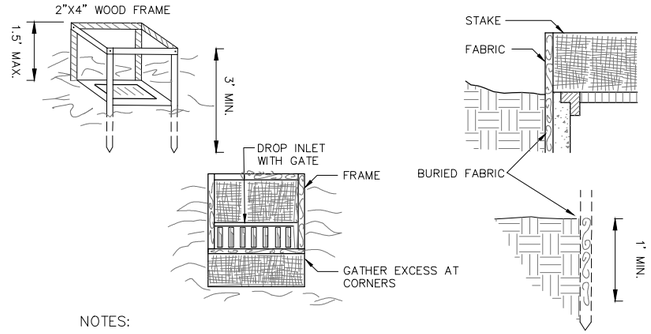


NOTES:

1. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE USED AT ALL POINTS OF CONSTRUCTION-RELATED INGRESS AND EGRESS, WHERE OTHER CONTROLS (E.G., DECONTAMINATION STATION) HAVE NOT BEEN UTILIZED.
2. MINIMUM WIDTH SHALL BE 12 FEET, BUT NOT LESS THAN THE FULL WIDTH OF POINTS OF INGRESS AND EGRESS.
3. THE CONTRACTOR SHALL PREVENT TRACKING OF SOIL MATERIALS ONTO OFF-SITE AREAS. ANY SOIL MATERIALS ACCIDENTALLY TRACKED OR OTHERWISE SPILLED/DROPPED ONTO OFF-SITE AREAS SHALL BE IMMEDIATELY CLEANED UP.
4. ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED BENEATH THE ENTRANCE. IF PIPING IS IMPRACTICAL CONTRACTOR SHALL NOTIFY ENGINEER.
5. CONTRACTOR SHALL INSPECT AND MAINTAIN CONSTRUCTION ENTRANCE (AS NECESSARY) FOLLOWING EACH RAIN EVENT.
6. CONSTRUCTION ENTRANCE SHALL BE MAINTAINED TO REDUCE THE POTENTIAL FOR TRACKING OF SEDIMENTS ONTO ROADWAYS, WHICH MAY INCLUDE TOP PRESSING ADDITIONAL AGGREGATE.
7. MINIMUM LENGTH SHALL BE 50 FEET, BUT NOT LESS THAN LENGTH OF LONGEST VEHICLE EXPECTED.

STABILIZED CONSTRUCTION ENTRANCE (2)

NOT TO SCALE



NOTES:

1. FILTER FABRIC SHALL HAVE AN AOS OF 40-85. BURLAP MAY BE USED FOR SHORT TERM APPLICATIONS.
2. CUT FABRIC FROM A CONTINUOUS ROLL TO ELIMINATE JOINTS. IF JOINTS ARE NEEDED THEY WILL BE OVERLAPPED 6" AND FOLDED TOGETHER.
3. SPACE STAKES EVENLY AROUND INLET 3 FEET APART AND DRIVE A MINIMUM 18 INCHES DEEP. SPANS GREATER THAN 3 FEET MAY BE BRIDGED WITH THE USE OF WIRE MESH BEHIND THE FILTER FABRIC FOR SUPPORT.
4. FABRIC SHALL BE EMBEDDED 1 FOOT MINIMUM BELOW GROUND AND BACKFILLED. IT SHALL BE SECURELY FASTENED TO THE STAKES AND FRAME.
5. A 2" x 4" WOOD FRAME SHALL BE COMPLETED AROUND THE CREST OF THE FABRIC FOR OVER FLOW STABILITY.
6. MAXIMUM DRAINAGE AREA 1 ACRE.

DROP INLET PROTECTION (3)

NOT TO SCALE

GENERAL NOTE:

1. ADDITIONAL SOIL EROSION AND SEDIMENT CONTROL DETAILS (I.E., TURBIDITY CURTAIN) WILL BE INCLUDED AS PART OF THE FINAL DESIGN, AS NECESSARY.

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IMAGES:

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed | Project Mgr.
Designed by | Drawn by | Checked by

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EROSION AND SEDIMENT CONTROL DETAILS

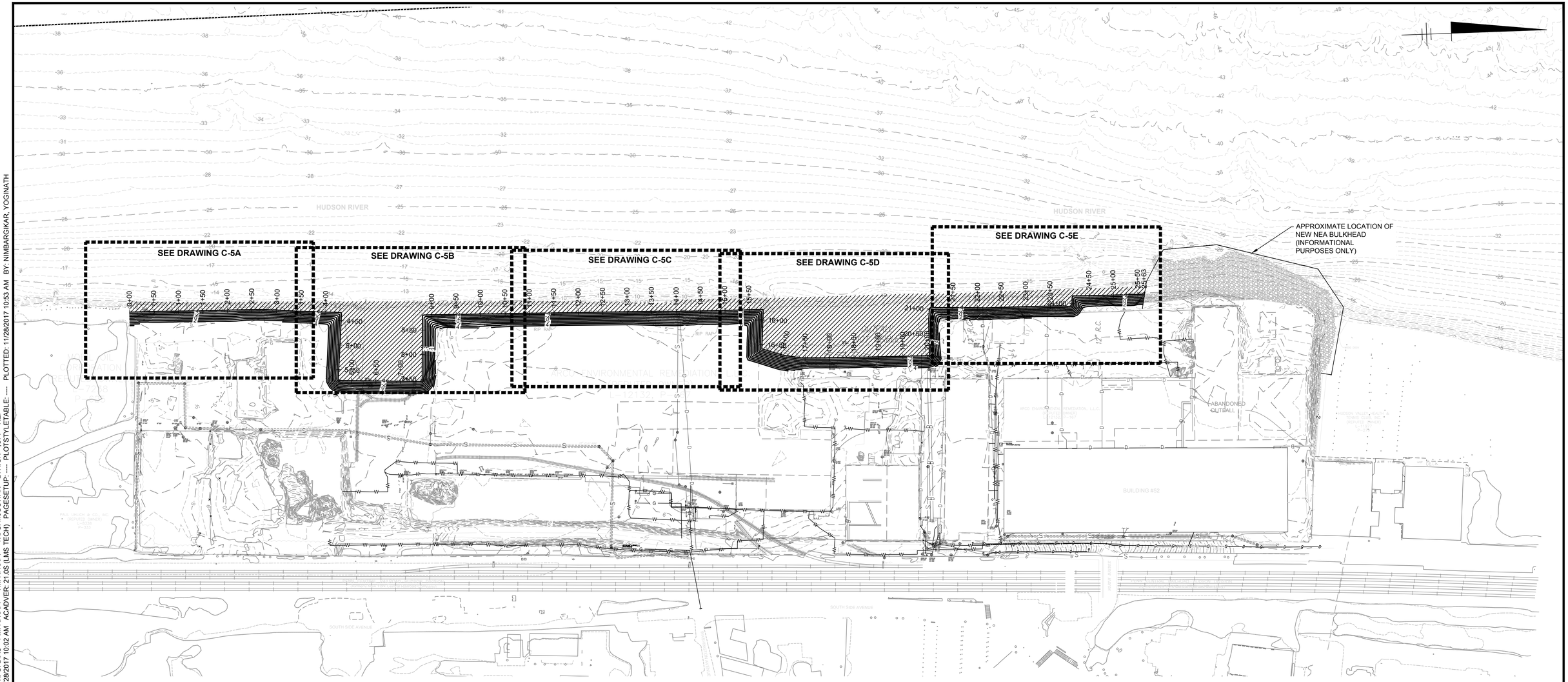
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NOVEMBER 2017

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Tel: 315-446-9120

C-4

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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01701X12
IMAGES:



LEGEND:

- 0+00 — 0+25 — STATIONING LINE
- EXISTING PILE FIELDS
- 10 — PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

NOTE:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.

100' 0 100' 200'
1"=100'

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Professional Engineer's No.
069985-1
State: NY | Date Signed: | Project Mgr.: .
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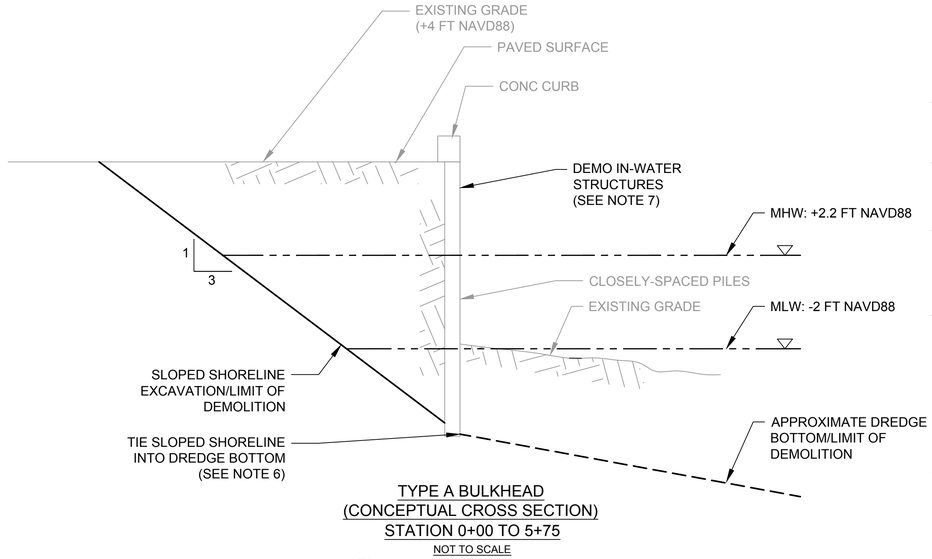
ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

GENERAL DEMOLITION PLAN

ARCADIS Project No.
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C-5



TYPE A BULKHEAD
(CONCEPTUAL CROSS SECTION)
STATION 0+00 TO 5+75

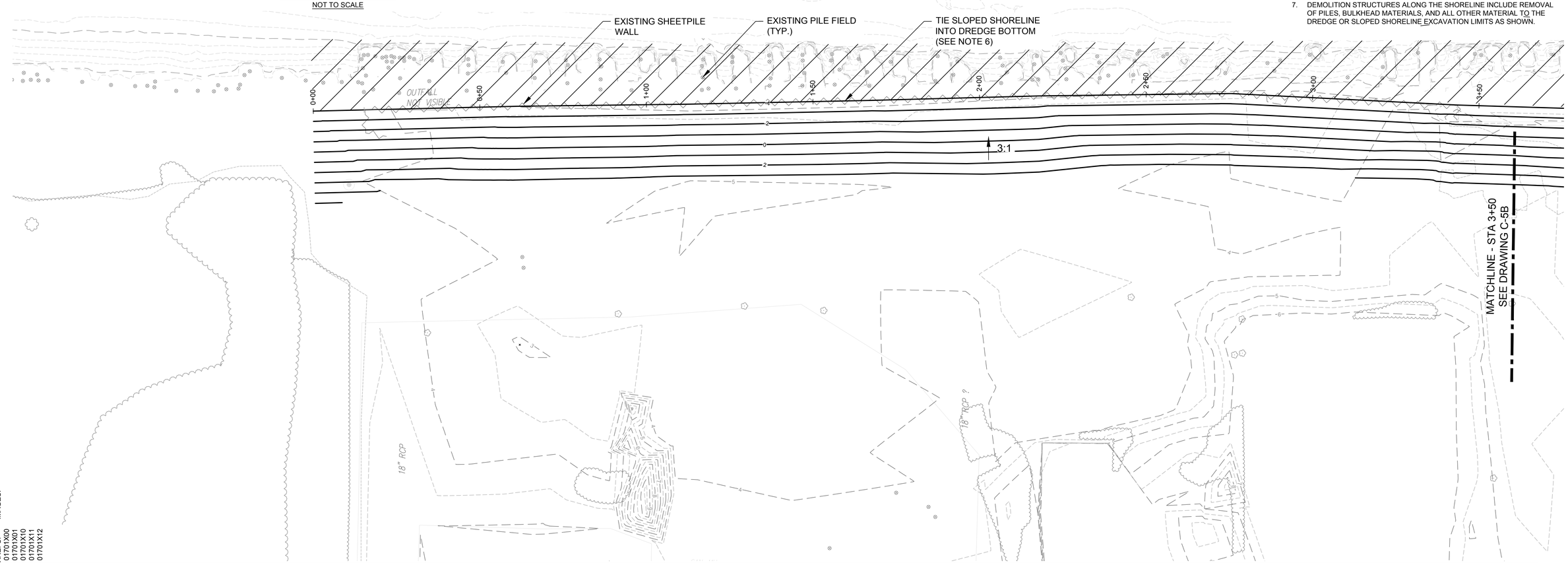
NOT TO SCALE

LEGEND:

- STATIONING LINE (0+00 — 0+25)
- EXISTING PILE FIELDS
- 10 — PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

NOTES:

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CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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1"=15' (15' 0 15' 30')

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USE TO VERIFY FIGURE REPRODUCTION SCALE

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Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: -
Designed by: | Drawn by: - | Checked by: -

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

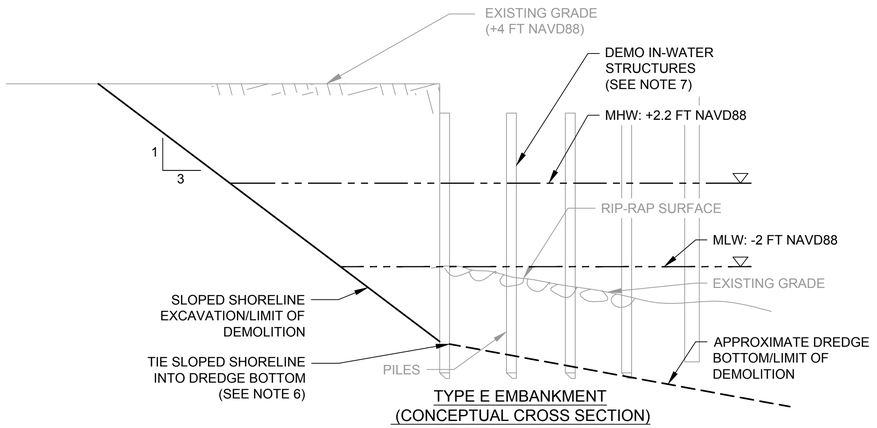
SHORELINE DEMOLITION PLAN - STATION 0+00 TO 3+50

ARCADIS Project No.
B0001701.0002.00134

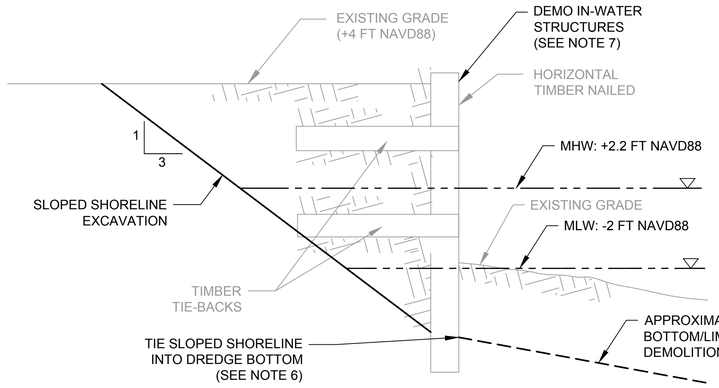
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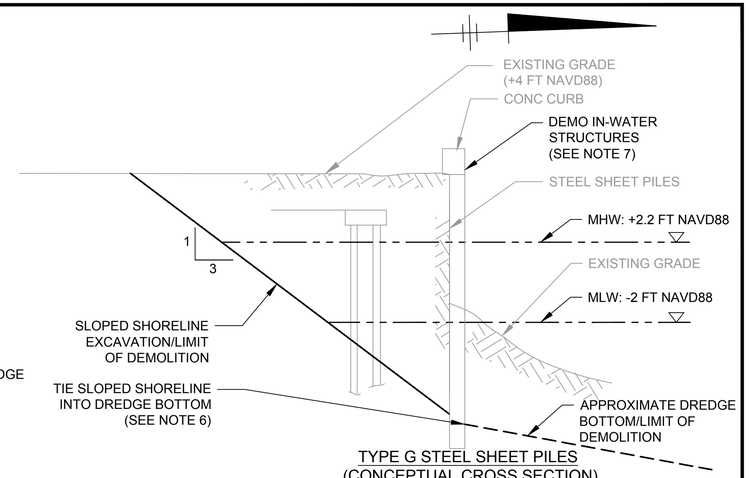
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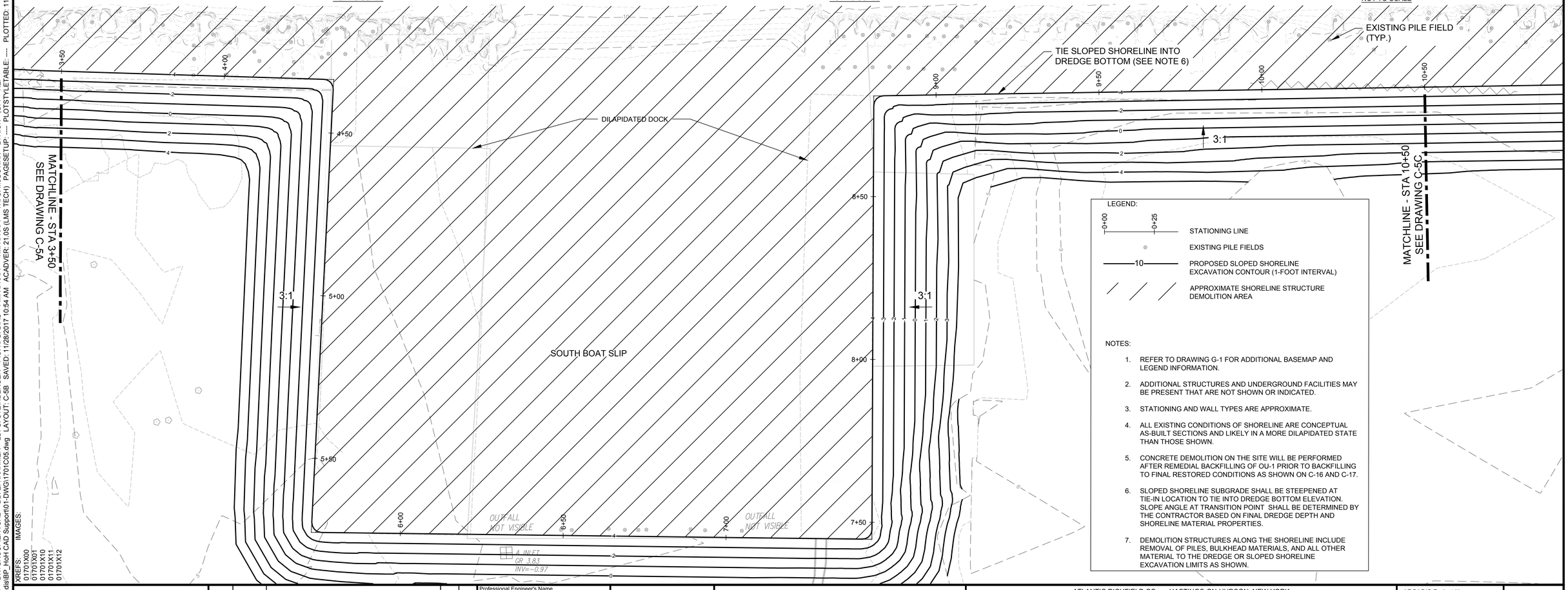
TYPE E EMBANKMENT
(CONCEPTUAL CROSS SECTION)
STATION 5+75 TO 7+25
NOT TO SCALE



TYPE D RETAINING WALL
(CONCEPTUAL CROSS SECTION)
STATION 7+25 TO 8+75
NOT TO SCALE



TYPE G STEEL SHEET PILES
(CONCEPTUAL CROSS SECTION)
STATION 9+75 TO 10+25
NOT TO SCALE



LEGEND:

- STATIONING LINE
- EXISTING PILE FIELDS
- PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

NOTES:

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1"=15' (15' 0 15' 30')

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY	.	.
Designed by	Drawn by	Checked by
.	.	.

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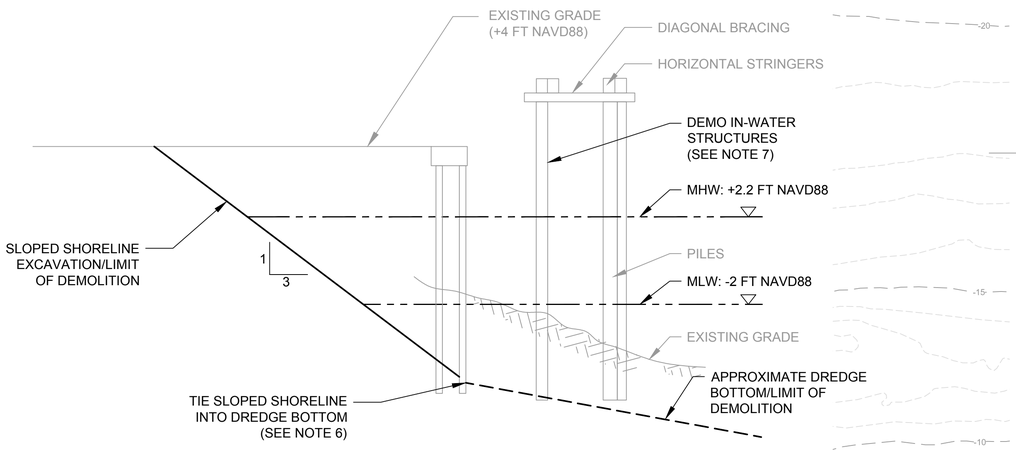
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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

SHORELINE DEMOLITION PLAN - STATION 3+50 TO 10+75

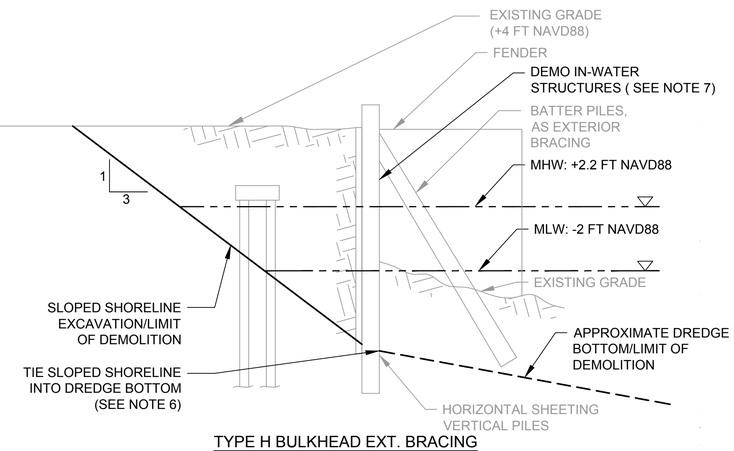
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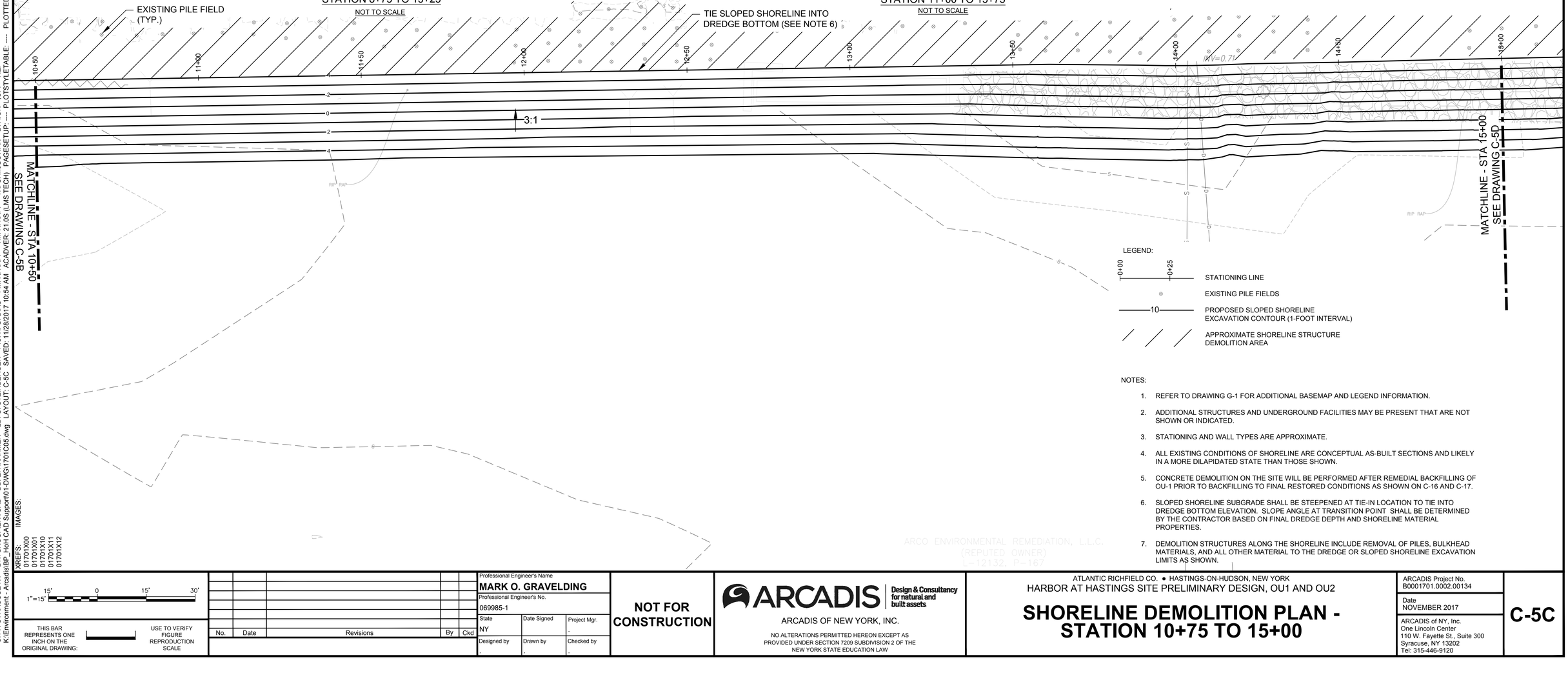
C-5B



TYPE F FENDER
(CONCEPTUAL CROSS SECTION)
STATION 8+75 TO 13+25
NOT TO SCALE



TYPE H BULKHEAD EXT. BRACING
(CONCEPTUAL CROSS SECTION)
STATION 11+00 TO 15+75
NOT TO SCALE



LEGEND:

- 0+00 — 0+25 — STATIONING LINE
- EXISTING PILE FIELDS
- 10 — PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

NOTES:

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State	Date Signed	Project Mgr.
NY		.

Designed by	Drawn by	Checked by
.	.	.

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

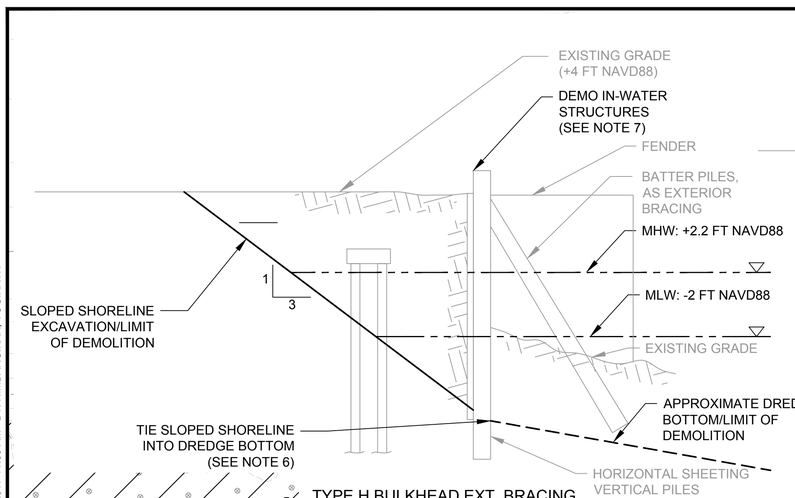
SHORELINE DEMOLITION PLAN - STATION 10+75 TO 15+00

ARCADIS Project No.
B0001701.0002.00134

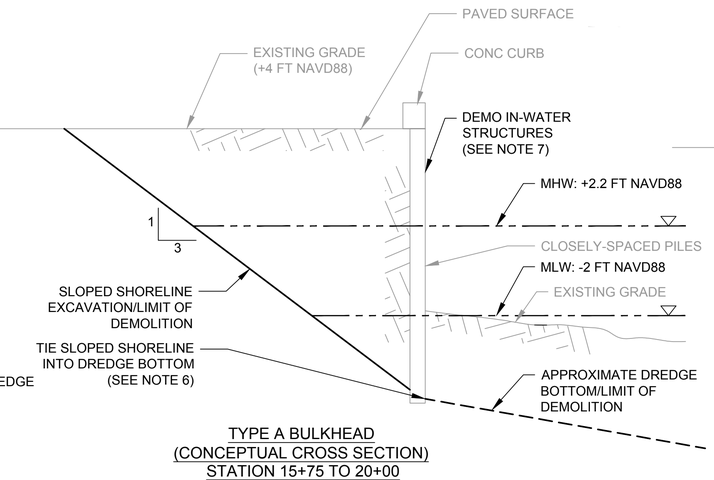
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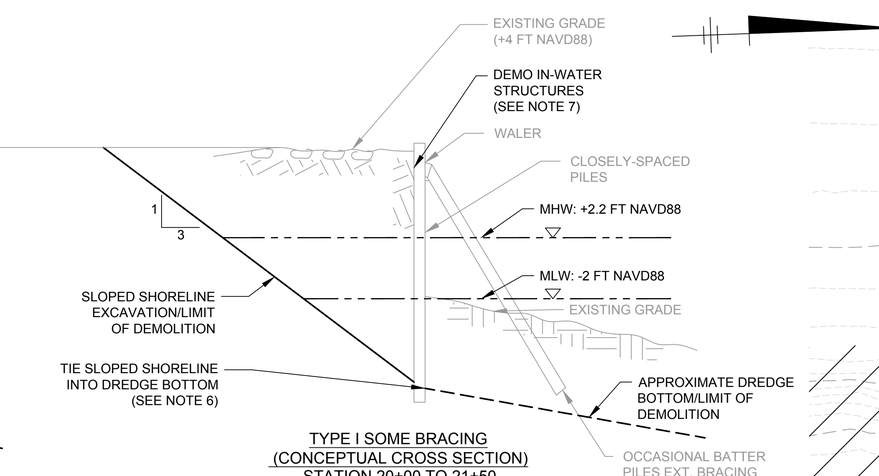
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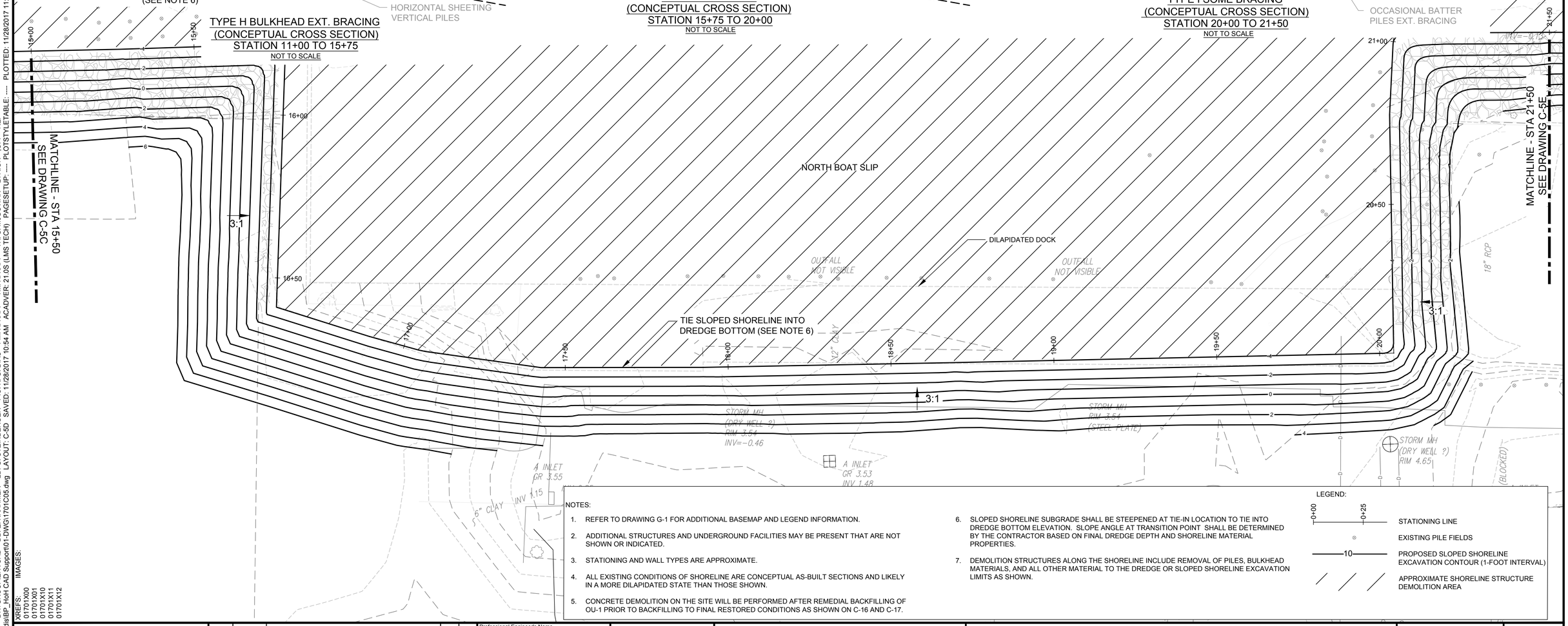
TYPE H BULKHEAD EXT. BRACING
(CONCEPTUAL CROSS SECTION)
STATION 11+00 TO 15+75
NOT TO SCALE



TYPE A BULKHEAD
(CONCEPTUAL CROSS SECTION)
STATION 15+75 TO 20+00
NOT TO SCALE



TYPE I SOME BRACING
(CONCEPTUAL CROSS SECTION)
STATION 20+00 TO 21+50
NOT TO SCALE



NOTES:

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LEGEND:

- 0+00 — 0+25: STATIONING LINE
- EXISTING PILE FIELDS
- 10: PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)
- APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS:
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01701X10
01701X11
01701X12

1"=15' (15' 0 15' 30')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		.
Designed by	Drawn by	Checked by
.	.	.

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

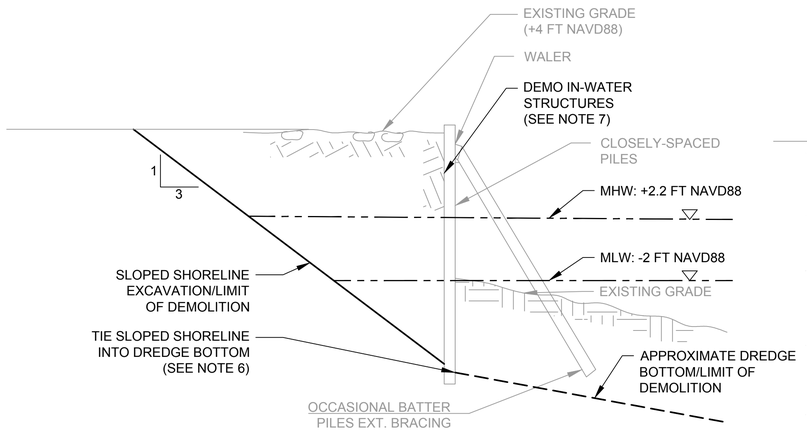
SHORELINE DEMOLITION PLAN - STATION 15+00 TO 21+75

ARCADIS Project No.
B0001701.0002.00134

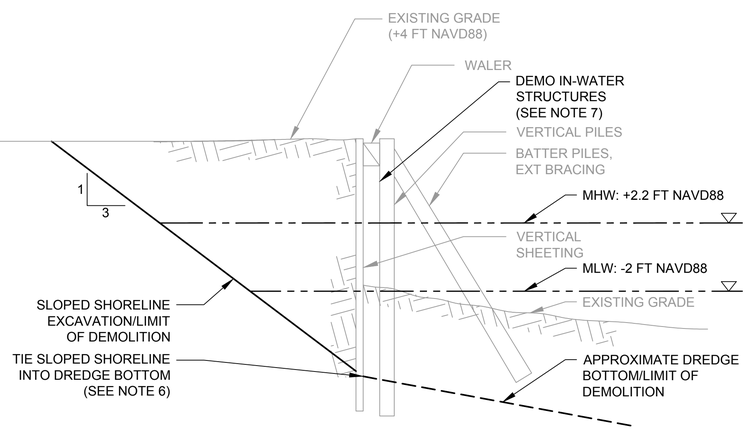
Date
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Syracuse, NY 13202
Tel: 315-446-9120

C-5D



TYPE I SOME BRACING
(CONCEPTUAL CROSS SECTION)
STATION 20+00 TO 21+50
NOT TO SCALE



TYPE J EXT. BRACING
(CONCEPTUAL CROSS SECTION)
STATION 21+50 TO 24+00
NOT TO SCALE

LEGEND:

0+00 0+25 STATIONING LINE

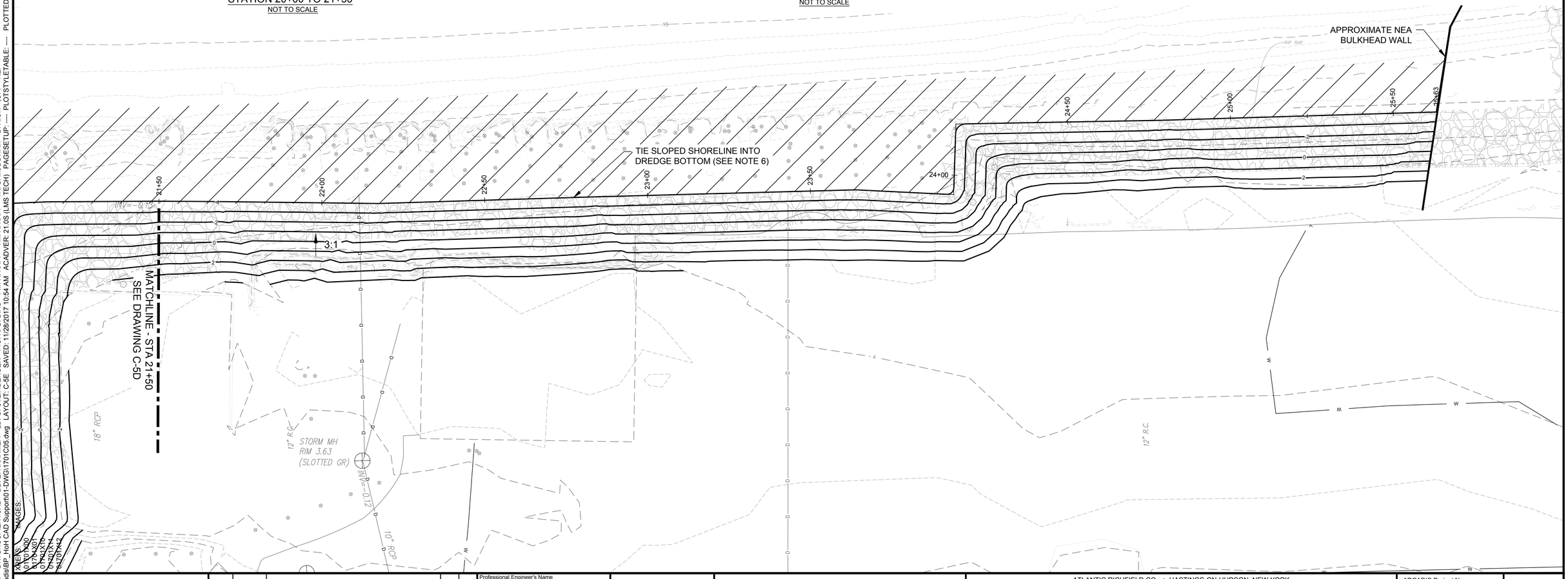
EXISTING PILE FIELDS

10 PROPOSED SLOPED SHORELINE EXCAVATION CONTOUR (1-FOOT INTERVAL)

APPROXIMATE SHORELINE STRUCTURE DEMOLITION AREA

NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.
2. ADDITIONAL STRUCTURES AND UNDERGROUND FACILITIES MAY BE PRESENT THAT ARE NOT SHOWN OR INDICATED.
3. STATIONING AND WALL TYPES ARE APPROXIMATE.
4. ALL EXISTING CONDITIONS OF SHORELINE ARE CONCEPTUAL AS-BUILT SECTIONS AND LIKELY IN A MORE DILAPIDATED STATE THAN THOSE SHOWN.
5. CONCRETE DEMOLITION ON THE SITE WILL BE PERFORMED AFTER REMEDIAL BACKFILLING OF OU-1 PRIOR TO BACKFILLING TO FINAL RESTORED CONDITIONS AS SHOWN ON C-16 AND C-17.
6. SLOPED SHORELINE SUBGRADE SHALL BE STEEPENED AT TIE-IN LOCATION TO TIE INTO DREDGE BOTTOM ELEVATION. SLOPE ANGLE AT TRANSITION POINT SHALL BE DETERMINED BY THE CONTRACTOR BASED ON FINAL DREDGE DEPTH AND SHORELINE MATERIAL PROPERTIES.
7. DEMOLITION STRUCTURES ALONG THE SHORELINE INCLUDE REMOVAL OF PILES, BULKHEAD MATERIALS, AND ALL OTHER MATERIAL TO THE DREDGE OR SLOPED SHORELINE EXCAVATION LIMITS AS SHOWN.



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XREFS:
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01701X01
01701X10
01701X11
01701X12
IMAGES:

15' 0 15' 30'
1"=15'

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USE TO VERIFY FIGURE REPRODUCTION SCALE

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Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		-
Designed by	Drawn by	Checked by
-	-	-

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SHORELINE DEMOLITION PLAN - STATION 21+75 TO 25+75

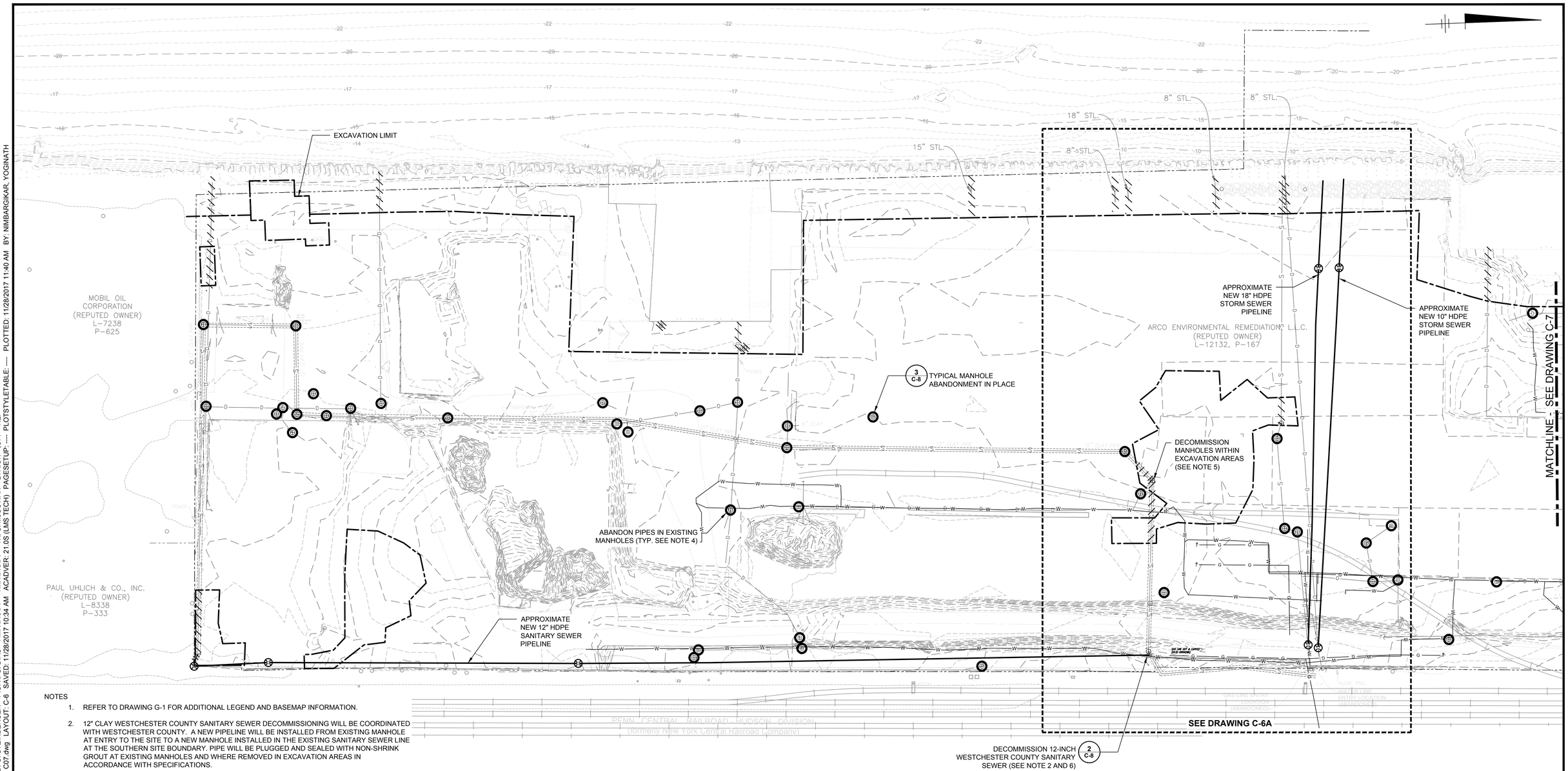
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NOTES

1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASEMAP INFORMATION.
2. 12" CLAY WESTCHESTER COUNTY SANITARY SEWER DECOMMISSIONING WILL BE COORDINATED WITH WESTCHESTER COUNTY. A NEW PIPELINE WILL BE INSTALLED FROM EXISTING MANHOLE AT ENTRY TO THE SITE TO A NEW MANHOLE INSTALLED IN THE EXISTING SANITARY SEWER LINE AT THE SOUTHERN SITE BOUNDARY. PIPE WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT AT EXISTING MANHOLES AND WHERE REMOVED IN EXCAVATION AREAS IN ACCORDANCE WITH SPECIFICATIONS.
3. ON-SITE DRAIN PIPES WILL BE ABANDONED IN PLACE. PIPE WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT AT LIMIT OF SLOPED SHORELINE/BANK EXCAVATION AREAS IN ACCORDANCE WITH SPECIFICATIONS.
4. MANHOLES FOR ON-SITE DRAIN PIPES WILL BE ABANDONED IN PLACE. PIPES WITHIN MANHOLES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
5. MANHOLES AND DRAINPIPES WITHIN EXCAVATION AREAS WILL BE COMPLETELY REMOVED OR ABANDONED AT LIMIT OF EXCAVATION. PIPES WILL BE ABANDONED PRIOR TO EXCAVATION WHEN POSSIBLE TO PREVENT WATER FLOW FROM OUTSIDE EXCAVAITON AREA. PIPES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
6. PIPES WITHIN ACTIVE SEWER MANHOLES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
7. EXISTING GAS AND WATER SERVICE LINES HAVE BEEN ABANDONED AT THE PROPERTY BOUNDARY.

LEGEND:

- EXCAVATION LIMIT
- UTILITY REMOVAL
- ABANDON MANHOLE IN PLACE (SEE NOTE 4)
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED STORM SEWER MANHOLE
- PROPOSED SEWER PIPELINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE (INACTIVE)
- EXSTING GAS LINE (INACTIVE)
- EXSTING SANITARY SEWER LINE

50' 0 50' 100'
1"=50'

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
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State	Date Signed	Project Mgr.
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Designed by	Drawn by	Checked by
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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

PIPE DEMOLITION AND REROUTE PLAN - SOUTH

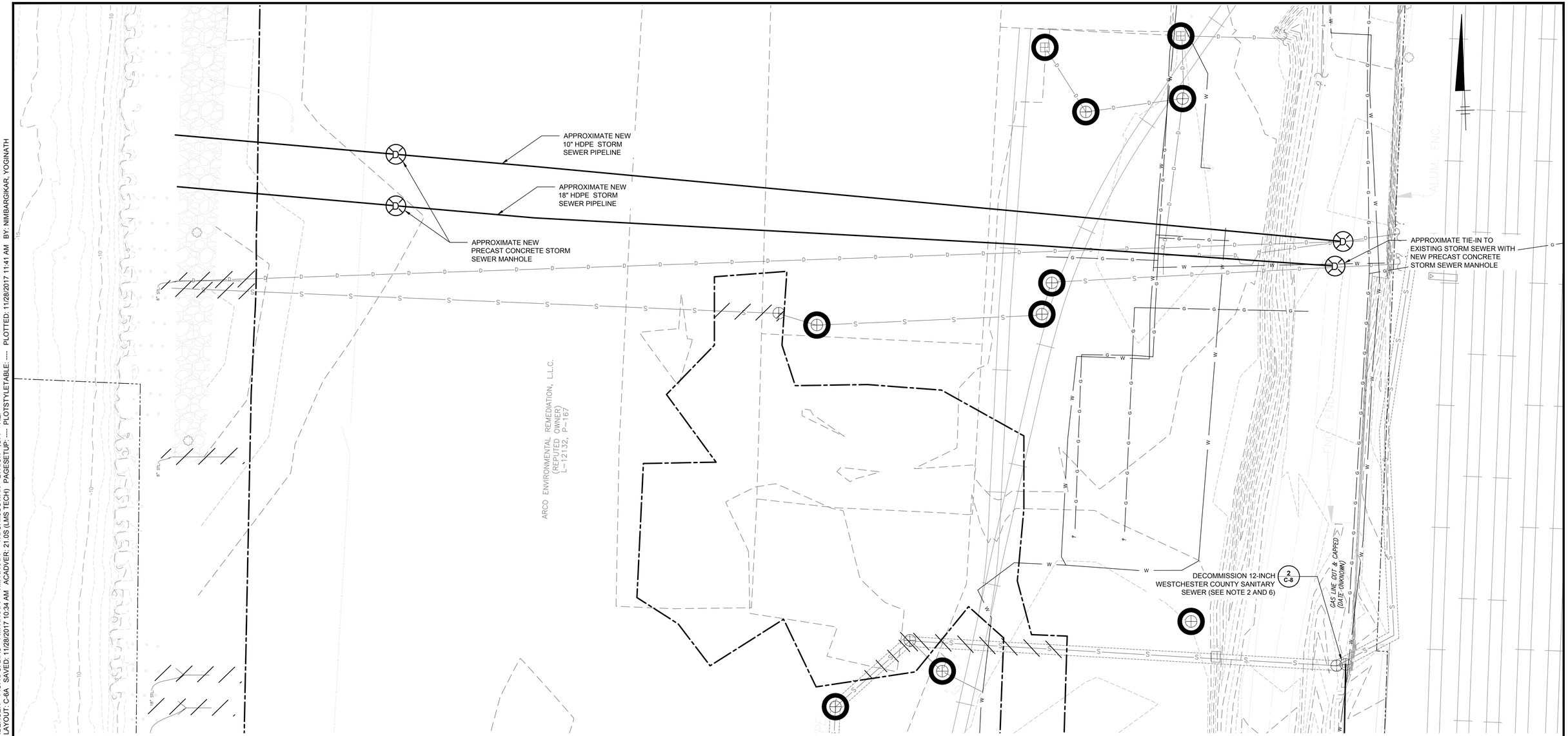
ARCADIS Project No.
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C-6

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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NOTES

1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASEMAP INFORMATION.
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4. MANHOLES FOR ON-SITE DRAIN PIPES WILL BE ABANDONED IN PLACE. PIPES WITHIN MANHOLES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.

LEGEND:

- EXCAVATION LIMIT
- UTILITY REMOVAL
- ABANDON MANHOLE IN PLACE (SEE NOTE 4)
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED STORM SEWER MANHOLE
- PROPOSED SEWER PIPELINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE (INACTIVE)
- EXISTING GAS LINE (INACTIVE)
- EXISTING SANITARY SEWER LINE

20' 0 20' 40'
1"=20'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Cko

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		-
Designed by -	Drawn by -	Checked by -

NOT FOR CONSTRUCTION

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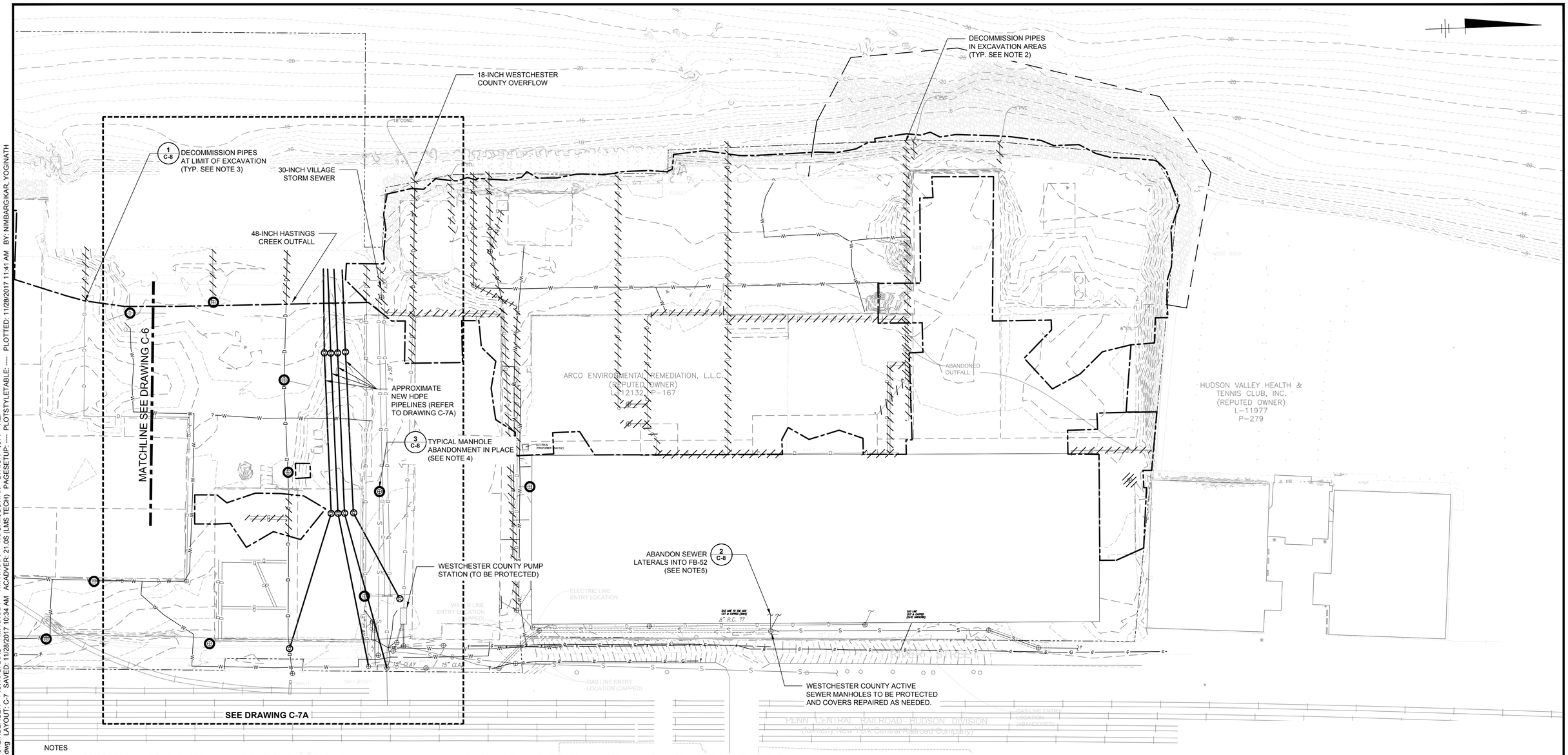
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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

PIPE DEMOLITION AND REROUTE PLAN - SOUTH OUTFALL

ARCADIS Project No.
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Syracuse, NY 13202
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C-6A

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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6. PIPES WITHIN ACTIVE SEWER MANHOLES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
7. EXISTING GAS AND WATER SERVICE HAVE BEEN ABANDONED AT THE PROPERTY BOUNDARY.
8. WATER AND GAS SERVICE TO THE SITE HAS BEEN ABANDONED AT THE PROPERTY LINES. WATER AND GAS PIPELINES SHOWN ON-SITE ARE INACTIVE AND WILL BE REMOVED WITHIN EXCAVATION AREAS WHEN ENCOUNTERED.

LEGEND:

- EXCAVATION LIMIT
- UTILITY REMOVAL
- ABANDON MANHOLE IN PLACE (SEE NOTE 4)
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED STORM SEWER MANHOLE
- PROPOSED SEWER PIPELINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE (INACTIVE)
- EXISTING GAS LINE (INACTIVE)
- EXISTING SANITARY SEWER LINE

1"=50' (50' 0 50' 100')

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Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

PIPE DEMOLITION AND REROUTE PLAN - NORTH

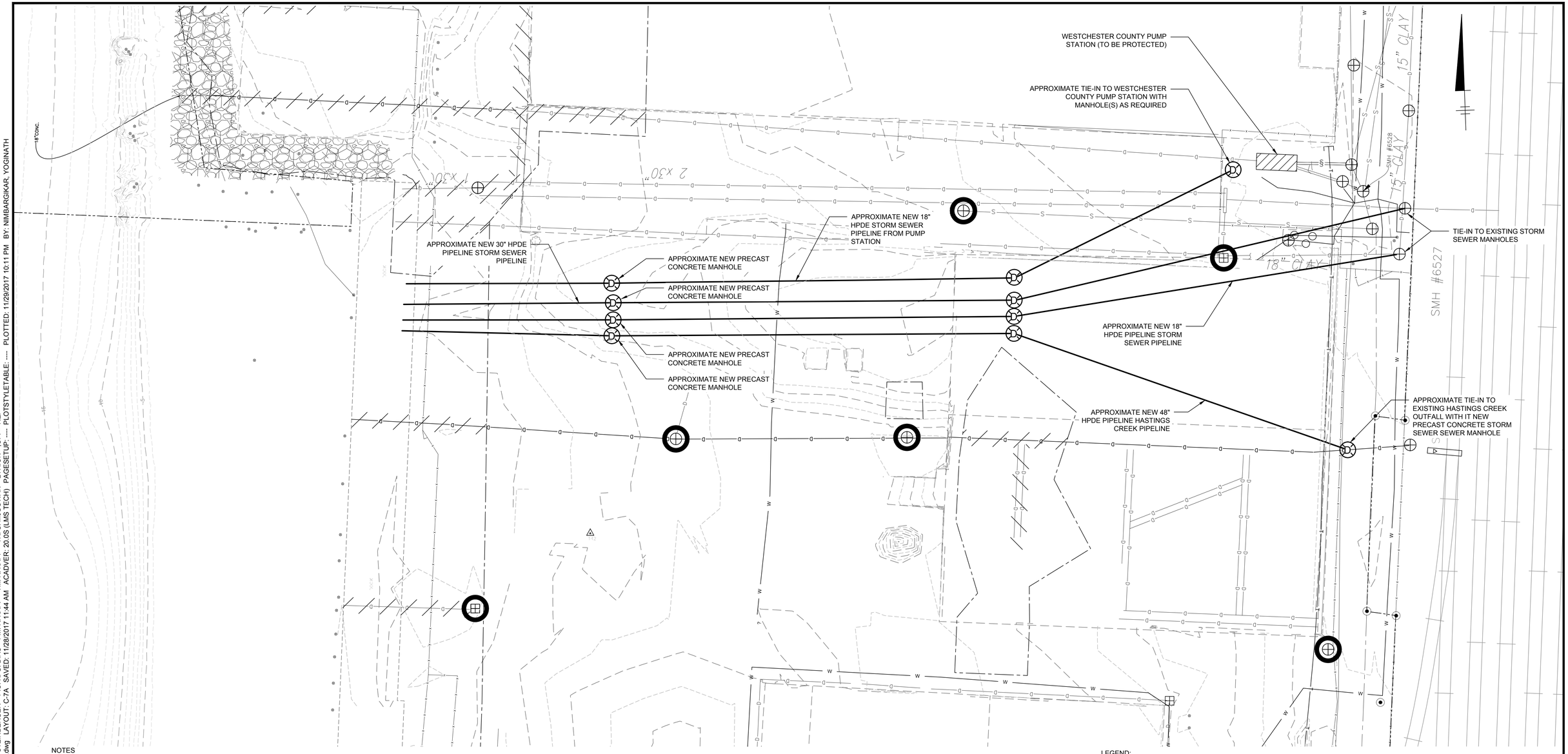
ARCADIS Project No.
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C-7

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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IMAGES:



NOTES

1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASEMAP INFORMATION.
2. ON-SITE DRAIN PIPES WILL COMPLETELY REMOVED OR ABANDONED AT LIMIT OF EXCAVATION. PIPES WILL BE ABANDONED PRIOR TO EXCAVATION WHEN POSSIBLE TO PREVENT WATER FLOW A FROM OUTSIDE EXCAVAITON AREA. PIPES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
3. PIPES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT AT LIMIT OF SLOPED SHORELINE/BANK EXCAVATION AREAS IN ACCORDANCE WITH SPECIFICATIONS.
4. MANHOLES FOR ON-SITE DRAIN PIPES WILL BE ABANDONED IN PLACE. PIPES WITHIN MANHOLES WILL BE PLUGGED AND SEALED WITH NON-SHRINK GROUT IN ACCORDANCE WITH SPECIFICATIONS.
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LEGEND:

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- EXISTING GAS LINE (INACTIVE)
- EXISTING SANITARY SEWER LINE

20' 0 20' 40'
1"=20'

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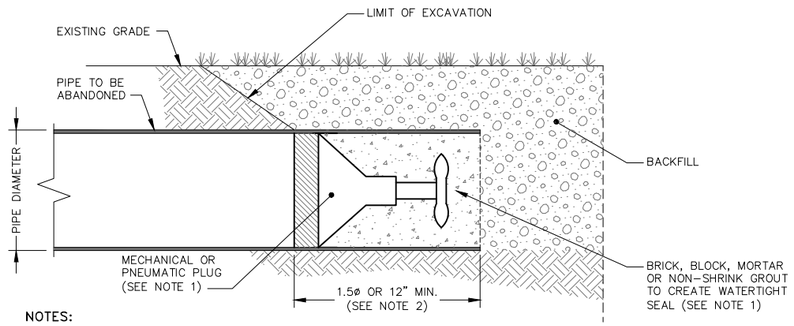
PIPE DEMOLITION AND REROUTE PLAN - NORTH OUTFALLS

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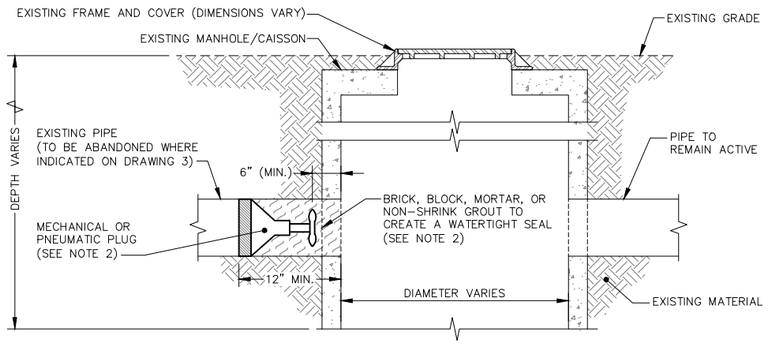


NOTES:

1. PRIOR TO INITIATING UTILITY ABANDONMENT ACTIVITIES, THE CONTRACTOR SHALL SUBMIT ALONG WITH WHERE EACH TECHNIQUE IS PROPOSED PRODUCT INFORMATION FOR BRICK, BLOCK, MORTAR, OR NON-SHRINK GROUT AND SEWER PLUGS FOR REVIEW.
2. PIPES SHALL BE PLUGGED 1.5 TIMES THE PIPE DIAMETER OR 12-INCHES (MINIMUM) WHICHEVER IS LESS.

PIPE ABANDONMENT 1

NOT TO SCALE

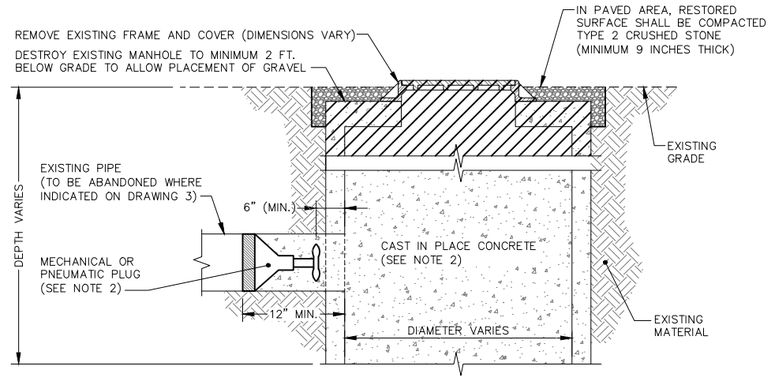


NOTES:

1. THIS DETAIL IS INTENDED ONLY TO SHOW A TYPICAL/CONCEPTUAL MANHOLE/CAISSON ABANDONMENT PROCEDURE, AS EXISTING MANHOLE/CAISSON SIZES AND CONFIGURATIONS VARY. PROCEDURES MAY BE MODIFIED IN THE FIELD, AS NECESSARY, BASED ON CONDITIONS ENCOUNTERED. PRIOR TO IMPLEMENTATION, FIELD MODIFICATIONS SHALL BE SUBMITTED (IN WRITING) TO FOR REVIEW.
2. PRIOR TO INITIATING UTILITY ABANDONMENT ACTIVITIES, THE CONTRACTOR SHALL SUBMIT PRODUCT INFORMATION FOR BRICK, BLOCK, MORTAR, OR NON-SHRINK GROUT AND SEWER PLUGS FOR REVIEW.

TYPICAL PIPE OPENING ABANDONMENT DETAIL 2

NOT TO SCALE



NOTES:

1. THIS DETAIL IS INTENDED ONLY TO SHOW A TYPICAL/CONCEPTUAL MANHOLE/CAISSON ABANDONMENT PROCEDURE, AS EXISTING MANHOLE/CAISSON SIZES AND CONFIGURATIONS VARY. PROCEDURES MAY BE MODIFIED IN THE FIELD, AS NECESSARY, BASED ON CONDITIONS ENCOUNTERED. PRIOR TO IMPLEMENTATION, FIELD MODIFICATIONS SHALL BE SUBMITTED (IN WRITING) TO THE ENGINEER FOR REVIEW.
2. AS AN ALTERNATE TO ABANDONING THE MANHOLE BY FILLING WITH CONCRETE, THE CONTRACTOR MAY OPT TO PUNCTURE THE MANHOLE FLOOR SO THAT IT CANNOT CONTAIN STANDING WATER, SEAL THE PIPE OPENING WITH SEWER PLUG AND NON-SHRINK GROUT, BRICK, BLOCK OR MORTAR, AND FILL THE MANHOLE WITH GENERAL FILL.
3. PRIOR TO INITIATING UTILITY ABANDONMENT ACTIVITIES, THE CONTRACTOR SHALL SUBMIT PRODUCT INFORMATION FOR CONCRETE, BRICK, BLOCK, MORTAR, OR NON-SHRINK GROUT AND SEWER PLUGS FOR REVIEW.

TYPICAL MANHOLE ABANDONMENT DETAIL 3

NOT TO SCALE

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ARCADIS OF NEW YORK, INC.
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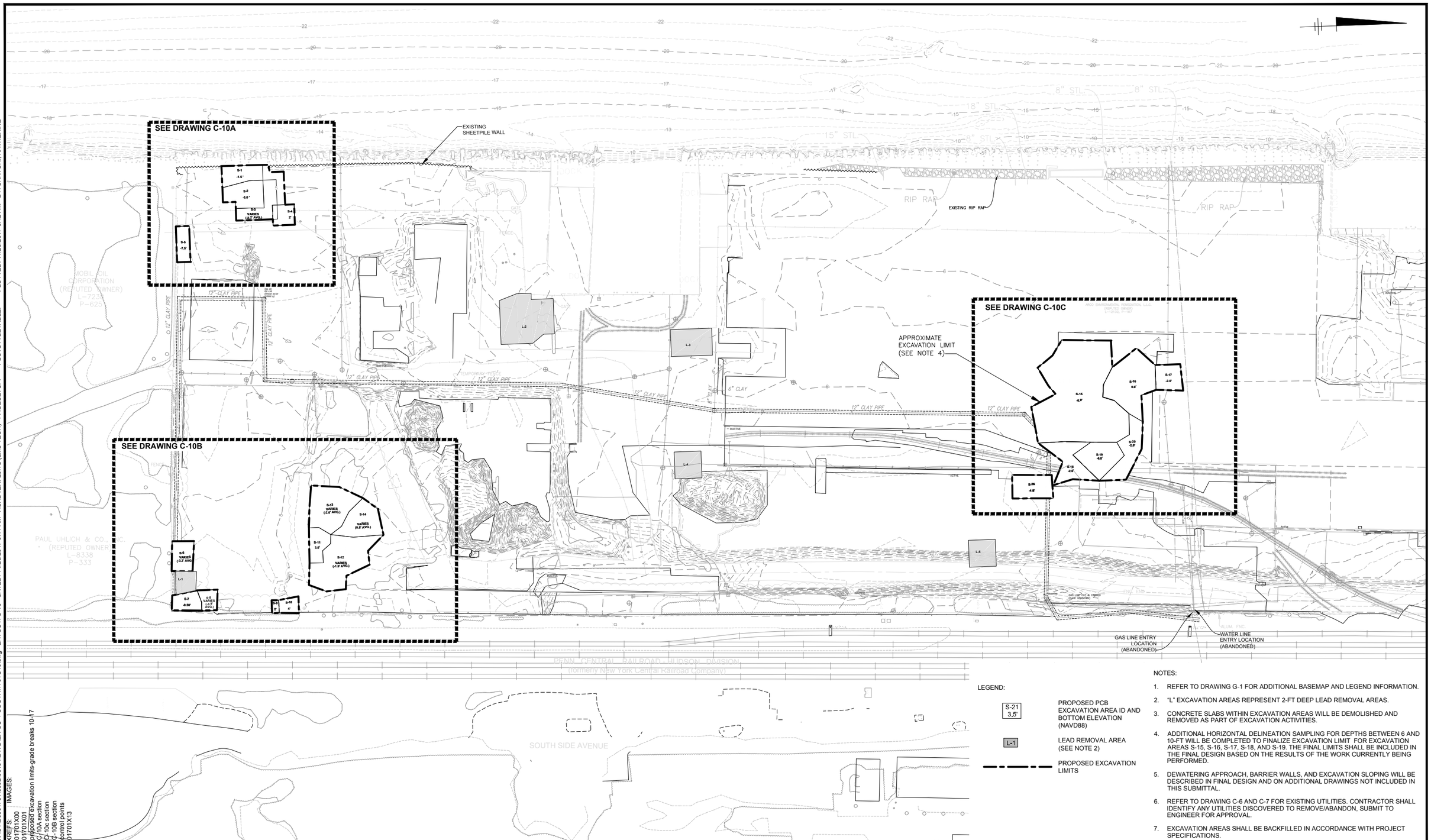
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

PIPELINE/MANHOLE ABANDONMENT DETAILS

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017
ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-8

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS: IMAGES:
017O1X00
017O1X01
proposed Excavation limits-grade breaks 10-17
C-10A section
C-10c section
C-10B section
proposed points
017O1X13

LEGEND:

- S-21 3.5' — PROPOSED PCB EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- L-1 — LEAD REMOVAL AREA (SEE NOTE 2)
- PROPOSED EXCAVATION LIMITS

NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.
2. "L" EXCAVATION AREAS REPRESENT 2-FT DEEP LEAD REMOVAL AREAS.
3. CONCRETE SLABS WITHIN EXCAVATION AREAS WILL BE DEMOLISHED AND REMOVED AS PART OF EXCAVATION ACTIVITIES.
4. ADDITIONAL HORIZONTAL DELINEATION SAMPLING FOR DEPTHS BETWEEN 6 AND 10-FT WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT FOR EXCAVATION AREAS S-15, S-16, S-17, S-18, AND S-19. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
5. DEWATERING APPROACH, BARRIER WALLS, AND EXCAVATION SLOPING WILL BE DESCRIBED IN FINAL DESIGN AND ON ADDITIONAL DRAWINGS NOT INCLUDED IN THIS SUBMITTAL.
6. REFER TO DRAWING C-6 AND C-7 FOR EXISTING UTILITIES. CONTRACTOR SHALL IDENTIFY ANY UTILITIES DISCOVERED TO REMOVE/ABANDON, SUBMIT TO ENGINEER FOR APPROVAL.
7. EXCAVATION AREAS SHALL BE BACKFILLED IN ACCORDANCE WITH PROJECT SPECIFICATIONS.

1"=50' — 50' 0 50' 100'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		-
Designed by	Drawn by	Checked by
-	-	-

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ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

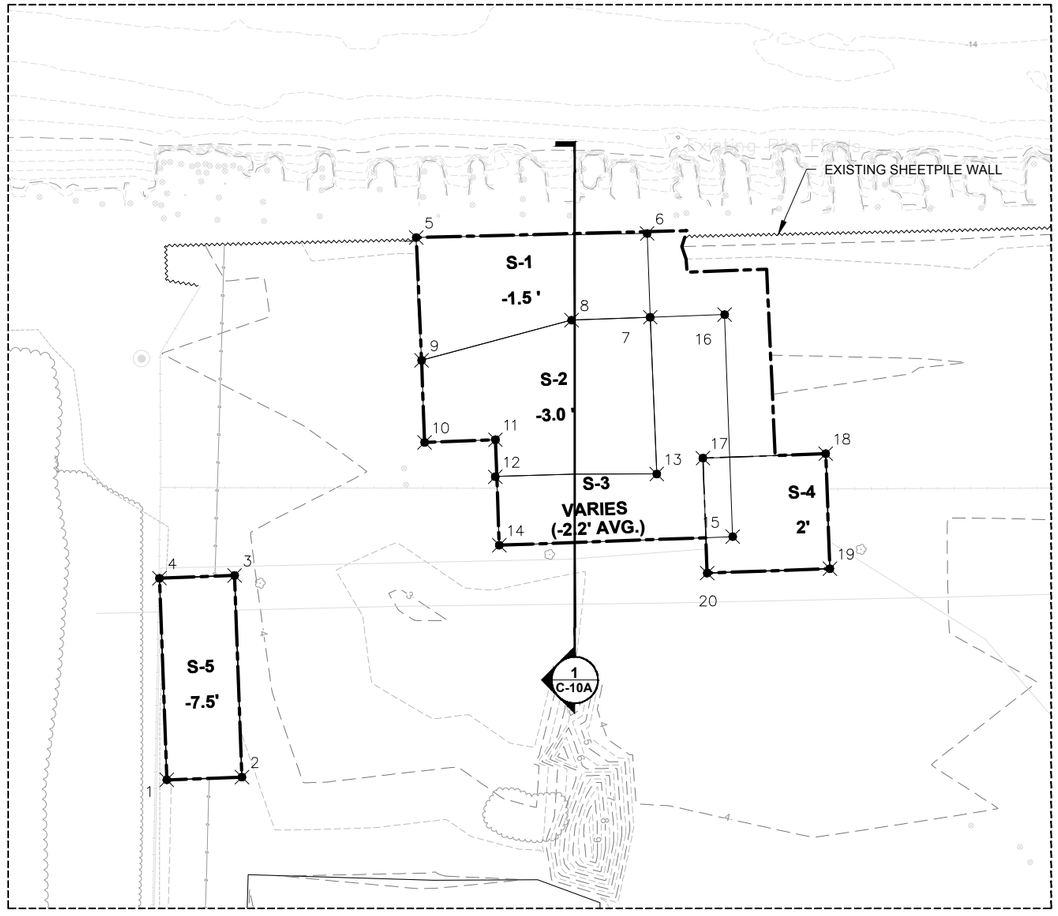
EXCAVATION OU1 SOUTH

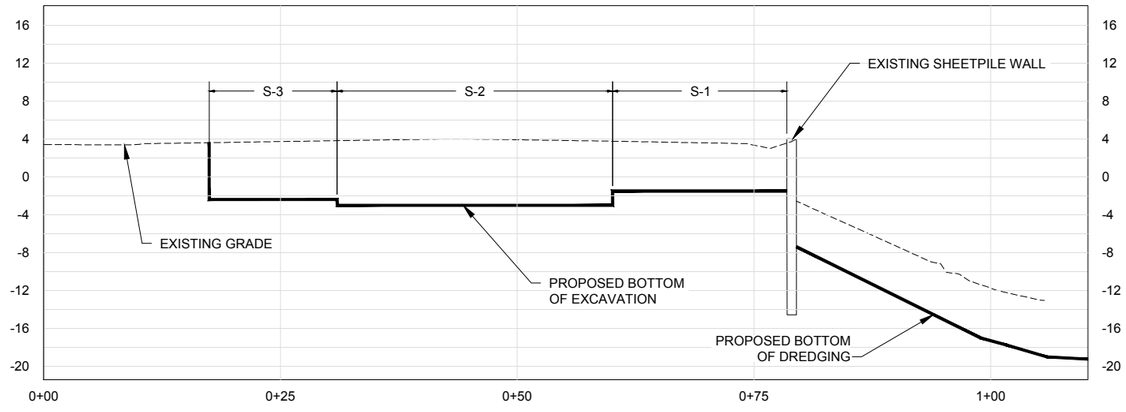
ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-10





CROSS SECTION 1 / C-10A

LEGEND:

- S-21 / 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- 1 — CONTROL POINTS

CONTROL POINT	NORTHING	EASTING
1	785986.14	661531.56
2	786001.02	661531.56
3	786001.02	661491.62
4	785986.14	661491.62
5	786039.40	661426.09
6	786085.12	661426.94
7	786085.12	661443.55
8	786069.53	661443.55
9	786039.57	661450.40
10	786039.57	661466.66
11	786053.61	661466.66
12	786053.31	661473.99
13	786085.28	661474.59
14	786053.61	661487.54
15	786099.84	661487.54
16	786099.84	661443.55
17	786094.53	661471.79
18	786118.85	661471.79
19	786118.85	661494.56
20	786094.53	661494.56

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
S-1	-1.5'
S-2	-3.0'
S-3	VARIES (12.2' AVG.)
S-4	2'
S-5	-7.5'

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.
2. SEQUENCE OF EXCAVATION AND NEARSHORE DREDGING WILL BE DETERMINED BY THE REMEDIAL CONTRACTOR. EXISTING SHEETPILE WALL MAY BE REMOVED PRIOR TO EXCAVATION.

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-10A section
C-10c section
C-10B section
contour points
01701X13

1"=15' (15' 0 15' 30')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: -
Designed by: - | Drawn by: - | Checked by: -

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 SOUTH PLAN AND CROSS SECTIONS (1 OF 3)

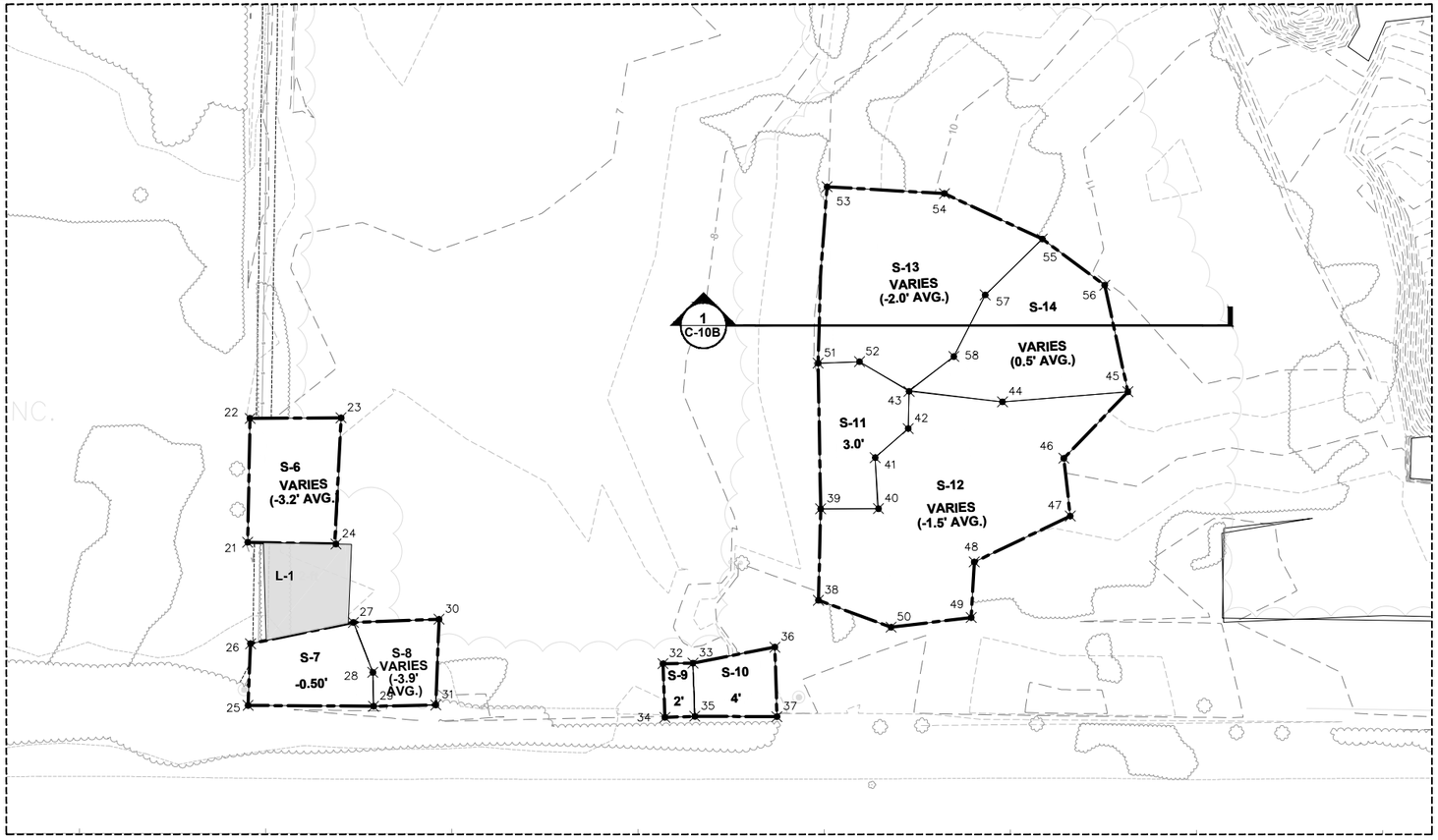
ARCADIS Project No. B0001701.0002.00134
Date NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-10A

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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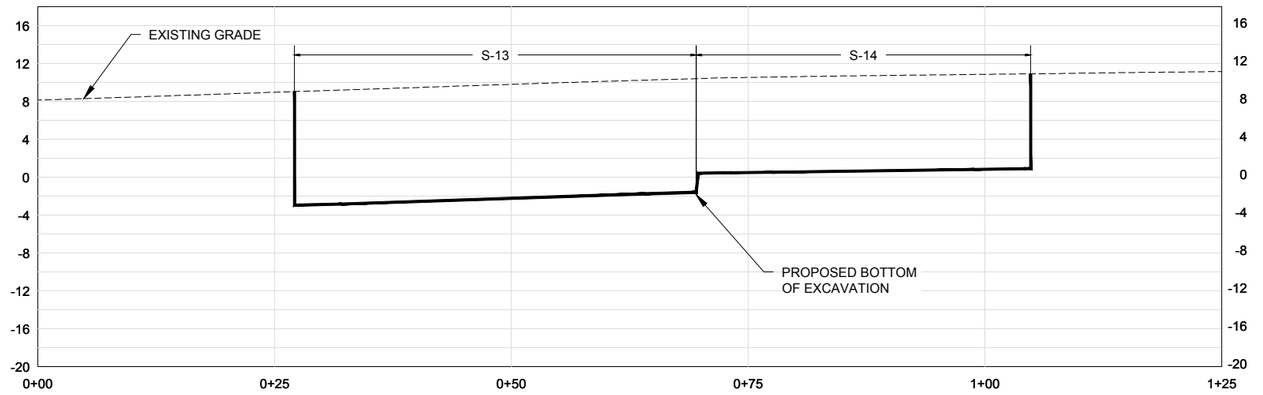
EXCAVATION AREA	BOTTOM ELEVATION
S-6	VARIES (-3.2' AVG.)
S-7	-0.50'
S-8	VARIES (-3.9' AVG.)
S-9	2'
S-10	4'
S-11	3.0'
S-12	VARIES (-1.5' AVG.)
S-13	VARIES (-2.0' AVG.)
S-14	VARIES (-0.5' AVG.)



LEGEND:

- S-21 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- 21 — CONTROL POINTS

CONTROL POINT	NORTHING	EASTING
21	785967.32	661875.46
22	785969.17	661842.21
23	785993.61	661842.96
24	785990.99	661876.78
25	785965.81	661919.23
26	785967.08	661902.69
27	785994.90	661897.99
28	785999.63	661911.60
29	785999.50	661920.69
30	786017.92	661898.00
31	786016.20	661920.95
32	786077.58	661912.10
33	786085.61	661912.25
34	786077.58	661926.55
35	786085.61	661926.55
36	786107.75	661908.76
37	786107.66	661927.43
38	786119.93	661896.62
39	786121.42	661872.10
40	786136.93	661872.60
41	786136.56	661858.87
42	786145.70	661851.40
43	786146.29	661841.42
44	786171.26	661845.16
45	786205.02	661843.67
46	786187.18	661860.88
47	786188.32	661876.48
48	786162.13	661887.85
49	786160.76	661902.74
50	786139.14	661904.54
51	786122.16	661832.97
52	786133.28	661832.97
53	786126.29	661785.70
54	786157.72	661788.68
55	786183.55	661801.84
56	786199.84	661814.83
57	786167.69	661816.29
58	786158.64	661832.50



CROSS SECTION 1 / C-10B

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.

XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-10A section
C-10c section
C-10B section
contour points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

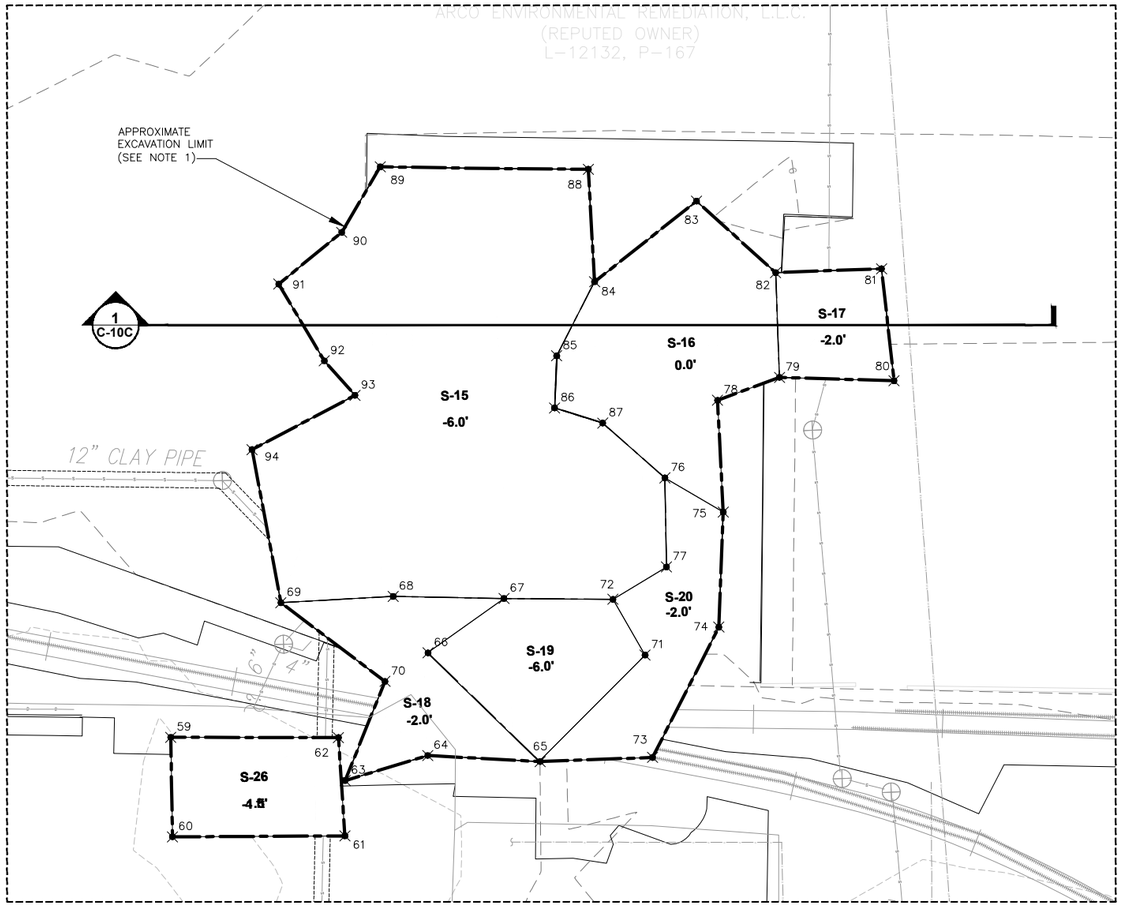
EXCAVATION OU1 SOUTH PLAN AND CROSS SECTIONS (2 OF 3)

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
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Tel: 315-446-9120

C-10B

CONTROL POINT	NORTHING	EASTING
59	786908.1907	661802.5606
60	786907.6890	661828.8112
61	786953.1798	661830.2324
62	786952.4272	661804.2326
63	786953.7701	661815.6455
64	786975.8000	661809.8300
65	787005.4030	661812.5115
66	786976.8642	661782.7687
67	786997.4148	661769.1626
68	786968.2100	661767.5500
69	786938.5400	661768.1200
70	786965.2342	661789.8845
71	787034.0900	661785.4400
72	787026.1580	661770.4349
73	787035.0800	661812.5000
74	787053.8200	661778.7800
75	787056.0840	661748.4690
76	787041.0210	661738.9110
77	787040.5806	661762.4080
78	787055.6500	661718.9500
79	787072.2153	661713.5200
80	787102.4000	661715.5100
81	787100.1898	661685.8618
82	787072.2153	661685.8618
83	787052.0300	661666.2500
84	787024.3700	661686.5400
85	787013.6600	661705.6900
86	787012.6000	661719.4200
87	787025.1616	661723.8619
88	787023.8100	661656.8000
89	786968.9500	661654.1600
90	786958.1400	661671.0700
91	786941.0300	661684.1000
92	786952.3200	661704.7800
93	786960.0700	661714.1700
94	786932.4000	661727.4800



LEGEND:

S-21 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)

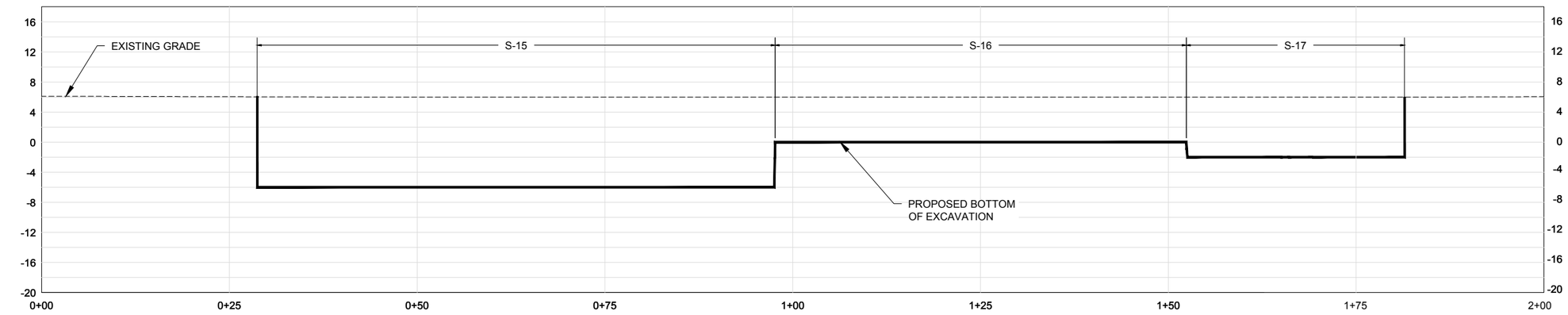
PROPOSED EXCAVATION LIMITS

59 — CONTROL POINTS

NOTES:

1. ADDITIONAL HORIZONTAL DELINEATION SAMPLING FOR DEPTHS BETWEEN 6 AND 10-FT WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT FOR EXCAVATION AREAS S-15, S-16, S-17, S-18, AND S-19. THE FINAL LIMITS SHALL BE INCLUDED IN THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
2. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
S-15	-6.0'
S-16	0.0'
S-17	-2.0'
S-18	-2.0'
S-19	-6.0'
S-20	-2.0'
S-26	-4.5'



CROSS SECTION 1 / C-10C

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF=*REF*
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XREFS: IMAGES:
01701X00
01701X01 proposed excavation limits-grade breaks 10-17
C-10A section
C-10c section
C-10B section
control points
01701X13

1"=40' 20' 0 20' 40'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed | Project Mgr. .
Designed by | Drawn by . | Checked by .

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 SOUTH PLAN AND CROSS SECTIONS (3 OF 3)

ARCADIS Project No. B0001701.0002.00134
Date NOVEMBER 2017

ARCADIS of NY, Inc.
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110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-10C

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13E section
C-13F
Section 13C
Section 13E
control points
01701X13

HUDSON RIVER

FORMER PIER

18" CONC.

EXISTING PILE FIELD

SEE DRAWING C-13A

SEE DRAWING C-13B

SEE DRAWING C-13C

SEE DRAWING C-13D

SEE DRAWING C-13E

SEE DRAWING C-13F

SEE DRAWING C-13G

OUTFALL NOT VISIBLE

STORM LINE IS BROKEN

AREA TO BE DELINEATED (SEE NOTE 5)

APPROXIMATE EXCAVATION LIMIT (SEE NOTE 4)

APPROXIMATE EXCAVATION LIMIT (SEE NOTE 4)

ABANDONED OUTFALL

NEA BULKHEAD (APPROXIMATE)

WOOD DOCK

GATE

Existing Pile Fields

HUDSON VALLEY HEALTH & TENNIS CLUB, INC. (REPUTED OWNER) L=11977 P=279

FB #52

GAS LINE TO THE SITE (CUT & CAPPED) (2004)

GAS LINE (CUT & CAPPED (DATE UNKNOWN))

12" CLAY

15" CLAY

24" CLAY

NORTH BRIDGE

PENN CENTRAL RAILROAD - HUDSON DIVISION (Formerly New York Central Railroad Company)

SOUTH SIDE AVENUE

LEGEND:

S-21 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)

PROPOSED EXCAVATION LIMITS

TO BE PERFORMED IN CONJUNCTION WITH NEAR SHORE DREDGING

NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL LEGEND AND BASEMAP INFORMATION.
2. DEWATERING APPROACH, BARRIER WALLS, AND EXCAVATION SLOPING WILL BE DESCRIBED IN FINAL DESIGN AND ON ADDITIONAL DRAWINGS NOT INCLUDED IN THIS SUBMITTAL
3. CONCRETE SLABS WITHIN EXCAVATION AREAS WILL BE DEMOLISHED AND REMOVED AS PART OF EXCAVATION ACTIVITIES.
4. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT ALONG BUILDING 52 LIMIT.
5. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE PERFORMED FOR EXCAVATION AREAS N10, N-12, N-17 N-18 ADJACENT TO FORMER JOB TRAILER AREA. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
6. REFER TO DRAWING C-6 AND C-7 FOR EXISTING UTILITIES. CONTRACTOR SHALL IDENTIFY ANY UTILITIES DISCOVERED TO REMOVE/ABANDON, SUBMIT TO ENGINEER FOR APPROVAL.
7. EXCAVATION AREAS SHALL BE BACKFILLED IN ACCORDANCE WITH PROJECT SPECIFICATIONS.

1"=50' (50' 0 50' 100')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: . | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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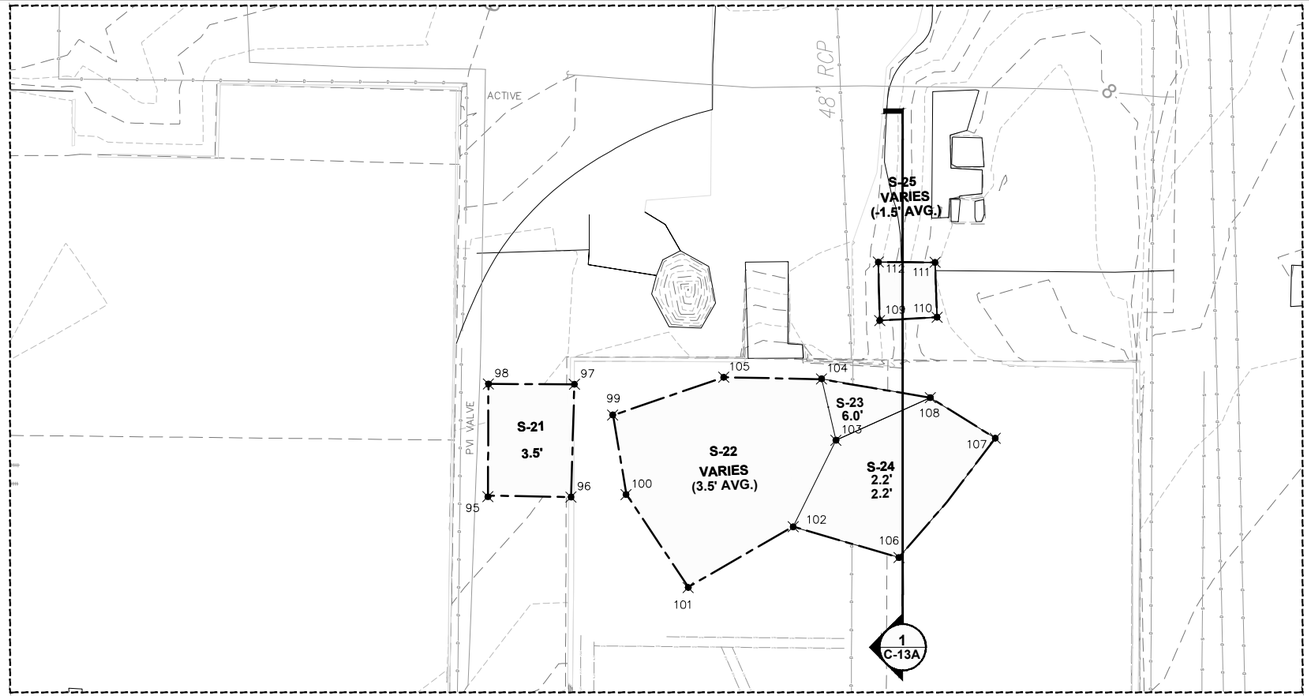
ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

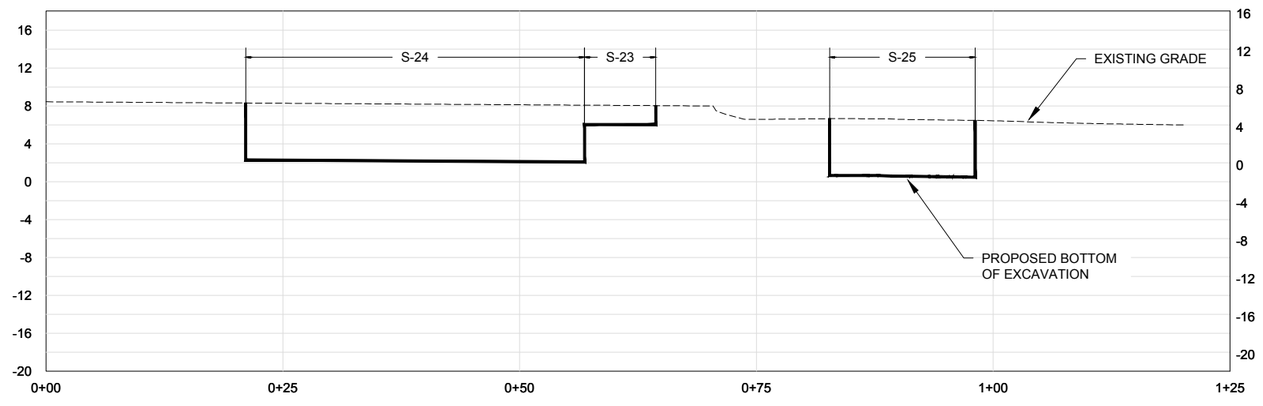
EXCAVATION OU1 NORTH

ARCADIS Project No.
B0001701.0002.00134
Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13





CROSS SECTION 1 / C-13A



LEGEND:

- S-21 / 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- CONTROL POINTS (1)

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.

CONTROL POINT	NORTHING	EASTING
95	787404.61	661827.29
96	787426.51	661828.18
97	787428.48	661798.48
98	787405.82	661797.56
99	787438.30	661806.93
100	787441.05	661828.05
101	787456.55	661853.17
102	787484.80	661838.17
103	787496.93	661815.74
104	787493.72	661799.42
105	787467.92	661798.06
106	787512.40	661847.28
107	787538.95	661816.74
108	787522.22	661805.42
109	787509.61	661784.60
110	787524.77	661784.27
111	787524.77	661769.79
112	787509.80	661769.17

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
S-21	3.5'
S-22	VARIES (3.5' AVE.)
S-23	6.0'
S-24	2.2'
S-25	VARIES (-1.5' AVE)

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF=*REF*
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XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13E section
C-13G
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

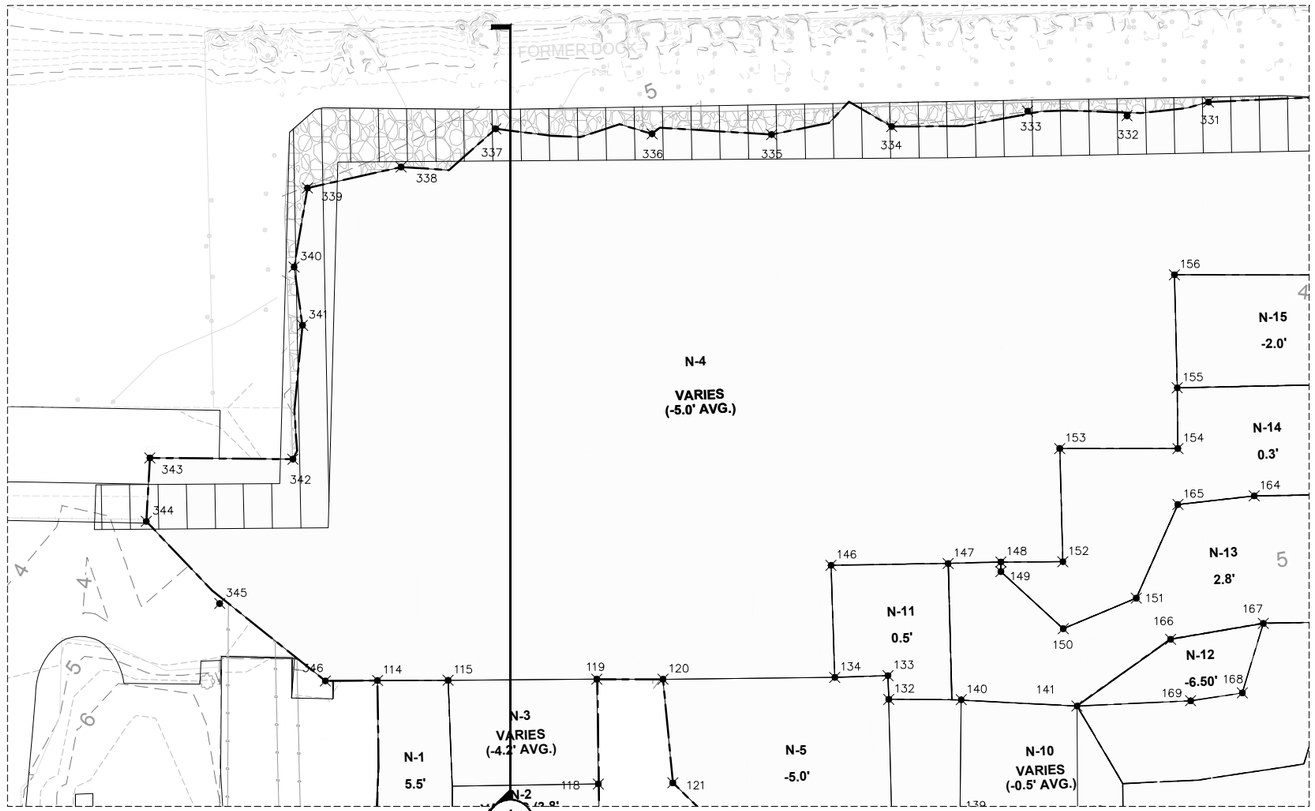
NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (1 OF 7)

ARCADIS Project No.
B0001701.0002.00134
Date
NOVEMBER 2017
ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13A



CONTROL POINT	NORTHING	EASTING
114	787627.41	661627.56
115	787646.03	661628.17
118	787684.66	661656.95
119	787685.25	661629.33
120	787702.72	661629.97
121	787704.33	661657.37
132	787762.07	661637.43
133	787762.09	661631.18
134	787748.05	661631.13
140	787781.18	661638.25
141	787811.66	661641.02
146	787748.13	661601.56
147	787779.05	661602.21
148	787792.98	661602.30
149	787792.88	661604.85
150	787808.78	661620.50
151	787828.34	661613.14
152	787809.31	661602.84
153	787809.60	661572.96
154	787840.74	661574.11
155	787841.16	661558.11
156	787841.52	661528.27
164	787860.45	661587.33
165	787840.21	661588.86
166	787836.99	661624.32
167	787861.60	661621.02
168	787855.39	661639.15
169	787841.69	661640.72
331	787852.17	661483.06
332	787830.54	661485.91
333	787804.39	661483.73
334	787768.36	661486.48
335	787733.04	661487.00

LEGEND:

S-21
3.5'
PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)

PROPOSED EXCAVATION LIMITS

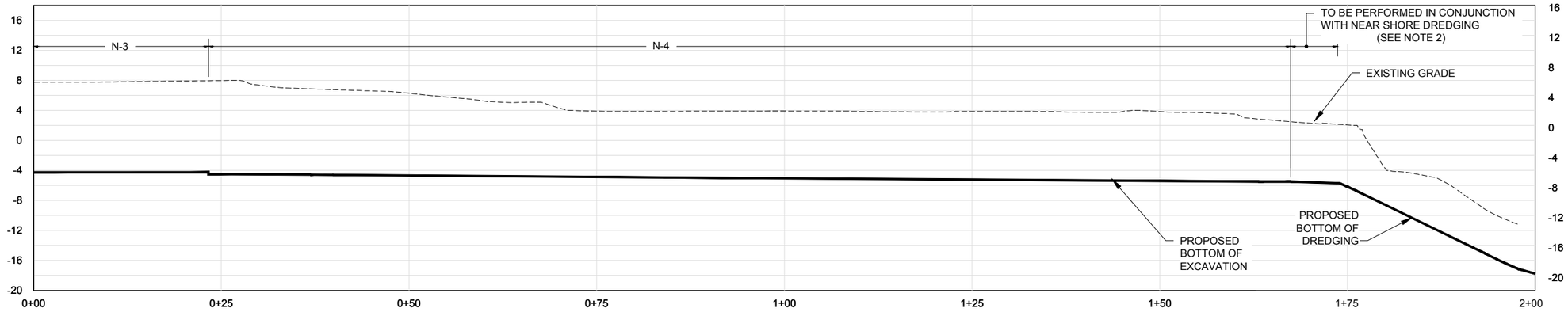
1
CONTROL POINTS

TO BE PERFORMED IN CONJUNCTION WITH NEAR SHORE DREDGING (SEE NOTE 2)

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.
2. SEQUENCE OF EXCAVATION AND NEARSHORE DREDGING WILL BE DETERMINED BY THE REMEDIAL CONTRACTOR. EXCAVATION LIMITS AND SLOPING SHOWN ARE PRELIMINARY AND MAY BE ADJUSTED DURING FINAL DESIGN.

CONTROL POINT	NORTHING	EASTING
335	787733.04	661487.00
336	787705.08	661486.08
337	787663.90	661483.26
338	787638.58	661492.42
339	787613.68	661497.06
340	787609.38	661517.76
341	787611.04	661533.20
342	787607.22	661568.39
343	787569.51	661566.68
344	787567.96	661583.39
345	787586.52	661605.75
346	787613.67	661627.17



CROSS SECTION 1 / C-13B

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP
G:\ENVCAD\SYRACUSE\ACTIB\B0001701\0002\00134\DWG\EX-OU-1_NORTH\1701C13.dwg LAYOUT: C-13B SAVED: 11/28/2017 4:02 PM BY: SARTORI, KATHERINE
ACADVER: 20.1S (LMS TECH) PAGESETUP:---- PLOTSTYLETABLE:---- PLOTTED: 11/28/2017 4:02 PM BY: SARTORI, KATHERINE

XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13E section
C-13C
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: . | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

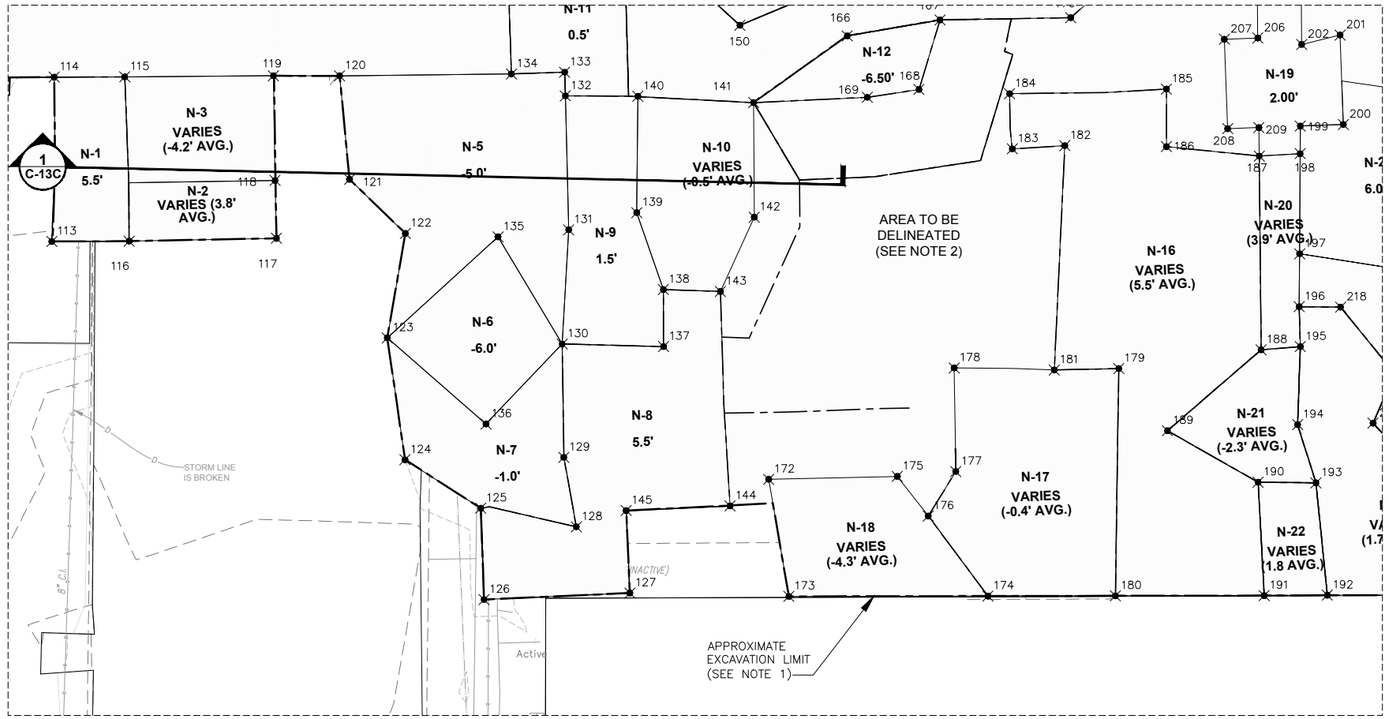
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 NORTH PLAN AND CROSS SECTION (2 OF 7)

ARCADIS Project No.
B0001701.0002.00134
Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13B

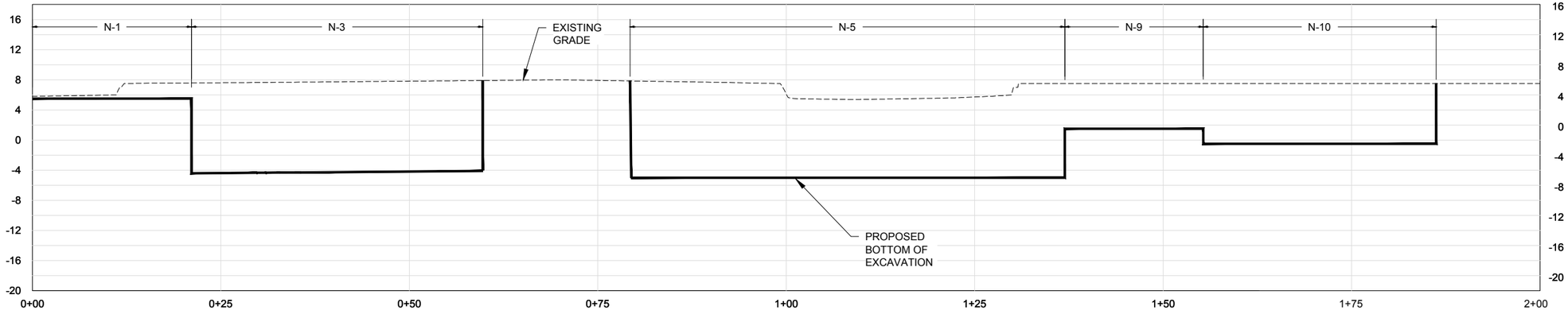


LEGEND:

- S-21 / 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- CONTROL POINTS

CONTROL POINT	NORTHING	EASTING
113	787625.21	661670.90
114	787627.41	661627.56
115	787646.03	661628.17
116	787645.61	661671.55
117	787684.49	661672.22
118	787684.66	661656.95
119	787685.25	661629.33
120	787702.72	661629.97
121	787704.33	661657.37
122	787718.53	661672.17
123	787712.76	661699.55
124	787716.27	661731.88
125	787735.77	661745.39
126	787735.76	661769.51
127	787774.29	661769.19
128	787760.82	661751.20
129	787758.17	661732.77
130	787758.85	661702.84
131	787761.64	661672.78
132	787762.07	661637.43
133	787762.09	661631.18

CONTROL POINT	NORTHING	EASTING
134	787748.05	661631.13
135	787742.94	661673.97
136	787737.97	661723.22
137	787785.54	661704.51
138	787786.05	661689.45
139	787779.77	661668.91
140	787781.18	661638.25
141	787811.66	661641.02
142	787810.71	661671.23
143	787801.07	661690.52
144	787801.55	661747.18
145	787774.11	661747.40
150	787808.78	661620.50
166	787836.99	661624.32
167	787861.60	661621.02
168	787855.39	661639.15
169	787841.69	661640.72
170	787896.09	661621.68
172	787812.00	661740.53
173	787816.19	661771.60
174	787868.70	661773.43
175	787845.93	661741.00
176	787853.73	661751.74
177	787861.42	661740.26
178	787862.00	661712.94
179	787905.40	661714.68
180	787902.32	661774.59
181	787888.38	661714.43
182	787893.31	661655.36
183	787879.43	661655.71
184	787879.26	661641.13
185	787920.66	661641.43
186	787920.10	661656.61
187	787944.50	661659.99
188	787943.12	661711.11
189	787917.64	661731.53
190	787941.07	661746.00
191	787941.58	661775.96
192	787958.23	661776.47
193	787956.30	661746.73
194	787952.03	661731.19
195	787953.49	661710.65
196	787953.59	661700.10
197	787954.20	661686.16
198	787955.30	661659.75
199	787955.61	661652.46
200	787966.97	661652.46
201	787966.97	661628.84
202	787956.76	661630.97
206	787945.25	661628.84
207	787936.42	661628.84
208	787936.42	661652.46
209	787944.68	661652.46
216	787971.94	661731.54
218	787964.48	661700.61



CROSS SECTION 1 / C-13C

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.
2. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT ALONG BUILDING 52 LIMIT.
3. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE PERFORMED FOR EXCAVATION AREAS N10, N-12, N-17 N-18 ADJACENT TO FORMER JOB TRAILER AREA. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
4. EXCAVATION BOTTOM ELEVATION SUMMARY FOR ALL NORTHERN AREAS PRESENTED ON SHEETS C-13F AND C-13G.

XREFS:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13F
C-13G section
Section 13C
Section 13E
control points
01701X13

IMAGES:

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF=*REF*
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1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: -
Designed by | Drawn by | Checked by

NOT FOR CONSTRUCTION

ARCADIS | Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

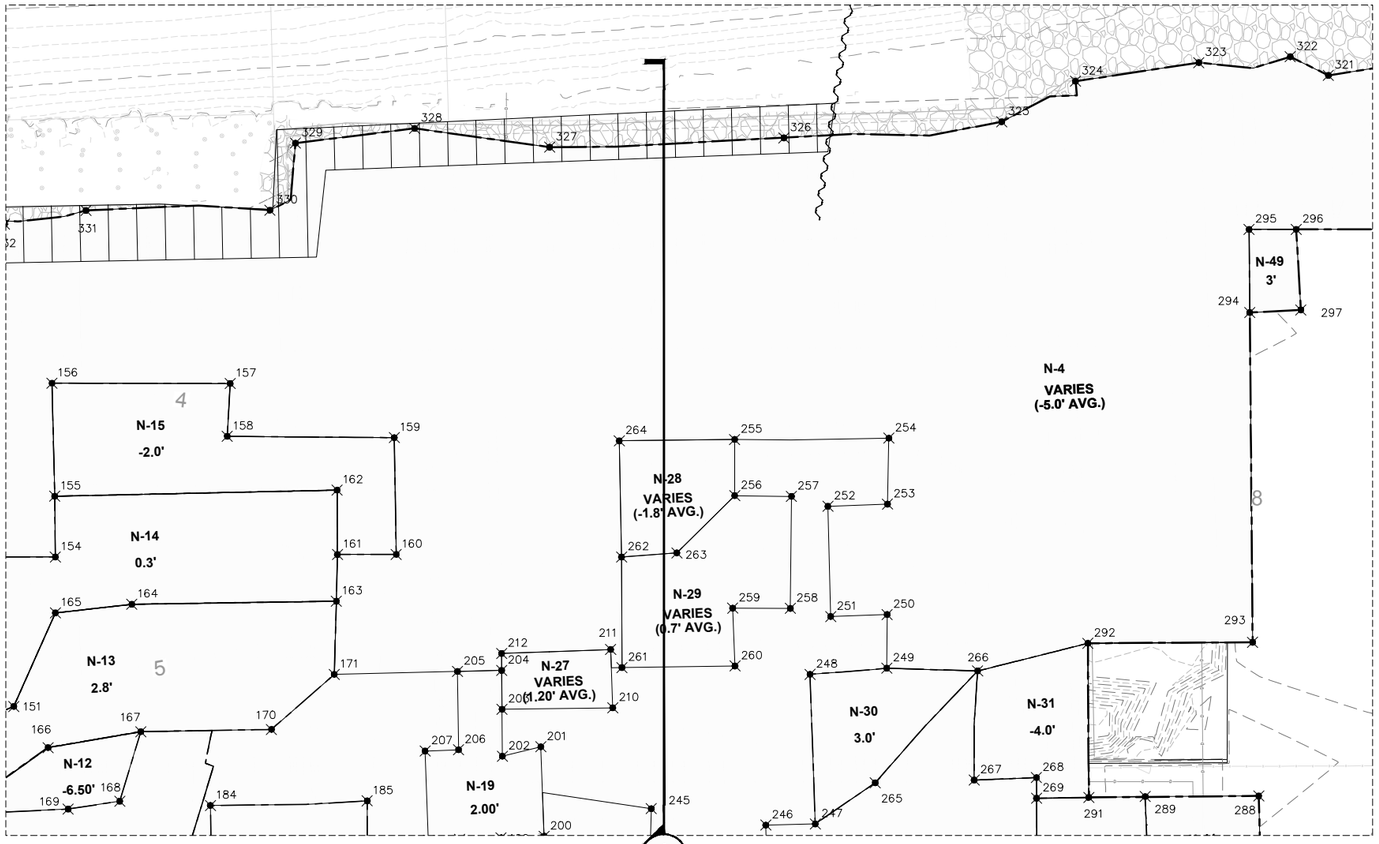
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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

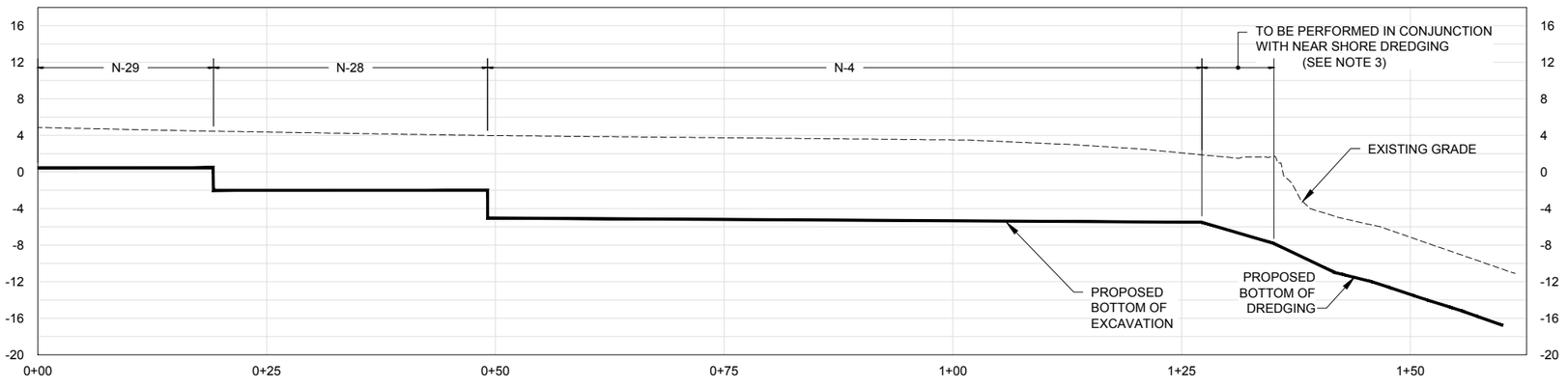
EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (3 OF 7)

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13C





CROSS SECTION 1 / C-13D

LEGEND:

- S-21 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- 1 — CONTROL POINTS
- TO BE PERFORMED IN CONJUNCTION WITH NEAR SHORE DREDGING

CONTROL POINT	NORTHING	EASTING
151	787828.34	661613.14
154	787840.74	661574.11
155	787841.16	661558.11
156	787841.52	661528.27
157	787888.53	661530.07
158	787887.24	661543.98
159	787931.30	661545.93
160	787930.68	661576.73
161	787915.18	661576.19
162	787915.70	661559.21
163	787914.44	661588.49
164	787860.45	661587.33
165	787840.21	661588.86
166	787836.99	661624.32
167	787861.60	661621.02
168	787855.39	661639.15
169	787841.69	661640.72
170	787896.09	661621.68
171	787913.19	661607.76
184	787879.26	661641.13
185	787920.66	661641.43
201	787966.97	661628.84
202	787956.76	661630.97

CONTROL POINT	NORTHING	EASTING
203	787957.10	661618.58
204	787957.39	661608.32
205	787945.73	661608.18
206	787945.25	661628.84
207	787936.42	661628.84
210	787986.33	661619.26
211	787986.34	661603.87
212	787957.54	661603.87
245	787995.51	661646.21
246	788025.57	661651.65
247	788038.64	661651.83
248	788038.69	661612.34
249	788059.00	661611.45
250	788059.60	661597.30
251	788044.71	661597.30
252	788045.02	661568.20
253	788060.76	661568.20
254	788061.76	661550.82
255	788021.07	661549.69
256	788020.54	661564.50
257	788035.51	661565.24
258	788034.14	661594.76
259	788018.92	661594.14
260	788018.98	661609.40
261	787989.14	661608.73
262	787990.11	661579.60
263	788004.74	661579.03
264	787990.62	661548.93
265	788054.85	661641.55
266	788082.94	661613.05
267	788080.97	661641.78
268	788097.41	661641.74
269	788097.24	661647.18
288	788155.90	661648.71
289	788125.93	661647.78
291	788111.06	661647.47
292	788112.29	661606.82
293	788155.75	661608.14
294	788158.18	661521.19
295	788158.79	661499.26
296	788171.23	661499.70
297	788171.67	661520.98
321	788181.20	661459.41
322	788171.32	661454.13
323	788147.15	661454.80
324	788114.44	661458.52
325	788094.59	661468.50
326	788036.97	661470.66
327	787975.07	661470.84
328	787939.64	661464.59
329	787908.06	661467.32
330	787900.69	661484.76
331	787852.17	661483.06

NOTES:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.
2. EXCAVATION BOTTOM ELEVATION SUMMARY FOR ALL NORTHERN AREAS PRESENTED ON SHEETS C-13F AND C-13G.
3. SEQUENCE OF EXCAVATION AND NEARSHORE DREDGING WILL BE DETERMINED BY THE REMEDIAL CONTRACTOR. EXCAVATION LIMITS AND SLOPING SHOWN

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G. STEINBERGER PIC:K. G. DAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON="OFF=*REF*
G:\ENVCAD\SYRACUSE\ACTIB\B0001701\0002\00134\DWG\EX-OU-1_NORTH\1701C13.dwg LAYOUT: C-13D SAVED: 11/28/2017 4:10 PM ACADVER: 20.1S (LMS TECH) PAGESETUP:---- PLOTSTYLETABLE: ---- PLOTTED: 11/28/2017 4:11 PM BY: SARTORI, KATHERINE

XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13E
C-13F section
C-13G
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

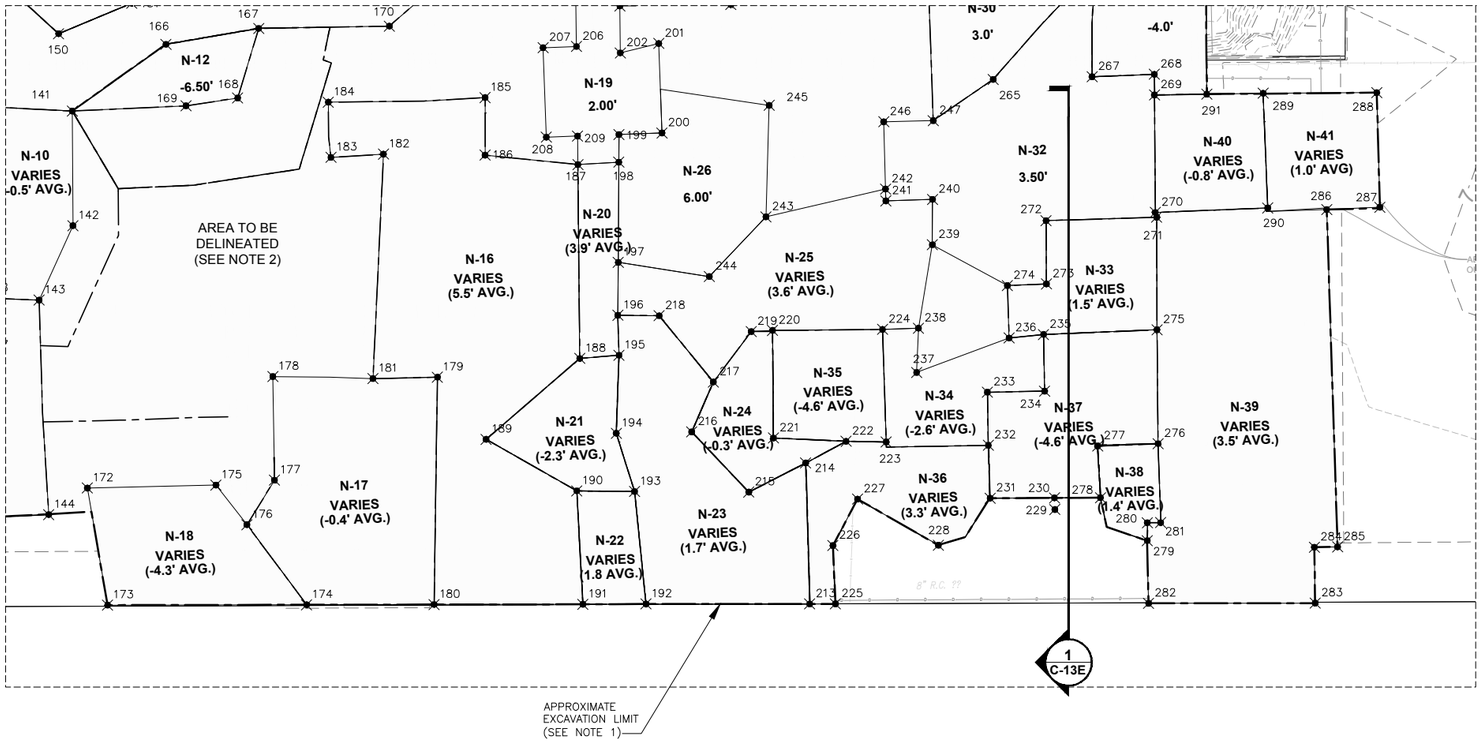
ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

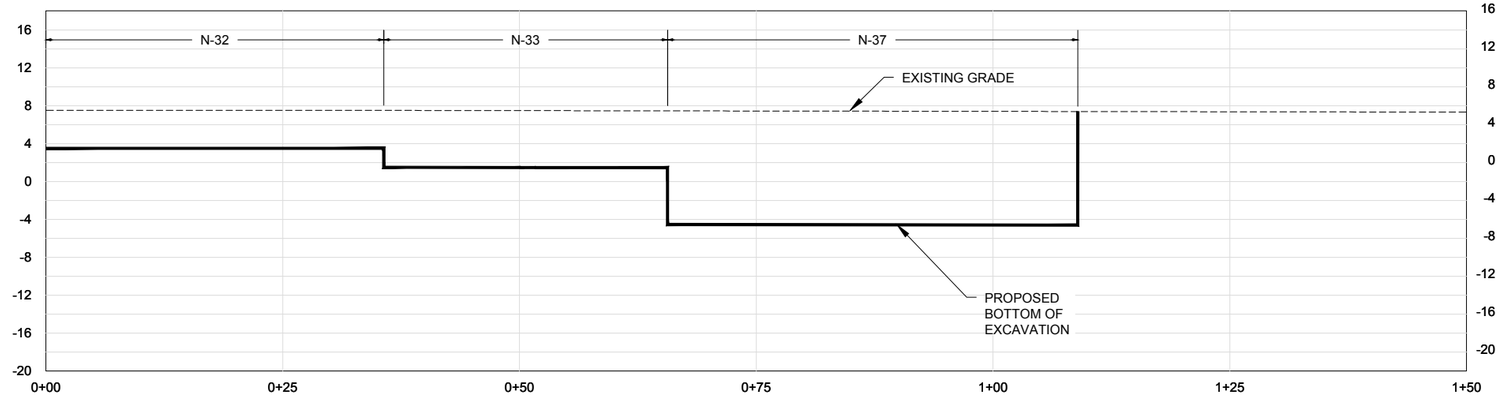
EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (4 OF 7)

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13D





CROSS SECTION 1 / C-13E

NOTES:
1. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT ALONG BUILDING 52 LIMIT. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
2. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE PERFORMED FOR EXCAVATION AREAS N10, N-12, N-17 N-18 ADJACENT TO FORMER JOB TRAILER AREA. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
3. EXCAVATION BOTTOM ELEVATION SUMMARY FOR ALL NORTHERN AREAS PRESENTED ON SHEETS C-13F AND C-13G.
4. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.

CONTROL POINT	NORTHING	EASTING
141	787811.66	661641.02
142	787810.71	661671.23
143	787801.07	661690.52
144	787801.55	661747.18
150	787808.78	661620.50
166	787836.99	661624.32
167	787861.60	661621.02
168	787855.39	661639.15
169	787841.69	661640.72
170	787896.09	661621.68
172	787812.00	661740.53
173	787816.19	661771.60
174	787868.70	661773.43
175	787845.93	661741.00
176	787853.73	661751.74
177	787861.42	661740.26
178	787862.00	661712.94
179	787905.40	661714.68
180	787902.32	661774.59
181	787888.38	661714.43
182	787893.31	661655.36
183	787879.43	661655.71
184	787879.26	661641.13
185	787920.66	661641.43
186	787920.10	661656.61
187	787944.50	661659.99
188	787943.12	661711.11
189	787917.64	661731.53
190	787941.07	661746.00
191	787941.58	661775.96
192	787958.23	661776.47
193	787956.30	661746.73
194	787952.03	661731.19
195	787953.49	661710.65
196	787953.59	661700.10
197	787954.20	661686.16
198	787955.30	661659.75
199	787955.61	661652.46
200	787966.97	661652.46
201	787966.97	661628.84
202	787956.76	661630.97
203	787957.10	661618.58
206	787945.25	661628.84
207	787936.42	661628.84
208	787936.42	661652.46
209	787944.68	661652.46
213	788001.40	661778.04
214	788001.70	661740.84
215	787986.43	661747.97
216	787971.94	661731.54
217	787978.14	661718.61
218	787964.48	661700.61
219	787988.62	661705.68
220	787994.25	661705.59
221	787993.45	661733.95
222	788012.57	661735.52
223	788023.14	661736.08
224	788023.26	661706.36
225	788008.20	661778.27

CONTROL POINT	NORTHING	EASTING
226	788008.09	661762.87
227	788015.05	661750.86
228	788035.93	661763.81
229	788066.99	661755.51
230	788066.99	661752.45
231	788050.02	661751.90
232	788050.06	661737.93
233	788050.31	661723.94
234	788065.41	661724.21
235	788065.69	661709.27
236	788056.56	661709.84
237	788031.84	661718.06
238	788032.75	661706.40
239	788037.21	661684.53
240	788037.70	661672.59
241	788025.38	661672.52
242	788025.40	661669.40
243	787993.60	661675.58
244	787978.08	661690.77
245	787995.51	661646.21
246	788025.57	661651.65
247	788038.64	661651.83
265	788054.85	661641.55
267	788080.97	661641.78
268	788097.41	661641.74
269	788097.24	661647.18
270	788096.35	661678.16
271	788096.65	661679.45
272	788067.44	661679.28
273	788066.94	661695.97
274	788056.61	661696.03
275	788095.66	661709.12
276	788094.84	661739.14
277	788078.88	661739.19
278	788079.12	661752.84
279	788091.06	661764.61
280	788091.26	661759.89
281	788094.76	661759.99
282	788090.80	661781.14
283	788134.75	661782.69
284	788135.07	661767.95
285	788141.20	661768.09
286	788141.57	661679.06
287	788155.62	661678.96
288	788155.90	661648.71
289	788125.93	661647.78
290	788126.03	661678.06
291	788111.06	661647.47

LEGEND:
- S-21 / 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- 1 — CONTROL POINTS

XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13F section
C-13G
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed | Project Mgr. .
Designed by . | Drawn by . | Checked by .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

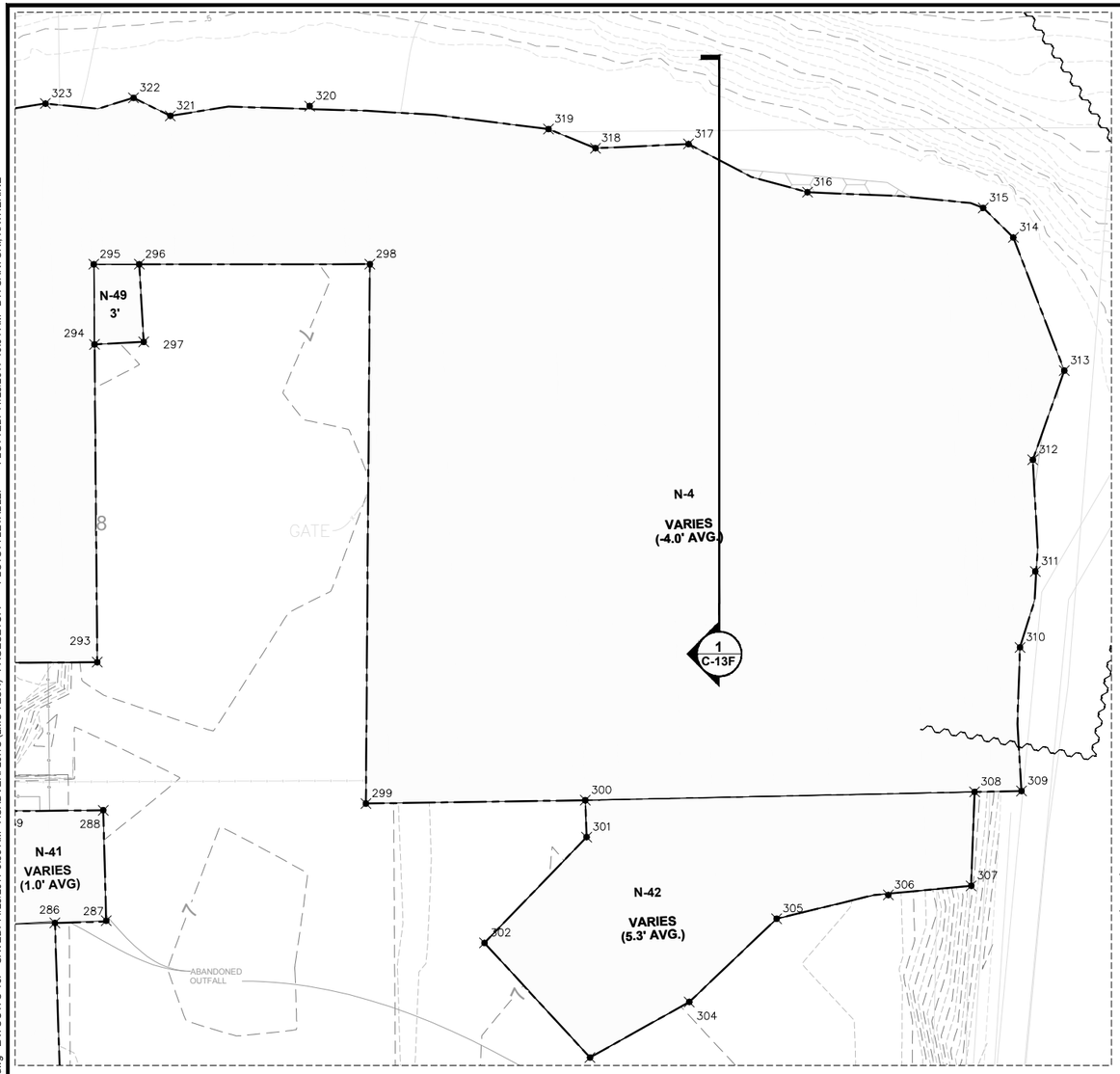
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (5 OF 7)

ARCADIS Project No. B0001701.0002.00134
Date NOVEMBER 2017
ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13E

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN
G:\ENVCAD\SYRACUSE\ACTIVE\B0001701\0002\20134\DWG\EX-OU-1_NORTH\1701C13.dwg LAYOUT: C-13E SAVED: 11/28/2017 9:55 AM ACADVER: 20.1S (LMS TECH) PAGESETUP:---- PLOTSTYLETABLE:---- PLOTTED: 11/28/2017 10:03 AM BY: SARTORI, KATHERINE



CONTROL POINT	NORTHING	EASTING
294	788158.18	661521.19
295	788158.79	661499.26
296	788171.23	661499.70
297	788171.67	661520.98
298	788234.33	661501.98
299	788227.85	661649.49
300	788287.91	661650.78
301	788287.91	661660.86
302	788258.91	661688.80
303	788286.63	661721.20
304	788314.37	661706.99
305	788339.09	661685.11
306	788369.87	661679.72
307	788392.65	661678.03
308	788394.54	661652.39
309	788407.38	661652.61
310	788408.40	661613.32
311	788413.34	661592.67
312	788413.77	661562.11
313	788423.28	661538.04
314	788410.67	661501.10
315	788402.71	661492.71
316	788354.78	661486.67
317	788322.73	661472.29
318	788297.21	661472.50
319	788284.55	661466.80
320	788219.43	661458.13
321	788181.20	661459.41
322	788171.32	661454.13
323	788147.15	661454.80

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
N-1	5.5'
N-2	VARIES (3.8' AVG.)
N-3	VARIES (-4.2' AVG.)
N-4	VARIES (-4.5' AVG.)
N-5	-5.0'
N-6	-6.0'
N-7	-1.0'
N-8	5.5'
N-9	1.5'
N-10	VARIES (-0.5' AVG.)
N-11	0.5'
N-12	-6.50'
N-13	2.8'
N-14	0.3'
N-15	-2.0'
N-16	VARIES (5.5' AVG.)
N-17	VARIES (-0.4' AVG.)
N-18	VARIES (-4.3' AVG.)
N-19	2.00'
N-20	VARIES (3.9' AVG.)
N-21	VARIES (-2.3' AVG.)
N-22	VARIES (1.8' AVG.)
N-23	VARIES (1.7' AVG.)
N-24	VARIES (-0.3' AVG.)
N-25	VARIES (3.6' AVG.)
N-26	6.00'
N-27	VARIES (1.20' AVG.)
N-28	VARIES (-1.8' AVG.)
N-29	VARIES (0.7' AVG.)
N-30	3.0'

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
N-31	-4.0'
N-32	3.50'
N-33	VARIES (1.5' AVG.)
N-34	VARIES (-2.6' AVG.)
N-35	VARIES (-4.6' AVG.)
N-36	VARIES (3.3' AVG.)
N-37	VARIES (-4.6' AVG.)
N-38	VARIES (1.4' AVG.)
N-39	VARIES (3.5' AVG.)
N-40	VARIES (-0.8' AVG.)
N-41	VARIES (1.0' AVG.)
N-42	VARIES (5.3' AVG.)

LEGEND:

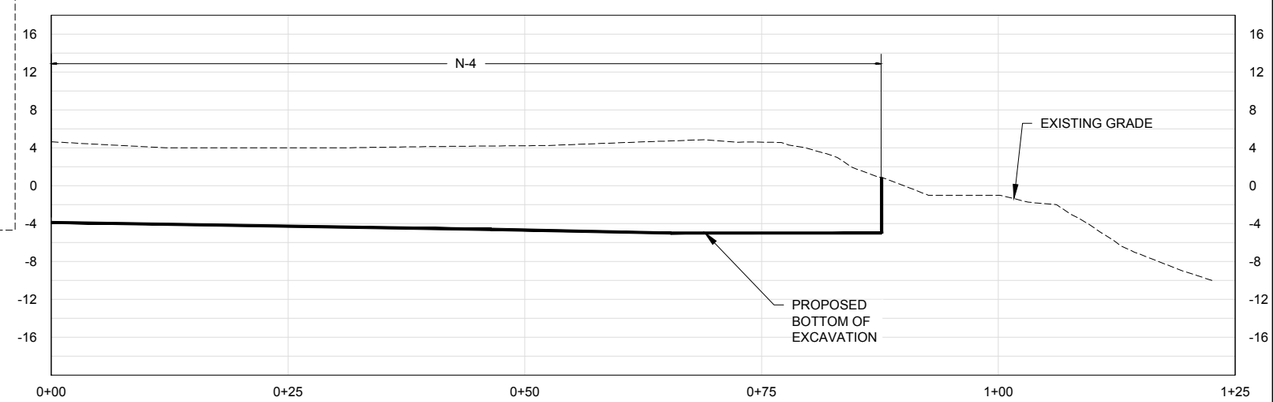
S-21 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)

PROPOSED EXCAVATION LIMITS

1 — CONTROL POINTS

NOTE:

1. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.



CROSS SECTION 1 / C-13F

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACTIVE\B0001701\0002\00134\DWG\EX-OU-1_NORTH\1701C13.dwg LAYOUT: C-13F SAVED: 11/28/2017 9:55 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/28/2017 10:04 AM BY: SARTORI, KATHERINE

XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13F section
C-13G
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: . | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

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ARCADIS OF NEW YORK, INC.
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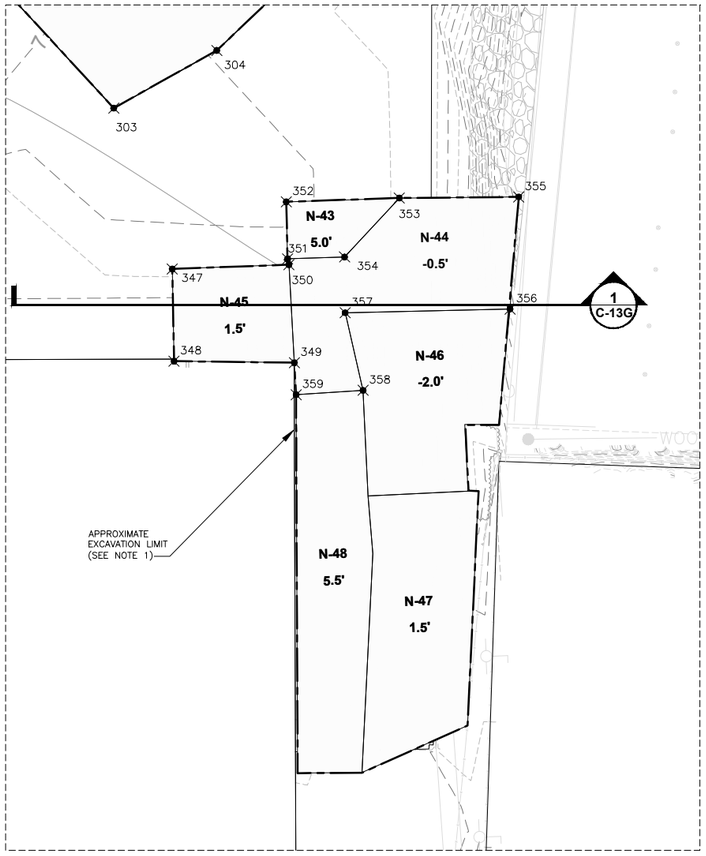
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

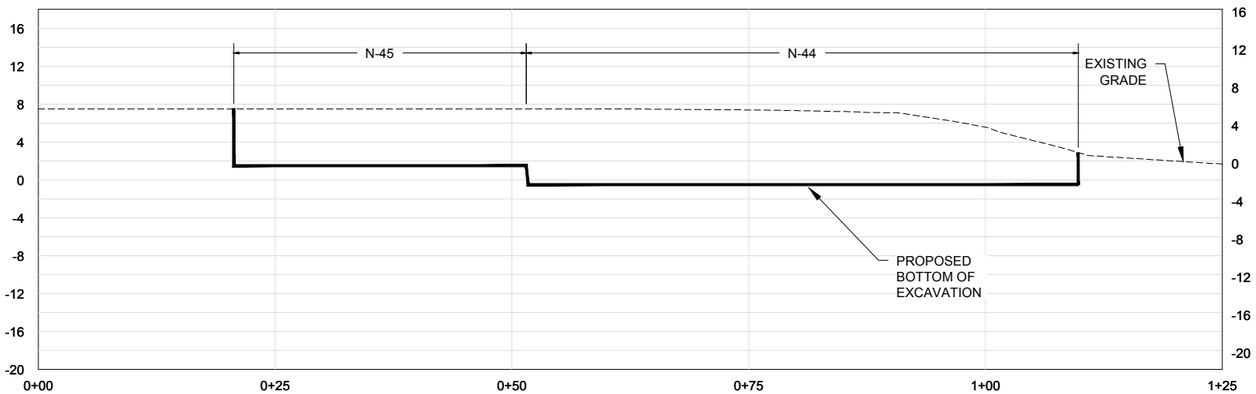
EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (6 OF 7)

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-13F





CROSS SECTION 1 / C-13G

LEGEND:

- S-21 / 3.5' — PROPOSED EXCAVATION AREA ID AND BOTTOM ELEVATION (NAVD88)
- PROPOSED EXCAVATION LIMITS
- 1 — CONTROL POINTS

EXCAVATION AREA	BOTTOM ELEVATION (NAVD88)
N-43	5.0'
N-44	-0.5'
N-45	1.5'
N-46	-2.0'
N-47	1.5'
N-48	5.5'
N-49	3.0'

CONTROL POINT	NORTHING	EASTING
347	788300.52	661764.19
348	788300.10	661788.51
349	788331.81	661790.07
350	788331.31	661764.17
351	788331.03	661762.63
352	788331.23	661747.57
353	788361.07	661747.66
354	788346.07	661762.68
355	788392.57	661748.53
356	788389.20	661778.01
357	788345.70	661777.39
358	788349.66	661798.01
359	788331.97	661798.52
360	788328.74	661898.33
361	788345.71	661898.81
362	788350.66	661841.12
363	788349.97	661825.91
364	788373.98	661887.40
365	788379.14	661825.70
366	788376.38	661825.61
367	788376.18	661807.99
368	788385.08	661808.34

NOTES:

1. ADDITIONAL HORIZONTAL DELINEATION SAMPLING WILL BE COMPLETED TO FINALIZE EXCAVATION LIMIT ALONG BUILDING 52 LIMIT. THE FINAL LIMITS SHALL BE INCLUDED IN THE FINAL DESIGN BASED ON THE RESULTS OF THE WORK CURRENTLY BEING PERFORMED.
2. BACKFILL WILL BE COMPLETED IN ACCORDANCE WITH THE SPECIFICATIONS THAT WILL BE INCLUDED AS PART OF THE FINAL DESIGN.

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G. STEINBERGER PIC:K. G. DAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACTIB\0001701\0002\00134\DWG\EX-OU-1_NORTH\1701C13.dwg LAYOUT: C-13G SAVED: 11/28/2017 10:04 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/28/2017 10:04 AM BY: SARTORI, KATHERINE
XREFS:
IMAGES:
01701X00
01701X01
proposed excavation limits-grade breaks 10-17
C-13A
C-13B
C-13D
C-13E section
C-13G
Section 13C
Section 13E
control points
01701X13

1"=40' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed: . | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

EXCAVATION OU1 NORTH PLAN AND CROSS SECTIONS (7 OF 7)

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

C-13G

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACTIVE\B0001701\0002\001040\DWG\CONTRACT\1701C16-17.dwg LAYOUT: C-16 SAVED: 11/28/2017 4:18 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/28/2017 4:25 PM BY: SARTORI, KATHERINE

NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.
2. ELEVATION 11 (TOP OF BANK), AS DEFINED BY THE CD, IS ESTIMATED TO BE APPROXIMATELY 80 TO 100 FEET FROM THE MEAN LOW WATER MARK (BUT NOT TO EXCEED 110 FEET FROM THE MEAN LOW WATER MARK) (AND APPROXIMATELY 60 TO 70 FEET FROM THE MEAN LOW WATER MARK ALONG THE NORTHERN BOAT SLIP AND SOUTHERN BOAT SLIP), RUNNING FROM THE SOUTHERN END OF THE NORTHWEST CORNER BULKHEAD TO THE SOUTHERN PROPERTY BOUNDARY.
3. REFER TO DREDGE DRAWINGS FOR IN RIVER RESTORATION.
4. THE WESTCHESTER COUNTY SANITARY SEWER PUMP STATION, ADJACENT SEWER LINES, AND SEWER LINE RUNNING EAST OF FORMER BUILDING FB#52 WILL BE RETAINED AND CONTINUE OPERATION AFTER REMEDIATION PROJECT COMPLETION. FINAL GRADING AROUND PUMP STATION AND MANHOLE REPAIR/REPLACEMENT WILL BE COORDINATED WITH WESTCHESTER COUNTY.
5. NEW SANITARY SEWER PIPELINE AND MANHOLE LOCATIONS ARE APPROXIMATE. FINAL GRADING AND LOCATION OF NEW PIPELINE AND MAHOLES WILL BE COORDINATED WITH WESTCHESTER COUNTY.

LEGEND:

- 11 — PROPOSED FINAL GRADE CONTOUR (1-FOOT INTERVAL)
- PROPOSED GRADEBREAK
- X 8.0 — FINAL GRADE SPOT ELEVATION
- PROPOSED STORM SEWER MANHOLE
- PROPOSED SEWER PIPELINE
- PROPOSED CHAIN-LINK FENCE
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) (+2.2 FT NAVD88)

HUDSON RIVER

1 / C16A

3.3% (TYP)

0.5% (TYP)

SOUTH BOAT SLIP

OPEN SPACE FOR FUTURE WALKWAY

PROPOSED CHAIN-LINK FENCE

DEVELOPABLE LAND

APPROXIMATE NEW 18" HDPE STORM SEWER PIPELINE

APPROXIMATE NEW 10" HDPE STORM SEWER PIPELINE

MATCHLINE C-16
MATCHLINE C-17

NEW SANITARY SEWER PIPELINE (SEE NOTE 5)

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

XREFs:
IMAGES:
01701X00
01701X01-For C-16 and C-17
01701X10
01701X11
01701X12

50' 0 50' 100'
1"=50'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: - | Project Mgr.: -
Designed by: - | Drawn by: - | Checked by: -

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ARCADIS Design & Consultancy for natural and built assets

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

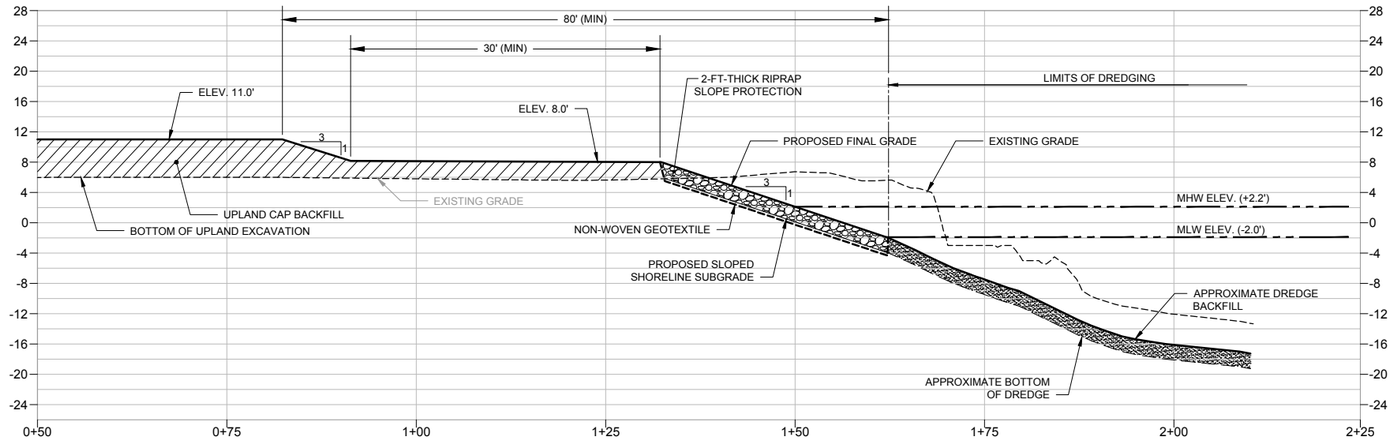
FINAL GRADING OU1 SOUTH

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-16



1 BANK CROSS SECTION

1"=10'

LEGEND:

- UPLAND CAP BACKFILL
- RAPRAP
- DREDGE BACKFILL

CITY: SYRACUSE NY DIVGROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0001701\0002\00104\DWG\CONTRACT\1701C16-17.dwg LAYOUT: C-16A SAVED: 11/28/2017 10:12 AM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/28/2017 10:15 AM BY: SARTORI, KATHERINE

XREFS: IMAGES:
01701X00
01701X01-For C-16 and C-17
01701X10
01701X11
01701X12

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

CROSS SECTION

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-16A

LEGEND:

- 11 — PROPOSED FINAL GRADE CONTOUR (1-FOOT INTERVAL)
- PROPOSED GRADEBREAK
- X 8.0 — FINAL GRADE SPOT ELEVATION
- PROPOSED STORM SEWER MANHOLE
- PROPOSED SEWER PIPELINE
- X — PROPOSED CHAIN-LINK FENCE
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) (+2.2 FT NAVD88)

NOTES:

1. REFER TO DRAWING G-1 FOR ADDITIONAL BASEMAP AND LEGEND INFORMATION.
2. ELEVATION 11 (TOP OF BANK), AS DEFINED BY THE CD, IS ESTIMATED TO BE APPROXIMATELY 80 TO 100 FEET FROM THE MEAN LOW WATER MARK (BUT NOT TO EXCEED 110 FEET FROM THE MEAN LOW WATER MARK) (AND APPROXIMATELY 80 TO 70 FEET FROM THE MEAN LOW WATER MARK ALONG THE NORTHERN BOAT SLIP AND SOUTHERN BOAT SLIP), RUNNING FROM THE SOUTHERN END OF THE NORTHWEST CORNER BULKHEAD TO THE SOUTHERN PROPERTY BOUNDARY.
3. REFER TO DREDGE DRAWINGS FOR IN RIVER RESTORATION.
4. THE WESTCHESTER COUNTY SANITARY SEWER PUMP STATION, ADJACENT SEWER LINES, AND SEWER LINE RUNNING EAST OF FORMER BUILDING FB#52 WILL BE RETAINED AND CONTINUE OPERATION AFTER REMEDIATION PROJECT COMPLETION. FINAL GRADING AROUND PUMP STATION AND MANHOLE REPAIR/REPLACEMENT WILL BE COORDINATED WITH WESTCHESTER COUNTY.

HUDSON RIVER

PROPOSED BULKHEAD WALL

1 C17A

NORTH BOAT SLIP

OPEN SPACE FOR FUTURE WALKWAY

33% (TYP)

1% (TYP)

0.5% (TYP)

APPROXIMATE NEW HDPE STORM SEWER PIPELINES

DEVELOPABLE LAND

MATCHLINE C-16
MATCHLINE C-17

EXISTING PUMP STATION (SEE NOTE 4)

WESTCHESTER COUNTY SEWER (SEE NOTE 4)

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

XREFS:
IMAGES:
C-17
01701X00
01701X01-For C-16 and
01701X10
01701X11
01701X12

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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50' 0 50' 100'
1"=50'

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USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		-
Designed by	Drawn by	Checked by
-	-	-

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ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

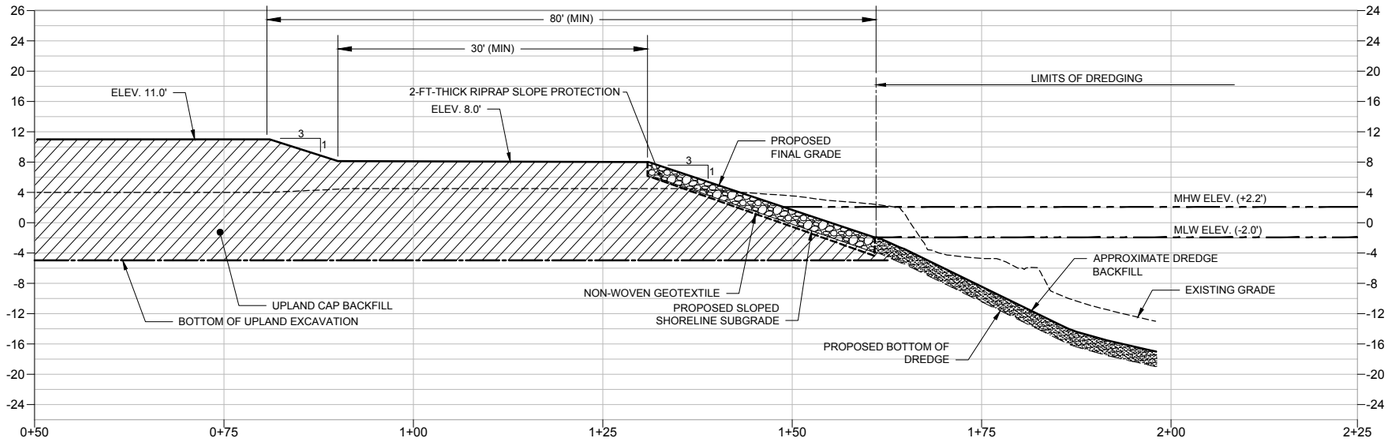
FINAL GRADING OU1 NORTH

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-17



1 BANK CROSS SECTION

10' 0 10' 20'
1"=10'

LEGEND:

- UPLAND CAP BACKFILL
- RAPRAP
- DREDGE BACKFILL

XREFS:
IMAGES:
01701X00
01701X01-For C-16 and C-17
01701X10
01701X11
01701X12

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: .
Designed by: . | Drawn by: . | Checked by: .

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

CROSS SECTION

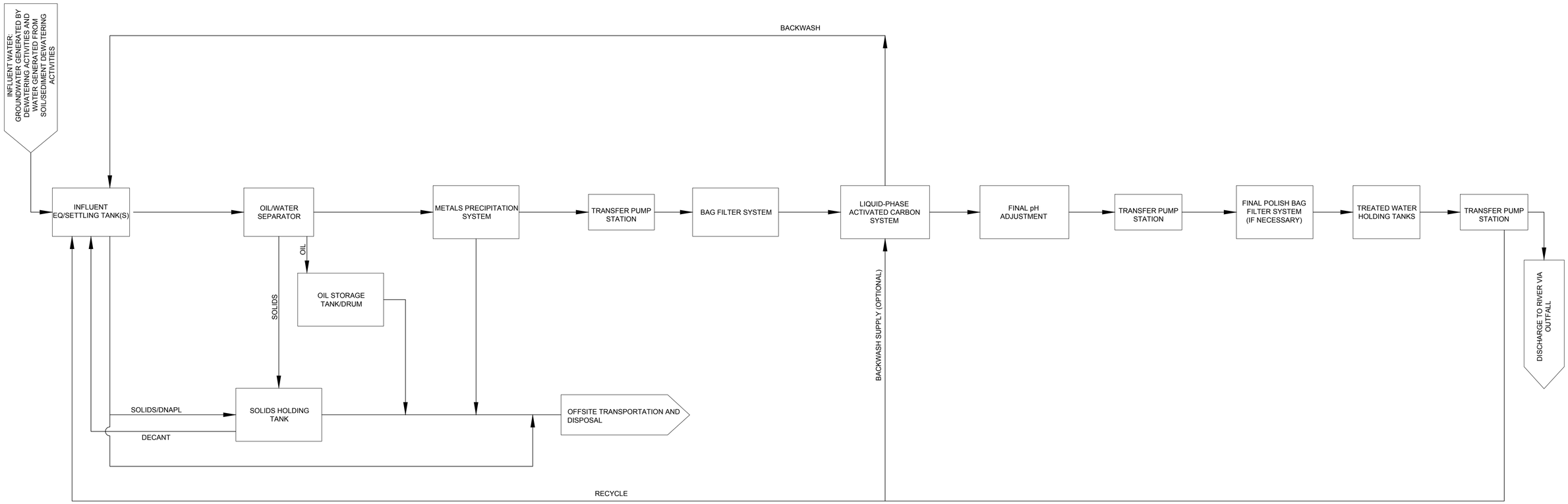
ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

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One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-17A

CITY: SYRACUSE NY DIV/GROUP:ENV/CAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN
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XREFS:
01701X00
IMAGES:



NOTE:

1. ALL WATER LINES EXCEPT WHERE NOTED.
2. FINAL TREATMENT SYSTEM CONFIGURATION WILL BE DETERMINED BY THE CONTRACTOR TO MEET THE DISCHARGE REQUIREMENTS.

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Re□isions	By	Ckd

Pro□essional Engineer's Na□e
MARK O. GRAVELDING
Pro□essional Engineer's No.
069985-1
State: NY | Date Signed: | Pro□ect Mgr.: -
Designed □y: - | Drawn □y: - | Checked □y: -

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

TEMPORARY WATER TREATMENT PLAN - PROCESS FLOW DIAGRAM

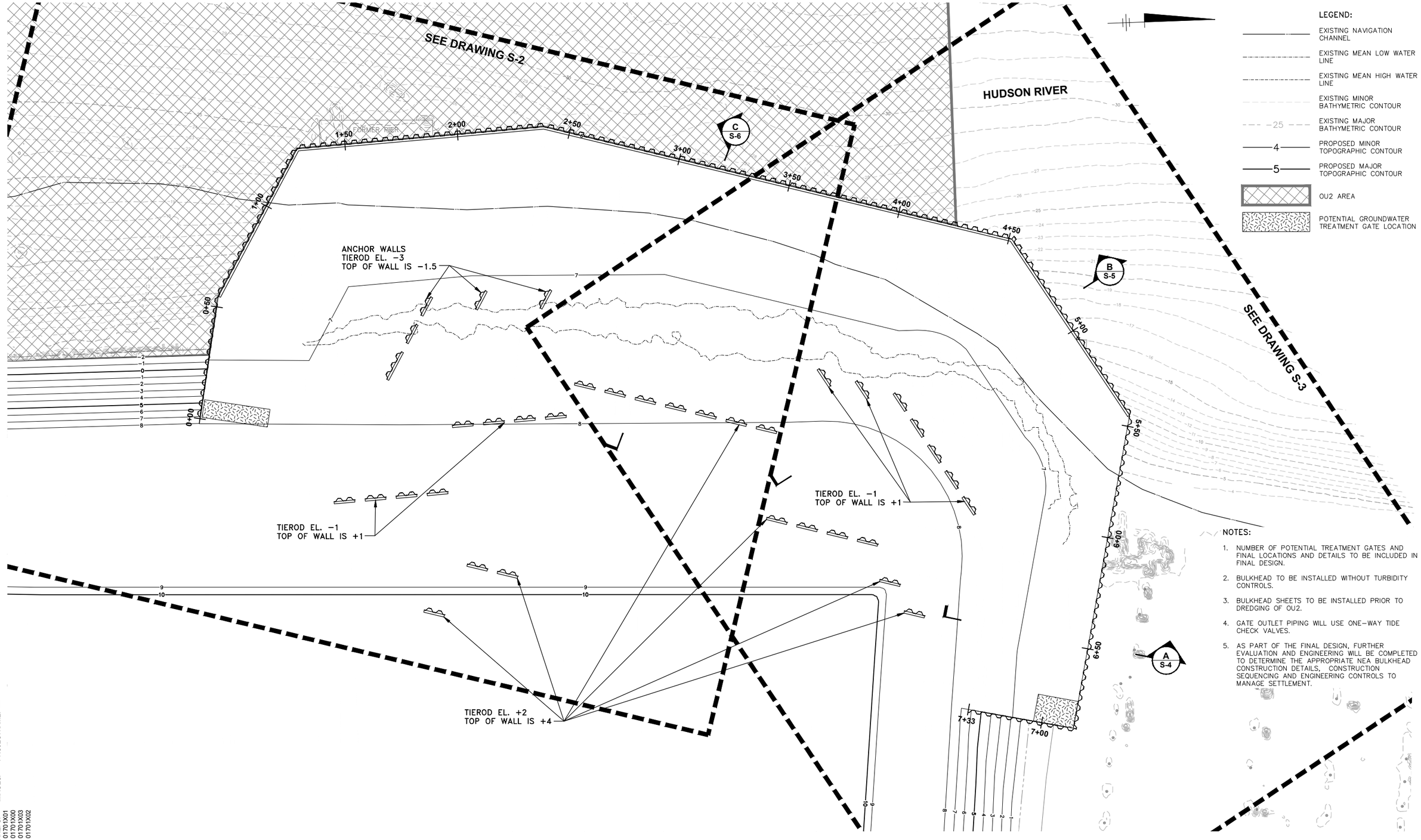
ARCADIS Pro□ect No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS o□NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

C-23

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER , K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*;OFF=*REF*
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XREFS: 01701X01 01701X00 01701X03 01701X02
IMAGES:
PROJECTNAME: ----



NOTES:

1. NUMBER OF POTENTIAL TREATMENT GATES AND FINAL LOCATIONS AND DETAILS TO BE INCLUDED IN FINAL DESIGN.
2. BULKHEAD TO BE INSTALLED WITHOUT TURBIDITY CONTROLS.
3. BULKHEAD SHEETS TO BE INSTALLED PRIOR TO DREDGING OF OU2.
4. GATE OUTLET PIPING WILL USE ONE−WAY TIDE CHECK VALVES.
5. AS PART OF THE FINAL DESIGN, FURTHER EVALUATION AND ENGINEERING WILL BE COMPLETED TO DETERMINE THE APPROPRIATE NEA BULKHEAD CONSTRUCTION DETAILS, CONSTRUCTION SEQUENCING AND ENGINEERING CONTROLS TO MANAGE SETTLEMENT.

1"=20' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		
Designed □y	Drawn □y	Checked □y

NOT FOR CONSTRUCTION

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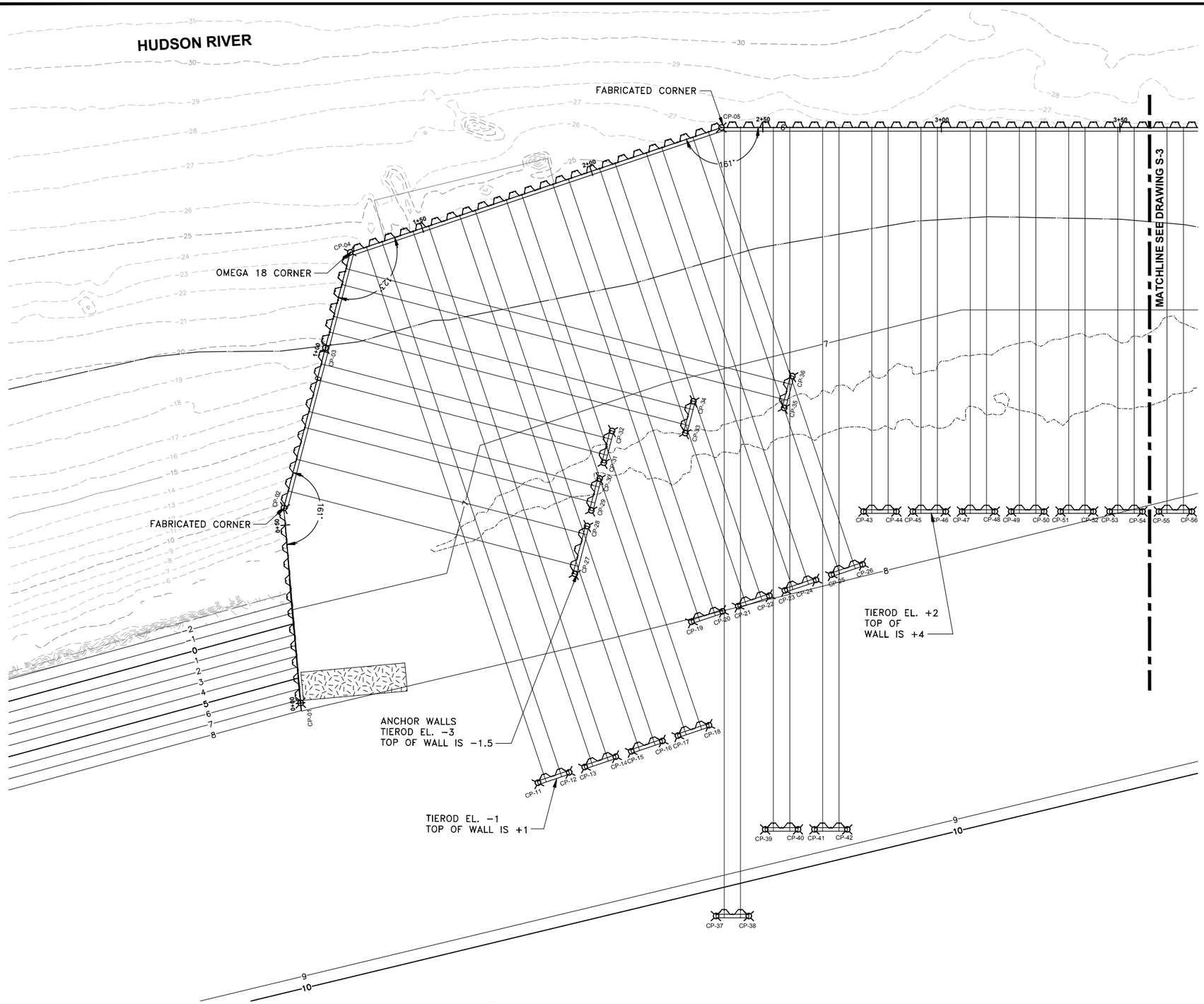
ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD ALIGNMENT PLAN

ARCADIS Project No.: B0001701.0002.00221
Date: NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-1



LEGEND:

- EXISTING NAVIGATION CHANNEL
- EXISTING MEAN LOW WATER LINE
- EXISTING MEAN HIGH WATER LINE
- EXISTING MINOR BATHYMETRIC CONTOUR
- EXISTING MAJOR BATHYMETRIC CONTOUR
- PROPOSED MINOR TOPOGRAPHIC CONTOUR
- PROPOSED MAJOR TOPOGRAPHIC CONTOUR
- POTENTIAL GROUNDWATER TREATMENT GATE LOCATION

HEADWALL & ANCHOR PILE CONTROL POINT SCHEDULE

ID	NORTHING(Y)	EASTING(X)
CP-01	788045.49	661492.57
CP-02	788055.66	661438.72
CP-03	788078.91	661398.71
CP-04	788092.82	661374.79
CP-05	788202.30	661369.07
CP-11	788103.50	661531.95
CP-12	788112.67	661531.47
CP-13	788117.26	661531.23
CP-14	788126.43	661530.75
CP-15	788131.02	661530.51
CP-16	788140.19	661530.03
CP-17	788144.78	661529.79
CP-18	788153.95	661529.31
CP-19	788157.03	661500.11
CP-20	788166.20	661499.63
CP-21	788170.79	661499.39
CP-22	788179.96	661498.91
CP-23	788184.55	661498.67
CP-24	788193.72	661498.19
CP-25	788198.31	661497.95
CP-26	788207.48	661497.47
CP-27	788129.18	661478.40
CP-28	788136.10	661466.48
CP-29	788138.41	661462.51
CP-30	788143.03	661454.57
CP-31	788145.33	661450.60

HEADWALL & ANCHOR PILE CONTROL POINT SCHEDULE

ID	NORTHING(Y)	EASTING(X)
CP-32	788149.95	661442.66
CP-33	788169.55	661448.74
CP-34	788174.17	661440.79
CP-35	788198.09	661449.39
CP-36	788202.70	661441.44
CP-37	788141.49	661581.27
CP-38	788150.34	661583.74
CP-39	788161.28	661561.63
CP-40	788170.13	661564.10
CP-41	788174.56	661565.34
CP-42	788183.40	661567.81
CP-43	788211.76	661483.32
CP-44	788220.61	661485.79
CP-45	788225.03	661487.03
CP-46	788233.88	661489.50
CP-47	788238.30	661490.73
CP-48	788247.15	661493.20
CP-49	788251.58	661494.44
CP-50	788260.42	661496.91
CP-51	788264.85	661498.14
CP-52	788273.70	661500.61
CP-53	788278.12	661501.85
CP-54	788286.97	661504.32
CP-55	788291.39	661505.55
CP-56	788300.24	661508.02

BULKHEAD HEADWALL SCHEDULE

WALL ALIGNMENT		ANCHOR ELEV	LENGTH OF WALL	WALL TYPE	REQUIRED SECTION	MIN. SHEET PILE LENGTH	MIN. SHEET PILE TIP EL.
FROM	TO	FT NAVD88	LF			FT	FT NAVD88
CP-01	CP-02	--	54	CANTILEVER	A□ 17-700	35	-29
CP-02	CP-03	-3	46	ANCHORED TIEBACK WALL	A□ 17-700	65	-59
CP-03	CP-05	-1	138	ANCHORED TIEBACK WALL	A□ 46-700N	79	-73
CP-05	CP-07	2	227	ANCHORED TIEBACK WALL	A□ 46-700N	79	-73

BULKHEAD ANCHOR SCHEDULE

WALL ALIGNMENT		TIE ROD/ WALE EL.	REQUIRED SECTION	MIN. ANCHOR OFFSET	MIN. SHEET PILE TIP EL.	PILE CUT-OFF EL.
FROM	TO	FT NAVD88		FT	FT NAVD88	FT NAVD88
CP-11	CP-26	-1	A□ 17-700	103	-18	1
CP-27	CP-36	-3	A□ 17-700	83	-12	-1.5
CP-37	CP-68	+2	A□ 17-700	104	-19	4

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER, K.SARTORI LD: G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*OFF=*REF*
G:\ENVCAD\SYRACUSE\ACTIVE\B0001701\0002\00221\DWG\STRUCTURAL\AL120170\S02-S03.dwg LAYOUT: S-2 SAVED: 11/28/2017 5:31 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/28/2017 5:37 PM BY: DECLERCQ, BRIAN
XREFS:
01701X01
01701X00
01701X03
01701X02
IMAGES:
PROJECTNAME: ----

15' 0 15' 30'
1"=15'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Re□isions	By	Ckd

Pro□essional Engineer's Na□e
MARK O. GRAVELDING
Pro□essional Engineer's No.
069985-1
State: NY
Date Signed:
Pro□ect Mgr.:
Designed □y:
Drawn □y:
Checked □y:

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

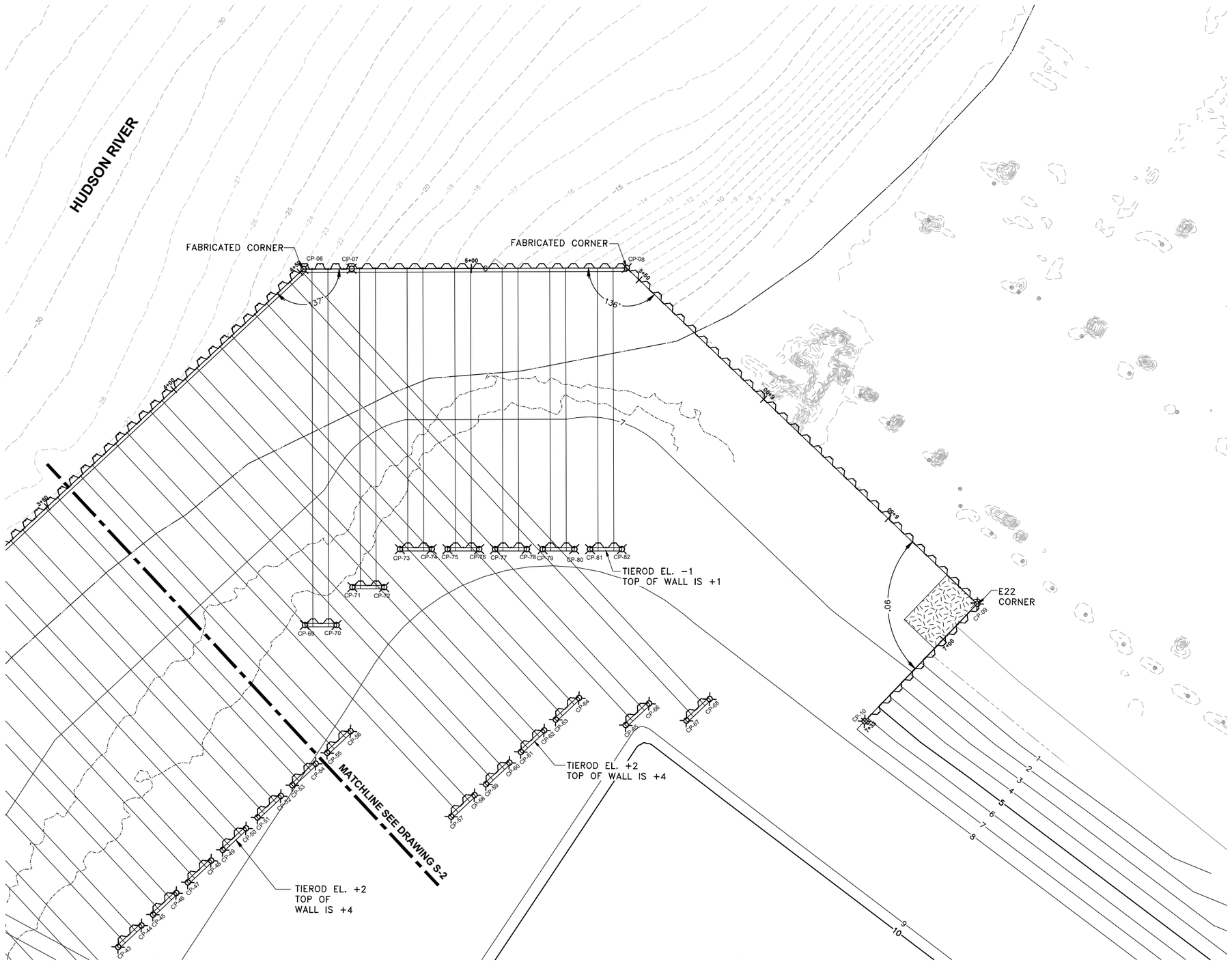
NEA BULKHEAD ALIGNMENT PLAN STA 0+00 TO 3+58

ARCADIS Pro□ect No.
B0001701.0002.00221

Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-2



HEADWALL & ANCHOR PILE CONTROL POINT SCHEDULE

ID	NORTHING(Y)	EASTING(X)
CP-06	788407.43	661426.34
CP-07	788414.76	661438.22
CP-08	788456.65	661506.07
CP-09	788426.75	661643.57
CP-10	788380.67	661633.56
CP-43	788211.76	661483.32
CP-44	788220.61	661485.79
CP-45	788225.03	661487.03
CP-46	788233.88	661489.50
CP-47	788238.30	661490.73
CP-48	788247.15	661493.20
CP-49	788251.58	661494.44
CP-50	788260.42	661496.91
CP-51	788264.85	661498.14
CP-52	788273.70	661500.61
CP-53	788278.12	661501.85
CP-54	788286.97	661504.32
CP-55	788291.39	661505.55
CP-56	788300.24	661508.02
CP-57	788294.45	661545.86
CP-58	788303.29	661548.33
CP-59	788307.72	661549.57
CP-60	788316.57	661552.04

HEADWALL & ANCHOR PILE CONTROL POINT SCHEDULE

ID	NORTHING(Y)	EASTING(X)
CP-61	788320.99	661553.27
CP-62	788329.84	661555.74
CP-63	788334.26	661556.98
CP-64	788343.11	661559.45
CP-65	788343.50	661575.13
CP-66	788352.35	661577.60
CP-67	788353.81	661589.43
CP-68	788362.66	661591.90
CP-69	788319.63	661480.66
CP-70	788324.43	661488.49
CP-71	788336.21	661486.66
CP-72	788341.01	661494.49
CP-73	788352.79	661492.65
CP-74	788357.60	661500.48
CP-75	788360.00	661504.40
CP-76	788364.80	661512.23
CP-77	788367.20	661516.14
CP-78	788372.00	661523.97
CP-79	788374.41	661527.89
CP-80	788379.21	661535.72
CP-81	788381.61	661539.64
CP-82	CP-82	661547.47

BULKHEAD HEADWALL SCHEDULE

WALL ALIGNMENT		ANCHOR ELEV	LENGTH OF WALL	WALL TYPE	REQUIRED SECTION	MIN. SHEET PILE LENGTH	MIN. SHEET PILE TIP EL.
FROM	TO	FT NAVD88	LF			FT	FT NAVD88
CP-05	CP-07	2	227	ANCHORED TIEBACK WALL	A□ 46-700N	79	-73
CP-07	CP-08	-1	80	ANCHORED TIEBACK WALL	A□ 17-700	65	-59
CP-08	CP-10	--	189	CANTILEVER	A□ 17-700	35	-29

BULKHEAD ANCHOR SCHEDULE

WALL ALIGNMENT		TIE ROD/ WALE EL.	REQUIRED SECTION	MIN. ANCHOR OFFSET	MIN. SHEET PILE TIP EL.	PILE CUT-OFF EL.
FROM	TO	FT NAVD88		FT	FT NAVD88	FT NAVD88
CP-37	CP-68	+2	A□ 17-700	104	-19	4
CP-69	CP-82	-1	A□ 17-700	81	-10	1

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER, K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON="OFF="REF"
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XREFS: IMAGES: PROJECTNAME: ----
01701X01
01701X00
01701X03
01701X02

15' 0 15' 30'
1"=15'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1
State: NY | Date Signed | Project Mgr.
Designed □y | Drawn □y | Checked □y

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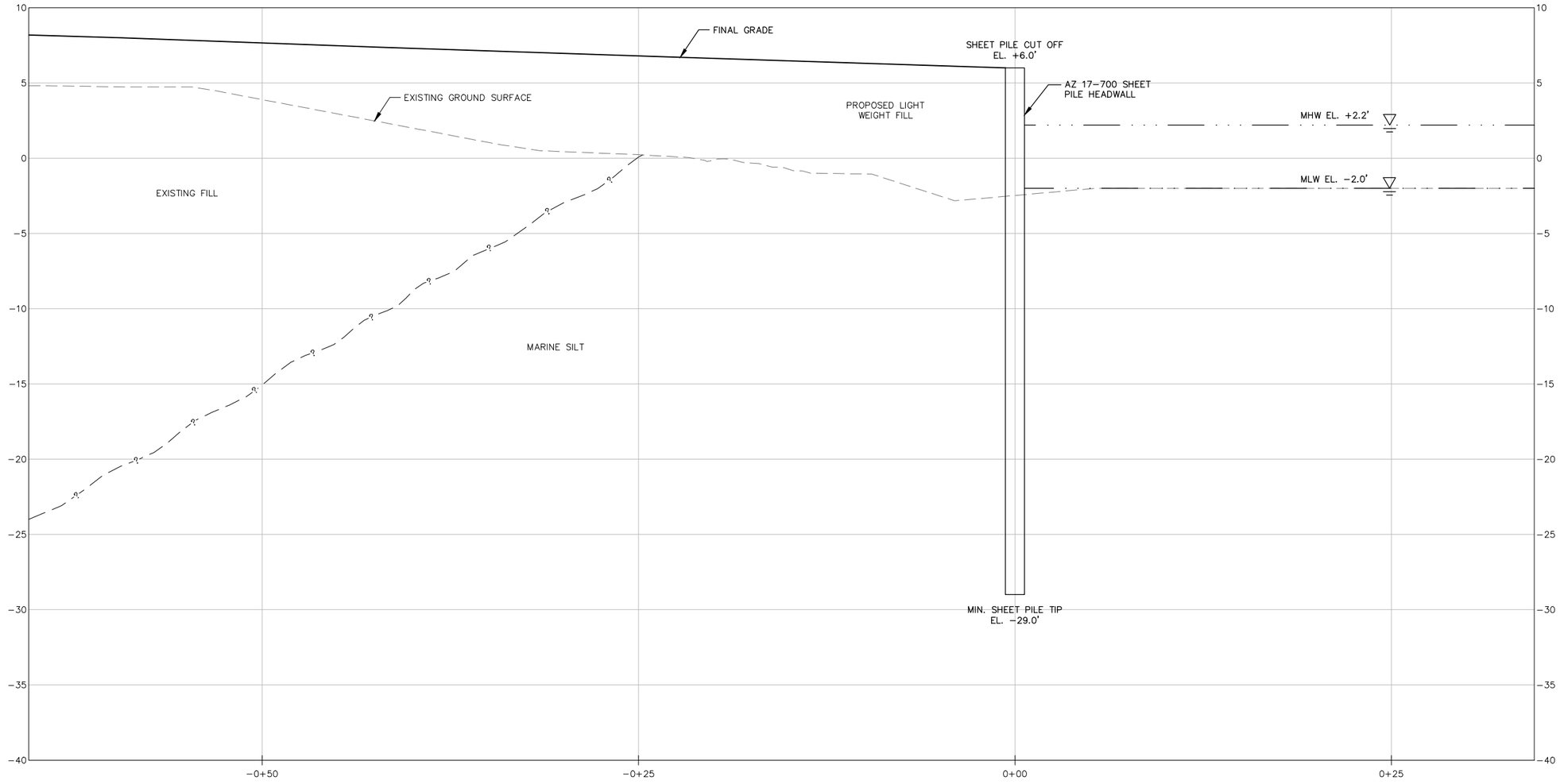
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD ALIGNMENT PLAN STA 3+58 TO 7+33

ARCADIS Project No.
B0001701.0002.00221
Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-3



CANTILEVER WALL (A)

CP-01 TO CP-02
CP-08 TO CP-10

LEGEND:

—?— —?— ASSUMED LITHOLOGICAL INTERFACE

NOTES:

1. SOIL TYPES AND GEOLOGIC CONTACTS ARE APPROXIMATE AND ARE INTERPOLATED BETWEEN SOIL BORING LOCATIONS. ACTUAL SUBSURFACE CONDITIONS MAY BE DIFFERENT THAN THOSE SHOWN OR INDICATED.
2. ADDITIONAL STRUCTURES, DEBRIS, AND UNDERGROUND FACILITIES MAY BE PRESENT THAT ARE NOT SHOWN OR INDICATED.
3. TYPE OF LIGHTWEIGHT FILL TO BE INCLUDED IN FINAL DESIGN.

CITY: SYRACUSE NY DIVGROUP:ENVCAD DB:E. KRAHMER, K.SARTORI LD:G.STEINBERGER PIC:M. GRAVELDING PM:E. DIEVENDORF TM:E. BUREAU LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0001701\0002\00221\DWG\STRUCTURAL\ALT2\01701S04-S06.dwg LAYOUT: S-4 SAVED: 11/28/2017 5:23 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/28/2017 5:27 PM BY: DECLERCQ, BRIAN
XREFS: IMAGES: PROJECTNAME: ---
01701X00

1"=4' (4' 0 4' 8')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		
Designed by	Drawn by	Checked by

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

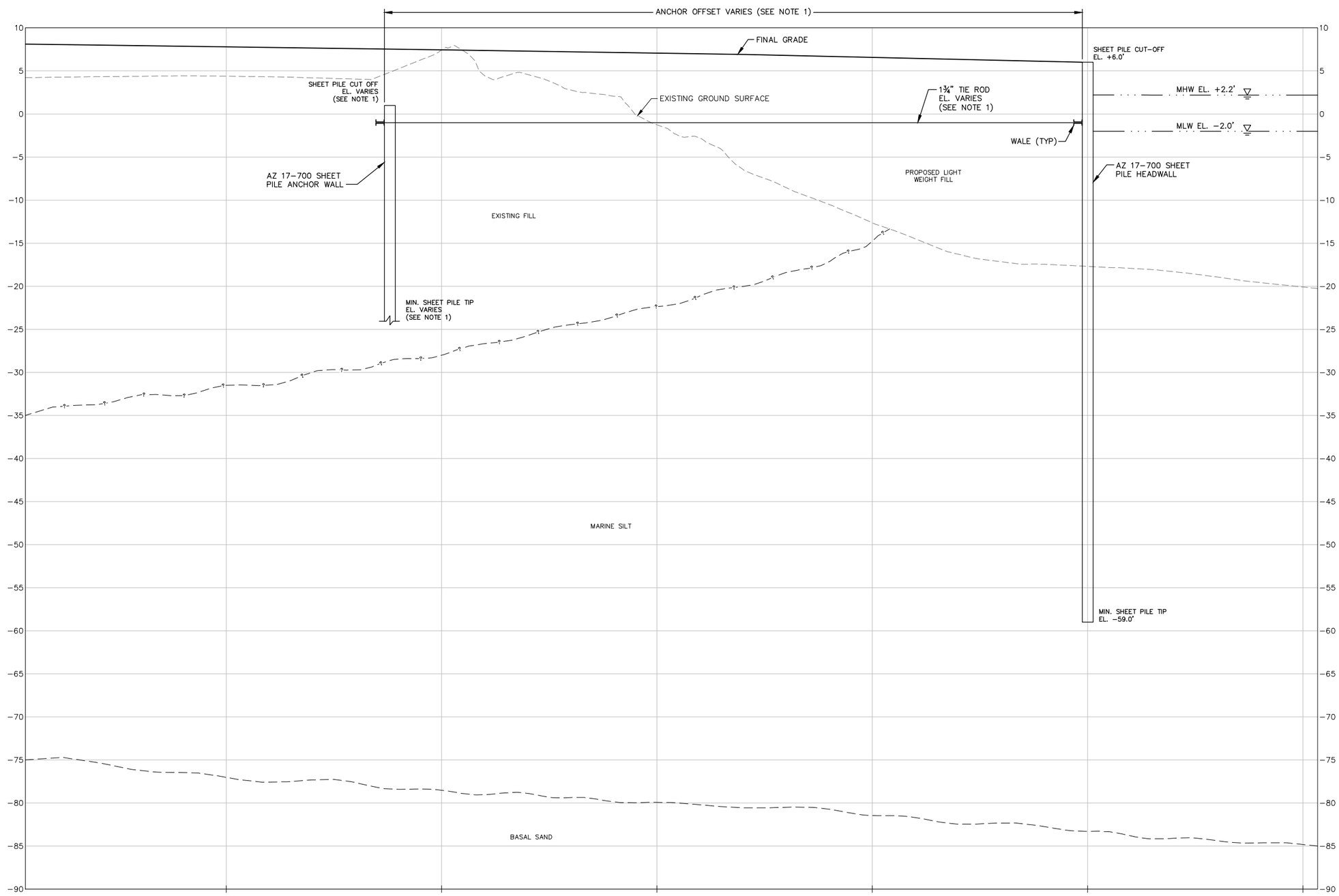
NEA BULKHEAD SECTION A

ARCADIS Project No.
B0001701.0002.00221

Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-4



LEGEND:

—?— —?— ASSUMED LITHOLOGICAL INTERFACE

— — — — APPROXIMATE LITHOLOGICAL INTERFACE

NOTES:

1. REQUIRED ANCHOR OFFSET, CUT-OFF ELEVATION, TIE ROD ELEVATION, AND MINIMUM PILE TIP ELEVATION VARY. SEE BULKHEAD ANCHOR SCHEDULE ON DRAWINGS S-2 THROUGH S-3.
2. SOIL TYPES AND GEOLOGIC CONTACTS ARE APPROXIMATE AND ARE INTERPOLATED BETWEEN SOIL BORING LOCATIONS. ACTUAL SUBSURFACE CONDITIONS MAY BE DIFFERENT THAN THOSE SHOWN OR INDICATED.
3. ADDITIONAL STRUCTURES, DEBRIS, AND UNDERGROUND FACILITIES MAY BE PRESENT THAT ARE NOT SHOWN OR INDICATED.
4. TYPE OF LIGHTWEIGHT FILL TO BE INCLUDED IN FINAL DESIGN.

ANCHORED TIEBACK WALL (B)

CP-02 TO CP-03
CP-07 TO CP-08

1"=6' (6' 0 6' 12')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1
State: NY | Date Signed | Project Mgr.
Designed: | Drawn: | Checked:

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD SECTION B

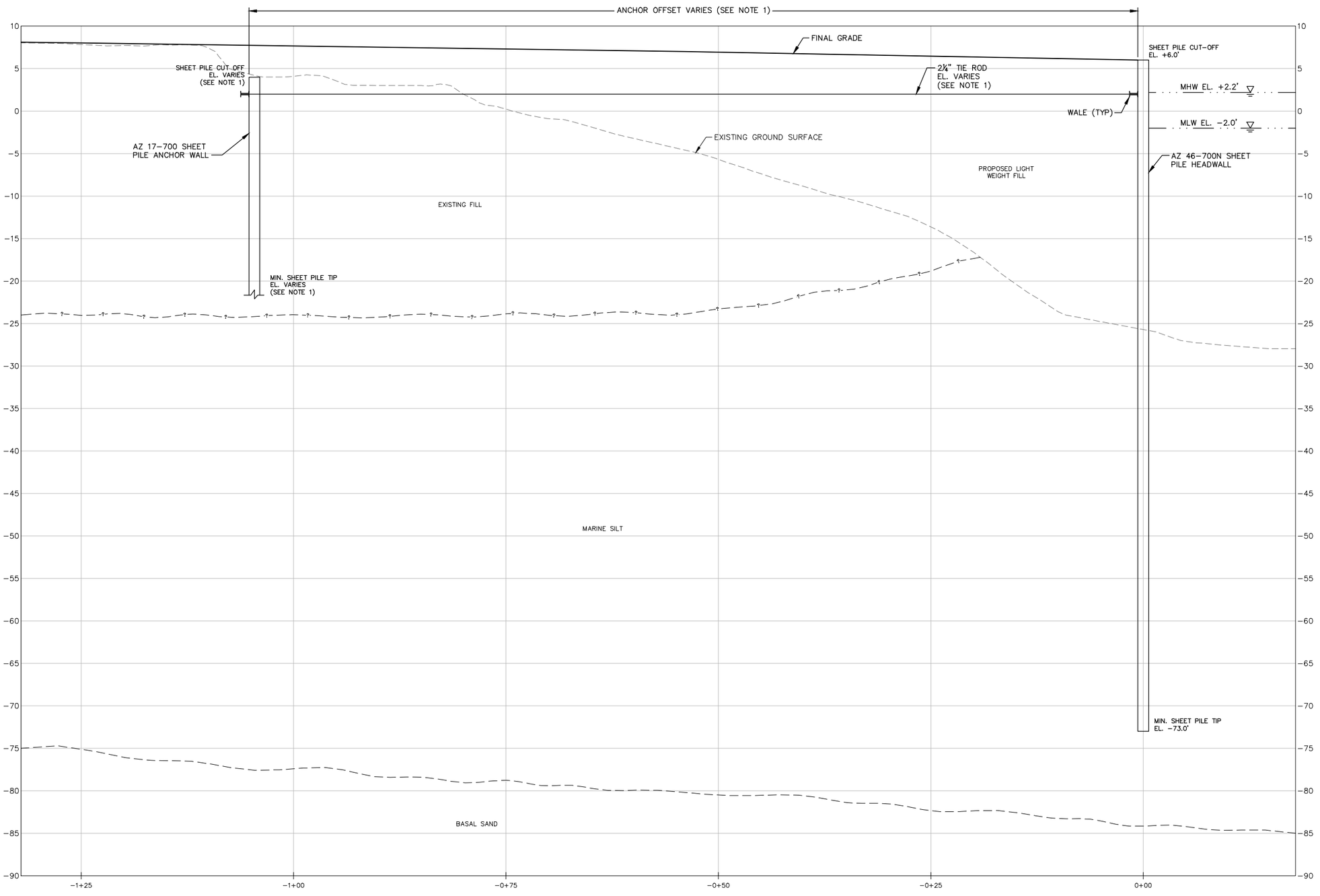
ARCADIS Project No.: B0001701.0002.00221
Date: NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-5

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER, K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*;OFF=*REF*
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01701X00

CITY: SYRACUSE NY DIVGROUP:ENVCAD DB:E.KRAHMER, K.SARTORI LD:G.STEINBERGER PIC:M.GRAVELDING PM:E.DIEVENDORF TM:E.BUREAU LYR:ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ---
01701X00



ANCHORED TIEBACK WALL (C)

CP-03 TO CP-05
CP-05 TO CP-07

LEGEND:

—?— —?— ASSUMED LITHOLOGICAL INTERFACE

— — — — APPROXIMATE LITHOLOGICAL INTERFACE

NOTES:

1. REQUIRED ANCHOR OFFSET, CUT-OFF ELEVATION, TIE ROD ELEVATION, AND MINIMUM PILE TIP ELEVATION VARY. SEE BULKHEAD ANCHOR SCHEDULE ON DRAWINGS S-2 THROUGH S-3.
2. SOIL TYPES AND GEOLOGIC CONTACTS ARE APPROXIMATE AND ARE INTERPOLATED BETWEEN SOIL BORING LOCATIONS. ACTUAL SUBSURFACE CONDITIONS MAY BE DIFFERENT THAN THOSE SHOWN OR INDICATED.
3. ADDITIONAL STRUCTURES, DEBRIS, AND UNDERGROUND FACILITIES MAY BE PRESENT THAT ARE NOT SHOWN OR INDICATED.
4. TYPE OF LIGHTWEIGHT FILL TO BE INCLUDED IN FINAL DESIGN.

6' 0 6' 12'
1"=6'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1
State: NY | Date Signed: | Project Mgr.:
Designed By: | Drawn By: | Checked By:

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.
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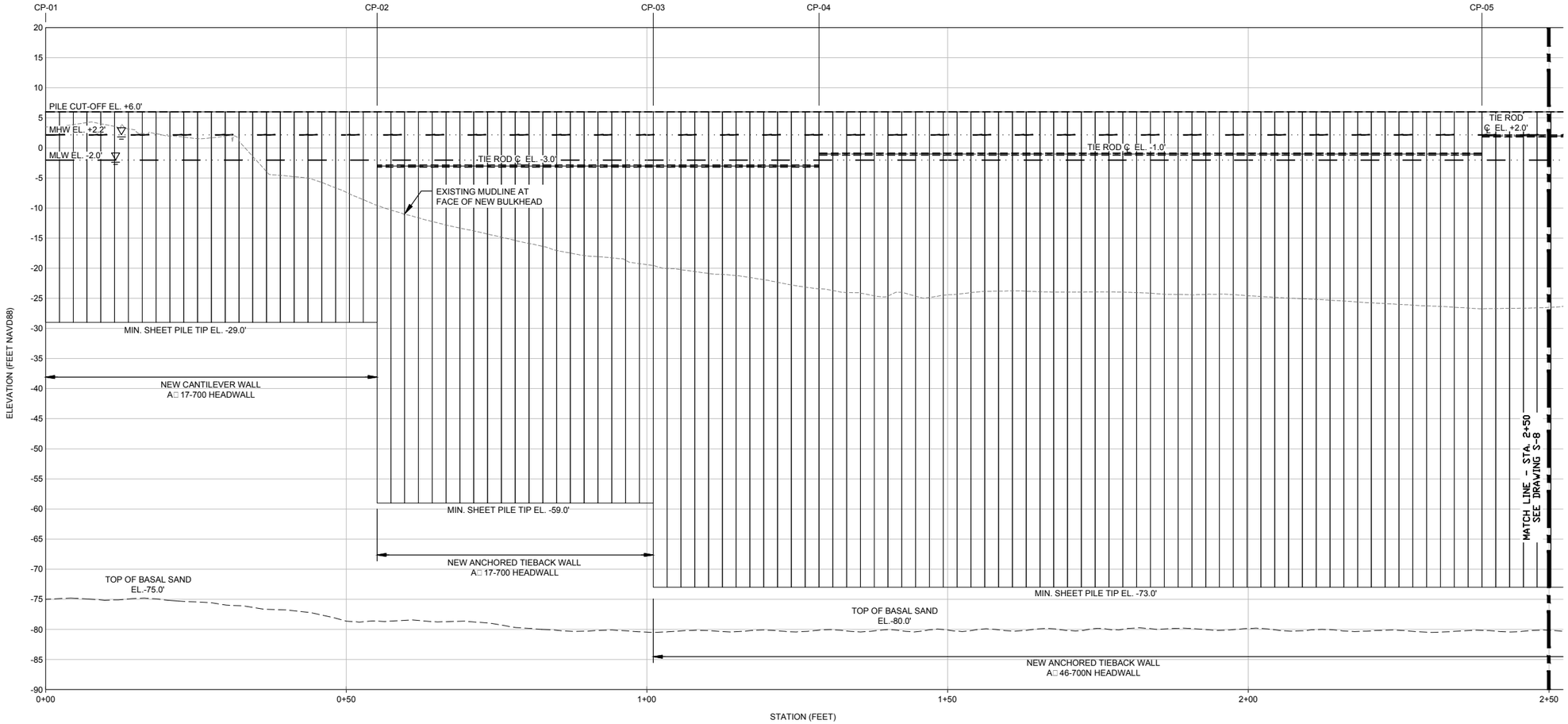
ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD SECTION C

ARCADIS Project No.
B0001701.0002.00221
Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-6



NOTE:

1. NUMBER AND LOCATION OF POTENTIAL TREATMENT GATES AND OUTFLOW DETAILS TO BE INCLUDED IN FINAL DESIGN.

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER , K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ----
01701X00

10' 0 10' 20'
1"=10'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		
Designed □y	Drawn □y	Checked □y

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

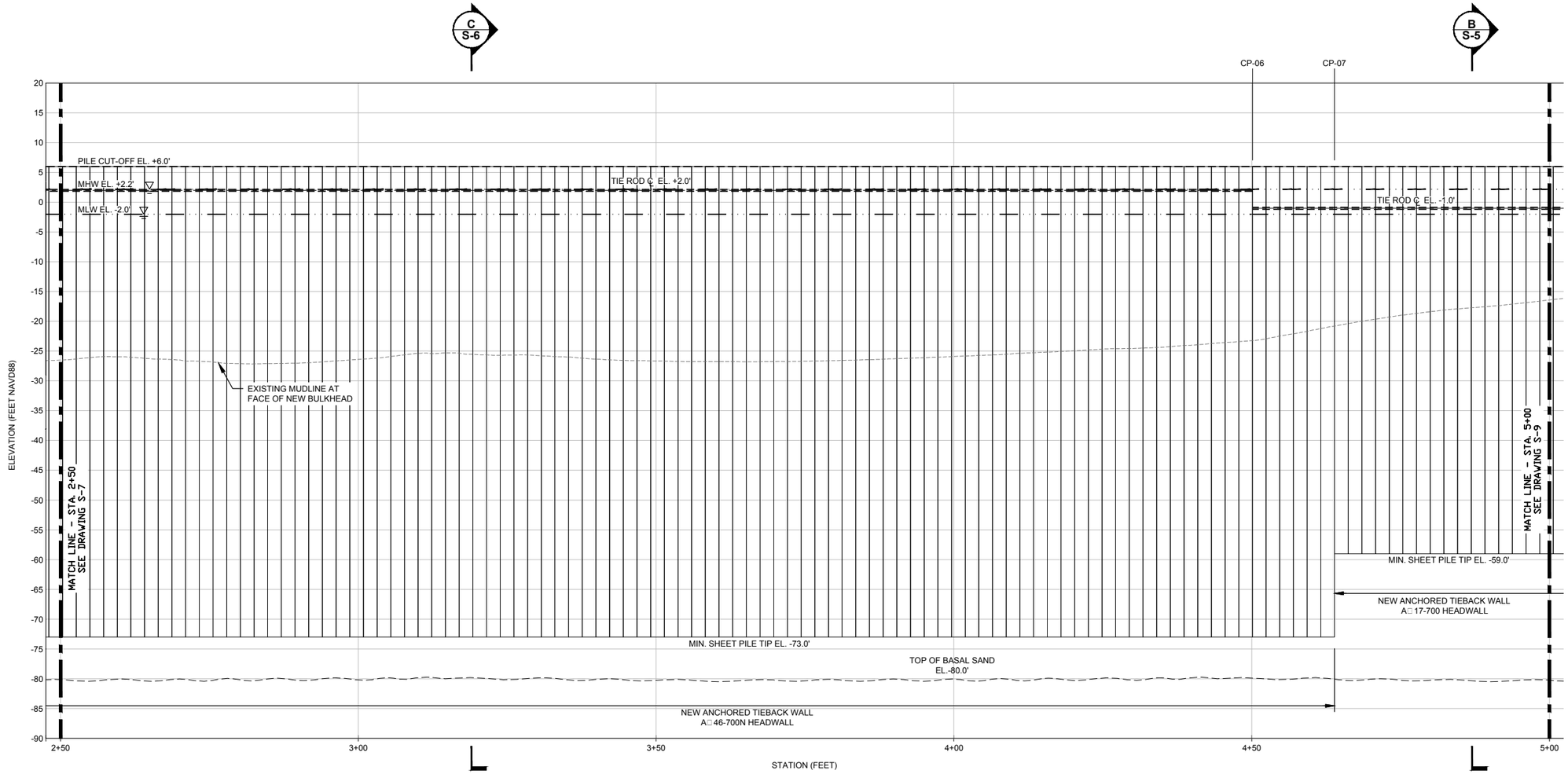
NEA BULKHEAD PROFILE STA. 0+00 TO STA. 2+50

ARCADIS Project No.
B0001701.0002.00221

Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-7



NOTE:

1. NUMBER AND LOCATION OF POTENTIAL TREATMENT GATES AND OUTFLOW DETAILS TO BE INCLUDED IN FINAL DESIGN.

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER , K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ----
017017X00

10' 0 10' 20'
1"=10'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		
Designed □y	Drawn □y	Checked □y

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD PROFILE STA. 2+50 TO STA. 5+00

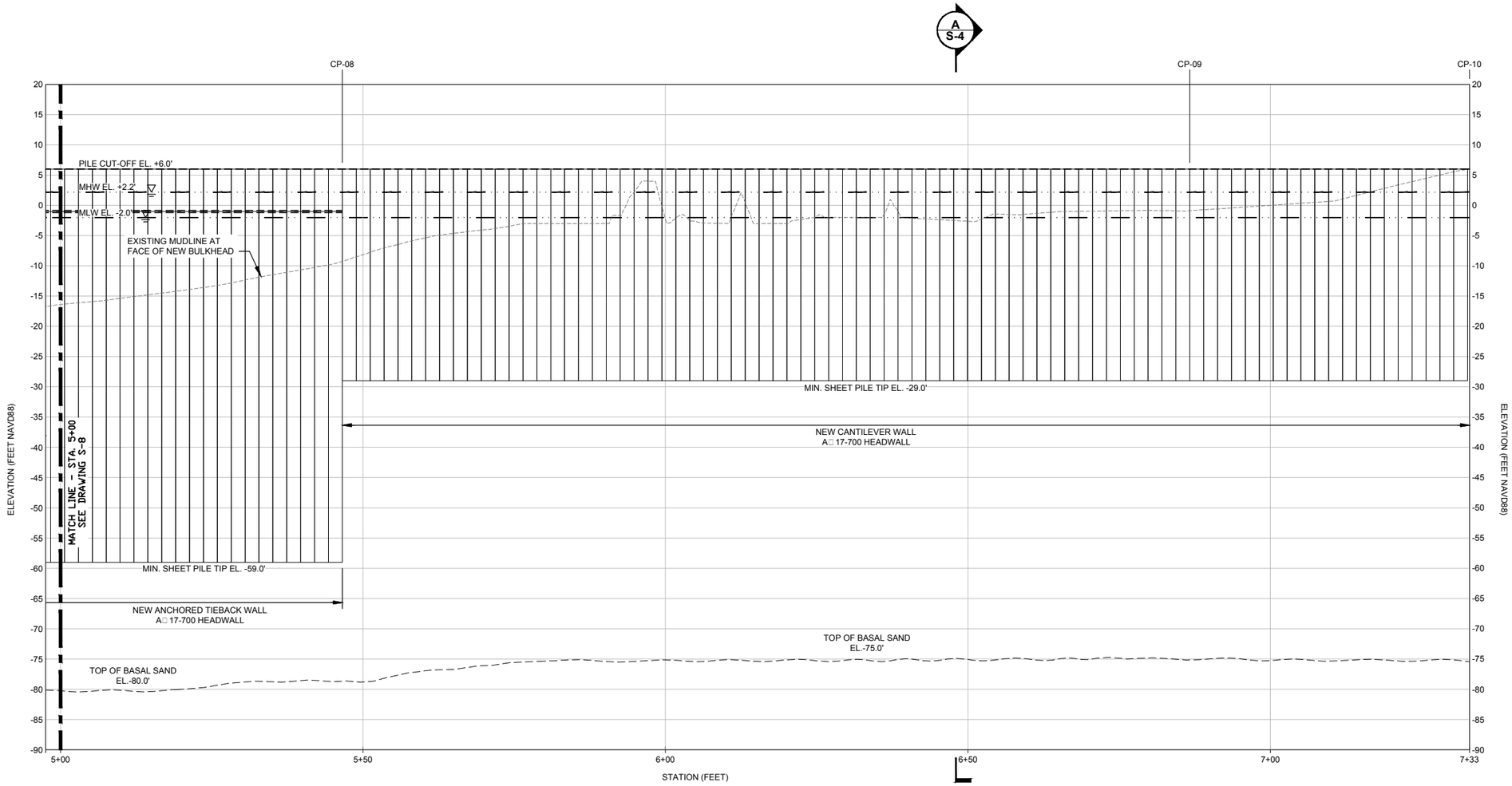
ARCADIS Project No.
B0001701.0002.00221

Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-8

CITY: SYRACUSE NY DIV/GROUP: ENVCAD DB: E. KRAHMER , K.SARTORI LD:G.STEINBERGER PIC: M. GRAVELDING PM: E. DIEVENDORF TM: E. BUREAU LYR:ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ----
017017X00



NOTE:

1. NUMBER AND LOCATION OF POTENTIAL TREATMENT GATES AND OUTFLOW DETAILS TO BE INCLUDED IN FINAL DESIGN.

10' 0 10' 20'
1"=10'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Re□isions	By	Ckd

Pro□essional Engineer's Na□e
MARK O. GRAVELDING
Pro□essional Engineer's No.
069985-1

State	Date Signed	Pro□ect Mgr.
NY		
Designed □y	Drawn □y	Checked □y

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ARCADIS Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEA BULKHEAD PROFILE STA. 5+00 TO STA. 7+33

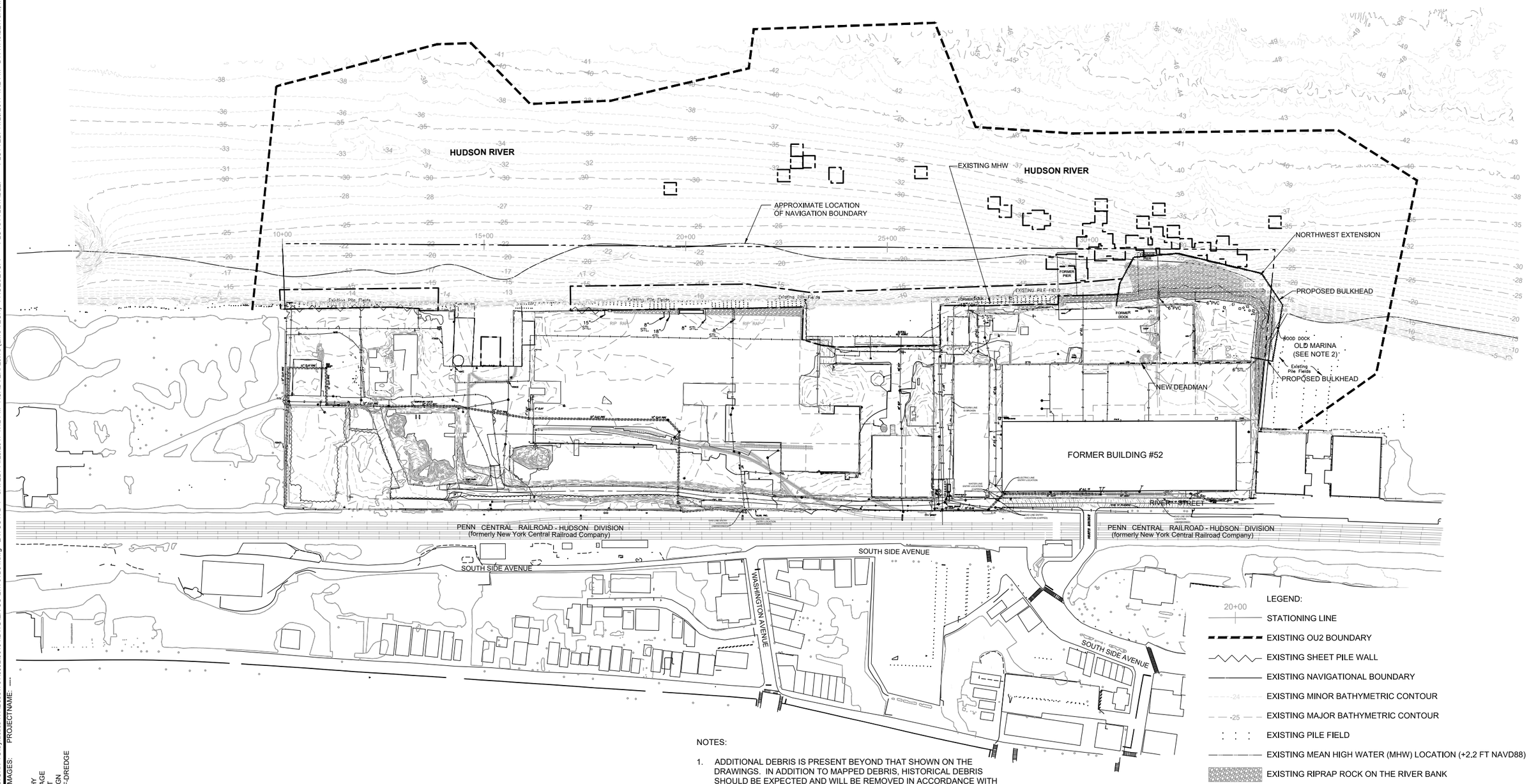
ARCADIS Pro□ect No.
B0001701.0002.00221

Date
NOVEMBER 2017

ARCADIS
ONE LINCOLN CENTER
110 WEST FAYETTE STREET
SYRACUSE, NY 13202-1355
TELEPHONE: 315-446-9120

S-9

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
C:\ENVCAD\NEWTOWN\ACT\2017\RETURN-TO\Syracuse-NY\B0001701\0002\00134\DWG\Ex-OU-2\1701D01.dwg LAYOUT: D-1 SAVED: 11/29/2017 1:42 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/29/2017 1:42 PM BY: WASILEWSKI, MATT
XREFS: IMAGES: PROJECTNAME: ---
01701X00
01701X01
01701X-BATHY
01701X-FOLIAGE
01701X-CONT
01701X-DESIGN
01701X-SURF-DREDGE



LEGEND:

- 20+00 — STATIONING LINE
- EXISTING OU2 BOUNDARY
- EXISTING SHEET PILE WALL
- EXISTING NAVIGATIONAL BOUNDARY
- -24 — EXISTING MINOR BATHYMETRIC CONTOUR
- -25 — EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- PROPOSED DREDGE LIMITS
- PROPOSED BULKHEAD

NOTES:

1. ADDITIONAL DEBRIS IS PRESENT BEYOND THAT SHOWN ON THE DRAWINGS. IN ADDITION TO MAPPED DEBRIS, HISTORICAL DEBRIS SHOULD BE EXPECTED AND WILL BE REMOVED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
2. POTENTIAL WORK IN THE OLD MARINA/KINNALLY COVE AREAS WILL BE DETERMINED IN THE FINAL DESIGN.

1"=120' — 120' 0 120' 240'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: LSK
Designed by: SM | Drawn by: MW | Checked by: ESD

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

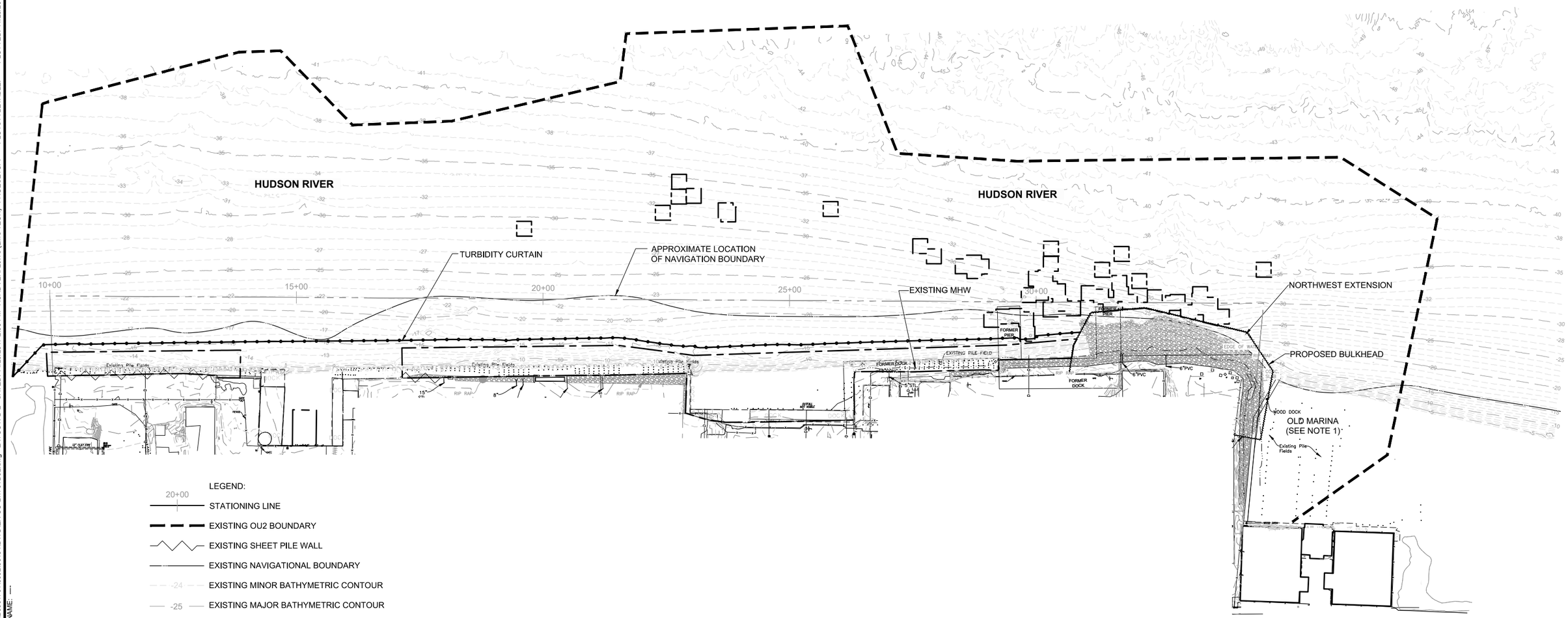
SITE LAYOUT PLAN - OU2

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-1

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
C:\ENVCAD\NEWTOWN\ACT\2017\RETURN-TO\Syracuse-NY\B0001701\0002\00134\DWG\EX-OU-2\1701D02.dwg LAYOUT: D-2 SAVED: 11/29/2017 2:55 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/29/2017 2:55 PM BY: WASILEWSKI, MATT



LEGEND:

- 20+00 — STATIONING LINE
- EXISTING OU2 BOUNDARY
- EXISTING SHEET PILE WALL
- EXISTING NAVIGATIONAL BOUNDARY
- -24 — EXISTING MINOR BATHYMETRIC CONTOUR
- -25 — EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED TURBIDITY CURTAIN
- PROPOSED DREDGE LIMITS
- PROPOSED BULKHEAD

NOTE:

1. POTENTIAL TURBIDITY CONTROLS, IF NECESSARY, IN THE OLD MARINA/KINNALLY COVE AREAS WILL BE DETERMINED IN THE FINAL DESIGN.

XREFS: IMAGES: PROJECT NAME: ---
01701X00
01701X01
01701X-BATHY
01701X-DESIGN
01701X-SURF-DREDGE

100' 0 100' 200'
1"=100'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

TURBIDITY CONTROLS LAYOUT

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-2

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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01701X00
01701X01
01701X-BATHY
01701X-DESIGN
01701X-DREDGE-HATCH
POINTS
01701X-SURF-DREDGE
IMAGES:
PROJECTNAME: ---

HUDSON RIVER

HUDSON RIVER

SEE DRAWING D-6

SEE DRAWING D-4

SEE DRAWING D-5

SEE DRAWING D-7

SEE DRAWING D-8

1 D-15

2 D-15

3 D-15

1 D-16

2 D-16

3 D-17

APPROXIMATE LOCATION OF NAVIGATION BOUNDARY

EXISTING MHW

SEE DETAIL 1 DRAWING D-8

NORTHWEST EXTENSION

PROPOSED BULKHEAD

OLD MARINA (SEE NOTE 1)

Existing Pile Fields

LEGEND:

- STATIONING LINE
- EXISTING OU2 BOUNDARY
- EXISTING SHEET PILE WALL
- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING MINOR BATHYMETRIC CONTOUR
- EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- PROPOSED FINAL GRADE CONTOUR (1-FOOT INTERVAL)
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- PROPOSED BULKHEAD
- SAMPLE ID

NOTE:

1. POTENTIAL WORK IN THE OLD MARINA/KINNALLY COVE AREAS WILL BE DETERMINED IN THE FINAL DESIGN.

100' 0 100' 200'
1"=100'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Cko

Professional Engineer's Name: MARK O. GRAVELDING
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGE EXTENT

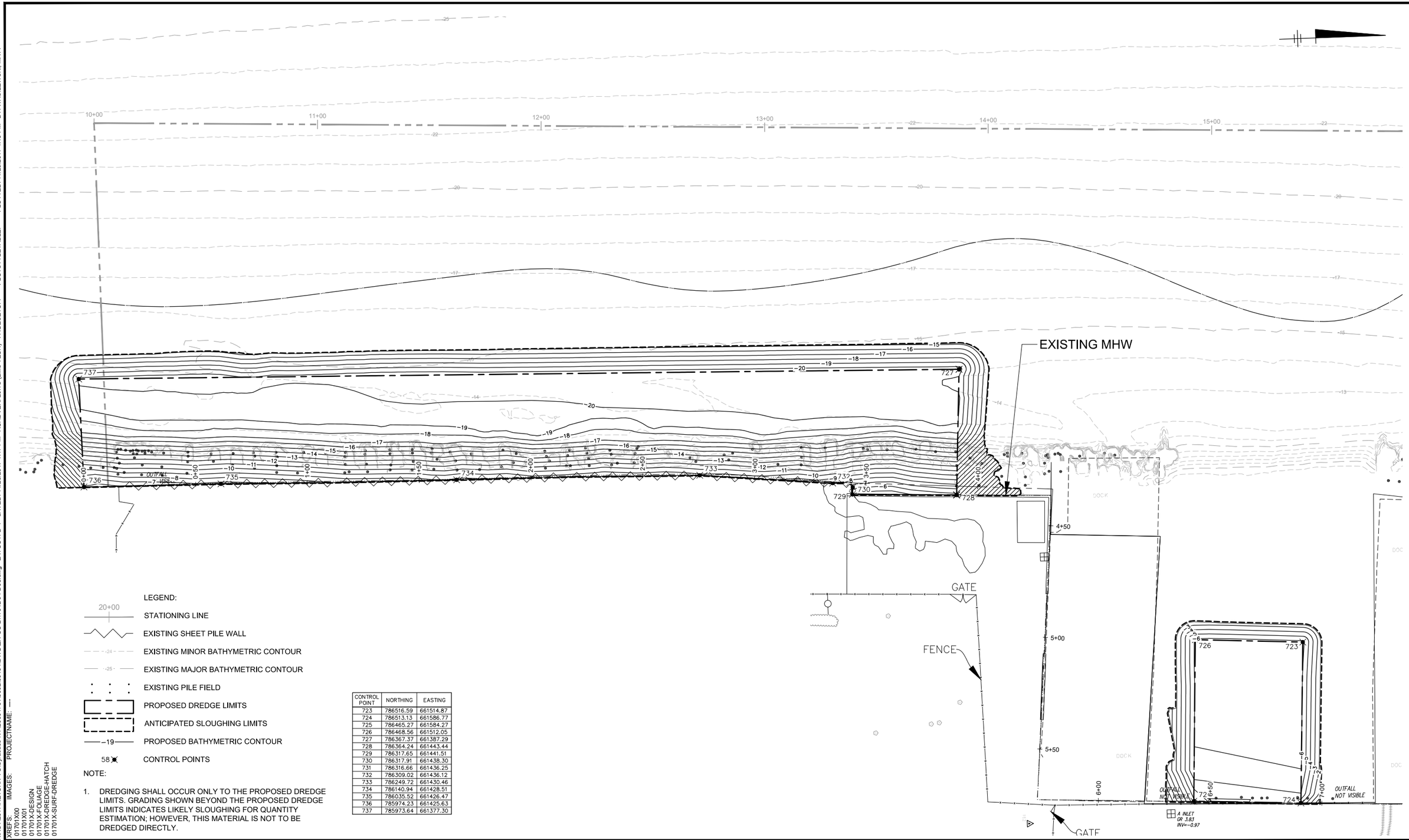
ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-3

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ---
01701X00
01701X01
01701X-DESIGN
01701X-FOLIAGE
01701X-DREDGE-HATCH
01701X-SURF-DREDGE



LEGEND:

- 20+00 — STATIONING LINE
- EXISTING SHEET PILE WALL
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- –19– PROPOSED BATHYMETRIC CONTOUR
- 58 CONTROL POINTS

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.

CONTROL POINT	NORTHING	EASTING
723	786516.59	661514.87
724	786513.13	661586.77
725	786465.27	661584.27
726	786468.56	661512.05
727	786367.37	661387.29
728	786364.24	661443.44
729	786317.65	661441.51
730	786317.91	661438.30
731	786316.66	661436.25
732	786309.02	661436.12
733	786249.72	661430.46
734	786140.94	661428.51
735	786035.52	661426.47
736	785974.23	661425.63
737	785973.64	661377.30

1"=20' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

NOT FOR CONSTRUCTION

ARCADIS Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGING ELEVATIONS - NEAR SHORE SOUTH

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-4

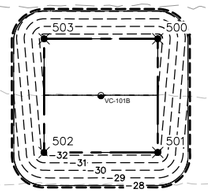
LEGEND:

- 20+00 — STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING SHEET PILE WALL
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- —19— PROPOSED BATHYMETRIC CONTOUR
- 58 CONTROL POINTS
- VC-102A SAMPLE ID

CONTROL POINT	NORTHING	EASTING
500	786966.28	661147.59
501	786965.18	661177.57
502	786935.20	661176.47
503	786936.30	661146.49
504	787248.43	661125.60

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.



XREFS:
01701X00
01701X01
01701X-DESIGN
01701X-FOLIAGE
01701X-DREDGE-HATCH
01701X-SURF-DREDGE

IMAGES:

PROJECTNAME: ---

CITY: SYRACUSE NY DIV/GROUP:ENV/CAD DB: E. KRAHMER LD: G.STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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1"=20' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

NOT FOR CONSTRUCTION

ARCADIS | Design & Consultancy for natural and built assets

ARCADIS OF NEW YORK, INC.

NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGING ELEVATIONS - NEAR SHORE SOUTH AND MISCELLANEOUS DEEPWATER

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-5

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
C:\ENVCAD\NEWTOWNACT\2017RETURN-TO\Syracuse-NYB0001701\0002\00134\DWG\EX-OU-2\1701D04-D08.dwg LAYOUT: D-6 SAVED: 11/29/2017 1:17 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/29/2017 1:19 PM BY: WASILEWSKI, MATT
XREFS: PROJECTNAME: ---
IMAGES:
01701X00
01701X01
01701X-DESIGN
01701X-FOLIAGE
01701X-DREDGE-HATCH
01701X-SURF-DREDGE

HUDSON RIVER

CONTROL POINT	NORTHING	EASTING
504	787248.43	661125.60
505	787247.33	661155.58
506	787217.35	661154.48
507	787218.45	661124.50
508	787281.94	661093.93
509	787280.84	661123.91
510	787250.86	661122.81
511	787251.96	661092.83
512	787283.84	661063.86
513	787282.79	661092.43
514	787312.49	661093.52
515	787311.39	661123.50
516	787281.41	661122.40
517	787282.46	661093.83
518	787252.76	661092.74
519	787253.86	661062.76
520	787375.98	661125.04
521	787375.67	661133.50
522	787380.98	661133.70
523	787379.88	661163.68
524	787349.90	661162.58
525	787350.21	661154.12
526	787344.90	661153.92
527	787346.00	661123.94
528	787588.86	661130.33
529	787587.76	661160.31
530	787557.78	661159.21
531	787558.88	661129.23
532	787767.53	661212.19
533	787766.77	661232.99
534	787794.60	661234.01
535	787793.50	661263.99
536	787763.52	661262.89
537	787764.28	661242.09
538	787736.45	661241.07
539	787737.55	661211.09

LEGEND:

- STATIONING LINE (20+00)
- EXISTING MINOR BATHYMETRIC CONTOUR (-24-)
- EXISTING MAJOR BATHYMETRIC CONTOUR (-25-)
- EXISTING PILE FIELD
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- PROPOSED BATHYMETRIC CONTOUR (-19-)
- CONTROL POINTS (58)
- SAMPLE ID (VC-102A)

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.

1"=20' (20' 0 20' 40')

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No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: LSK
Designed by: SM | Drawn by: MW | Checked by: ESD

NOT FOR CONSTRUCTION

ARCADIS | Design & Consultancy for natural and built assets
ARCADIS OF NEW YORK, INC.

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ATLANTIC RICHFIELD CO. • HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGING ELEVATIONS - DEEPWATER

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

D-6

CITY: SYRACUSE NY DIVGROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYRON="";OFF="REF*"
C:\ENVCAD\NEWTOWN\ACT\2017\RETURN-TO\Syracuse-NY\B0001701\0002\00134\DWG\EX-OU-2\1701D04-D08.dwg LAYOUT: D-7 SAVED: 11/29/2017 1:17 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/29/2017 1:19 PM BY: WASILEWSKI, MATT

XREFS: IMAGES: PROJECTNAME: ---
01701X00
01701X01
01701X-DESIGN
01701X-FOLIAGE
01701X-DREDGE-HATCH
01701X-SURF-DREDGE

CONTROL POINT	NORTHING	EASTING
697	787790.61	661481.27
698	787724.91	661480.89
699	787623.44	661476.68
700	787612.52	661476.73
701	787609.54	661479.47
702	787607.65	661501.28
703	787606.34	661571.46
704	787603.29	661574.40
705	787394.36	661569.44
706	787394.41	661571.10
707	787344.54	661569.35
708	787308.99	661562.70
709	787307.26	661562.61
710	787285.06	661555.32
711	787264.07	661547.85
712	787269.84	661467.19
713	787206.69	661466.04
720	787284.26	661431.46
721	787611.14	661432.66

HUDSON RIVER

APPROXIMATE LOCATION OF NAVIGATION BOUNDARY

EXISTING MHW

OUTFALL NOT VISIBLE

STORM MH (DRY WELL ?) RIM 3.54 INV=-0.46

STORM MH RIM 3.54 (STEEL PLATE)

STORM MH (DRY WELL ?) RIM 4.65

A INLET

18" RCP

LEGEND:

- STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING MINOR BATHYMETRIC CONTOUR
- EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- PROPOSED BATHYMETRIC CONTOUR
- CONTROL POINTS

NOTE:

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGING ELEVATIONS - NEAR SHORE NORTH

ARCADIS Project No.: B0001701.0002.00134

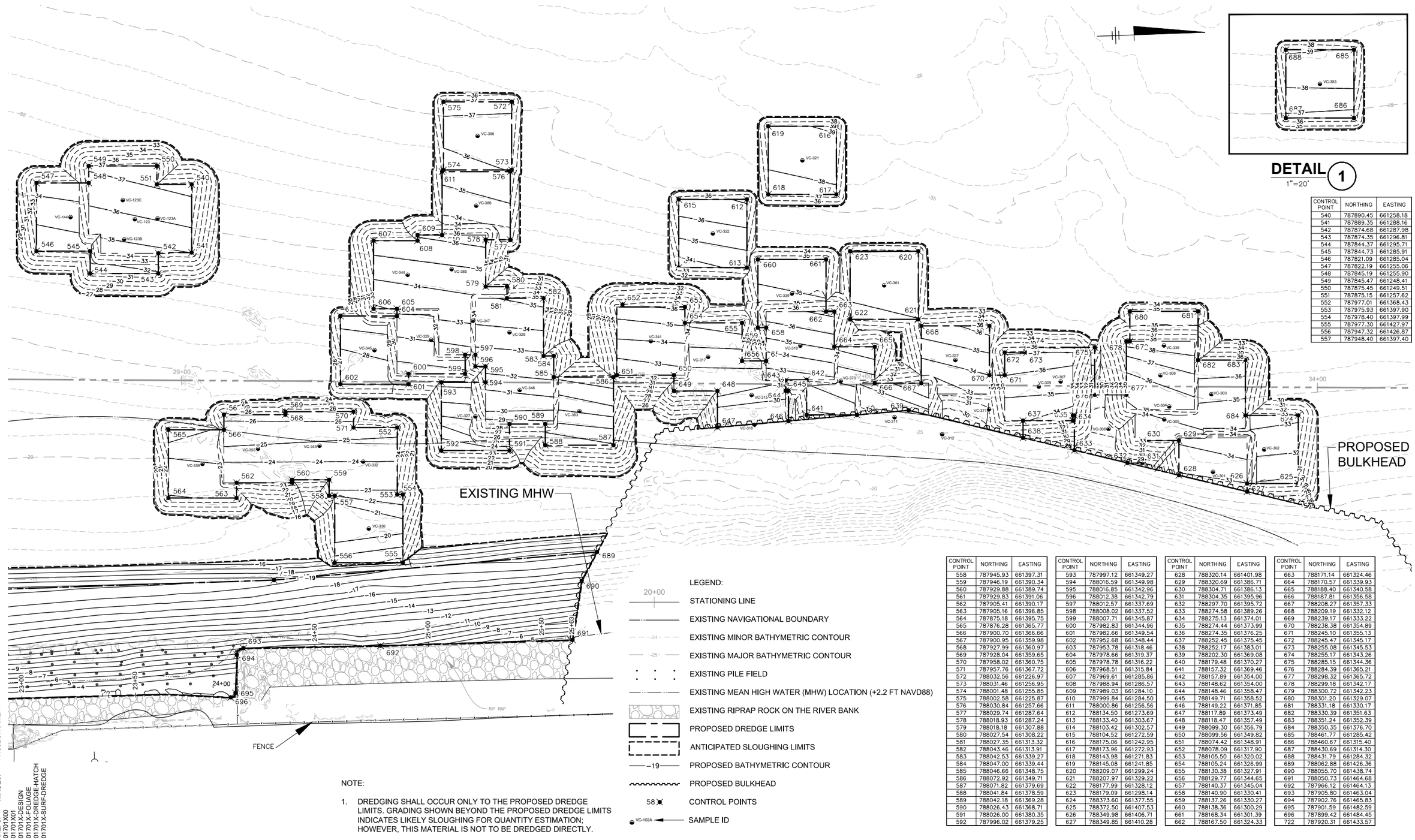
Date: NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
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D-7

CITY: SYRACUSE NY DIV/GROUP:ENV/CAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
C:\ENVCAD\NEWTOWNACT2017\RETURN-TO\Syracuse-NY\B0001701\0002\001134\DWG\EX-OU-2\170ID04-D08.dwg LAYOUT: D-8 SAVED: 11/29/2017 1:17 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 11/29/2017 1:19 PM BY: WASILEWSKI, MATT

XREFS: PROJECTNAME: ---
IMAGES:
01701X00
01701X01
01701X-DESIGN
01701X-FOLIAGE
01701X-DREDGE-HATCH
01701X-SURF-DREDGE



CONTROL POINT	NORTHING	EASTING
540	787890.45	661258.18
541	787889.35	661288.16
542	787874.68	661287.98
543	787874.35	661296.81
544	787844.37	661295.71
545	787844.73	661285.91
546	787821.09	661285.04
547	787822.19	661255.06
548	787845.19	661255.90
549	787845.47	661248.41
550	787875.45	661249.51
551	787875.15	661257.62
552	787977.01	661368.43
553	787975.93	661397.90
554	787978.40	661397.99
555	787977.30	661427.97
556	787947.32	661426.87
557	787948.40	661397.40

CONTROL POINT	NORTHING	EASTING
558	787945.93	661397.31
559	787946.19	661390.34
560	787929.88	661389.74
561	787929.83	661391.06
562	787905.41	661390.17
563	787905.16	661396.85
564	787875.18	661395.75
565	787876.28	661365.77
566	787900.70	661366.66
567	787900.95	661359.98
568	787927.99	661360.97
569	787928.04	661359.65
570	787958.02	661360.75
571	787957.76	661367.72
572	788032.56	661226.97
573	788031.46	661256.95
574	788001.48	661255.85
575	788002.58	661225.87
576	788030.84	661257.66
577	788029.74	661287.64
578	788018.93	661287.24
579	788018.18	661307.88
580	788027.54	661308.22
581	788027.35	661313.32
582	788043.46	661313.91
583	788042.53	661339.27
584	788047.00	661339.44
585	788046.66	661348.75
586	788072.92	661349.71
587	788071.82	661379.69
588	788041.84	661378.59
589	788042.18	661369.28
590	788026.43	661368.71
591	788026.00	661380.35
592	787996.02	661379.25

CONTROL POINT	NORTHING	EASTING
593	787997.12	661349.27
594	788016.59	661349.98
595	788016.85	661342.96
596	788012.38	661342.79
597	788012.57	661337.69
598	788008.02	661337.52
599	788007.71	661345.87
600	787982.83	661344.96
601	787982.66	661349.54
602	787952.68	661348.44
603	787953.78	661318.46
604	787978.66	661319.37
605	787978.78	661316.22
606	787968.51	661315.84
607	787969.61	661285.86
608	787988.94	661286.57
609	787989.03	661284.10
610	787999.84	661284.50
611	788000.86	661256.56
612	788134.50	661273.69
613	788133.40	661303.67
614	788103.42	661302.57
615	788104.52	661272.59
616	788175.06	661242.95
617	788173.96	661272.93
618	788143.98	661271.83
619	788145.08	661241.85
620	788209.07	661299.24
621	788207.97	661329.22
622	788177.99	661328.12
623	788179.09	661298.14
624	788373.60	661377.55
625	788372.50	661407.53
626	788349.98	661406.71
627	788349.85	661410.28

CONTROL POINT	NORTHING	EASTING
628	788320.14	661401.98
629	788320.69	661386.71
630	788304.71	661386.13
631	788304.35	661395.96
632	788297.70	661395.72
633	788274.58	661389.26
634	788275.13	661374.01
635	788274.44	661373.99
636	788274.35	661376.25
637	788252.45	661375.45
638	788252.17	661383.01
639	788202.30	661369.08
640	788179.48	661370.27
641	788157.32	661369.46
642	788157.89	661354.00
643	788148.62	661354.00
644	788148.46	661358.47
645	788149.71	661358.52
646	788149.22	661371.85
647	788117.89	661373.49
648	788118.47	661357.49
649	788099.30	661356.79
650	788099.56	661349.82
651	788074.42	661348.91
652	788078.09	661317.90
653	788105.50	661320.02
654	788105.24	661326.99
655	788130.38	661327.91
656	788129.77	661344.65
657	788140.37	661345.04
658	788140.90	661330.41
659	788137.26	661330.27
660	788138.36	661300.29
661	788168.34	661301.39
662	788167.50	661324.33

CONTROL POINT	NORTHING	EASTING
663	788171.14	661324.46
664	788170.57	661339.93
665	788188.40	661340.58
666	788187.81	661356.58
667	788208.27	661357.33
668	788209.19	661332.12
669	788239.17	661333.22
670	788238.38	661354.89
671	788245.10	661355.13
672	788245.47	661345.17
673	788255.08	661345.53
674	788255.17	661343.26
675	788285.15	661344.36
676	788284.39	661365.21
677	788298.32	661365.72
678	788299.18	661342.17
679	788300.72	661342.23
680	788301.20	661329.07
681	788331.18	661330.17
682	788330.39	661351.63
683	788351.24	661352.39
684	788350.35	661376.70
685	788461.77	661285.42
686	788460.67	661315.40
687	788430.69	661314.30
688	788431.79	661284.32
689	788062.88	661426.36
690	788055.70	661438.74
691	788050.73	661464.68
692	787966.12	661464.13
693	787905.80	661463.04
694	787902.76	661465.83
695	787901.59	661482.59
696	787899.42	661484.45
722	787920.31	661433.57

LEGEND:

- 20+00 — STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- EXISTING PILE FIELD
- EXISTING MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- EXISTING RIPRAP ROCK ON THE RIVER BANK
- PROPOSED DREDGE LIMITS
- ANTICIPATED SLOUGHING LIMITS
- -19- PROPOSED BATHYMETRIC CONTOUR
- PROPOSED BULKHEAD
- 58 CONTROL POINTS
- VC-102A SAMPLE ID

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.

1"=20' 20' 0 20' 40'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name
MARK O. GRAVELDING
Professional Engineer's No.
069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DREDGING ELEVATIONS - NEAR SHORE NORTH, NEA AND DEEPWATER

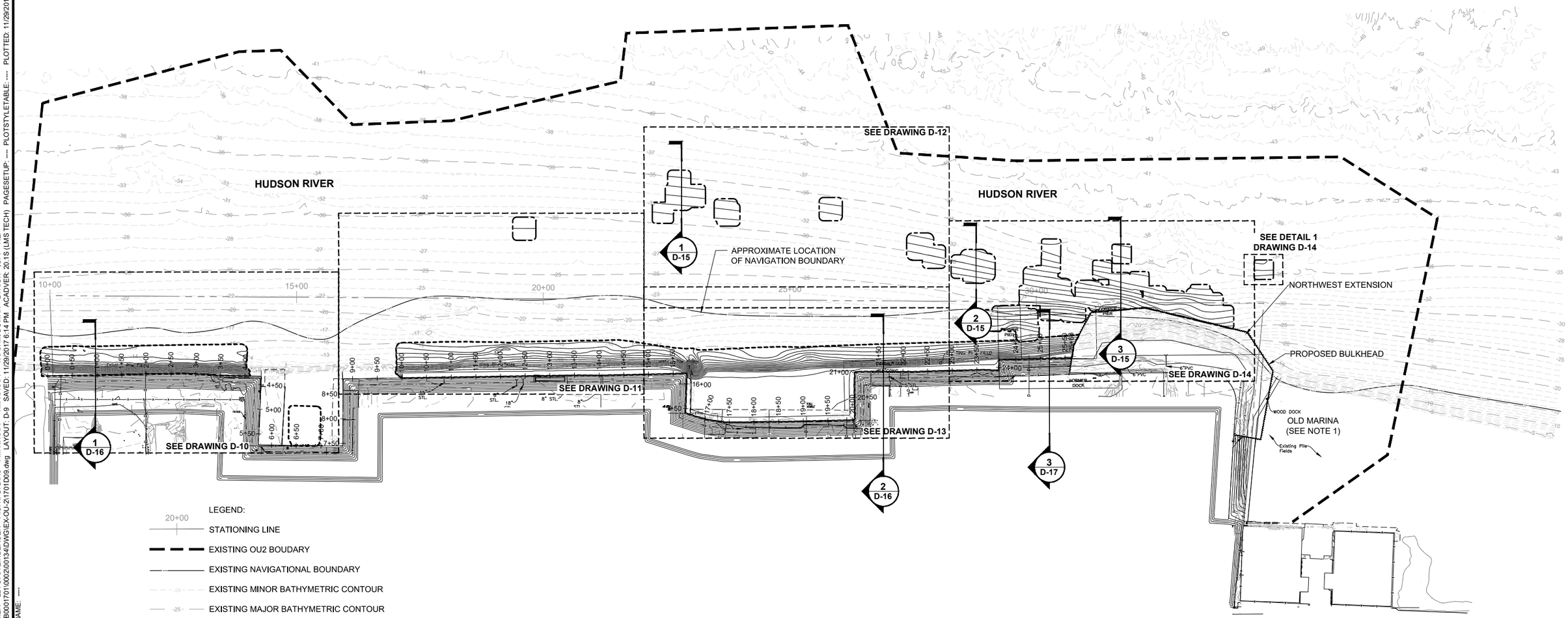
ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
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Syracuse, NY 13202
Tel: 315-446-9120

D-8

CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB:E. KRAHMER LD:G. STEINBERGER PIC:K. G. DIAS PM:R. KAPP TM:R KAPP TR:S. McGOWAN LYR:ON=*;OFF=*REF*
C:\ENVCAD\NEWTOWN\ACT\2017\RETURN-TO\Syracuse-NY\B0001701\0002\00134\DWG\EX-OU-2\1701D09.dwg LAYOUT: D-9 SAVED: 11/29/2017 6:14 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/29/2017 6:14 PM BY: WASILEWSKI, MATT



LEGEND:

- 20+00 — STATIONING LINE
- EXISTING OU2 BOUDARY
- EXISTING NAVIGATIONAL BOUNDARY
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- PROPOSED NEARSHORE ISOLATION CAP AREA
- PROPOSED DEEPWATER BACKFILL AREA
- PROPOSED FINAL GRADE CONTOUR (1-FOOT INTERVAL)
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED BULKHEAD

NOTES:

1. POTENTIAL WORK IN THE OLD MARINA/KINNALLY COVE AREAS WILL BE DETERMINED IN THE FINAL DESIGN.
2. THE FINAL RESTORED GRADES WILL MATCH PRE-CONSTRUCTION GRADES, AS SHOWN. THIS MAY INCLUDE AN ALLOWANCE OF UP TO 1 FOOT OF MATERIAL DEPOSITED NATURALLY, WHICH WILL BE EVALUATED AND PROPOSED BASED ON THE RESULTS OF THE ONGOING HYDRODYNAMIC STUDY.

XREFS:
IMAGES:
PROJECTNAME: ----
01701X00
01701X01
01701X-BATHY
01701X-DESIGN
01701X-DREDGE-HATCH
POINTS
01701X-SHEETPILE
Surface00S-RESTORATION
01701X-OU-1 FINAL GRADING

100' 0 100' 200'
1"=100'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd.

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

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ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK

HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

RESTORATION ELEVATIONS

ARCADIS Project No.
B0001701.0002.00134

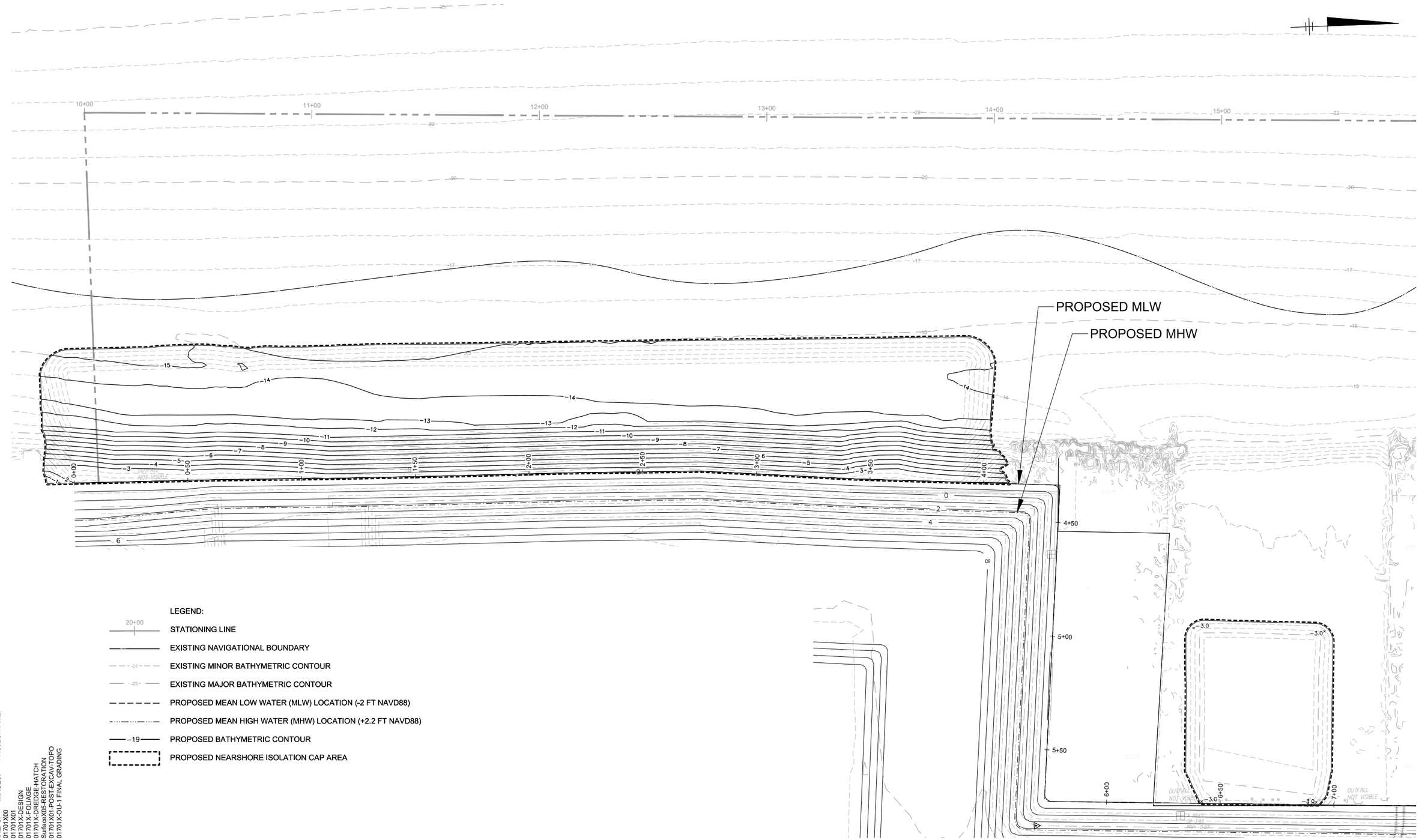
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D-9

CITY: SYRACUSE NY DIV/GROUP:ENV/CAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYRON=*;OFF=*REF*
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01701X-FOLIAGE
01701X-DREDGE-HATCH
SurfaceX08-RESTORATION
01701X-RES-EXIST-TOPO
01701X-OU-1 FINAL GRADING



LEGEND:

- 20+00 — STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING MINOR BATHYMETRIC CONTOUR
- EXISTING MAJOR BATHYMETRIC CONTOUR
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED BATHYMETRIC CONTOUR
- PROPOSED NEARSHORE ISOLATION CAP AREA

1"=20' (20' 0 20' 40')

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: **MARK O. GRAVELDING**
Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

NOT FOR CONSTRUCTION

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

RESTORATION ELEVATIONS - NEAR SHORE SOUTH

ARCADIS Project No.
B0001701.0002.00134

Date
NOVEMBER 2017

ARCADIS of NY, Inc.
One Lincoln Center
110 W. Fayette St., Suite 300
Syracuse, NY 13202
Tel: 315-446-9120

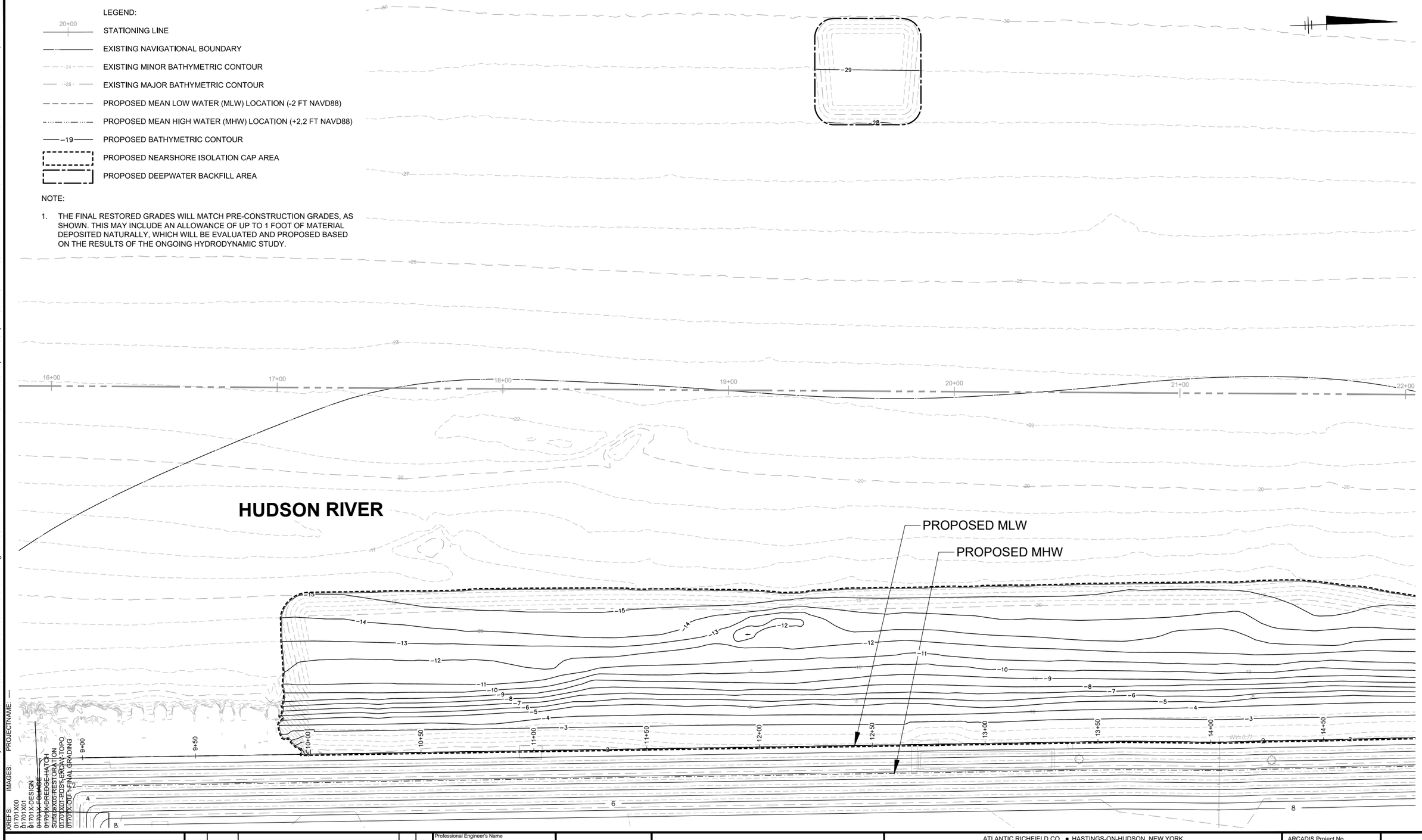
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LEGEND:

- 20+00 — STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2,2 FT NAVD88)
- –19– PROPOSED BATHYMETRIC CONTOUR
- PROPOSED NEARSHORE ISOLATION CAP AREA
- PROPOSED DEEPWATER BACKFILL AREA

NOTE:

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01701X-DREDGE-HATCH
01701X05-RESTORATION SURFACE
01701X05-RESTORATION TOPO
01701X-OU1-FINAL GRADING

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LD: G. STEINBERGER
DB: E. KRAHMER
DIV/GROUP:ENVCAD
CITY: SYRACUSE NY
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Professional Engineer's No.: 069985-1
State: NY | Date Signed: | Project Mgr.: LSK
Designed by: SM | Drawn by: MW | Checked by: ESD

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CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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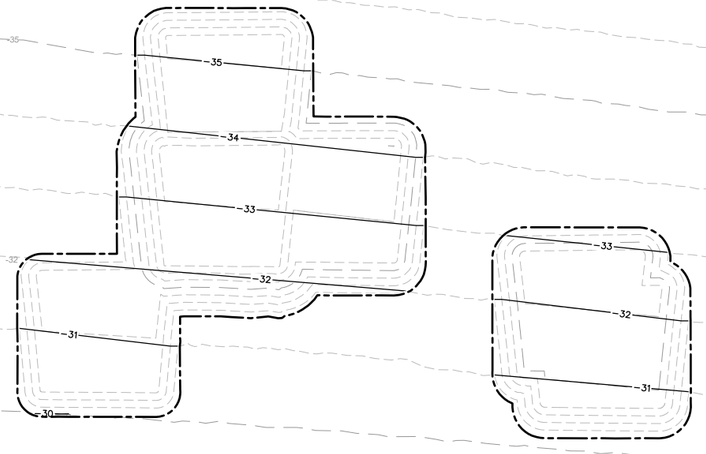
HUDSON RIVER

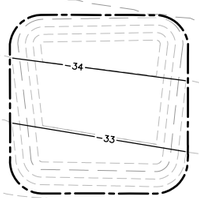
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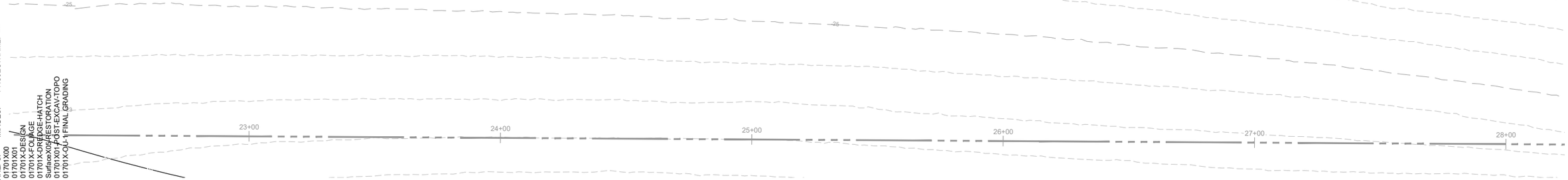
- 20+00 — STATIONING LINE
- EXISTING NAVIGATIONAL BOUNDARY
- -24- EXISTING MINOR BATHYMETRIC CONTOUR
- -25- EXISTING MAJOR BATHYMETRIC CONTOUR
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- –19– PROPOSED BATHYMETRIC CONTOUR
- PROPOSED DEEPWATER BACKFILL AREA

NOTE:

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Professional Engineer's No.: 069985-1

State	Date Signed	Project Mgr.
NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

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RESTORATION ELEVATIONS - DEEPWATER

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D-12

CITY: SYRACUSE NY DIV/GROUP: ENV/CAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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~~01701X-DREDGE-HATCH~~
SurfaceX05-RESTORATION
01701X-PRE-CONSTRUCTION-TOPO
01701X-OU-1 FINAL GRADING

23+00 24+00 25+00 26+00 27+00 28+00

HUDSON RIVER

APPROXIMATE LOCATION
OF NAVIGATION BOUNDARY

PROPOSED MLW

PROPOSED MHW

15+00 15+50 16+00 16+50 17+00 17+50 18+00 18+50 19+00 19+50 20+00 20+50 21+00 21+50 22+00 22+50

LEGEND:

- 20+00 — STATIONING LINE
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Professional Engineer's No.
069985-1

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NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

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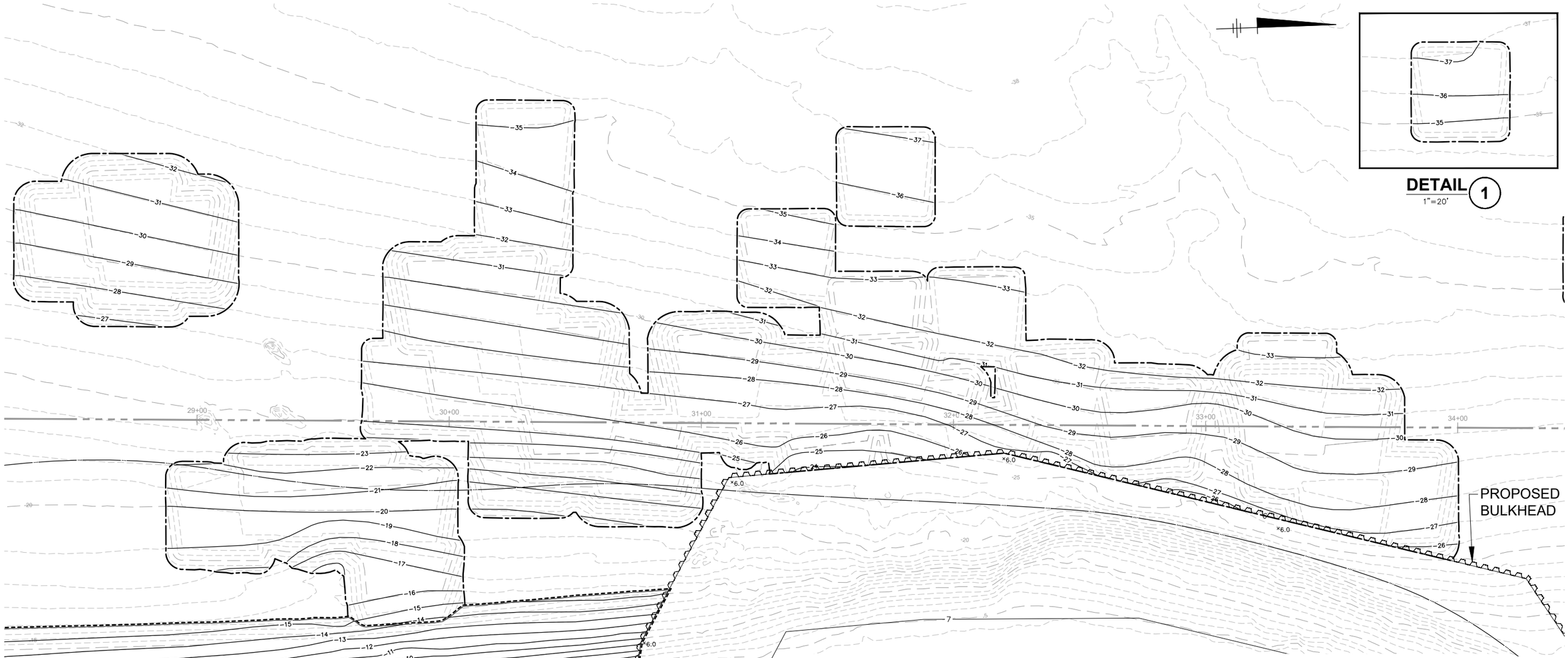
RESTORATION ELEVATIONS - NEAR SHORE NORTH

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B0001701.0002.00134

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NOVEMBER 2017

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D-13



LEGEND:

- STATIONING LINE (20+00)
- EXISTING NAVIGATIONAL BOUNDARY
- EXISTING MINOR BATHYMETRIC CONTOUR (-24)
- EXISTING MAJOR BATHYMETRIC CONTOUR (-25)
- PROPOSED MEAN LOW WATER (MLW) LOCATION (-2 FT NAVD88)
- PROPOSED MEAN HIGH WATER (MHW) LOCATION (+2.2 FT NAVD88)
- PROPOSED BATHYMETRIC CONTOUR (-19)
- PROPOSED NEARSHORE ISOLATION CAP AREA

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01701X-DREDGE-HATCH
SurfaceX05-RESTORATION
01701X-OU1-EXCAVATION
01701X-OU1-FINAL GRADING

CITY: SYRACUSE NY DIV/GROUP-ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYRON=*;OFF=*REF*
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1"=20' 20' 0 20' 40'

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No.	Date	Revisions	By	Ckd

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Professional Engineer's No.: 069985-1

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NY		LSK
Designed by	Drawn by	Checked by
SM	MW	ESD

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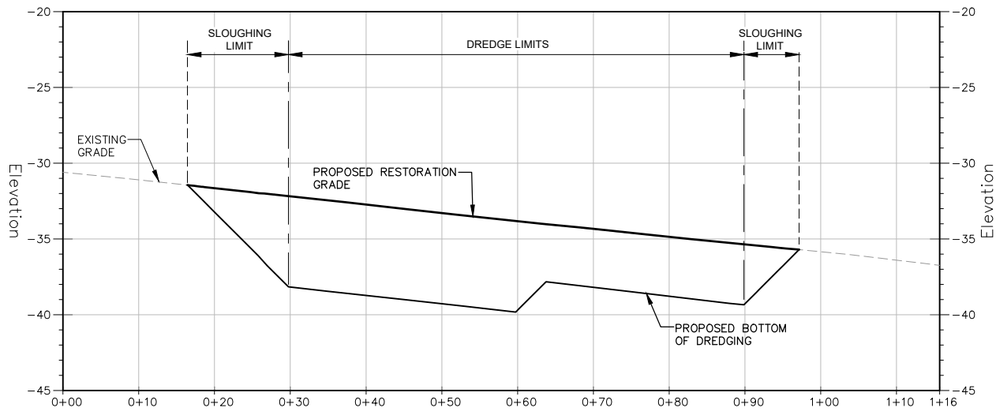
RESTORATION ELEVATIONS - NEAR SHORE NORTH, NEA AND DEEPWATER

ARCADIS Project No.
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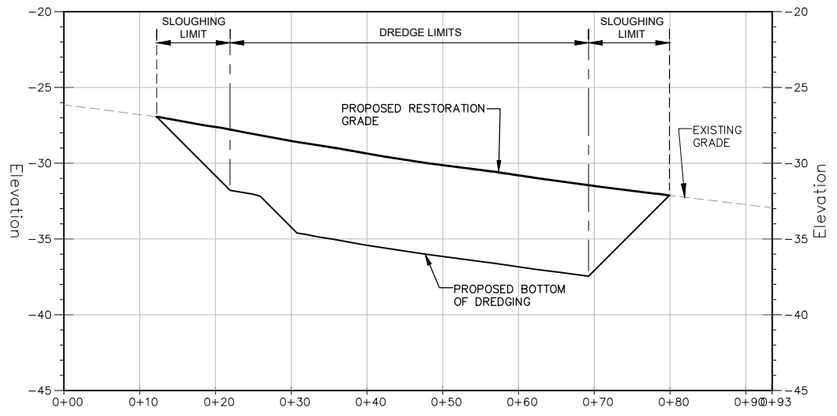
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Syracuse, NY 13202
Tel: 315-446-9120

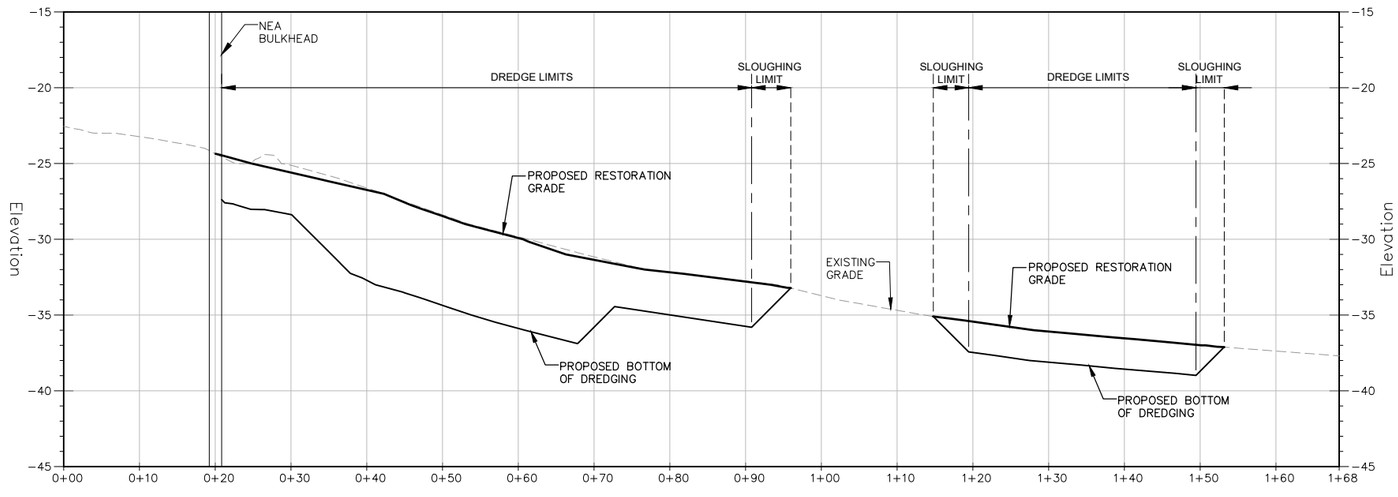
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CROSS SECTION 1 / D-15



CROSS SECTION 2 / D-15



CROSS SECTION 3 / D-15

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.
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CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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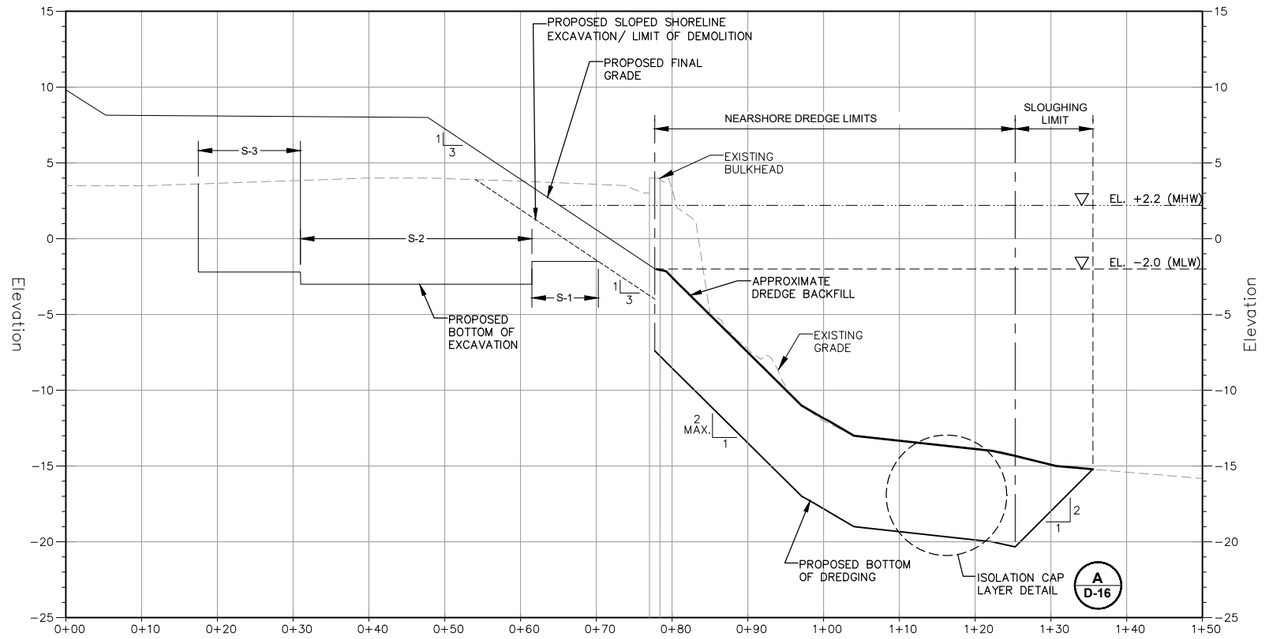
ATLANTIC RICHFIELD CO. ● HASTINGS-ON-HUDSON, NEW YORK
HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

DEEP WATER CROSS SECTIONS

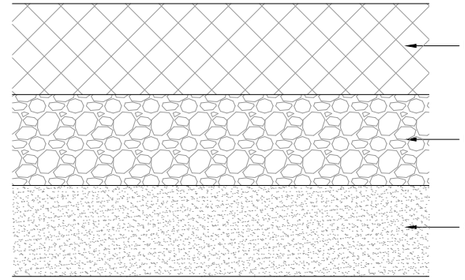
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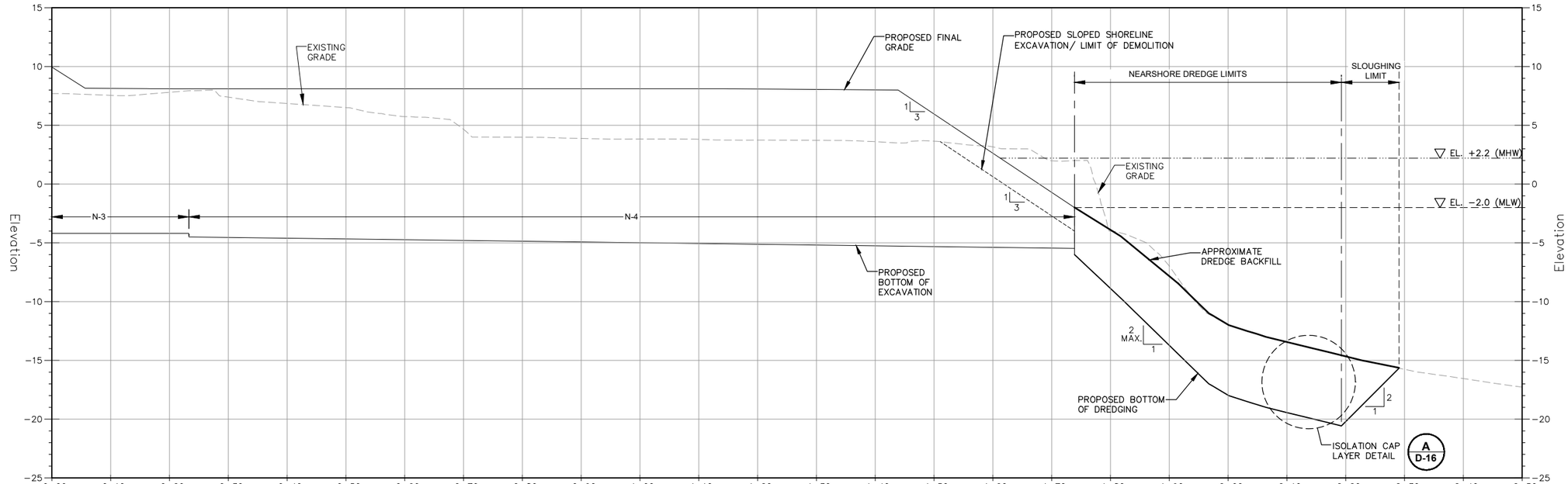
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CROSS SECTION 1 D-16



ISOLATION CAP LAYERS DETAIL A D-16



CROSS SECTION 2 D-16

NOTE:

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NEARSHORE CROSS SECTIONS

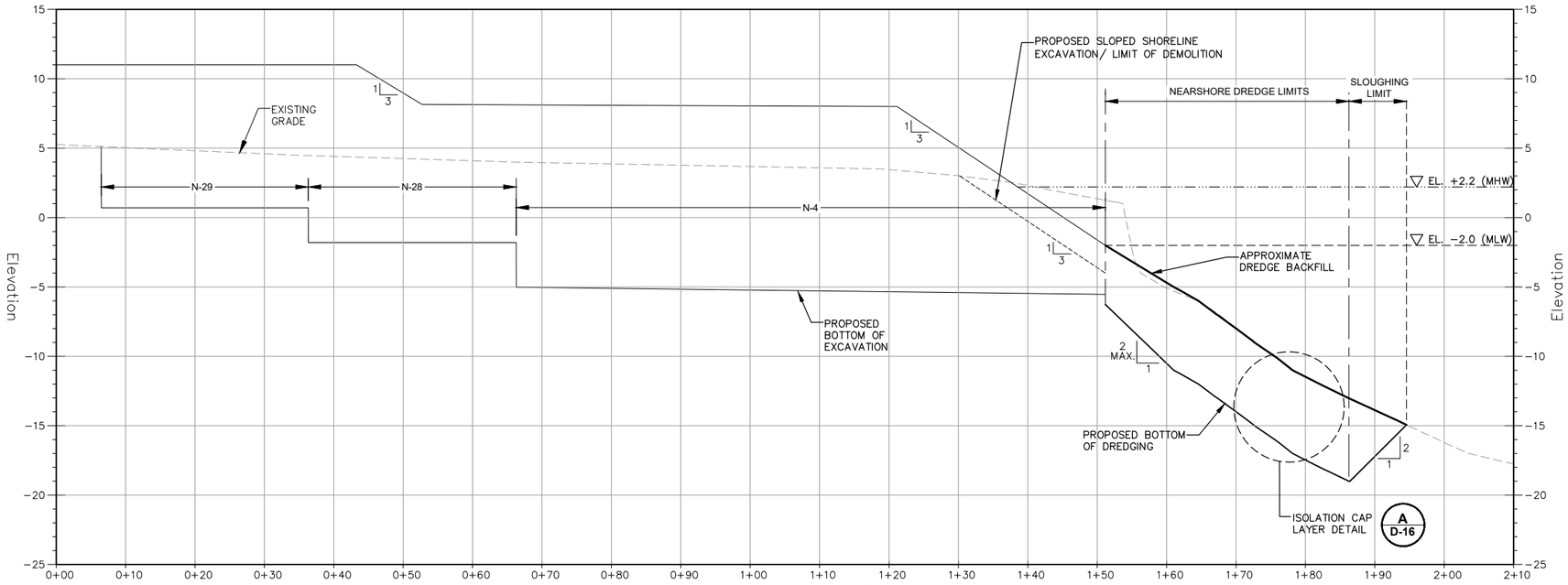
ARCADIS Project No.: B0001701.0002.00134
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CITY: SYRACUSE NY DIV/GROUP:ENVCAD DB: E. KRAHMER LD: G. STEINBERGER PIC: K. G. DIAS PM: R. KAPP TM: R. KAPP TR: S. McGOWAN LYR:ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ---
01701X00



CROSS SECTION 3 D-17

NOTE:

1. DREDGING SHALL OCCUR ONLY TO THE PROPOSED DREDGE LIMITS. GRADING SHOWN BEYOND THE PROPOSED DREDGE LIMITS INDICATES LIKELY SLOUGHING FOR QUANTITY ESTIMATION; HOWEVER, THIS MATERIAL IS NOT TO BE DREDGED DIRECTLY.

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Professional Engineer's No.: 069985-1

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HARBOR AT HASTINGS SITE PRELIMINARY DESIGN, OU1 AND OU2

NEARSHORE CROSS SECTIONS

ARCADIS Project No.: B0001701.0002.00134
Date: NOVEMBER 2017

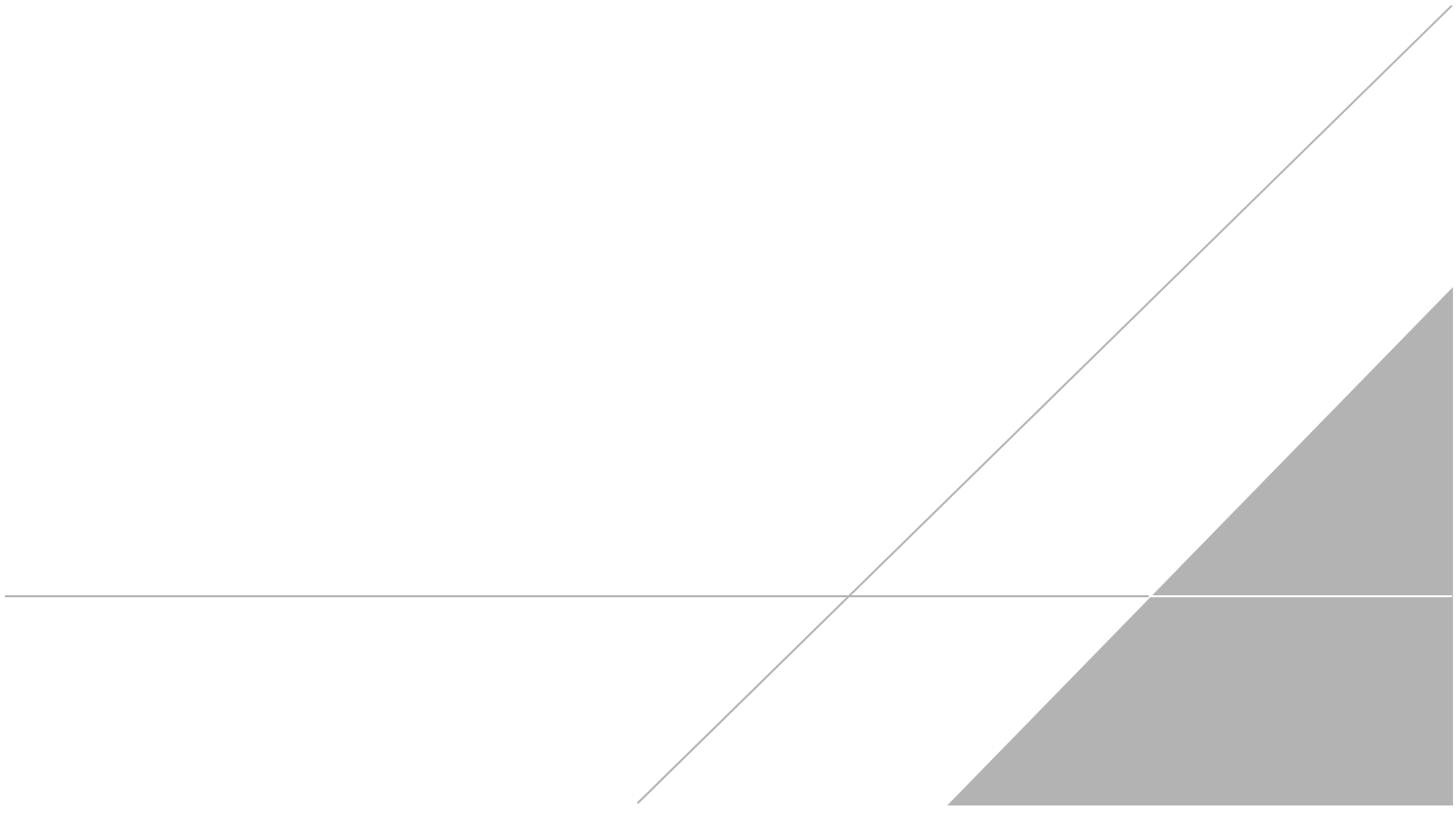
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Syracuse, NY 13202
Tel: 315-446-9120

D-17

APPENDIX B

Remedial Design Calculations

Bulkhead Preliminary Design



ARCADIS Design & Consultancy for natural and built assets

Improving quality of life

Draft Basis of Design

Client: Atlantic Richfield Company **Project:** B0001701.0000

Prepared by: A. Baird and L. Selleck **Date:** 10/25/2017

Title: Bulkhead Preliminary Design – Harbor at Hastings

Reviewed By: R. Kilkenny **Date:** 10/27/2017
A. Chwalibog **Date:** 11/29/2017

Subject: Calculations for the installation and fill behind new bulkhead alignment at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

OBJECTIVE: Determine assumptions and requirements to:

- Install new bulkhead extension into the Hudson River that will meet the remedial construction phases:
  - Outboard dredging of offshore sediments to 6 ft below existing sediment surface with the bulkhead acting as a cantilever support of the Northwest area of the site.
  - After backfilling of dredge area, filling behind the bulkhead with lightweight fill material to create the Northwest Extension Area with the following construction sequence:
    - Bulkhead acting as a cantilever wall for intermediate filling to +0 ft NAVD88 for consolidation efforts and tieback installation.
    - Bulkhead acting as a tieback anchored wall with final grade at +6 ft NAVD88.

ATTACHMENTS:

A. Lightweight Fill Data Summary
B. Geotechnical Data Summary
C. Design Soil Profiles
D. Groundwater References and Data Summary
E. Boussinesq Surcharge Estimate
F. Bulkhead ProSheet Outputs
G. Anchor Wall ProSheet Outputs
H. Global Slope Stability Analysis
I. Tie Rod Analysis

ABBREVIATIONS:

ARC	Atlantic Richfield Company
Arcadis	Arcadis U.S., Inc.
bgs	below ground surface
bss	below sediment surface
BOD	basis of design
DNAPL	dense non-aqueous phase liquid
ft.	feet
H&A	Haley & Aldrich of New York
I	Moment of Inertia
in	inch
ksi	kips per square inch
lf	lineal feet
MHHW	Mean Higher-High Water
MLLW	Mean Lower-Low Water
N-Value	Penetration resistance of the soil
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NEA	Northwest Extension Area
NOAA	National Oceanic and Atmospheric Administration
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	State of New York Department of Transportation
OU	Operable Unit
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
psf	pound per square foot
sf	square feet
SPT	Standard Penetration Test
S_x	Section Modulus

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Draft Basis of Design

GENERAL ASSUMPTIONS:

1. The Site is located at 1 River Street, Hastings-on-Hudson, New York. It consists of a 28-acre property on the shore of the Hudson River that was home to a former wire and cable manufacturing facility operated by the Anaconda Wire & Cable Company, which ceased operations in 1974. Wire manufacturing operations during a portion of the operating period caused the release of polychlorinated biphenyls (PCBs) and metals to site soil, groundwater and sediments. The New York State Department of Environmental Conservation designated the Site as a Class 2 Inactive Hazardous Waste Site.

2. Part of the site remedy consists of creating the Northwest Extension Area (NEA) that will be created by installation of a bulkhead wall within the Hudson River and filling behind the bulkhead to +6 ft NAVD88. The NEA will provide containment and allow for the potential recovery of liquid PCB DNAPL offshore of the northwest corner of the site.

3. The NEA bulkhead will be designed for three phases:

    a. As a cantilever wall for dredging sediments up to 6 ft deep on the river side, where applicable, but prior to filling of the northwest corner with lightweight fill material. Areas initially identified for dredging near the Northwest Extension Area are shown in the Preliminary Design Report Appendix A.

    b. As a cantilever wall while filling up to elevation +0 ft to install wick drains and during resulting consolidation settlement periods.

        i. As a cantilever wall to fill up to one foot below tie-rod installation elevations (only one case is up to +1 ft; all others are below wick drain installation elevation and not controlling).

    c. As an anchored wall tied into an upland deadman anchor to the proposed final elevation (+6 ft NAVD88). The sheet pile wall will be filled with lightweight fill to an elevation that rises to meet the upland grade. The proposed bulkhead extension is shown in the Preliminary Design Report Appendix A.

4. Vertical coordinates are North American Vertical Datum of 1988. Horizontal coordinates (northing and easting) are U.S. State Plane coordinates in U.S. survey feet and are referenced to the North American Datum of 1983, New York State East Zone. Topographic and surface features were surveyed by Wendel Architecture, Engineering, Surveying & Landscape Architecture, PC (2013 and 2014). Bathymetry surface was surveyed by Ocean Surveys, Inc. (Ocean Surveys, Inc. 2012). Current surface features may vary since the time of the surveys.

Imported Backfill Assumptions

1. For filling behind the bulkhead extension area, engineered lightweight fill will be used to reduce loads on the bulkhead and minimize settlements between the bulkhead and tieback walls. For design, Norlite Corporation expanded shale aggregate was referenced for lightweight fill properties and compared with typical lightweight fill aggregate alternatives. The fill properties used for analysis are included in Table 1 and lightweight fill data references are provided in Attachment A.

Basal Sand Penetration Assumptions

1. Investigations along the proposed wall alignment have been performed to determine potential obstructions and indications of PCB materials, noting liquid or semi-solid states. The proposed bulkhead has been aligned to not penetrate PCB materials observed and is shown on Figure 3.4A in Attachment B.

2. Given the alignment is cleared of PCB material to avoid potential drag down of impacts by the bulkhead installation, the bulkhead is assumed to be able to penetrate the Basal Sand along this proposed alignment.

Wick Drain Consolidation Assumptions

1. Wick drains will be used to consolidate the thick Marine Silt layer in order to minimize any differential settlement between the bulkhead and anchor walls. The wick drain consolidation calculations and alternative settlement control method analyses will be provided in a separate attachment and be part of the Final Design.

Construction Sequencing Assumptions

Analysis of the bulkhead sections and minimum wall requirements assume a construction sequence to minimize pressures on the proposed bulkhead and allow ease of installation. Construction is assumed to proceed with:

1. Install upland isolation slurry wall.

2. Install cantilever steel sheets pile wall along the bulkhead alignment, except for those areas left uninstalled to allow water to freely travel on either side of the bulkhead.

3. Dredge down to 6 ft bss in areas with impacted sediment on the riverside of the bulkhead.

4. Backfill dredged areas.

5. Install remaining sheet piles to isolate NEA from the Hudson River.

6. Fill behind sheet pile wall with lightweight aggregate to elevation +0 ft to allow wick drain installation and subsequent water management for consolidation.

7. Add additional fill to account for settlements and to reach elevations to facilitate tieback installation.

8. Install tie-rods connected to anchor wall on existing upland portion of the site.

9. Fill behind bulkhead to proposed final elevation with lightweight aggregate.

Bulkhead Design Assumptions

1. The proposed NEA is being constructed to contain on-site impacts and shall consist of steel sheet piles with sealant applied to the interlocks. The wall system will also include passive groundwater treatment gates to adsorb contaminants that may be present in groundwater before discharge to the

river. The wall system will have sufficient corrosion protection to meet the design life of the bulkhead and deadman system.

2. Design life for the bulkhead is assumed to be 100 years. Corrosion design will be analyzed during final design.

3. The geotechnical design sections were interpreted using topographic survey data (Wendel. 2014), bathymetry data (Ocean Surveys, 2012) and soil boring data from H&A and Parsons (H&A 2015; Parsons 2006), which is summarized in Attachment B.

4. Minimum soil stockpile and staging distances from the bulkhead will be 85 ft from the face of the bulkhead to minimize any additional surcharge loads on the bulkhead.

5. For the purpose of this design, estimates for the engineering properties of the soil layers were determined from engineering judgment and referenced:

    a. field standard penetration test (SPTs) resistances (N Values), also corrected to $(N_1)_{60}$, (H&A 2015)
    b. field vane shear tests (H&A 2011)
    c. laboratory test data collected during previous investigations (H&A, 2006, 2011 and 2015)

    The estimation was based on information found in *Design of Sheet Pile Walls* (U.S. Army Corps of Engineers. 1994) and *Soil Mechanics in Engineering Practice* (Terzaghi, Peck, Mesri. 1996). Boring locations for historical investigations are provided in Attachment B and Attachment C presents the estimated soil parameters and profiles used in the bulkhead design analyses.

6. Upland groundwater near the NEA have been observed with average highs near elevation 3.5 ft NAVD88 and average lows near 0.1 ft NAVD88 (H&A, 2015). River water levels have been recorded with Mean Higher-High (MHHW) tide elevation at 2.2 ft NAVD88 and Mean Lower-Low (MLLW) tide elevation at -2 ft NAVD88 (Parsons, 2006). Reference and groundwater data is summarized in Attachment D.

7. For bulkhead design, a conservative water differential is assumed. River water elevations were assumed as -2.0 ft NAVD88 in the Hudson River (MLLW) and the groundwater in the NEA is assumed as being one foot above the associated low tide groundwater levels observed (+0 ft) for an associated design elevation at +1 ft NAVD88 (similar to mean tide monitoring wells elevations, +1.0 ft NAVD88) (H&A, 2016b). This 3 ft water differential is used only for final design conditions, assuming that during construction sequencing water will either be allowed to flow freely or controlled once the NEA is isolated by upland slurry wall and full sheet pile installation.

8. Profiles for soil conditions are shown in Attachment C. The table below summarizes the soil strengths used in the design.

Draft Basis of Design

Table 1: Soil Properties

Layer	Elevation (NAVD88) (ft NAVD88) Bulkhead Design ID		$(N_1)_{60}$	γ (moist)	γ (sat)	Φ	δ	Su
	01 and 02	03		*(pcf)*	*(pcf)*	*(deg)*	*(deg)*	*(psf)*
Existing Fill (Upland)	+4 to -17	+4 to -17	8	120	125	29	15.66	
Lightweight Fill (NWE)	+6 to Mudline	+6 to Mudline	—	60	90	37	19.98	
Marine Silt (1)	Mudline to -40	Mudline to -25	WOR		105	28	15.12	300
Marine Silt (2)	-40 to -60	-25 to -45	WOR		105	30	16.20	600
Marine Silt (3)	-60 to -80	-45 to -75	WOR		105	31	16.74	900
Basal Sand	-80 to -130	-75 to 130	18		125	34	18.36	

Notes:

Bgs – below ground surface
pcf – pounds per cubic foot
deg – degrees
psf – pounds per square foot

γ - Unit weight
Φ - Angle of friction
Su – Shear Strength
δ – Drained Interface

9. The analysis sections along the bulkhead alignment were separated based on the mudline elevations determined by the bathymetry (Ocean Surveys 2012) and resulting difference in retained upland fill by the shoring wall system.

10. The soil layer thicknesses of the Marine Silt and Basal Sand were correlated to borings performed near the alignment as part of the 2015 PDI (H&A 2015). The analysis sections relate to the following borings advanced within the sections:

    - Section 01: correlated to PD2-GR-001 and PD2-GR-004
    - Section 02: correlated to PD2-GR-002, PD2-GR-003, and PD2-GR-005
    - Section 03: correlated to PD2-GR-006

    The design soil profile sections in Attachment C show SPT data for all the borings near the proposed alignment and Figure 2B provides shear vane test data collected near the northwest area for comparison ((H&A 2011).

11. Generally, BOD soil profiles are analyzed for three (3) sections along the extension bulkhead alignment corresponding with various retained thicknesses. Sections are summarized in the table below and are shown in plan view in Attachment C.

Table 2: Bulkhead Barrier Wall Design Sections

Bulkhead Design ID	Drawing Section ID	Wall Alignment Control Points	Design Sediment Surface Elevation (FT NAVD88)
01	B	CP-02 TO CP-03, CP-07 TO CP-08	-20
02	A	CP-03 TO CP-07	-27
03	C	CP-01 TO CP 02, CP-08 TO CP-10	-5

12. Surcharges are assumed to be applied to the upland side of the bulkhead during the construction sequences as follows:

    Cantilever wall:
    a. Dredge Phase – No loading since no fill in NEA
    b. Wick Install – 366 psf boussinesq load from wick drain installation equipment 8 ft from wall and 16 feet long perpendicular to the wall (mats 4'x20') (Attachment E provides load distribution estimate)
    c. Installation Transition – 100 psf uniform load to install tieback anchors. Only one case for additional fill above wick drain install height was checked since other tieback installation elevations are lower than fill height during wick drain installation.

    Anchored Wall:
    a. Final – 250 psf for construction loading (NYSDOT. 2015)

13. The earth pressures acting on the walls will be determined with the computer program ProSheet (ProfilARBED, 2009), which uses the Coulomb theory for passive earth pressure coefficients. Sheet pile design and anchor load calculations will also be performed with ProSheet. Due to the earth pressure theory and inputs required for ProSheet, the gentler slopes on the river passive side (range from 6.5:1 to 10:1) were assumed as a flat plane at a reduced elevation based on geometry of the failure wedge (see Attachment I for profile wedges).

14. Wall friction (δ) is expressed as a fraction of the angle of internal friction (Φ). The following equation applies to cohesionless soils against steel walls:

$$\delta = 0.54\ \Phi \qquad (2)$$

15. Shoring section modulus (Sx) and moment of inertia (I) for AZ steel piles will be assumed based on the Skyline Steel database (Skyline Steel, 2017).

16. The minimum acceptable factor of safety for passive pressures (FSP) for geotechnical integrity (rotation) is 1.5 for free-draining soils and 2.0 for clay (NYSDOT, 2015 and U.S. Army Corps of Engineers, 1994).

17. The minimum acceptable factor of safety for structural integrity (FSS) (yielding) is 2.0 (U.S. Army Corps of Engineers. 1994). The yield strengths for the bulkhead system are as follows:

    a. Bulkhead Sheet Piles – 50 ksi
    b. Anchor Sheet Piles – 50 ksi

c. Tie Rods – 75 ksi

18. To avoid compounding factors of safety, the retaining system stability/embedment will be calculated with reduced passive pressures per the above FSP, but the structural components will be designed using a passive pressure FSP of 1.0 to calculate the forces and moments and a structural integrity FSS applied to steel strengths.

19. Due to the critical nature of anchorages, the design of the tie-rods and wales are based on the anchor force calculated from the stability analysis with a factor of safety applied to the passive soil pressure (FSP).

CALCULATIONS:

Bulkhead Design

Static:

The sheet pile designs and anchor load calculations are performed using the ProSheet computer program (ProfilARBED, 2012). ProSheet requires soil properties, surcharge loading, and water level conditions to be input, and then determines moment, shear, deflection, embedment, and sheet pile factor of safety based on force equilibrium.

Deadman anchors are assumed to connect headwalls at different depths to allow overlap of the tie rods, which is required due to the alignment configuration. The tieback anchors are angled at 0 degrees from horizontal. The analysis results are summarized in Table 5 and 6 below. Outputs results for bulkhead analyses for each design section can be found in Attachment F.

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Table 5: Bulkhead Analysis Sections

Wall Analysis ID	Wall Type	Sequence	Elev. In Front of Wall [1]	Surface Elev. Behind Wall	Surcharge Load	Water Elev. in Front of Wall	Water Elev. Behind Wall	Analysis Type	Min. Sheet Length	Min. Sx	Assumed Sheet Pile Section	Pile Sx	Pile I	Anchor Elev.	Anchor Load	Max. Deflection
			Ft NAVD88	*Ft NAVD88*	*lb/ft*	*ft NAVD88*	*ft NAVD88*		*ft*	*in³/ft*		*in³/ft*	*in⁴/ft*	*ft NAVD88*	*kip/ft*	*in*
01	Cantilever	Dredge	-26	-20	0	-2	-1	Drained	50.6	12.884	AZ 46-700N	85.653	844.828	--	--	0.94
								Undrained	47.7	10.179	AZ 46-700N	85.653	844.828			0.68
	Cantilever	Wick Install	-20	+0	366 (Boussinesq)	-2	-2	Drained	43.4	9.443	AZ 46-700N	85.653	844.828	--	--	0.48
								Undrained	48.6	7.542	AZ 46-700N	85.653	844.828			0.37
	Anchored	Final	-20	+6	250 (Uniform)	-2	1	Drained	38.6	10.557	AZ 17-700	32.178	265.304	-3	6.236	0.31
								Undrained	**55.4**	**12.382**	**AZ 17-700**	32.178	265.304		**8.301**	0.65
	Anchored	Final	-20	+6	250 (Uniform)	-2	1	Drained	39.2	13.413	AZ 17-700	32.178	265.304	-1	5.845	0.43
								Undrained	**56.0**	**16.145**	**AZ 17-700**	32.178	265.304		**7.960**	1.01
02	Cantilever	Dredge	-30	-21.5[1]	0	-2	-1	Drained	56.6	17.474	AZ 46-700N	85.653	844.828	--	--	1.60
								Undrained	53.0	13.755	AZ 46-700N	85.653	844.828			1.19
	Cantilever	Wick Install	-30	+0	366 (Boussinesq)	-2	-2	Drained	62.7	34.873	AZ 46-700N	85.653	844.828	--	--	3.61[2]
								Undrained	76.1	44.447	AZ 46-700N	85.653	844.828			6.11[2]
	Cantilever	Installation Transition	-30	+1	100 (Uniform)	-2	-2	Drained	63.7	47.155	AZ 46-700N	85.653	844.828	--	--	4.57[2]
								Undrained	**78.4**	63.192	AZ 46-700N	85.653	844.828			7.81[2]
	Anchored	Final	-30	+6	250 (Uniform)	-2	1	Drained	53.0	36.955	AZ 46-700N	85.653	844.828	-1	9.168	0.85
								Undrained	72.3	63.819	AZ 46-700N	85.653	844.828		**14.116**	2.23
	Anchored	Final	-30	+6	250 (Uniform)	-2	1	Drained	53.4	42.850	AZ 46-700N	85.653	844.828	+2	8.609	1.16
								Undrained	73.0	71.633	AZ 46-700N	85.653	844.828		**13.499**	2.92
03	Cantilever	Dredge	-11	-5	0	-2	-1[2]	Drained	29.3	2.907	AZ 46-700N	85.653	844.828	--	--	0.06
								Undrained	24.2	1.529	AZ 46-700N	85.653	844.828		--	0.024
	Cantilever	Wick Install	-5	+0	366 (Boussinesq)	-2	-2	Drained	15.6	0.192	AZ 46-700N	85.653	844.828	--	--	0.00
								Undrained	13.3	0.117	AZ 46-700N	85.653	844.828		--	0.00
	Cantilever	Final	-5	+6	250 (Uniform)	-2	1	Drained	30.7	9.823	AZ 17-700	32.178	265.304	--	--	0.768
								Undrained	**34.2**	6.919	AZ 17-700	32.178	265.304		--	0.576

Notes:

1. Analysis elevation used due to existing slopes.
2. No groundwater control inside NEA. Minimal differential inward greatly reduces deflection.

Anchor Design

Static:

Due to the shallow depth of the water table at the anchor location and the variation in anchor wall heights, it is not suitable to connect the tie rod to the center of the gravity of the anchor. Due to the high location of the tie rod connection, the anchor cannot be designed by free earth analysis and must account for the eccentricity of the anchor pull. The eccentricity of this load is accounted for by increasing the embedment of the anchor to create a counterbalance of the tie rod force by the reactions of the ground on the fixed toe of the wall. The theoretical depth of the fixed earth support is that which cancels the moment caused by the anchor pull and the soil resistance on the front side of the anchor wall (ProfilArbed, 1991).

The fixed earth design is modeled in the design program ProSheet (ProfilArbed, 2009). The base model consisted of a discontinuous anchor wall with each individual wall supporting two tieback anchors and a space between every third AZ sheet of the bulkhead. This will allow groundwater to flow through the anchor wall, however it results in an increased wale force required on the anchor wall in a 3:2 ratio. Therefore, the factored anchor force from the bulkhead analysis is increased by this ratio when analyzing the wale load to be distributed onto the anchor wall. Groundwater is modeled for the existing level of +1 ft NAVD88 and no differential.

The design requirements of the anchor are presented in Table 6.

Anchor wall ProSheet analysis results and outputs can be seen in Attachment G.

After determining the dimensions of the anchor wall to resist the pull of the anchor load, the offset of the anchor walls from the headwall are determined. To ensure an economical and safe offset of anchor wall, a check is performed that determines the length of the tie-rods which allows the full development of the soil-resistance on the anchor wall without interfering with the active wedge of the headwall (ProfilArbed,1991). The top of the soil pressure wedges can be considered the top depth of the anchor wall. In the case of fixed bulkheads, origin of the sliding surface can be considered at the level of the maximum bending moment on the buried part of the bulkhead (where the shearing stress cancels itself) (ProfilArbed, 1991). Due to a large silt layer, offset wedges were assumed at 45º angles from the design bulkhead and anchor tips and the geometry check is included in Attachment I.

Table 6: Anchor Design Requirements and Results

Wall ID	Anchor Wall Alignment		Anchor Tie Rod Elev.	Bulkhead Factored Wale Load	Bulkhead Tributary Width	Anchor Section Width	Discontinuous Anchor Wale Load	Ground Surface Elev.	Anchor Top Elev.	Min Anchor Tip Elev.	Required Anchor Section	Min Anchor Wall Setback[3]
	FROM	TO	*ft NAVD88*	*kip/ft*	*ft*	*kip/ft*	*kip/ft*	*ft NAVD88*	*ft NAVD88*	*ft NAVD88*		*ft*
01	CP-27	CP-36	-3	8.301	13.78	9.2	12.45	6	-1.5	-11.3	AZ 17-700[1]	83
	CP-69	CP-82	-1	7.96	13.78	9.2	11.94	6	+1	-9.7	AZ 17-700[2]	81
02	CP-11	CP-26	-1	14.116	13.78	9.2	21.17	6	+1	-17.3	AZ 17-700	103
	CP-37	CP-68	+2	13.499	13.78	9.2	20.25	6	+4	-18.2	AZ 17-700	104

Note:

1. Due to height of material above anchor wall, analysis for structural requirements ran with soil level only at top of anchor wall (7.5 ft bgs). This was done in order to reach equilibrium and include the anchor load, otherwise the additional fill above fixes the wall and analysis outputs show an overly shortened and small sheet size, which is not conservative and does not include temporary construction conditions while filling.
2. Due to height of material above anchor wall, analysis files for structural requirements ran with soil level only at top of anchor wall (5 ft bgs). This was done in order to reach equilibrium and include the anchor load, otherwise the additional fill above fixes the wall and analysis outputs show an overly shortened and small sheet size, which isn't conservative and does not include temporary construction conditions while filling.
3. Select anchor locations are offset further back from the headwall than the minimum design offset to minimize overlap between passive and active soil wedges of intersecting anchor walls (see Drawings S-1 through S-3 of Appendix A of the Preliminary Design Report).

Global Stability Analysis

A global stability check is also required for the bulkhead sections to confirm there is a sufficient factor of safety for a global soil failure around the retaining structure. Analyses were performed using GEO-SLOPE International, Ltd.'s Slope/W software based on the controlling sheet pile embedments from the ProSheet bulkhead analyses. The Slope/W model is run for both the undrained and drained condition and a factor of safety determined for the bulkhead sections. If the factor of safety is less than 1.5, then the sheet pile tip elevation was lowered until the failure surface was deep enough to reach a factor of safety of 1.5. This is considered the controlling case.

For one undrained condition, the bulkhead depth was not deep enough to reach a factor of safety of 1.5, so additional analyses were performed until the sheet pile length was sufficient to reach this safety factor.

Attachment H provides outputs for the checks of the ProSheet embedment depths and the additional controlling depth for the undrained case.

Table 7: Global Stability Results

Wall ID	Bulkhead Wall Alignment	Analysis Type	ProSheet Wall Depth (ft)	Global Factor of Safety	Slope/W Adjusted Wall Depth (ft)	Global Factor of Safety
01	CP-02 to CP-03; CP-07 to CP-08	Drained	57	3.047	--	--
		Undrained		1.454	65	1.541
02	CP-03 to CP-07	Drained	79	3.077	--	--
		Undrained		1.6934	--	--
03	CP-01 to CP-02; CP-08 to CP-10	Drained	35	3.842	--	--
		Undrained		2.177	--	--

Tie Rod Diameter

Tie rod diameter is determined using the total force in each tie rod with an applied factor of safety of 1.5, calculated in ProSheet (Attachment F). Tie rod diameter calculations are shown in Attachment I. Recommendations are provided in the table below.

Table 8: Tie Rod Diameter Results

Wall ID	Bulkhead Wall Alignment		Anchor Elevation	Bulkhead Factored Wale Load	Tie Rod Tributary Width	Tie Rod Force (T_{rod})	Tie Rod Diameter (75 ksi)
	FROM	TO	*ft NAVD88*	*kip/ft*	ft	kip	in
01	CP-02	CP-03	-3	8.301	13.78	57.3	1 ¾
	CP-07	CP-08	-1	7.96	13.78	54.9	1 ¾
02	CP-03	CP-05	-1	14.116	13.78	97.4	2 ¼
	CP-05	CP-07	+2	13.499	13.78	93.1	2 ¼

SUMMARY:

The following tables summarize the requirements for the proposed bulkhead extension at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

Table 9: Bulkhead Headwall Requirements

Bulkhead Wall Alignment		Wall ID	Anchor Elev.	Length of Wall	Wall Type	Required Section	Min. Sheet Pile Length	Min. Sheet Pile Tip El.
FROM	TO		ft NAVD88	lf			ft	ft NAVD88
CP-01	CP-02	03	--	54	CANTILEVER	AZ 17-700	35	-29
CP-02	CP-03	01	-3	46	ANCHORED TIEBACK WALL	AZ 17-700	65	-59
CP-03	CP-05	02	-1	138	ANCHORED TIEBACK WALL	AZ 46-700N	79	-73
CP-05	CP-07	02	+2	227	ANCHORED TIEBACK WALL	AZ 46-700N	79	-73
CP-07	CP-08	01	-1	80	ANCHORED TIEBACK WALL	AZ 17-700	65	-59
CP-08	CP-10	03	--	189	CANTILEVER	AZ 17-700	35	-29

Table 10: Anchor Wall Requirements

Wall ID	Anchor Wall Alignment		Tie Rod/ Wale El.	Required Section	Min Anchor Offset	Min. Sheet Pile Tip El.	Pile Cut-Off El.
	FROM	TO	ft NAVD88		ft	ft NAVD88	ft NAVD88
01	CP-27	CP-36	-3	AZ 17-700	83	-12	-1.5
	CP-69	CP-82	-1	AZ 17-700	81	-10	1
02	CP-11	CP-26	-1	AZ 17-700	103	-18	1
	CP-37	CP-68	+2	AZ 17-700	104	-19	4

Table 11: Tie Rod Requirements

Wall ID	Bulkhead Wall Alignment		Tie Rod Diameter (75 ksi)
	FROM	TO	in
01	CP-02	CP-03	1 ¾"
	CP-07	CP-08	
02	CP-03	CP-05	2 ¼"
	CP-05	CP-07	

Attachment A

Lightweight Fill Data Summary

TILCON IMPORT MATERIALS SUMMARY

OU	ITEM	QTY	UNIT	DESCRIPTION	COMMENTS	ORIGIN
OU-1	Total Remaining Fill Requirement	208,000	CY	Import fill req'd to get to 2 ft below final grade	Screenings	Haverstraw
OU-1	Import - Gravel Transition Zone (2 ft)	6,317	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Topsoil (6 inches)	11,678	CY	topsoil to final grade	Certified clean	N/A
OU-1	Import - Clean fill (18 inches)	35,034	CY	clean fill to 6 in. below final grade	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Stone (thickness varies)	3,912	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Stone (2 feet)	10,567	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Riprap (Armor: 2' of 12" D50)	7,699	CY	south slopeback, Old Marina	14" - 24" Average	Clinton Pt.
OU-1	Import - Riprap (Filter: 2' of 6" D50)	5,775	CY	south slopeback, Old Marina	4" - 10" Average	Clinton Pt.
	6" sand layer	1,924	CY		Stone Sand	Clinton Pt.
OU-2	Lightweight fill*	20,907	CY	for NW extension backfill	saturated unit weight of 90 pcf, expanded shale aggregate (See more details below)	N/A
OU-2	Offshore Backfill	~25,000-45,000	CY	Offshore cap for Nearshore/Backwater/Deepwater	Screenings	Haverstraw
OU-2	Offshore Cap	7,888	CY	up to numbers for Cap	Stone Sand	Clinton Pt.
OU-2	Offshore Cap	3,944	CY		1-1/2" Washed	Clinton Pt.
OU-2	Offshore Cap	3,944	CY		Capping - sand with organic content	N/A

New items added.

*Lightweight Fill: Lightweight fill shall consist of rotary kiln dried expanded shale aggregate as manufactured by Norlite Corporation or equivalent, 3/8 in. aggregate size, having a maximum in-place dry unit weight of 50 pcf and a maximum in place saturated unit weight of 90 pcf and a minimum friction angle of 32 degrees. Expanded shale lightweight fill shall meet the requirements of ASTM C330. Contractor may propose equivalent suppliers of expanded shale lightweight fill subject to the approval of the Engineer. The criteria for approval shall be: a) expanded shale lightweight fill shall be chemically inert and non-corrosive and durable, b) no by-product slag, cinders or by products of coal combustion shall be permitted, c) the maximum soundness loss when tested with 5 cycles of magnesium sulfate shall be 10% in accordance with ASTM C-88, and d) the lightweight fill shall satisfy the unit weights and friction angle requirements.

NORTHEAST SOLITE CORPORATION

NORTHEAST SOLITE CORPORATION

PO Box 437, Mount Marion, NY 12456 PHONE (845) 246-2646 FAX (845) 246-3356

Website: www.nesolite.com

Recommended general procedures for Geofill installation of Solite® are as follows:

- The Solite® material should conform to ASTM – C330 with a gradation 7 % (+/- 2 %) maximum retained on the ¾" sieve.
- If stockpiled on site, care should be taken not to contaminate the material with soil or other aggregates.
- No vehicular traffic shall drive across the material until after it is placed and compacted in the work.
- The material should be placed in the work by front-end loader or other means and leveled into 12" to 18" lifts.
- After placement it shall be compacted in two or three passes with a smooth drum non-vibratory roller with a maximum capacity of no more than 10 tons.
- The "target" in place density of the fill shall be 62 (+/- 2) pcf.
- Care should be taken not to over compact the material so as not to increase the in place density beyond the optimum value.

The method for determining "yield" is as follows:

In place density (pcf) x 27 cu ft / cu yd = lbs / cu yd.

2000(lbs /ton) / lbs / cu yd = cu yd / ton

Example:

60 pcf x 27 cu ft / cu yd = 1620 lbs /cu yd
2000 lbs/ton / 1620 lbs/cu yd = 1.234 cu yds / ton

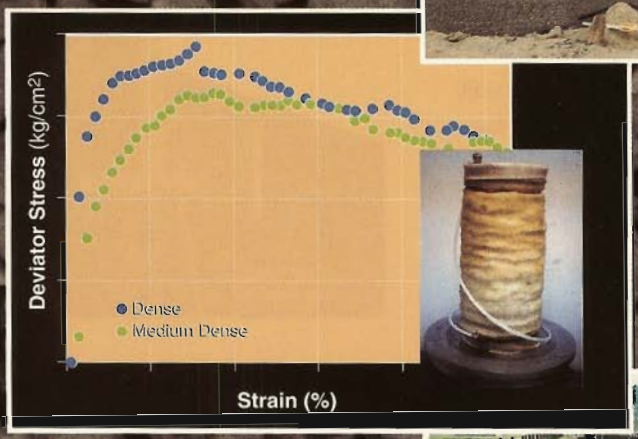
Therefore, the expected yield of 60 pcf compacted material is 1.234 cubic yards of fill per ton of Solite®.

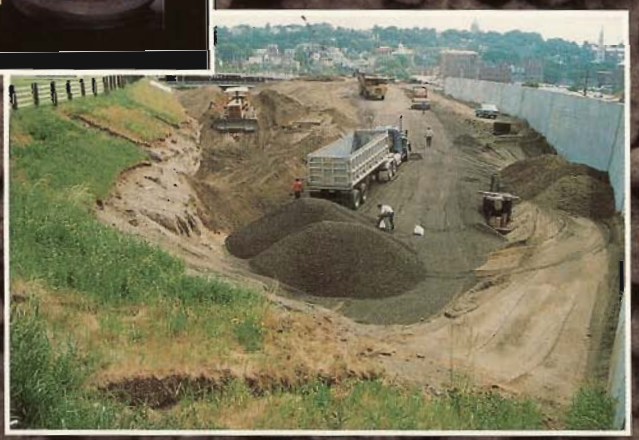
Using this algorithm, the following in place densities equate to the following yields:

59 pcf	1.255 cu yds / ton
60 pcf	1.234 cu yds / ton
61 pcf	1.214 cu yds / ton
62 pcf	*1.194 cu yds / ton*
63 pcf	1.175 cu yds / ton
64 pcf	1.157 cu yds / ton

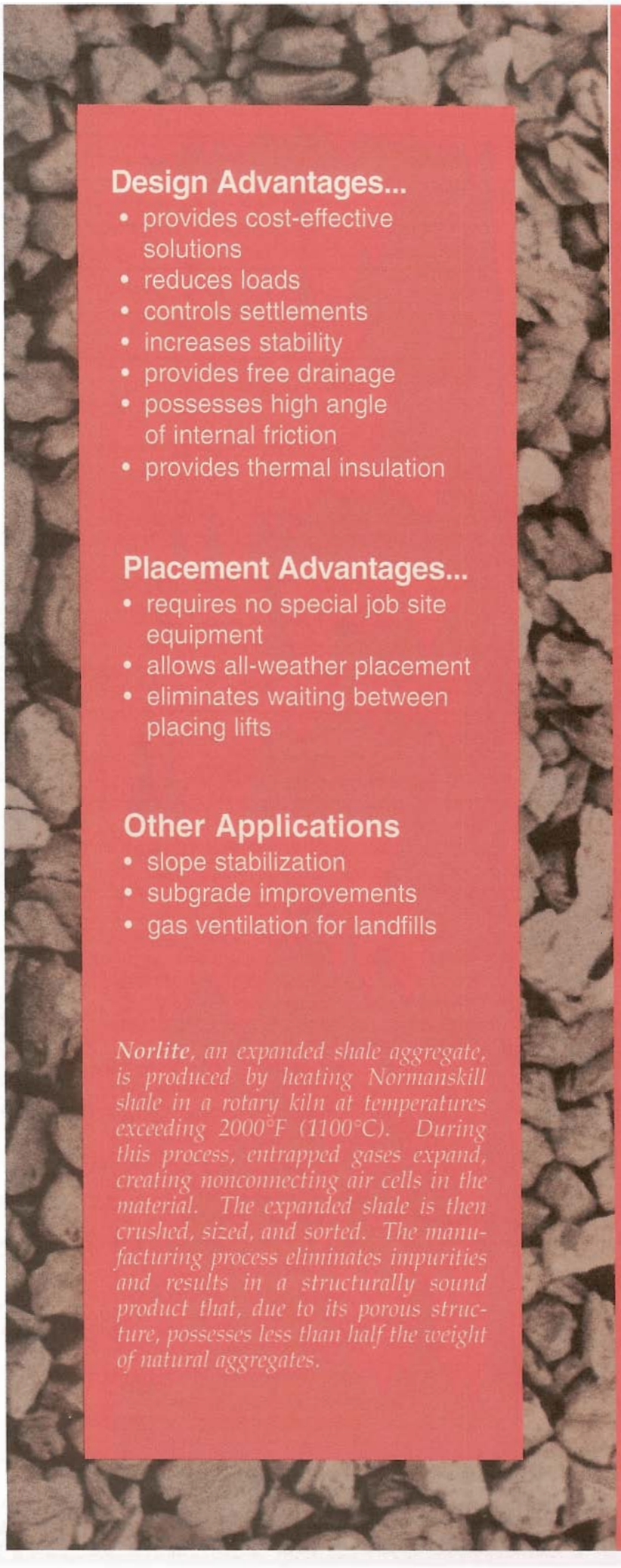
Norlite Suggested Specs







Lightweight Aggregate for Geotechnical Applications



Design Advantages...

- provides cost-effective solutions
- reduces loads
- controls settlements
- increases stability
- provides free drainage
- possesses high angle of internal friction
- provides thermal insulation

Placement Advantages...

- requires no special job site equipment
- allows all-weather placement
- eliminates waiting between placing lifts

Other Applications

- slope stabilization
- subgrade improvements
- gas ventilation for landfills

Norlite, an expanded shale aggregate, is produced by heating Normanskill shale in a rotary kiln at temperatures exceeding 2000°F (1100°C). During this process, entrapped gases expand, creating nonconnecting air cells in the material. The expanded shale is then crushed, sized, and sorted. The manufacturing process eliminates impurities and results in a structurally sound product that, due to its porous structure, possesses less than half the weight of natural aggregates.

Suggested Norlite Specifications for Lightweight Geotechnical Applications

Materials

Lightweight aggregate fill shall be Norlite or approved rotary kiln substitute meeting the requirements of ASTM C-330. No by-product slags, cinders or by-products of coal combustion shall be permitted. Lightweight aggregate shall have a proven record of durability, as determined by ASTM C-88 and ASTM C-131, and be non-corrosive, as determined by CAL DOT 422 with the following physical properties:

A. Delivered Gradation:

Sieve Size		% Passing
1"	(25.0mm)	100
3/4"	(19.0mm)	90 - 100
3/8"	(9.5mm)	10 - 50
#4	(4.75mm)	0 - 15

B. The dry loose density shall be less than 50 pcf (801 kg/m^3).

C. The maximum in situ density (moist, surface dry) shall be less than 60 pcf (961 kg/m^3). The minimum compacted dry density shall be equal to 65% relative density as determined by ASTM D-4253 and D-4254, or as otherwise specified by the engineer.

D. The maximum soundness loss when tested with 5 cycles of magnesium sulfate shall be 10% (ASTM C-88).

E. The maximum chloride content (CAL DOT 422) shall be 100 ppm.

F. The minimum strength of loosely placed material, as determined from drained triaxial tests, shall equal that of cohesionless soil with an angle of internal friction of 36°. Minimum strength of material compacted to 65% relative density shall equal that of a cohesionless soil with an angle of internal friction of 40°.

Method of Construction

Lightweight fill can be placed in approximately uniform layers not to exceed 12 inches loose thickness. Each layer shall be compacted using vibratory compaction equipment weighing not more than 12 tons static weight. The actual lift thickness, exact number of passes, and need for vibrating the roller will be determined by the engineer, depending on the project requirements (i.e., strength, compressibility, unit weight) and equipment used. The contractor shall take all necessary precautions during construction activities in operations on or adjacent to the lightweight fill to ensure that the material is not over-compacted. Construction equipment, other than for compaction, shall not operate on the exposed lightweight fill.

Material Properties of Norlite Lightweight Aggregate

Property	Measuring Method	Test Method	Norlite	Natural Granular Fill
Dry Loose Density	Minimum Density Test	ASTM D-4254	40.2 pcf (644 kg/m³)	89.0 pcf[1] (1426 kg/m³)
Dry Compacted Density	Maximum Density Test	ASTM D-4253	45.5 pcf (729 kg/m³)	146.0 pcf[1] (2339 kg/m³)
Strength (ϕ)	Triaxial Test	Consolidated Drained	42°-53°[2] (medium dense)	36°-42°[3] (medium dense)
Gradation	Sieve Analysis	ASTM C-136	*See Material Specs*	
Soundness	Magnesium Sulfate	ASTM C-88	5.1%	<6%
Abrasive Resistance	Los Angeles Abrasion	ASTM C-131 (B grading)	32%	30-45%
	Modified	FM 1-T 096	21%	
Permeability	Constant Head (i=0.29-0.43)	ASTM D-2434	13.4-15.0 cm/sec	0.016 cm/sec[4]
Resistivity				
- Field (stockpiled)	"Four Terminal" Method	G-57	5.3 x 10^5 ohm-cm	5-10 x 10^5 ohm-cm[5]
- Lab	Resistivity Meter	CAL DOT 643	32,234 ohm-cm	
pH	pH Meter	CAL DOT 643	7.4	4-6.5[6]
Chloride Content	Chloride Content of Soils	CAL DOT 422	<5-46 ppm	
Sulfate Content	Sulfate Content of Soils	CAL DOT 417	146 ppm	
Thermal Conductivity	Guarded Hot Plate	ASTM C-177	.98 Btu/hr ft² °F/in[7] (.141 W/m °C)	9-12 Btu/hr ft² °F/in[8] (1.35-1.7 W/m °C)

[1] Silty Sand & Gravel from T. W. Lambe and R. V. Whitman, *Soil Mechanics* (New York: John Wiley & Sons, Inc., 1969), 31.

[2] Strength envelope defined by ϕ = f(confining stress). Range of ϕ values shown represent confining stresses from 2.05 tsf (196 kPa) to 0.25 tsf (24 kPa), respectively. Contact Norlite for additional strength information.

[3] Sand & Gravel from T. W. Lambe and R. V. Whitman, *Soil Mechanics* (New York: John Wiley & Sons, Inc., 1969), 149.

[4] Sandy Gravel from T. W. Lambe and R. V. Whitman, *Soil Mechanics* (New York: John Wiley & Sons, Inc., 1969), 290.

[5] Boulders, Gravels, Dry Sands from A. Rico Rodriguez, H. del Castillo and G. F. Sowers, *Soil Mechanics in Highway Engineering* (Clausthal-Zellerfeld Trans Tech Publications, 1988), 114.

[6] Humid Forest Soils from L. M. Thompson and F. R. Troeh, *Soil and Soil Fertility* (New York: McGraw-Hill Publishing , Co.), 169.

[7] Conductivity for 40 pcf (641 kg/m³) dry lightweight aggregate from Rudolph C. Valore, Jr., *The Thermo-physical Properties of Masonry and its Constituents, Part 1, Thermal Conductivity of Masonry Materials*

[8] Conductivity for 120 pcf (1922 kg/m³) Sand with Clay & Gravel from Rudolph C. Valore, Jr., *The Thermo-physical Properties of Masonry and its Constituents, Part 1, Thermal Conductivity of Masonry Materials*

Norlite Corporation
628 South Saratoga Street
Cohoes, NY 12047

518-235-0401

2008 Norlite Geotechnical Testing

GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

April 18, 2008
Project 071810

Mr. William H. Wolfe
Senior Engineer
Norlite Corporation
628 South Saratoga Street
Cohoes, New York 12047

Dear Mr. Wolfe:

Re: **Geotechnical Testing for Norlite Lightweight Aggregate**
Norlite Corporation
Cohoes, New York

This letter report presents the results of the laboratory and field testing program performed by GEI Consultants, Inc. on ¾-inch Norlite lightweight aggregate. The lightweight aggregate is an expanded shale material manufactured by the Norlite Corporation. Material for the laboratory testing program was supplied by Norlite in early June 2007. Field testing was performed at the Norlite facility in Cohoes, New York on June 29, 2007.

The testing program was performed to evaluate geotechnical properties of Norlite's current production of ¾-inch lightweight aggregate.

Mr. William Wolfe of Norlite Corporation authorized our work by signed copy of GEI proposal 614618 (Rev. 1) dated August 21, 2006, and subsequent proposal revisions.

Scope of Work

Our scope included the following laboratory and field tests:

1. Grain size analyses
2. Density tests
   - Maximum-minimum density
   - Compaction
3. Permeability tests
4. Triaxial compression tests

GEI Consultants, Inc.
400 Unicorn Park Drive, Woburn, MA 01801
781.721.4000 fax: 781.721.4073

Density Tests

Maximum-Minimum Density Tests

We performed maximum and minimum density tests in general accordance with ASTM procedures D4253 and D4254, respectively. The results of the tests are presented in Appendix B1.

The maximum density test was performed using an eccentric weight, vertically vibrating table to densify aggregate placed in a mold. One maximum density was measured using oven-dried aggregate (Method 2A) and one using wet aggregate (Method 2B). Both tests were conducted using a 0.5 cubic foot mold.

The minimum density test was performed by pouring dry aggregate loosely into a 0.5 cubic foot mold using Method A.

The maximum dry density of the lightweight aggregate was 43.2 lb/ft^3 using the wet method and 43.5 lb/ft^3 using the dry method. The minimum dry density was 42.5 lb/ft^3.

Compaction Tests

To measure the compacted density, we performed one Standard Proctor in general accordance with ASTM D698, Method C and one test at a reduced compaction energy. The results of the Standard Proctor tests are shown in Appendix B2.

The Standard Proctor test was performed using six trial points and water contents varying between 1.4 and 10.4 percent. The compacted dry density was determined to be about 53 lb/ft^3 as shown in Table B2. As shown in Figure B2, the compacted density of the lightweight aggregate does not appear to be sensitive to its moisture content. The Standard Proctor compaction test caused visible grain breakage of the aggregate. The higher measured densities relative to the maximum density test densities are likely caused by grain breakage causing the void spaces to become partially filled with broken aggregate.

A second compaction test was performed at a reduced energy to help evaluate the effects of grain breakage. The second test was performed using 25 blows per lift instead of 56 blows per lift. As shown in Table B2, the maximum compacted dry density of this test was 52.2 lb/ft^3, with an average compacted density of 49 lb/ft^3. The maximum dry densities determined by the modified Standard Proctor test are still higher than the maximum index density of the material. The higher densities at lower water contents shown in Figure B1 may be a result of greater grain breakage of the drier materials. The natural "as-delivered" moisture content of the lightweight aggregate is approximately 7.5 percent. Table B1 shows a compacted density of approximately 48 lb/ft^3 at that water content.

The minimum index density of 42.5 lb/ft^3 is very close to the average maximum index density of 43.4 lb/ft^3 obtained using the ASTM D-4253 procedure. Therefore, it appears that a relatively compact material can be achieved without much compactive effort.

We anticipate, however, that regardless of the method of placement of the lightweight aggregate, some breakage will occur. Therefore, we performed the remaining tests on either "loose" material, at approximate dry densities of 42.5 lb/ft^3 or lower, or "dense" material with approximate dry densities of 47 lb/ft^3. The density of 47 lb/ft^3 was chosen as approximately the average between the maximum index density (ASTM D4253) and the densities obtained from the modified Standard

Proctor test (ASTM D698). This density appears to be representative of the density of placed and lightly compacted lightweight aggregate in the field, the "as-placed" density.

Permeability Tests

GeoTesting Express performed two constant head permeability tests in a 10-inch diameter permeameter, in general accordance with ASTM D2434, "Standard Test Method for Permeability of Granular Soils (Constant Head)". The results of the constant head permeability tests are shown in Appendix C.

The first test was performed in material loosely placed in the permeameter, resulting in a measured dry density of 40.1 lb/ft^3. The second test was performed on material lightly compacted in the permeameter in lifts, resulting in a dry density of 47.0 lb/ft^3. To allow water to saturate the porous lightweight aggregate, both samples were soaked for 48 hours in de-aired water prior to testing. The tests were performed at gradients varying between 0.33 to 0.44 and 0.26 to 0.38 for the loose and dense samples respectively.

The results of these tests are presented in Table C1. The average permeability of the loose sample was 2.5 cm/sec. The average permeability of the dry sample was 1.1 cm/sec.

Triaxial Compression Tests

We performed two sets of consolidated-drained triaxial compression (CIDC) tests on loose and dense specimens of lightweight aggregate. The samples were prepared using different methods to compact the samples to achieve loose and dense samples. Three consolidation stresses were used for each set of tests. Due to the size of the aggregate, the tests were performed on specimens approximately 6 inches in diameter and 12 inches in height. Results of the triaxial tests are summarized in Table D1 and shown in Figures D1 through D6 of Appendix D. Photos of the testing are shown on the last page of Appendix D.

Aggregate used for triaxial testing was soaked in de-aired water for 48 hours prior to testing. Loose specimens were prepared by loosely placing the aggregate in a membrane lined split mold, centered over the bottom pedestal of the triaxial test frame. Achieved dry densities varied between 41.5 and 43 lb/ft^3. Dense specimens were placed in the mold in one inch thicknesses and each lightly tamped. This method of placement resulted in densities ranging between 45.9 and 46.3 lb/ft^3.

The specimens were subjected to a vacuum through the top and bottom platens to allow removal of the split mold, leaving the specimen intact. The compression chamber was then assembled and the cell was filled with water. All the specimens were back-pressure saturated to fill the voids between the aggregate particles with water. The loose samples were then consolidated to 0.74, 2.2 and 4.1 kips/ft^3. The dense samples were consolidated to 0.41, 2.1 and 4.2 kips/ft^3. Once consolidated, the samples were loaded in compression and sheared with the drain lines open.

Figures D1 through D6 show that the friction angle decreased with increasing confining stress in both sets of tests. It varied from 42.1 to 37.5 degrees for the loose specimen and from 55.7 to 42.6 degrees for the dense specimen. Both loose and dense specimens dilated during shearing under the lower confining stresses, and became increasingly contractive with increasing confining stress.

The membrane of test S2 developed a leak at the end of the test. The membrane of test S3 ruptured at 11.5 percent strain. Therefore, subsequent tests were performed using a double membrane.

Electrical and Chemical Properties Tests

pH

We performed a total of three pH tests on the lightweight aggregate in general accordance with AASHTO T289, "Standard Method of Test for Determining pH of Soil for Use in Corrosion Testing." The tests were performed on crushed material passing the No. 10 sieve. The average pH of the material was 6.76. Test results are summarized in Table E1.

Chloride Content

Alternative Testing Laboratories performed one test for water soluble chloride ion content in soil. The test was performed in accordance with AASHTO T290, "Determining Water-Soluble Chloride Ion Content in Soil," Method A, except the material was tested in its "as-delivered" condition. The AASHTO procedure calls for pulverizing the material and testing the portion that passes the No. 10 sieve. The material was tested "as-delivered," because this condition would more accurately represent the placed condition of the lightweight aggregate. Placement of the material and light compaction of the material in the field would not result in pulverized material.

The water soluble chloride content of the "as-delivered" lightweight aggregate was 24 ppm. The chloride test results are included in Appendix E1.

Sulfate Content

Similarly, Alternative Testing Laboratories performed one test for water soluble sulfate ion content in soil. The test was performed in accordance with AASHTO T291, "Determining Water-Soluble Sulfate Ion Content in Soil," Method B, except the material was tested "as-delivered". This AASHTO procedure also calls for pulverizing the material and testing the portion that passes the No. 10 sieve. The material was tested "as-delivered," because this condition would more accurately represent the placed condition of the lightweight aggregate. Placement of the material and light compaction of the material in the field would not result in pulverized material

The water soluble sulfate content of the "as-delivered" lightweight aggregate was 74 ppm. The sulfate test results are included in Appendix E1.

Organic Content

We performed one organic content test on crushed material passing the No. 10 sieve in accordance with AASHTO T267, "Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition". The organic content was determined to be 0.04 percent. The results are tabulated in Table E1.

Resistivity Tests

To measure the resisitivity properties of the lightweight aggregate we performed two types of tests: a laboratory procedure in general accordance with AASHTO T288, "Determining Minimum Laboratory Resistivity" and a field resistivity test in general accordance with ASTM G57, "Field Measurement of Soil Resistivity using the Wenner Four-Electrode Method."

Appendix A – Grain Size Analyses

TABLE A1 - SUMMARY OF INDEX TESTS
Norlite Lightweight Aggregate
Norlite Corporation
Cohoes, New York

Grain Size Analysis [1]		
Gravel **(%)**	***Sand*** **(%)**	***Fines*** **(%)**
94.9	4.0	1.1
93.9	5.4	0.7
94.6 [2]	5.2 [2]	0.2 [2]
87.1 [3]	12.2 [3]	0.7 [3]

Notes:
1. Grain-size analysis performed on four separate samples in general accordance with ASTM C136
2. Test performed on sample S6 prior to triaxial test
3. Test performed on sample S6 following triaxial test

TABLE B1 - SUMMARY OF MAXIMUM-MINIMUM DENSITY TESTS
Norlite Lightweight Aggregate
Norlite Corporation
Cohoes, New York

Method for Maximum Density [1]	Maximum Index Density [2] (lb/ft^3)	Minimum Index Density [3] (lb/ft^3)
Dry	43.5	42.5
Wet	43.2	--

Notes:
1. Dry Method - Aggregate was placed in 0.5 cubic foot mold in an oven-dry state
   Wet Method - Aggregate was submerged in water for at least 24 hours and placed in 0.5 cubic foot mold in a saturated state
2. Maximum density test performed using oven-dried and saturated material in accordance with ASTM D4253, Method 2A (dry), Method 2B (wet)
3. Minimum density test performed using oven-dried material in accordance with ASTM D4254, Method A

Appendix B – Density Tests

B2 Compaction Tests

TABLE B2 - SUMMARY OF COMPACTION TESTS
Norlite Lightweight Aggregate
Norlite Corporation
Cohoes, New York

Compacted Density Reduced Compaction Energy[1]				Compacted Density Standard Proctor[2]			
Determination No.	*Water Content (%)*	*Wet Density (lb/ft^3)*	*Dry Density (lb/ft^3)*	*Determination No.*	*Water Content (%)*	*Wet Density (lb/ft^3)*	*Dry Density (lb/ft^3)*
1	0.1	52.3	52.2	1	1.5	54.7	53.9
2	4.9	54.4	51.9	2	4.2	55.1	52.9
3	6.2	50.8	47.8	3	7.5	56.5	52.6
4	7.4	51.2	47.7	4	8.7	59.9	55.1
5	17.2	53.3	45.5	5	8.5	56.0	51.6
--	--	--	--	6	10.4	58.4	52.9

Notes:

1. Test performed in accordance with ASTM D698, Procedure C except 25-blows were used for compacting each lift. Test was performed using a 5.5 pound hammer dropping 12 inches and compacted in 3 lifts with 25-blows per lift.
2. Test performed in general accordance with ASTM D698, Procedure C. Test was performed using a 5.5 pound hammer dropping 12 inches and compacted in 3 lifts with 56 blows per lift.

Appendix C – Permeability Tests

TABLE C1 - **SUMMARY OF PERMEABILITY TESTS**
Norlite Lightweight Aggregate
Norlite Corporation
Cohoes, New York

Loose Sample: Dry Density = 40.1 lb/ft^3		Dense Sample: Dry Density = 47.0 lb/ft^3	
Hydraulic Gradient	**Average Permeability (cm/sec.)**	**Hydraulic Gradient**	**Average Permeability (cm/sec.)**
0.33	2.5	0.26	1.1
0.38	2.6	0.34	1.1
0.44	2.4	0.38	1.0

Notes:

1. Aggregate soaked in water for 48 hours prior to test. Specimens were typically 12-inches in height
2. Test performed in 10" permeameter and in general accordance with ASTM D2434

Appendix D – Triaxial Tests

- CIDC Triaxial Test Results
- Triaxial Test Photographs

TABLE D1 - SUMMARY OF TRIAXIAL STRENGTH TESTS
Norlite Lightweight Aggregate
Norlite Corporation
Cohoes, New York

Test No.	Dry Unit Weight (pcf)	Effective Confining Stress (ksf)	Peak Shear Stress, q[1] (ksf)	Effective Friction Angle, Φ (deg.)	Strain (%)
S1	41.5	0.74	1.50	42.1	3.3
S2	43.0	2.19	4.60	42.6 (2)	12.7
S3	42.8	4.10	6.39	37.5 (3)	11.2
S4	46.3	0.41	1.95	55.7	4.0
S5	45.9	2.05	5.22	45.9	10.2
S6	46.2	4.18	8.76	42.6	11.5

Notes:
1. Peak shear stress is the shear stress on the 45-degree plane (1/2 deviator stress).
2. Membrane developed leak at end of test.
3. Membrane ruptured at approximately 11.5% strain.

Alternatives Comparison

INFORMATION SHEET 6001
GEOTECH JANUARY 2004

Lightweight Expanded Shale, Clay and Slate Aggregate for Geotechnical Applications



General Information

Compacted fills using Expanded Shale, Clay and Slate (ESCS) lightweight aggregates are approximately half the weight of fills using common materials. The load reduction, coupled with the high internal friction angle of the lightweight aggregate can reduce vertical and lateral forces by more than one-half. ESCS has been used to solve numerous geotechnical engineering problems and to convert soft and unstable soil into usable property. Since ESCS aggregate has high thermal resistivity, it provides durable, inorganic insulation around water and steam lines, and other thermally sensitive elements. ESCS aggregates provide a practical, reliable and economical geotechnical solution.

General Engineering Properties of ESCS 3/4" to No. 4 Aggregate Grading*

Aggregate Property	Measuring Method	Test Method	Commonly Used Specifications for ESCS	Typical Values For ESCS Aggregate	Typical Design Values For Ordinary Fills
Soundness Loss	Magnesium Sulfate	AASHTO T 104	<30%	<6 %	<6 %
Abrasion Resistance	Los Angeles Abrasion	ASTM C 131	<40 %	20 - 40%	10 - 45%
Chloride Content	Chloride Content of Soils	AASHTO T 291	<100 ppm	10 - 70 ppm	
Grading	Sieve Analysis	ASTM C 136	Comment No. 1	Comment No. 1	
Compacted In-Place Bulk Density (Unit Weight)	Density Test	Comment No. 2	<70 lb/ft^3	40 - 65 lb/ft^3 Moist	100-130 lbs/ft^3
Stability (Phi Angle, ϕ)	Direct Shear Test Consolidated Drained Triaxial-Consolidated Drained	ASTM D 3080 Comment 3 Corps of Engineers EM 1110-2-1906 Appendix X Comment 3	Comment No. 3	35° - 45° +	30° - 38° (fine sand - sand & gravel)
Loose Bulk Density (Unit Weight)	Loose	ASTM C 29	Dry <50 lb/ft^3 Saturated <65 lb/ft^3	Dry 30 - 50 lb/ft^3	89 -105 lb/ft^3
pH	pH Meter	AASHTO T 289	5 - 10	7.0 - 10	5 - 10

*For Other Gradings See Comment No. 1

For Metric Conversion See Comment No. 5

GEOTECH

Expanded Shale, Clay and Slate (ESCS) Lightweight Aggregate Soil Mechanics

Properties and Applications



Equal Weights (25 Tons / 1Truckload) of Ordinary Granular Aggregate (*left)* and ESCS Lightweight Aggregate (*Right*)

Expanded Shale, Clay and Slate (ESCS) compacted geotechnical fills are approximately half the weight of ordinary aggregate fills. This advantage, coupled with the high angle of internal friction of ESCS, can also reduce lateral forces by more than one-half. ESCS has been effectively used to solve numerous geotechnical engineering problems and to convert unstable soil into usable land. ESCS is a reliable, economical geotechnical solution.

ABSTRACT of the following paper: *Structural grade lightweight aggregates (LWA) have been extensively used throughout North America for more than [80] years in cast-in-place structural lightweight concretes for high-rise buildings and bridges, and are now being widely used for geotechnical applications. Structural grade LWA, when used in backfills and over soft soils, provides geotechnical physical properties that include reduced density, high stability, high permeability, and high thermal resistance. These improved physical properties are found in aggregates with a reduced specific gravity and a predictable stability resulting from a consistently high angle of internal friction. The open texture available from a closely controlled manufactured aggregate gradation ensure high permeability. High thermal resistance results from porosity developed during the production process. In this publication, the physical properties of structural grade LWA and geotechnical engineering properties of LWA backfills are illustrated. Additionally, references to extensive testing programs that developed data on shear strength, compressibility, durability, and in-place density are given. Representative case studies are reported from [several hundred] projects that illustrate completed applications of structural grade LWA fills over soft soils and behind retaining walls and bridge abutments.*

Lightweight Aggregate Soil Mechanics: *Properties and Applications*

T.A. Holm and A.J. Valsangkar

For more than [80] years, shales, clays, and slates have been expanded in rotary kilns to produce structural grade LWA for use in concrete and masonry units. Millions of tons of structural grade LWA produced annually are used in structural concrete applications. Its availability is currently widespread throughout most of the industrially developed world. Consideration of structural grade LWA as a remedy to geotechnical problems stems primarily from the improved physical properties of reduced dead weight, high internal stability, high permeability, and high thermal resistance. These significant advantages arise from the reduction in particle specific gravity, stability that results from the inherent high angle of internal friction, the controlled open-textured gradation available from a manufactured aggregate which assures high permeability, and the high thermal resistance developed because of the high particle porosity.



Retaining wall backfill, Providence, Rhode Island

PHYSICAL PROPERTIES OF STRUCTURAL LIGHTWEIGHT AGGREGATES

Particle Shape and Gradation

As with naturally occurring granular materials, manufactured LWA's have particle shapes that vary from round to angular with a characteristically high interstitial void content that results from a narrow range of particle sizes. Applications of LWA to geotechnical situations require recognition of two primary attributes: (a) the high interstitial void content typical of closely controlled manufactured granular coarse aggregate that closely resembles a clean, crushed stone, and (b) the high volume of pores enclosed within the cellular particle.

Structural grade LWA gradations commonly used in high-rise concrete buildings and long-span concrete bridge decks conform to the requirements of ASTM C330. The narrow range of particle sizes ensures a high interstitial void content that approaches 50% in the loose state. North American rotary kiln plants producing expanded shales, clays, and slates currently supply coarse [and fine] aggregates to ready-mix and precast concrete manufacturers with 20 to 5 mm (3/4 - #4), 13 to 5 mm (1/2 - #4), or 10 to 2 mm (3/8 - #8) gradations [and various fine aggregate gradings]. With [coarse] gradations there is a minimum percentage of fines smaller than 2 mm (#8 mesh) and insignificant amounts passing the 100 mesh screen.

Particle Porosity and Bulk Density

When suitable shales, clays, and slates are heated in rotary kilns to temperatures in excess of 1100° C (2012°F), a cellular structure is formed of essentially noninterconnected spherical pores surrounded by a strong, durable ceramic matrix that has characteristics similar to those of vitrified clay brick. Oven-dry specific gravities of LWA vary but commonly range from 1.25 to 1.40. Combination of this low specific gravity with high interparticle void content results in LWA bulk dry densities commonly in the range of 720 kg/m^3 (45 pcf). Compaction of expanded aggregates in a manner similar to that used with crushed stone provides a highly stable interlocking network that will develop in-place moist densities of less than [960 kg/m^3 (60 pcf)].

Differences in porosity and bulk density between LWA's

GEOTECHNICAL PROPERTIES OF LIGHTWEIGHT FILL

In-Place Compacted Moist Density

Results of compacted LWA density tests conducted in accordance with laboratory procedures (Proctor tests) should be interpreted differently from those for natural soils. Two fundamental aspects of lightweight aggregate soil fill will modify the usual interpretation soils engineers place on Proctor test data. The first is that the absorption of LWA is greater than natural soils. Part of the water added during tests will be absorbed within the aggregate particle and will not affect interparticle physics (bulking, lubrication of the surfaces, etc.). Second, unlike cohesive natural soils, structural grade LWA contains limited fines, limiting the increase in density due to packing of the fines between large particles. The objective in compacting structural grade LWA fill is not to aim for maximum in-place density, but to strive for an optimum density that provides high stability without unduly increasing compacted density. Optimum field density is commonly achieved by two to four passes of rubber tire equipment. Excessive particle degradation developed by steel-tracked rolling equipment should be avoided. Field density may be approximated in the laboratory by conducting a one-point ASTM D698, AASHTO T99 Proctor test [using a 0.5 ft.^{3} bucket] on a representative LWA sample that contains a moisture content typical of the field delivery. Many projects have been successfully supplied where specifications called for an in-place, compacted, moist density not to exceed 960 kg/m^3 (60 pcf).

Shear Strength

Structural grade LWA's provide an essentially cohesionless, granular fill that develops stability from inter-particle friction. Extensive testing on large 250 x 600 mm (10 x 24 in. high) specimens has confirmed angles of internal friction of more than 40 degrees (*1*). Triaxial compression tests completed on LWA from six production plants, which included variations in gradations, moisture content, and compaction levels, revealed consistently high angles of internal friction. With a commonly specified in-place moist compacted unit weight less than 960 kg/m^3 (60 pcf), it may be seen from a simplistic analysis that lateral pressures, overturning moments, and gravitational forces approach one-half of those generally associated with ordinary soils.

A summary of the extensive direct shear testing program conducted by Valsangkar and Holm (*2*), presented in the following table, confirm the high angle of internal friction measured on large-scale triaxial compression testing procedures as reported earlier by Stoll and Holm (*1*).

	Angle of Internal Friction (degree)	
Material	*Loose*	*Compacted*
Minto [LWA]	40.5	48.0
Solite [LWA]	40.0	45.5
Limestone	37.0	N/A
Solite (*1*) [LWA]	39.5	44.5

Compressibility

Large-scale compressibility tests completed on lightweight aggregate fills demonstrated that the curvature and slope of the LWA fill stress-strain curves in confined compression were similar to those developed for companion limestone samples (*2*). Cyclic plate-bearing tests on LWA fills indicated vertical subgrade reaction responses that were essentially similar for the lightweight and normal weight aggregate samples tested (*3*).

Attempts by concrete technologists to estimate aggregate strength characteristics by subjecting unbound LWA samples to piston ram pressures in a confined steel cylinder have provided inconsistent and essentially unusable data for determination of the strength making characteristics of concretes that incorporate structural grade LWA. By ASTM C330 specifications, all structural grade LWA's are required to develop concrete strengths above 17.2 MPa (2500 psi). Most structural grade LWA concrete will develop 34.4 MPa (5000 psi), and a small number can be used in concretes that develop compressive strengths greater than 69 MPa (10,000 psi).

Thermal Resistance

For more than [8] decades, design professionals have used lightweight concrete masonry and lightweight structural concrete on building facades to reduce energy losses through exterior walls. It is well demonstrated that the thermal resistance of LWC is considerably less than that of ordinary concrete, and this relationship extends to aggregates in the loose state (4).

Permeability

Attempts to measure permeability characteristics of unbound LWA have not been informative because of the inability to measure the essentially unrestricted high flow rate of water moving through open-graded structure. This characteristic has also been observed in the field, where large volumes of water have been shown to flow through LWA drainage systems. Exfiltration applications of LWA have demonstrated a proven capacity to effectively handle high volumes of storm water runoff. Subterranean exfiltration systems have provided competitive alternatives to infiltration ponds by not using valuable property areas as well as eliminating the long-term maintenance problems associated with open storage of water.

Interaction Between Lightweight Aggregate Fills and Geotextiles

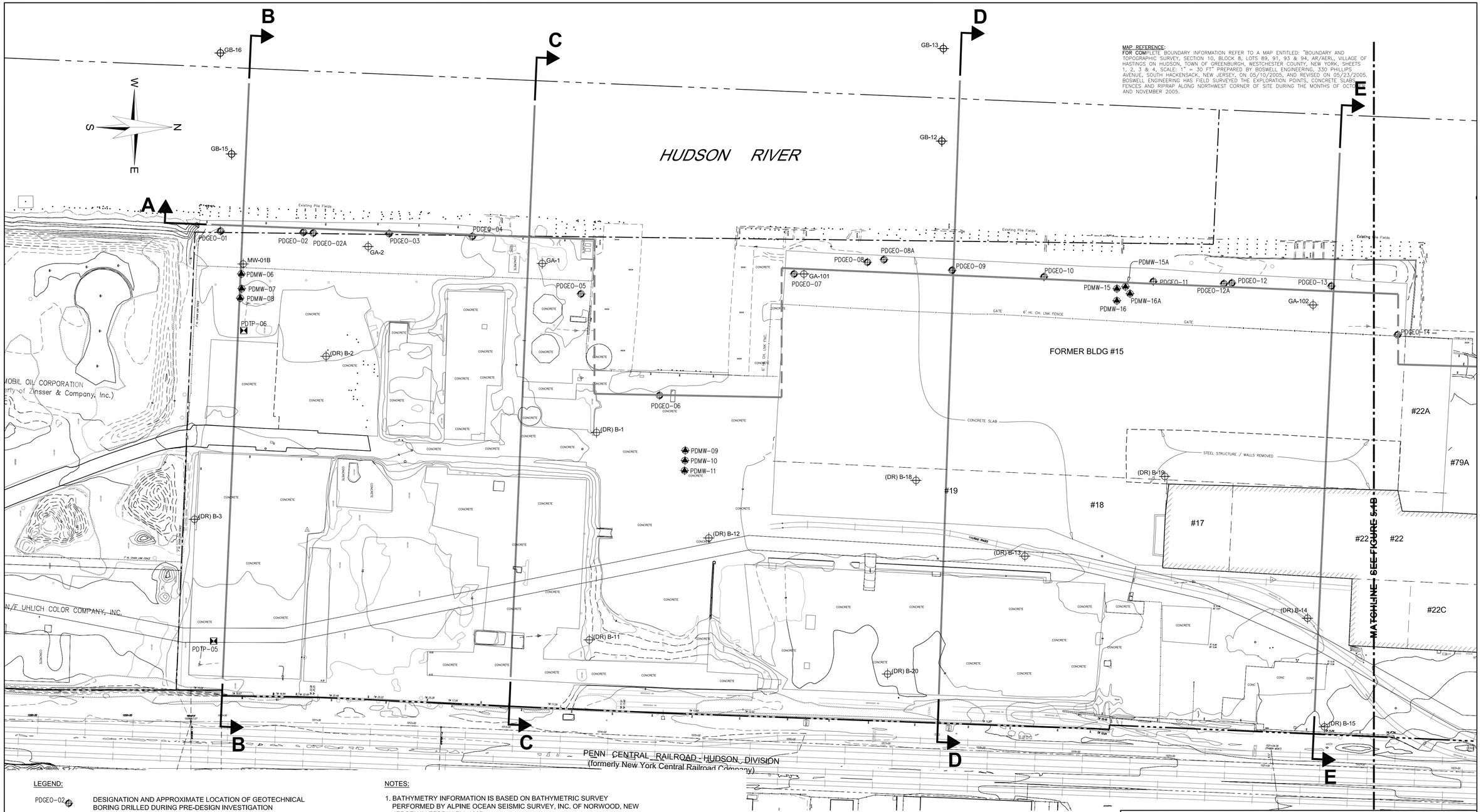
Valsangkar and Holm (5) reported results of testing programs on the interaction between geotextiles and LWA fills that included the variables of differing aggregate types and densities, thickness of aggregate layer, and geotextile types. The results indicated that the overall roadbed stiffness is unaffected when LWA is used instead of normal weight aggregate for small deflections and initial load applications. These tests were followed by a large-scale test (2), which reported that the comparison of the friction angles between the LWA or the normal weight aggregate and the geotextiles indicate that interface friction characteristics are, in general, better for LWA than normal weight aggregates.

Attachment B

Geotechnical Data Summary

ARCADIS Design & Consultancy for natural and built assets

Historic Investigation Plan Drawings



LEGEND:

PDGEO–02	DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
PDMW–06	DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
PDTP–06	DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
GA-1	DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
A A	DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1A

28612-116 D092
J:\GRAPHICS\28612\28612-116-D092.DWG

LED: "BOUNDARY AND
& 94, AR/AERL, VILLAGE OF
OUNTY, NEW YORK, SHEETS
INEERING, 330 PHILLIPS
ND REVISED ON 05/23/2005.
POINTS, CONCRETE SLABS,
G THE MONTHS OF OCTOBER

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

MATCHLINE - SEE FIGURE 5.1A

#57 #22A #79A #22B #22 #22 #22C #72A #72 #51 #51A #52

FORMER BLDG #53 FORMER BLDG #52B FORMER BLDG #54 FORMER BLDG #52A

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

N/F THE HARBOR AT HASTINGS ASSOCIATES
100 River Street

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A A A A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1B

28612-116 D093 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

2015 PDI



LEGEND

PD2-GR-009 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.

PD2-GL-001 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED ON LAND DURING PRE-DESIGN INVESTIGATION IN 2013.

PD2-TP-2 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION IN 2014.

PROPERTY LINE

RAIL ROAD

EXISTING STRUCTURES

CONCEPTUAL LOCATION OF NORTHWEST BULKHEAD EXTENSION WALL. ALIGNMENT SHOWN IS APPROXIMATE ONLY AND SUBJECT TO CHANGE.

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
3. GRID SYSTEM IS THE NEW YORK STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAD 83, U.S. SURVEY FEET.
4. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND ARE BASED ON DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2009 AND OBTAINED FROM THE NEW YORK STATE GIS CLEARINGHOUSE (NYGIS).
5. THE BATHYMETRY CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

DRAFT

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

LOCATION PLAN - GEOTECHNICAL BORINGS AND TEST PITS

SCALE: AS SHOWN
JULY 2015

FIGURE 3.7A

POSTOLOWSKI, KEVIN Printed: 7/20/2015 11:39 AM Layout: FIGURE 7-1
\\DTRCOMMON\28612 HASTINGS\286\CAD\28612-286_008 AS-DRILLED TEST PITS R6.DWG

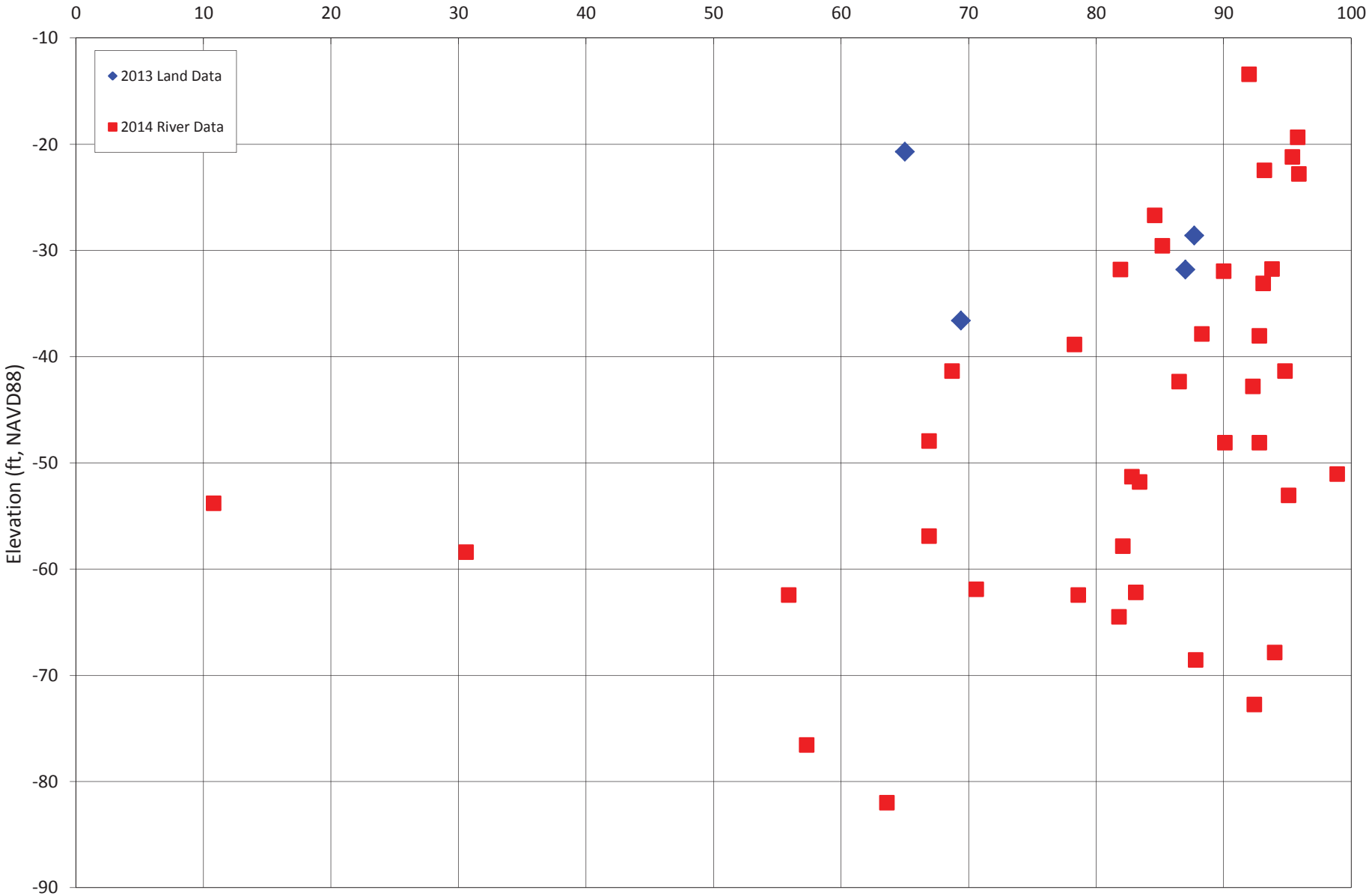
ARCADIS Design & Consultancy for natural and built assets

2015 Pre-Design Investigation
Soil Parameter Figures and
Laboratory Test Data Summary
Tables (H&A 2015)

from 2015 PDI

1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7B
PERCENT FINES IN MARINE SILT STRATUM VERSUS ELEVATION



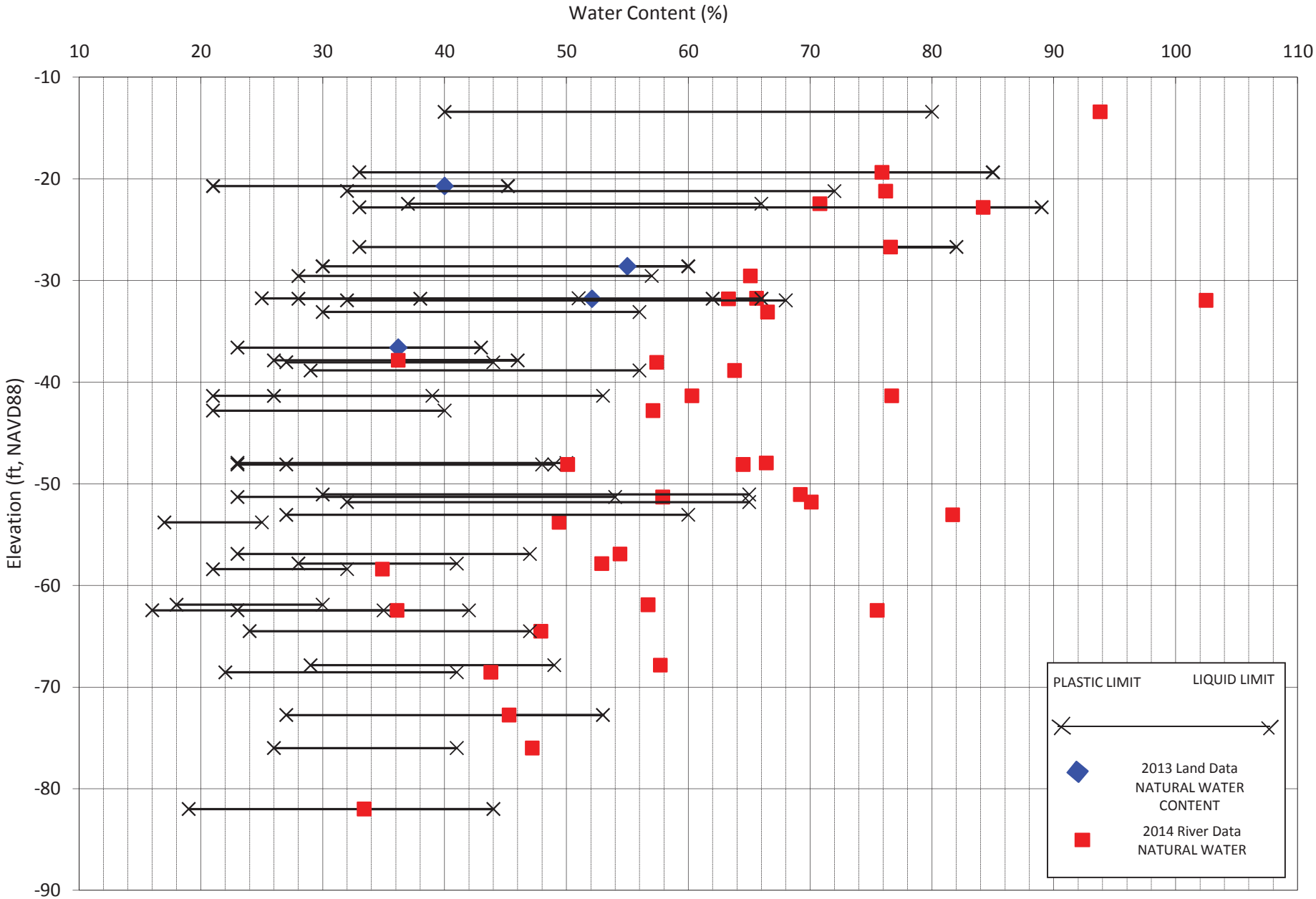
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Prepared by Haley & Aldrich

Printed on 8/7/2015

1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7C
ATTERBERG LIMITS VERSUS ELEVATION IN MARINE SILT STRATUM



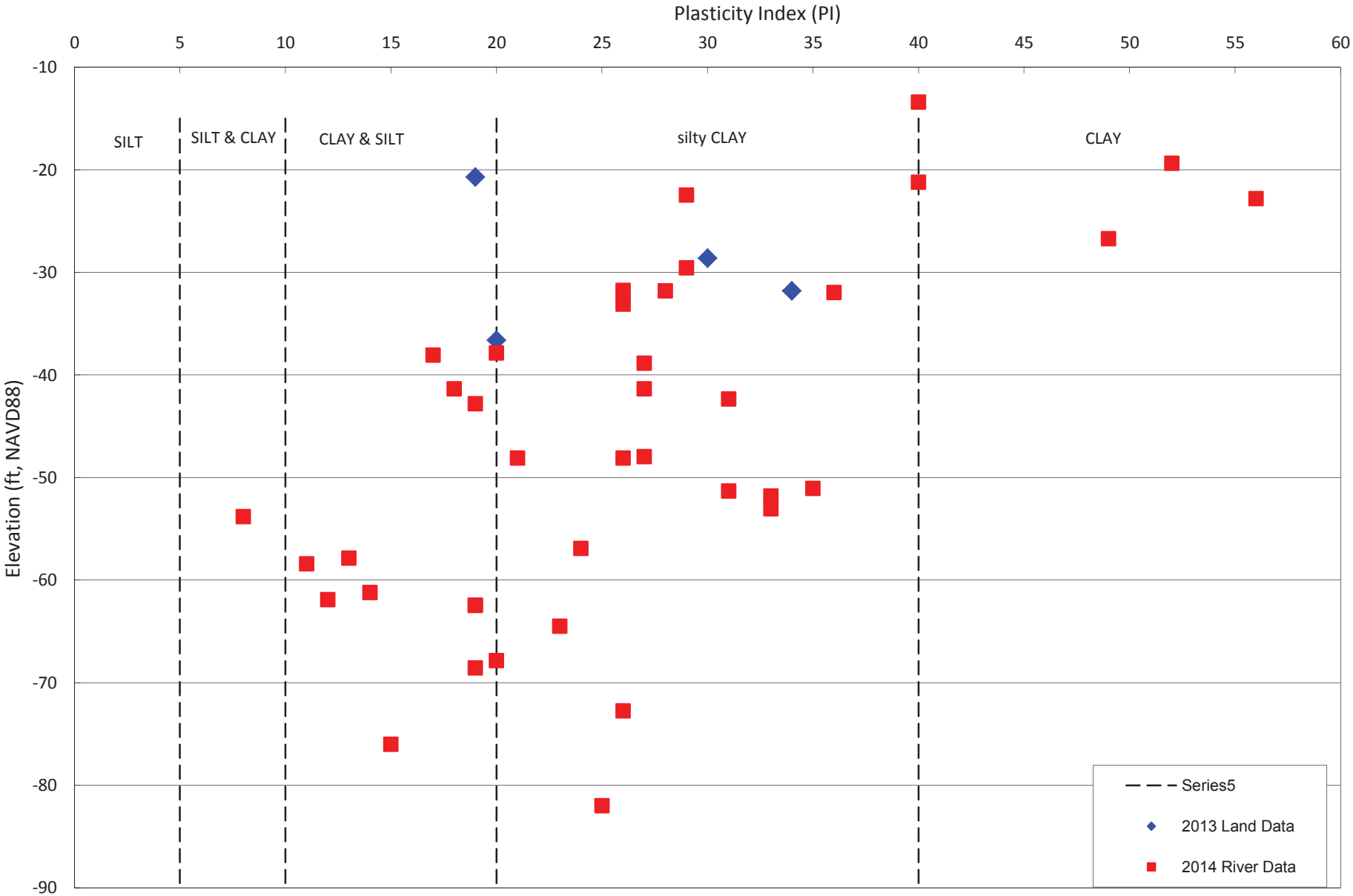
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1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7D
PLASTICITY INDEX VERSUS ELEVATION IN MARINE SILT STRATUM
and CORRESPONDING BURMISTER CLASSIFICATION



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FIGURE 3.7E
PLASTICITY INDEX VERSUS LIQUID LIMIT IN MARINE SILT STRATUM

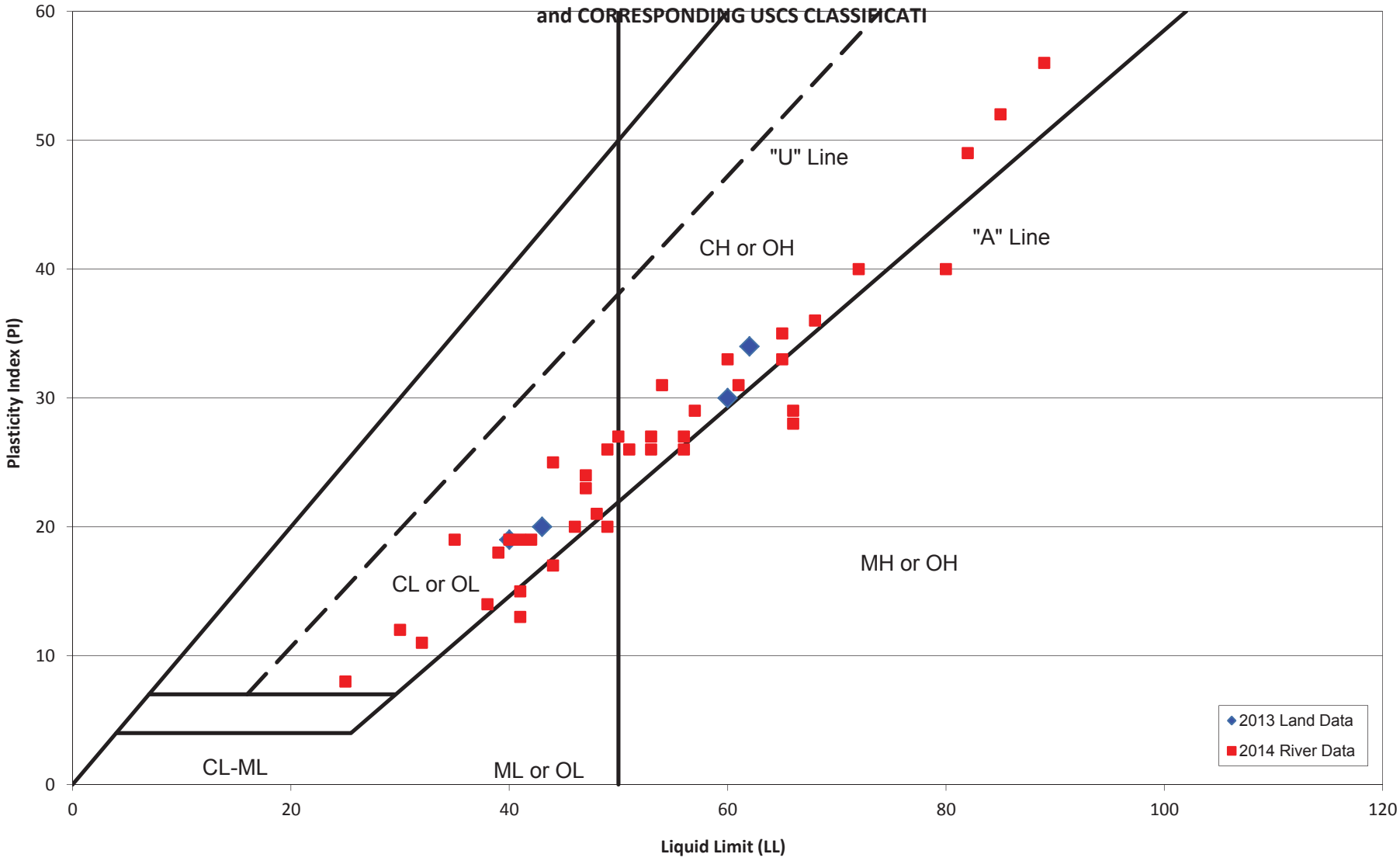
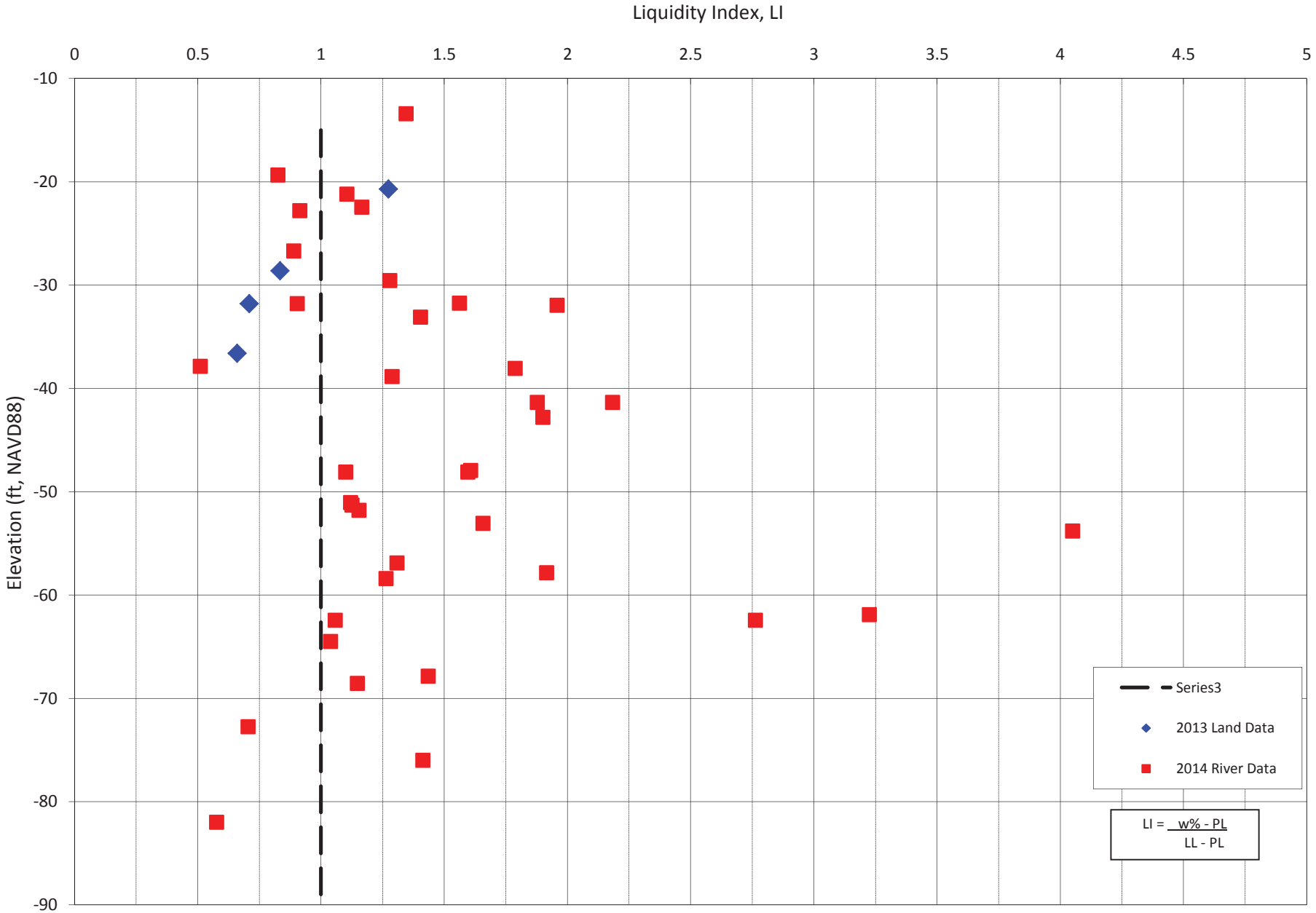
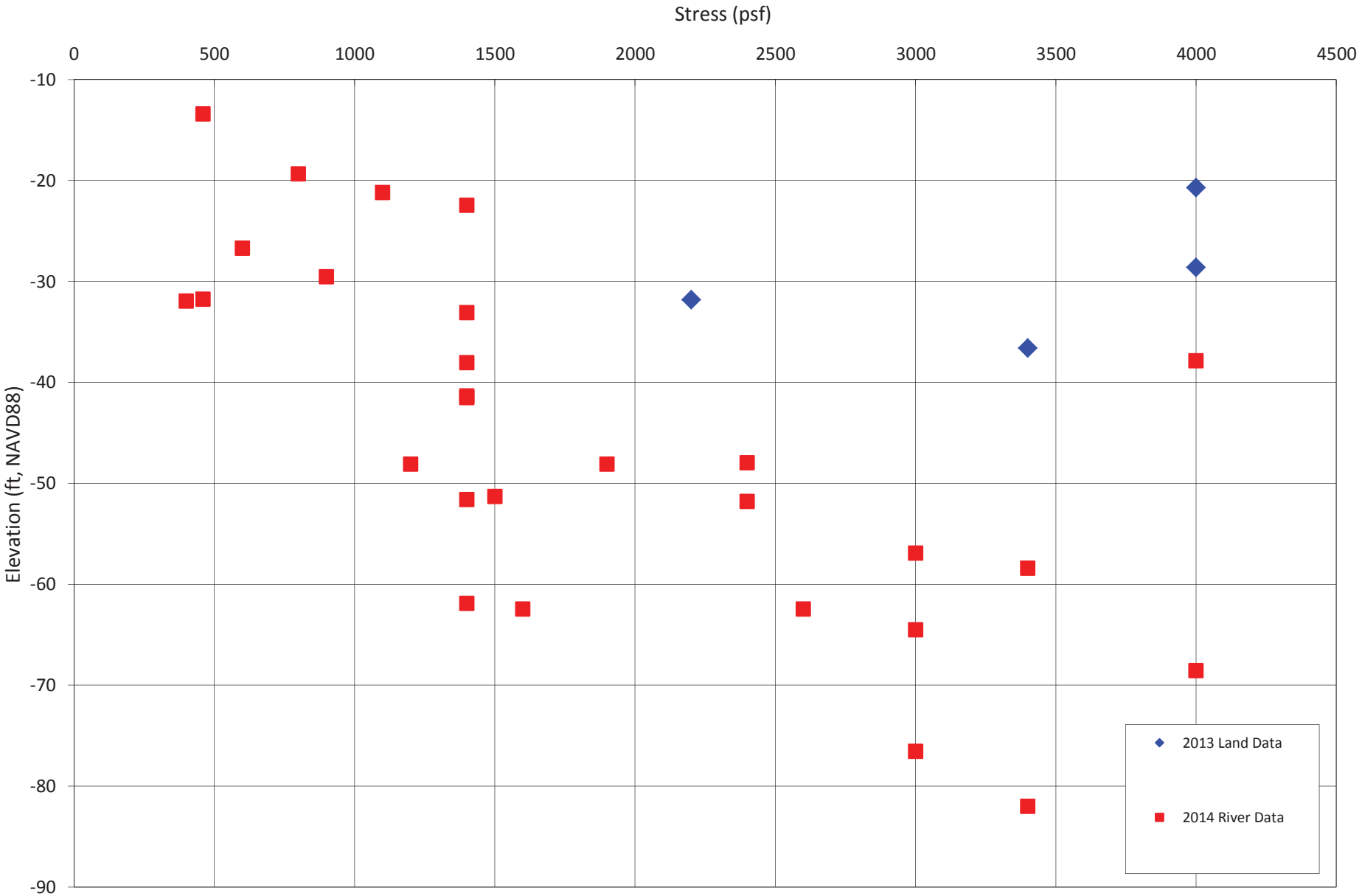


FIGURE 3.7F
LIQUIDITY INDEX VERSUS ELEVATION IN MARINE SILT STRATUM



1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7G
PRECONSOLIDATION PRESSURE VERSUS ELEVATION IN MARINE SILT STRATUM



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.
Prepared by Haley & Aldrich
Printed on 8/7/2015

FIGURE 3.7H
COMPRESSION RATIO VERSUS ELEVATION IN MARINE SILT STRATUM

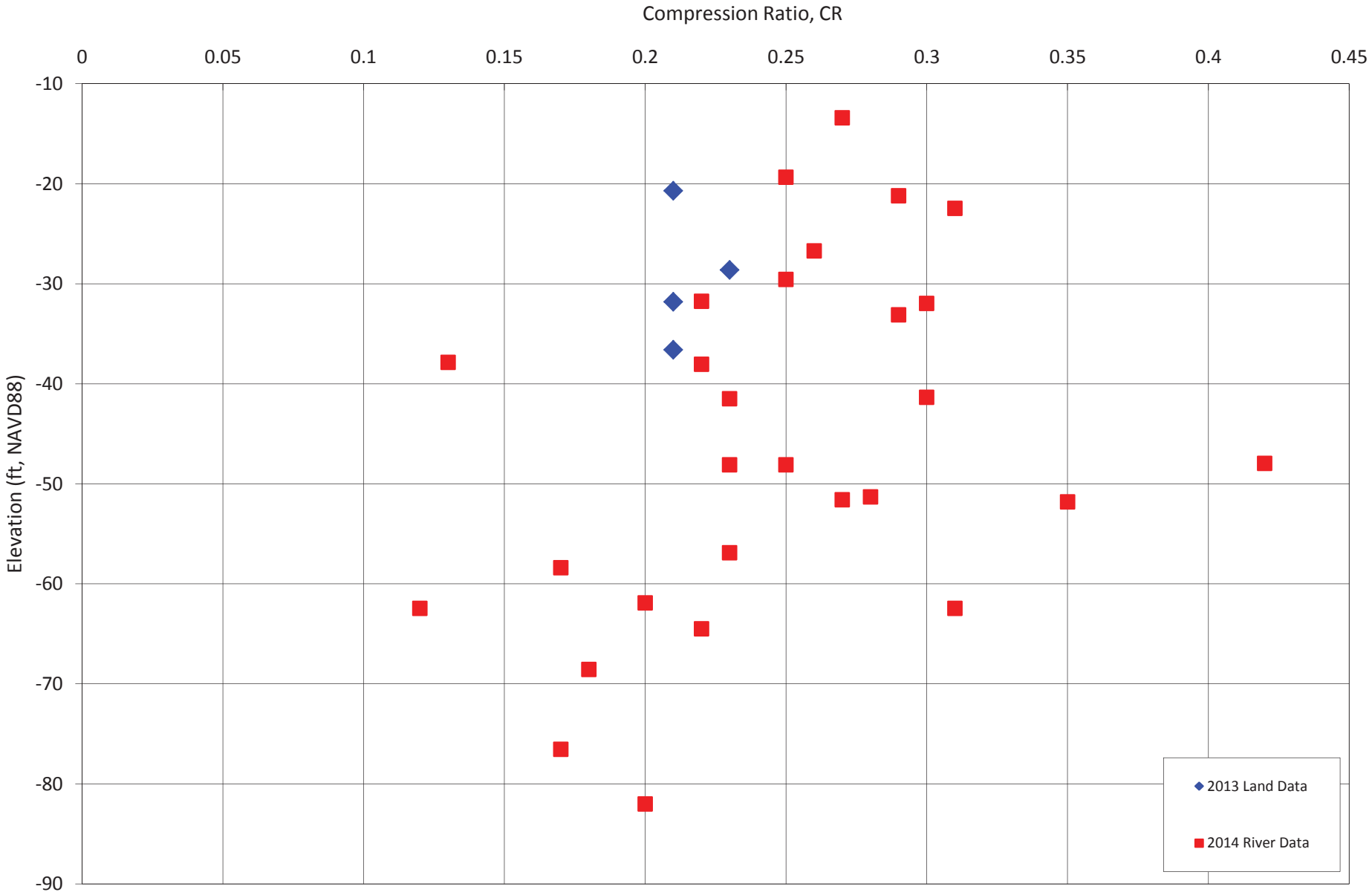


FIGURE 3.7I
RECOMPRESSION RATIO VERSUS ELEVATION IN MARINE SILT STRATUM

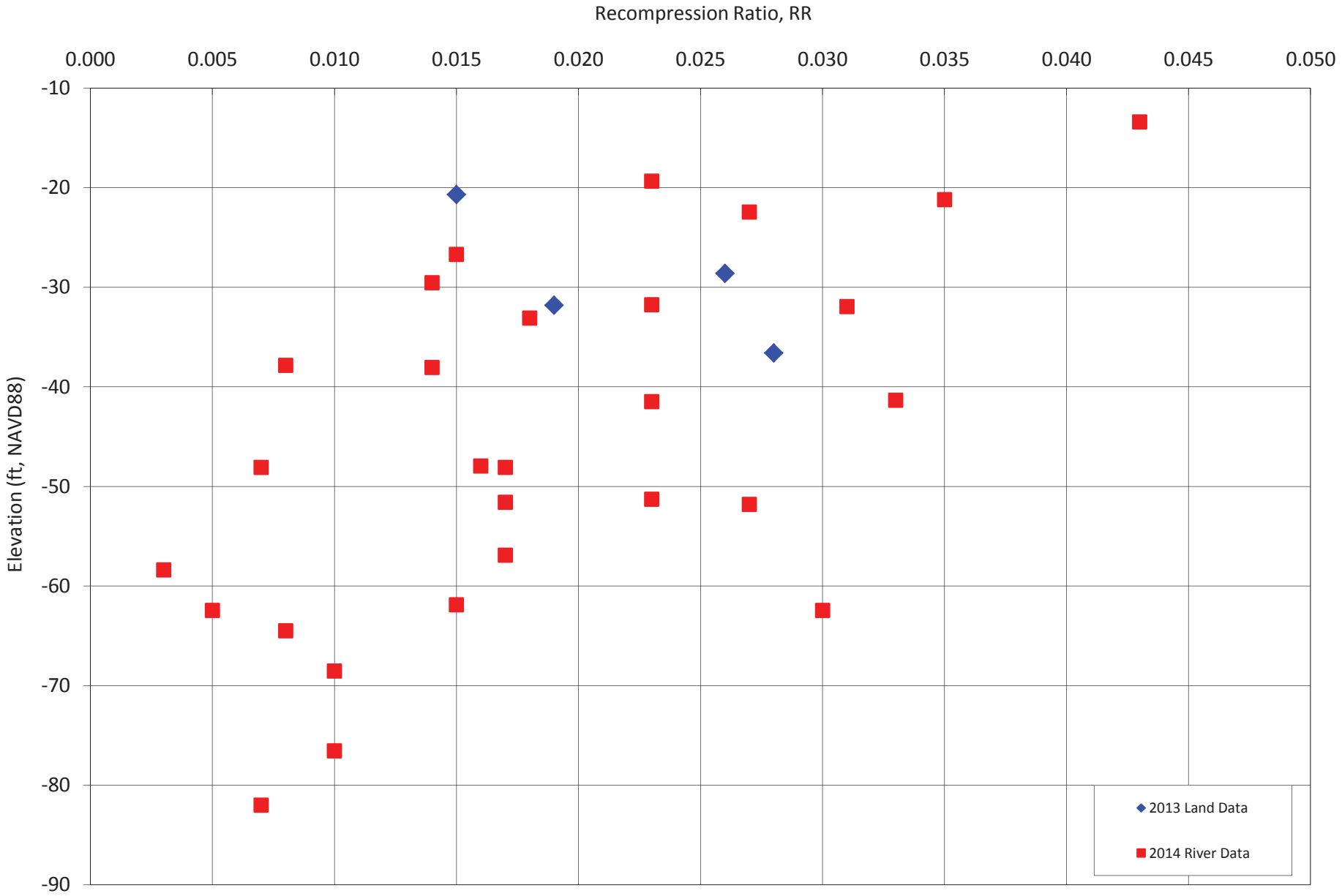
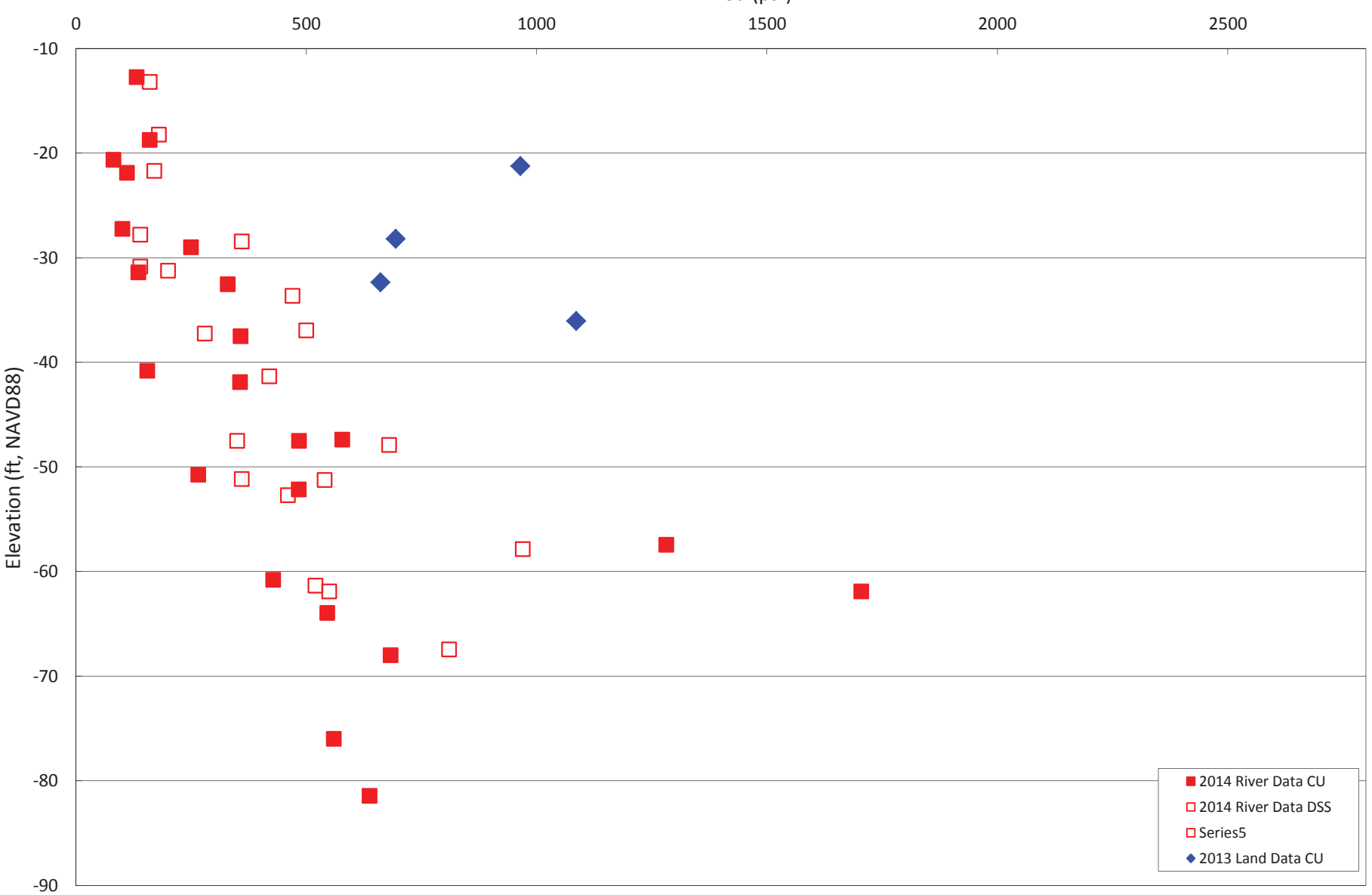


FIGURE 3.7J
UNDRAINED SHEAR STRENGTH VERSUS ELEVATION IN MARINE SILT STRATUM
FROM TRIAXIAL CONSOLIDATED UNDRAINED (CU) OR DIRECT SIMPLE SHEAR (DSS)



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Printed on 8/7/2015

TABLE 3.7A

SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM

1 RIVER STREET

HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
																											Corrected					Lab					
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d (pcf)	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)	OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	(pcf)
PD-GL-001	7	U-3	28	-21																																113.6
PD-GL-001	7	U-3	27.45	-20.45		42.6																														
PD-GL-001	7	U-3B	27.7	-20.7	CL	45.2	40	21	19.0	1.3		65		10	3.4												2	4000	0.21	0.015	9	1.7	3400	2.32			110.4	
PD-GL-001	7	U-3	28	-21		47.1																														
PD-GL-001	7	U-3C	28.25	-21.25	CL	44.3															44.3	76.2	1460	965	8.7	12.7								110		
PD-GL-001	7	U-4	36	-29																																116
PD-GL-001	7	U-4A	35.2	-28.2	CL	31.1															31.1	87.0	1040	694	6.3	14.7								114.1		
PD-GL-001	7	U-4B	35.6	-28.6	CH	55	60	30	30.0	0.8		87.7		19													2	4000	0.23	0.026	3	2	4000	1.98			105.3	
PD-GL-001	7	U-5	43	-36																																120.6
PD-GL-001	7	U-5	42.25	-35.25		39.8																														
PD-GL-001	7	U-5	42.8	-35.8		24.8																														
PD-GL-001	7	U-5	43.05	-36.05	SC	25.8															25.8	100.2	1580	1086	15	16.6								126		
PD-GL-001	7	U-5	43.35	-36.35		33.8																														
PD-GL-001	7	U-5C	43.6	-36.6	CL	36.2	43	23	20.0	0.7		69.4		18													1.7	3400	0.21	0.028	6	1.5	3000	1.41			108.2	
PD-GL-002	7	U-4	39	-32																																101.9
PD-GL-002	7	U-4	38.55	-31.55		50.8																														
PD-GL-002	7	U-4B	38.8	-31.8	CH	52.1	62	28	34.0	0.7		87		17	3												1.1	2200	0.21	0.019	7	1.1	2200	1.03			106.8	
PD-GL-002	7	U-4	39.1	-32.1		58.4																														
PD-GL-002	7	U-4	39.35	-32.35	CH	61.7															61.7	63.1	1010	661	12.7	15.8								102.1		
PD2-GR-001	-10.9	U-1	11.5	-22.4																																91.9
PD2-GR-001	-10.9	U-1	10.75	-21.65		67.1																														
PD2-GR-001	-10.9	U-1A	11	-21.9	MH	80.8															80.8	50.2	180	111	8.7	3.0								90.7		
PD2-GR-001	-10.9	U-1	11.3	-22.2		71.5																														
PD2-GR-001	-10.9	U-1B	11.55	-22.45	MH	70.8	66	37	29.0	1.2	0.8	93.2		26													0.7	1400	0.31	0.027	4	0.4	800	1.27			94	
PD2-GR-001	-10.9	U-3	26.5	-37.4																																99
PD2-GR-001	-10.9	U-3	25.8	-36.7		67.4																														
PD2-GR-001	-10.9	U-3A	26.05	-36.95	ML	60.3										60.3	62.6	1500	500	0.33														100.4			
PD2-GR-001	-10.9	U-3	26.35	-37.25		58.4																														
PD2-GR-001	-10.9	U-3B	26.6	-37.5	ML	65.3															65.3	60.4	540	357	5.3	6.9								99.9		
PD2-GR-001	-10.9	U-3	26.9	-37.8		67.5																														
PD2-GR-001	-10.9	U-3C	27.15	-38.05	ML	57.4	44	27	17.0	1.8	1.0	92.8		17													0.7	1400	0.22	0.014	4	0.7	1400	0.86			103.5	
PD2-GR-001	-10.9	U-4	36.5	-47.4																																105
PD2-GR-001	-10.9	U-4	35.7	-46.6		50.1																														
PD2-GR-001	-10.9	U-4	36.25	-47.15		54.3																														
PD2-GR-001	-10.9	U-4B	36.5	-47.4	CH	60															60	63.1	870	578	13.1	9.5								100.9		
PD2-GR-001	-10.9	U-4	36.8	-47.7		54.2																														
PD2-GR-001	-10.9	U-4C	37.05	-47.95	CH	66.4	50	23	27.0	1.6		66.9		13													1.2	2400	0.42	0.016	3	0.8	1600	1.23			99.4	
PD2-GR-001	-10.9	U-5	46.5	-57.4																																115.5
PD2-GR-001	-10.9	U-5	45.75	-56.65		61.1																														
PD2-GR-001	-10.9	U-5A	46	-56.9	CL	54.4	47	23	24.0	1.3		66.9		17													1.5	3000	0.23	0.017	9	0.9	1800	1.25			105.1	
PD2-GR-001	-10.9	U-5	46.3	-57.2		31.7																														
PD2-GR-001	-10.9	U-5B	46.55	-57.45	SM	32.4															32.4	87.5	1800	1281	15	12.1								115.9		
PD2-GR-001	-10.9	U-5	46.85	-57.75		31.8																														
PD2-GR-002A	-24.3	U-5	37	-61.3																																90.4
PD2-GR-002A	-24.3	U-5	36.5	-60.8	CL	58.7															58.7	65.0	640	428	4.1	9.7								103.1		
PD2-GR-002A	-24.3	U-5	36.8	-61.1		65.1																														
PD2-GR-002A	-24.3	U-5	37.05	-61.35	CL	53.8										53.8	67.0	2090	520	0.25														103.1			
PD2-GR-002A	-24.3	U-5	37.35	-61.65		60																														
PD2-GR-002A	-24.3	U-5	37.6	-61.9	CL	56.7	30	18	12	3.2		70.6		21													0.7	1400	0.2	0.015	8	0.7	1400	0.88			106.2	
PD2-GR-002A	-24.3	U-7	57	-81.3																																117.8
PD2-GR-002A	-24.3	U-7	56.35	-80.65		29.7																														
PD2-GR-002A	-24.3	U-7	56.9	-81.2		25.6																														
PD2-GR-002A	-24.3	U-7	57.15	-81.45	CL	27.8															27.8	94.6	880	637	4.5	14.9								120.9		
PD2-GR-002A	-24.3	U-7	57.45	-81.75		29.9																														
PD2-GR-002A	-24.3	U-7	57.7	-82	CL	33.4	44	19	25	0.6	0.8	63.6		20													1.7	3400	0.2	0.007	4	1.4	2800	1.11			117.3	
PD2-GR-003	-27.7	U-2	13.5	-41.2																																105.3
PD2-GR-003	-27.7	U-2	12.85	-40.55		59.2																														
PD2-GR-003	-27.7	U-2B	13.1	-40.8	OH	44.1															44.4	79.1	220	155	9.3	3.5								114.2		
PD2-GR-003	-27.7	U-2	13.4	-41.1		68.7																														
PD2-GR-003	-27.7	U-2C	13.65	-41.35	OH	76.7	53	26	27.0	1.9	0.7	68.7		10													0.7	1400	0.3	0.033	4	0.6	1200	3.32			94.9	
PD2-GR-003	-27.7	U-3	23.5	-51.2																																101.1
PD2-GR-003	-27.7	U-3	22.8	-50.5		59.6																														
PD2-GR-003	-27.7	U-3B	23.05	-50.75	CH	57.5															57.5	64.4	400	266	6.2	6.1								101.4		
PD2-GR-003	-27.7	U-3	23.35	-51.05		39.4																														
PD2-GR-003	-27.7	U-3	23.45	-51.15	CH	66.9										66.9	58.8	1330	360	0.27														98.2			
PD2-GR-003	-27.7	U-3C	23.6	-51.3	CH	57.9	54	23	31.0	1.1	0.8	82.8		16													0.75	1500	0.28	0.023	5	0.8	1600	1.61			103.6	
PD2-GR-003	-27.7	U-5	48.5	-76.2																																110.6
PD2-GR-003	-27.7	U-5	48.05	-75.75		52.7																														
PD2-GR-003	-27.7	U-5B	48.3	-76	ML	47.2	41	26	15.0	1.4	0.8										47.2	72.5	820	560	11.4	12.7								106.7		
PD2-GR-003	-27.7	U-5	48.6	-76.3		25.2																														
PD2-GR-003	-27.7	U-5C	48.85	-76.55	ML	40.6						57.3		13													1.5	3000	0.17	0.010	6	1.2	2400	1.30			111.4	
PD2-GR-004	-9.8	U-1	9	-18.8																																92.2
PD2-GR-004	-9.8	U-1	8.2	-18		79.7																														
PD2-GR-004	-9.8	U-1	8.45	-18.25	CH	88.1										88.1	48.3	510	180	0.35														90.9			
PD2-GR-004	-9.8	U-1	8.7	-18.5		83.7																														
PD2-GR-004	-9.8	U-1	8.95	-18.75	CH	77.7															77.7	53.5	250	160	9.8	2.4								95		
PD2-GR-004	-9.8	U-1	9.3	-19.1		70.1																														
PD2-GR-004	-9.8	U-1	9.55	-19.35	CH	75.9	85	33	52	0.8	0.78	95.8		23													0.4	800	0.25	0.023	4	0.5	1000	2.88			93.1	
PD2-GR-004	-9.8	U-2	19	-28.8																																95
PD2-GR-004	-9.8	U-2	18.4	-28.2		79.8																														
PD2-GR-004	-9.8	U-2	18.65	-28.45	CH	82										82	51.2	1090	360	0.33														93.1			
PD2-GR-004	-9.8	U-2	18.95	-28.75		84.3																														
PD2-GR-004	-9.8	U-2	19.2	-29	CH	78.2															78.2	53.0	390	250	7	4.9								94.4		
PD2-GR-004	-9.8	U-2	19.5	-29.3		65.6																														
PD2-GR-004	-9.8	U-2	19.75	-29.55	CH	65.1	57	28	29	1.3	0.81	85.2		14													0.45	900	0.25	0.014	4	0.6	1200	1.27			100	
PD2-GR-004	-9.8	U-3	30	-39.8																																98.5
PD2-GR-004	-9.8	U-3	28.25	-38.05		66.6																														
PD2-GR-004	-9.8	U-3	28.8	-38.6		58.8																														
PD2-GR-004	-9.8	U-3	29.05	-38.85	CH	63.8	56	29	27	1.3		78.3		15																							
PD2-GR-004	-9.8	U-3	29.35	-39.15		72.4																														
PD2-GR-004	-9.8	U-5	44	-53.8																																120.3
PD2-GR-004	-9.8	U-5	43.2	-53		39.3																														
PD2-GR-004	-9.8	U-5	43.75	-53.55		33.1																														
PD2-GR-004	-9.8	U-5	44	-53.8	SP-SC	49.4	25	17	8	4.1		10.8		1																							
PD2-GR-004	-9.8	U-6	54	-63.8																																102.2
PD2-GR-004	-9.8	U-6	53.35	-63.15		47.5																														
PD2-GR-004	-9.8	U-6	53.9	-63.7		53.1																														
PD2-GR-004	-9.8	U-6	54.15	-63.95	CL	51.1															51.1	70.2	800	546	4.5	14.1								106		

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TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress	Su/p	w% initial	ρ_d initial	1/2 sdev (lab)	1/2 sdev (corrected)	% STRAIN	σ'con	Corrected					Lab		OCR	DSS	CU TRX	Consol	
																	(pcf)										Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)		(pcf)	(pcf)	(pcf)	(pcf)
						(%)						(%)	(%)	(%)	(%)				(psf)			(pcf)	(psf)	(psf)		(psi)											
PD2-GR-005	-22.4	U-1	8.75	-31.15		73.2																														
PD2-GR-005	-22.4	U-1	9	-31.4	OH	79.8															79.8	53.4	210	136	4.4	2.4								96.1		
PD2-GR-005	-22.4	U-1	9.3	-31.7		87.8																														
PD2-GR-005	-22.4	U-1	9.55	-31.95	OH	102.5	68	32	36	2.0	0.59	90		20													0.2	400	0.3	0.031	3	0.2	400	1.54		91.2	
PD2-GR-005	-22.4	U-2	20	-42.4																																107.4
PD2-GR-005	-22.4	U-2	19.6	-42		57.2																														
PD2-GR-005	-22.4	U-2	20.15	-42.55		58.1																														
PD2-GR-005	-22.4	U-2	20.4	-42.8	CL	57.1	40	21	19	1.9	1.03	92.3		17																						
PD2-GR-005	-22.4	U-3	30	-52.4																																102.1
PD2-GR-005	-22.4	U-3	29.3	-51.7		62.7																														
PD2-GR-005	-22.4	U-3	29.85	-52.25		66.2																														
PD2-GR-005	-22.4	U-3	30.4	-52.8		50.3																														
PD2-GR-005	-22.4	U-3	30.65	-53.05	CH	81.7	60	27	33	1.7		95.1		23																						
PD2-GR-005	-22.4	U-4	40	-62.4																																
PD2-GR-005	-22.4	U-4	39.25	-61.65		21																														121.8
PD2-GR-005	-22.4	U-4	39.5	-61.9	SC	26.7															26.7	97.7	2335	1705	15	10.4								123.8		
PD2-GR-005	-22.4	U-4	39.8	-62.2		21.4																														
PD2-GR-005	-22.4	U-4	40.05	-62.45	CL	36.1	35	16	19	1.1		55.9		7													1.3	2600	0.12	0.005	4	1	2000	1.32		113.1	
PD2-GR-005	-22.4	U-5	50	-72.4																																102.3
PD2-GR-005	-22.4	U-5	49.55	-71.95		59.8																														
PD2-GR-005	-22.4	U-5	50.1	-72.5		53.2																														
PD2-GR-005	-22.4	U-5	50.35	-72.75	CH	45.3	53	27	26	0.7		92.4		29																						
PD2-GR-006	-4.9	U-1	8	-12.9																																92.9
PD2-GR-006	-4.9	U-1	7.6	-12.5		85.9																														
PD2-GR-006	-4.9	U-1	7.85	-12.75	MH	82.1															82.1	50.7	210	132	7.1	2.1								92.3		
PD2-GR-006	-4.9	U-1	8.15	-13.05		89.3																														
PD2-GR-006	-4.9	U-1	8.3	-13.2	MH	93.3										93.3	46.5	450	160	0.36														89.9		
PD2-GR-006	-4.9	U-1	8.5	-13.4	MH	93.8	80	40	40	1.3	0.78	92		28													0.23	460	0.27	0.043	2	0.4	800	2.08		90	
PD2-GR-006	-4.9	U-2	18	-22.9																																90.6
PD2-GR-006	-4.9	U-2	17.65	-22.55		78																														
PD2-GR-006	-4.9	U-2	17.9	-22.8	CH	84.2	89	33	56	0.9		95.9		27																						
PD2-GR-006	-4.9	U-3	28	-32.9																																99.2
PD2-GR-006	-4.9	U-3	27.4	-32.3		68.3																														
PD2-GR-006	-4.9	U-3	27.65	-32.55	MH	66															66	60.2	500	330	15	7.3								99.9		
PD2-GR-006	-4.9	U-3	27.95	-32.85		50.8																														
PD2-GR-006	-4.9	U-3	28.2	-33.1	MH	66.5	56	30	26	1.4	0.79	93.1		17													0.7	1400	0.29	0.018	4	0.7	1400	1.37		100.3	
PD2-GR-006	-4.9	U-3	28.5	-33.4		67.2																														
PD2-GR-006	-4.9	U-3	28.75	-33.65	MH	65.3										65.3	59.8	1580	470	0.30														98.8		
PD2-GR-006	-4.9	U-5	43	-47.9																																104.9
PD2-GR-006	-4.9	U-5	42.35	-47.25		44.2																														
PD2-GR-006	-4.9	U-5	42.6	-47.5	CL	54															54	69.1	710	484	10	11.2								106.4		
PD2-GR-006	-4.9	U-5	42.9	-47.8		68.3																														
PD2-GR-006	-4.9	U-5	43	-47.9	CL	55.8										55.8	66.1	2430	680	0.28														103		
PD2-GR-006	-4.9	U-5	43.2	-48.1	CL	50.1	48	27	21	1.1		90.1		18													0.95	1900	0.23	0.007	6	0.8	1600	1.04		106.3	
PD2-GR-006	-4.9	U-6	53	-57.9																																112.1
PD2-GR-006	-4.9	U-6	52.7	-57.6		32.5																														
PD2-GR-006	-4.9	U-6	52.95	-57.85	SC	28.9										28.9	95.0	2990	970	0.32														122.5		
PD2-GR-006	-4.9	U-6	53.25	-58.15		28																														
PD2-GR-006	-4.9	U-6	53.5	-58.4	SC	34.9	32	21	11	1.3		30.6		6													1.7	3400	0.17	0.003	6	1.6	3200	1.19		117.6	
PD2-GR-006	-4.9	U-7	63	-67.9																																107.7
PD2-GR-006	-4.9	U-7	62.3	-67.2		55.4																														
PD2-GR-006	-4.9	U-7	62.55	-67.45	CL	54.9										54.9	67.1	3540	810	0.23														104		
PD2-GR-006	-4.9	U-7	62.85	-67.75		44.8																														
PD2-GR-006	-4.9	U-7	63.1	-68	CL	49.6															49.6	72.6	990	683	5.6	16.5								108.6		
PD2-GR-006	-4.9	U-7	63.4	-68.3		50.7																														
PD2-GR-006	-4.9	U-7	63.65	-68.55	CL	43.8	41	22	19	1.1		87.8		18													2	4000	0.18	0.010	5	1.7	3400	1.36		110.2	
PD2-GR-007	-22.8	U-1	9	-31.8																																102.1
PD2-GR-007	-22.8	U-1	8.2	-31		74																														
PD2-GR-007	-22.8	U-1A	8.45	-31.25	CH	55.3										55.3	66.1	420	200	0.48														102.6		
PD2-GR-007	-22.8	U-1	8.75	-31.55		76.3																														
PD2-GR-007	-22.8	U-1	8.95	-31.75	CH	65.6	51	25	26.0	1.6	0.8	93.8		14													0.23	460	0.22	0.023	4	0.3	600	1.53		97.6	
PD2-GR-007	-22.8	U-2	19	-41.8																																101
PD2-GR-007	-22.8	U-2	18.2	-41		87.9																														
PD2-GR-007	-22.8	U-2	18.7	-41.5		66.5																														
PD2-GR-007	-22.8	U-2	19.25	-42.05		79.8																														
PD2-GR-007	-22.8	U-2C	19.55	-42.35	OH		61	30	31.0		0.6	86.5		12																						
PD2-GR-007	-22.8	U-3	29	-51.8																																105.5
PD2-GR-007	-22.8	U-3A	28.25	-51.05	OH	69.2	65	30	35.0	1.1	0.7	98.9		79																						
PD2-GR-007	-22.8	U-3	28.55	-51.35		74.5																														
PD2-GR-007	-22.8	U-3B	28.8	-51.6	OH	63.5																					0.7	1400	0.27	0.017	6	0.7	1400	1.36		99.8	
PD2-GR-007	-22.8	U-3	29.1	-51.9		41																														
PD2-GR-007	-22.8	U-3C	29.35	-52.15	SP-SM/OH	34.1															34.1	81.0	700	484	15	7.6								108.6		
PD2-GR-007	-22.8	U-4	38.85	-61.65		55.3																														
PD2-GR-007	-22.8	U-4B	39.1	-61.9	CL	55.6										55.6	66.1	2200	550	0.25														102.9		
PD2-GR-007	-22.8	U-4	39.4	-62.2		47.9																														
PD2-GR-007	-22.8	U-4	39.65	-62.45	CL	75.5	42	23	19.0	2.8	1.0	78.6		20													0.8	1600	0.31	0.030	4	0.7	1400	1.23		96.7	
PD2-GR-008	-19.3	U-1	8	-27.3																																91.7
PD2-GR-008	-19.3	U-1	7.15	-26.45		83.6																														
PD2-GR-008	-19.3	U-1A	7.4	-26.7	OH	76.6	82	33	49.0	0.9	0.6	84.6		12													0.3	600	0.26	0.015	7	0.2	400	2.53		96.1	
PD2-GR-008	-19.3	U-1	7.7	-27		88.5																														
PD2-GR-008	-19.3	U-1B	7.95	-27.25	OH	84.9															84.9	50.0	160	101	5.5	2.1								92.4		
PD2-GR-008	-19.3	U-1	8.25	-27.55		91.9																														
PD2-GR-008	-19.3	U-1C	8.5	-27.8	OH	86.7										86.7	49.2	450	140	0.31														91.8		
PD2-GR-008	-19.3	U-2	18	-37.3																																97.6
PD2-GR-008	-19.3	U-2	17.7	-37		81.2																														
PD2-GR-008	-19.3	U-2B	17.95	-37.25	OH	89.3										89.3	48.1	1010	280	0.28														91.1		
PD2-GR-008	-19.3	U-2	18.25	-37.55		61.8																														
PD2-GR-008	-19.3	U-2	18.55	-37.85	OL	36.2	46	26	20.0	0.5	0.7	88.3		19													2	4000	0.13	0.008	1	3.4	6800	4.30		114.1	
PD2-GR-008	-19.3	U-3	28	-47.3																																105.1
PD2-GR-008	-19.3	U-3	27.4	-46.7		69.5																														
PD2-GR-008	-19.3	U-3	27.95	-47.25		55.5																														
PD2-GR-008	-19.3	U-3	28.2	-47.5	CL	51.8										51.8	69.4	1580	350	0.22														105.3		
PD2-GR-008	-19.3	U-3	28.5	-47.8		67.1																														
PD2-GR-008	-19.3	U-3	28.8	-48.1	CL	64.5	49	23	26	1.6		92.8		16													0.6	1200	0.25	0.017	3	0.6	1200	1.11		101.5	
PD2-GR-008	-19.3	U-4	38	-57.3																																101.7
PD2-GR-008	-19.3	U-4	37.2	-56.5		61.4																														
PD2-GR-008	-19.3	U-4	37.75	-57.05		45.5																														
PD2-GR-008	-19.3	U-4	38.3	-57.6		52.3																														

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TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Corrected					Lab		OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	
																	(pcf)										Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)					
						(%)						(%)	(%)	(%)	(%)																						
PD2-GR-008	-19.3	U-5	48.3	-67.6		58.5																														
PD2-GR-008	-19.3	U-5C	48.55	-67.85	ML	57.7	49	29	20	1.4		94		23																						
PD2-GR-009	-14.2	U-1	7	-21.2																																93.3
PD2-GR-009	-14.2	U-1A	6.45	-20.65	OH	74.8															74.8	53.8	130	82	12.3	1.8									94.1		
PD2-GR-009	-14.2	U-1	6.75	-20.95		76.8																														
PD2-GR-009	-14.2	U-1B	7	-21.2	OH	76.2	72	32	40	1.1	0.74	95.4		27													0.55	1100	0.29	0.035	2	0.5	1000	5.19			94.3	
PD2-GR-009	-14.2	U-1	7.25	-21.45		68.3																														
PD2-GR-009	-14.2	U-1C	7.5	-21.7	OH	77.8										77.8	52.2	400	170	0.43														92.8			
PD2-GR-009	-14.2	U-2	17	-31.2																																100.1
PD2-GR-009	-14.2	U-2	16.25	-30.45		49.3																														
PD2-GR-010	-14.2	U-3	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	17.35	-31.55		64.1																														
PD2-GR-009	-14.2	U-2C	17.6	-31.8	OH	63.3	66	38	28	0.9	0.67	81.9		4																						
PD2-GR-009	-14.2	U-3	27	-41.2																																105.1
PD2-GR-009	-14.2	U-3	26.35	-40.55		68																														
PD2-GR-009	-14.2	U-3	26.9	-41.1		51.4																														
PD2-GR-009	-14.2	U-3	27.15	-41.35	CL	60.3	39	21	18	2.2	0.9	94.8		15		60.3	62.6	1520	420	0.28														100.4			
PD2-GR-009	-14.2	U-3	27.3	-41.5	CL	57.5																					0.7	1400	0.23	0.023	4	0.7	1400	1.41		100.3	
PD2-GR-009	-14.2	U-3	27.45	-41.65		48.8																														
PD2-GR-009	-14.2	U-3C	27.7	-41.9	CL	41.4															41.4	81.7	500	356	7.9	7.1									115.5		
PD2-GR-009	-14.2	U-4	37	-51.2																																103.4
PD2-GR-009	-14.2	U-4	36.25	-50.45		65																														
PD2-GR-009	-14.2	U-4	36.8	-51		57.7																														
PD2-GR-009	-14.2	U-4	37.05	-51.25	CH	57.3										57.3	64.5	2090	540	0.26														101.4			
PD2-GR-009	-14.2	U-4	37.35	-51.55		49																														
PD2-GR-009	-14.2	U-4C	37.6	-51.8	CH	70.1	65	32	33	1.2		83.4		14													1.2	2400	0.35	0.027	3	1	2000	1.84		98.6	
PD2-GR-009	-14.2	U-5	47	-61.2																																109.8
PD2-GR-009	-14.2	U-5	46.2	-60.4		28.4																														
PD2-GR-009	-14.2	U-5	46.75	-60.95		45.4																														
PD2-GR-009	-14.2	U-5	47	-61.2	CL		38	24	14																											
PD2-GR-009	-14.2	U-5	47.55	-61.75		43.4																														
PD2-GR-009	-14.2	U-5B	48	-62.2	CL	49.1						83.1		14																						

Notes:
1. Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88).

Legend:
LL_{oven} = liquid limit by oven-dried method
LL_{air} = liquid limit by air-dried method
σ_{dev} = deviator stress at failure
$\sigma'_{confined}$ = effective confining stress
CU TRX = consolidated undrained triaxial test
ε_{vo} - strain at in-situ effective stress
CR = compression ratio (strain per log cycle stress)
RR = recompression ratio (strain per log cycle stress)
Pp = preconsolidation pressure

TABLE 3.7B

SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM BASAL SAND STRATUM

1 RIVER STREET

HASTINGS-ON-HUDSON, NEW YORK

										ATTERBERG LIMITS			
BORING NO.	GROUND SURFACE ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	USCS CLASSIFICATION	WATER CONTENT (%)	% PASSING NO. 200 SIEVE (%)	% SILT (%)	% CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX
PD2-GR-001	-10.3	S-13	89-91	-100.9	SM	16.5	17.7	15.7	2				
PD2-GR-001	-10.3	S-14	94-96	-105.9	CL	30.2	70.3	63.3	7	25	17	8	1.65
PD2-GR-002A	-24.3	S-8	71-73	-93.6	CL-ML	21.3	73.1	69.1	4				
PD2-GR-002A	-24.3	S-10	81-83	-106.3	SP-SM	24.4	8.6	8.6	0				
PD2-GR-003	-27.7	S-11	77.5-79.5	-106.2	CL-ML	27	94.4	91.4	3				
PD2-GR-003	-27.7	S-14	92.5-94.5	-121.2	CL-ML	27.7	82.4	71.4	11	24	19	5	1.74
PD2-GR-007	-22.8	S-8	62.9-64.9	-86.7	CL	53.2				44	23	21	1.44
PD2-GR-007	-22.8	S-9	67.9-69.9	-91.7	CL	37.7				36	21	15	1.11
PD2-GR-007	-22.8	S-10	72.9-74.9	-96.7	CL	36.6				39	21	18	0.87

Notes:

1. Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88).

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2011 Geotechnical Data Report
Vane Shear Data and
Laboratory Summary Table
(H&A 2011)

2011 Geotechnical Data Report, H&A

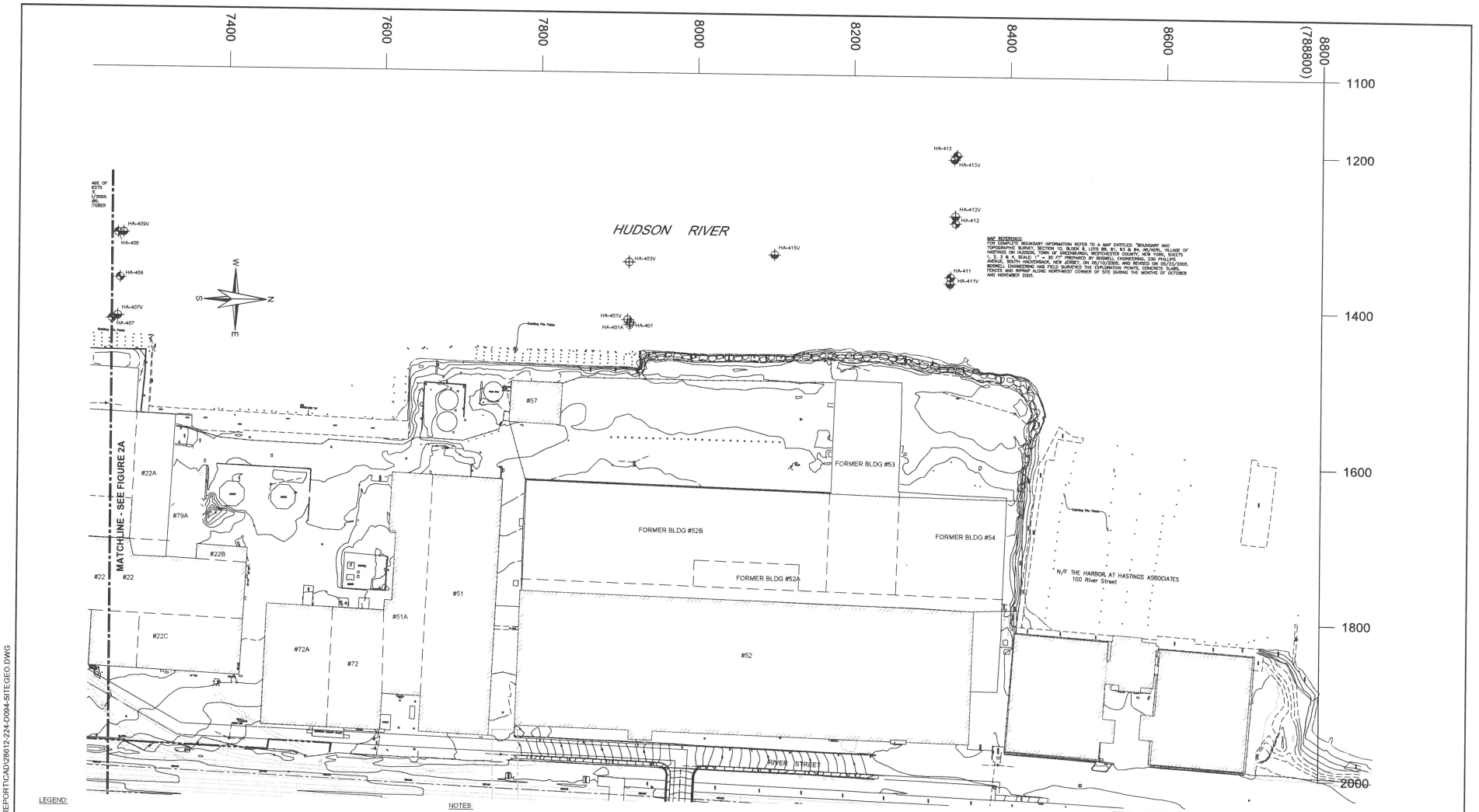


Table 5.1. Field Vane Results.

Test Location	FVT Test ID	Depth* (ft)	Peak Undrained Strength (psf)	Post-Peak Undrained Strength (psf)	Remolded Undrained Strength (psf)
HA 404 FV	404-1	7	58	41	-
	404-2	10	165	145	-
	404-3	15	156	132	-
	404-4	20	438	373	165
	404-5	25	692	601	-
	404-6	30	631	566	-
	404-7	35	668	644	-
	404-8	40	666	473	349
	404-9	45	705	577	-
HA 406 FV	406-1	7	200	189	-
	406-2	10	256	228	-
	406-3	15	299	247	-
	406-4	20	482	458	-
	406-5	25	545	477	178
	406-6	30	653	467	-
	406-7	35	781	664	-
	406-8	40	829	404	323
	406-9	45	811	399	-
HA 407 FV	407-1	10	414	399	-
	407-2	15	477	367	106
	407-3	20	744	658	-
	407-4	25	601	460	-
	407-5	30	621	462	195
	407-6	35	703	551	-
	407-7	40	879	388	-
	407-8	45	>896	N/A	-
	407-9	49	N/A	N/A	-
HA 409 FV	409-1	10	144	144	-
	409-2	15	343	301	51
	409-3	20	271	271	-
	409-4	25	449	377	-
	409-5	30	517	458	-
	409-6	35	636	492	250
	409-7	40	784	670	-
	409-8	45	878	717	-
HA 411 FV	411-1	10	305	288	-
	411-2	12	509	432	-
	411-3	14	577	534	-
	411-4	16	488	416	293
	411-5	18	522	454	-
	411-6	20	454	386	-
	411-7	22	589	479	-
	411-8	24	458	458	89
	411-9	26	1213	780	-

	411-10	28	1234	661	-
	411-11	30	767	683	-
	411-12	32	1246	1145	310
	411-13	34	1456	1068	-
	411-14	36	1128	844	-
	411-15	38	1056	886	-
	411-16	40	1382	1051	1755(sand?)
	411-17	42	1221	1056	-
	411-18	44	1246	1060	-
	411-19	46	1280	1047	-
	411-20	48	1255	1081	280
	411-21	50	1361	954	-
HA 412 FV	412-1	10	352	322	-
	412-2	15	555	526	-
	412-3	20	1022	704	157
	412-4	25	882	666	-
	412-5	30	810	N/A	416
	412-6	35	1039	971	-
	412-7	40	1399	1030	76
	412-8	45	924	818	-
	412-9	50	1247	869	212
HA 413 FV	413-1	10	445	394	-
	413-2	15	398	398	-
	413-3	20	432	407	-
	413-4	25	674	589	144
	413-5	30	1030	687	-
	413-6	35	1857 (sand?)	1666	-
	413-7	40	N/A	N/A	N/A
	413-8	45	2035 (sand?)	1560	742
	413-9	50	>2722 (sand?)	N/A	N/A
HA 414 FV	414-1	10	242	242	-
	414-2	12	326	326	55
	414-3	14	365	339	-
	414-4	16	403	360	-
	414-5	18	424	390	-
	414-6	20	505	437	267
	414-7	22	449	390	-
	414-8	24	538	496	-
	414-9	26	628	543	-
	414-10	28	615	547	191
	414-11	32	746	602	-
	414-12	34	729	602	-
	414-13	36	695	619	182
	414-14	38	708	640	-
	414-15	40	649	598	-
	414-16	42	946	861	-
	414-17	44	1132	890	140

	414-18	46	903	644	-
	414-19	48	1013	835	-
HA 415 FV	415-1	7	229	191	-
	415-2	10	310	310	-
	415-3	15	394	335	114
	415-4	20	619	496	-
	415-5	25	695	602	-
	415-6	30	653	581	170
	415-7	35	725	581	-
	415-8	40	547	N/A	-
	415-9	45	907	754	229
	415-10	50	988	806	-
	415-11	55	1166	869	-

* Depth measured from top of mudline

6.0 DISCUSSION OF RESULTS

6.1 Peak Strength

Figure 6.1 shows the variation in peak undrained strength with depth for all tests. As can be seen, most of the profiles show very similar results with one significant exception. Test profile HA 411 FV shows much higher peak undrained strength values below a depth of about 25 ft. The reason for this obvious difference in comparison to the other test locations is not known at this time however, it is possible that this test location was located near a previous boring that may have been grouted, or near an old driven timber pile, in which case the soil may have experienced some gain in strength. Two other very high values in location HA 413FV are likely the result of a sand lens as these results were very erratic during the test and not indicative of other tests. These results and those from HA 411 FV should be disregarded when using the results to develop a design profile, unless other data from this area become available.

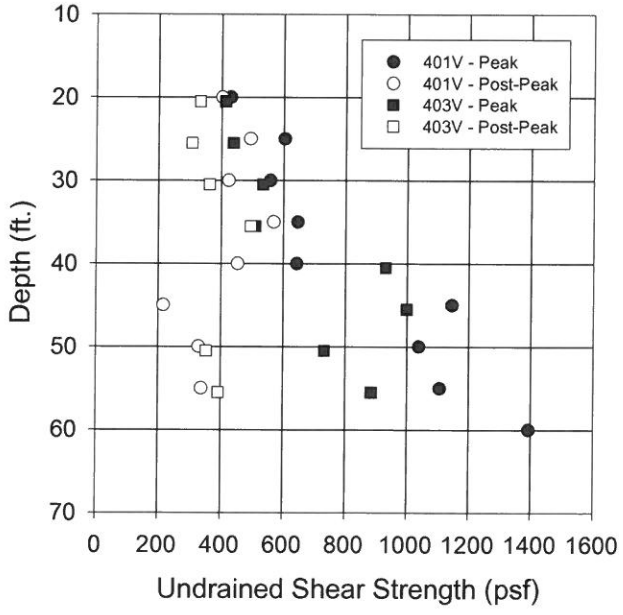
The results shown in Figure 6.1 indicate that the peak undrained shear strength shows a more-or-less linear increase with depth, which is very typical in very soft and soft near normally consolidated soils and generally expected at this site in the absence of any overconsolidated crust. These data suggest a constant undrained strength to vertical effective stress ratio (s_u/σ'_{VO}) at the site. It appears that extrapolation of this linear trend backwards to intersect the depth scale would give zero strength at a depth of zero feet which is also characteristic of a normally consolidated deposit. The magnitude of the undrained strength ratio will depend on the unit weight of the soil and the in situ pore water pressure at each test location. At this site, the pore water pressure can generally be assumed to increase with depth at a constant rate, but may be influenced by tidal fluctuations. Unit weight values needed for calculating in situ vertical effective stress may be obtained from undisturbed samples or water content samples. In general, the results shown in Figure 6.1 suggest

APPENDIX A: Previous Field Vane Test Results

Table A.1. Results of Previous Field Vane Tests.

Test Location	FVT Test ID	Depth* (ft)	Peak Undrained Strength (psf)	Post-Peak Undrained Strength (psf)	Remolded Undrained Strength (psf)
HA 401V	401-1	20	430	402	-
	401-2	25	604	493	-
	401-3	30	558	424	302
	401-4	35	647	569	-
	401-5	40	645	454	350
	401-6	45	1147	217	-
	401-7	50	1040	330	513
	401-8	55	1108	339	-
	401-9	60	>1394**	-	-
HA 403V	403-1	20.5	413	332	-
	403-2	25.5	439	306	-
	403-3	30.5	534	363	119
	403-4	35.5	510	495	-
	403-5	40.5	>932**	-	-
	403-6	45.5	>1000**	-	-
	403-7	50.5	734	354	313
	403-8	55.5	886	393	-

* Depth measured from top of mudline **Peak failure not achieved (possible obstruction??).



a linear increase in undrained strength of approximately s_u (psf) = Depth (ft.) x 20.

Figure 6.2 shows a comparison between the results obtained in the current investigation and previous results obtained at the site. Previous results are given in Appendix A. As can be seen from Figure 6.2, the results of both investigations fall very close to each other.

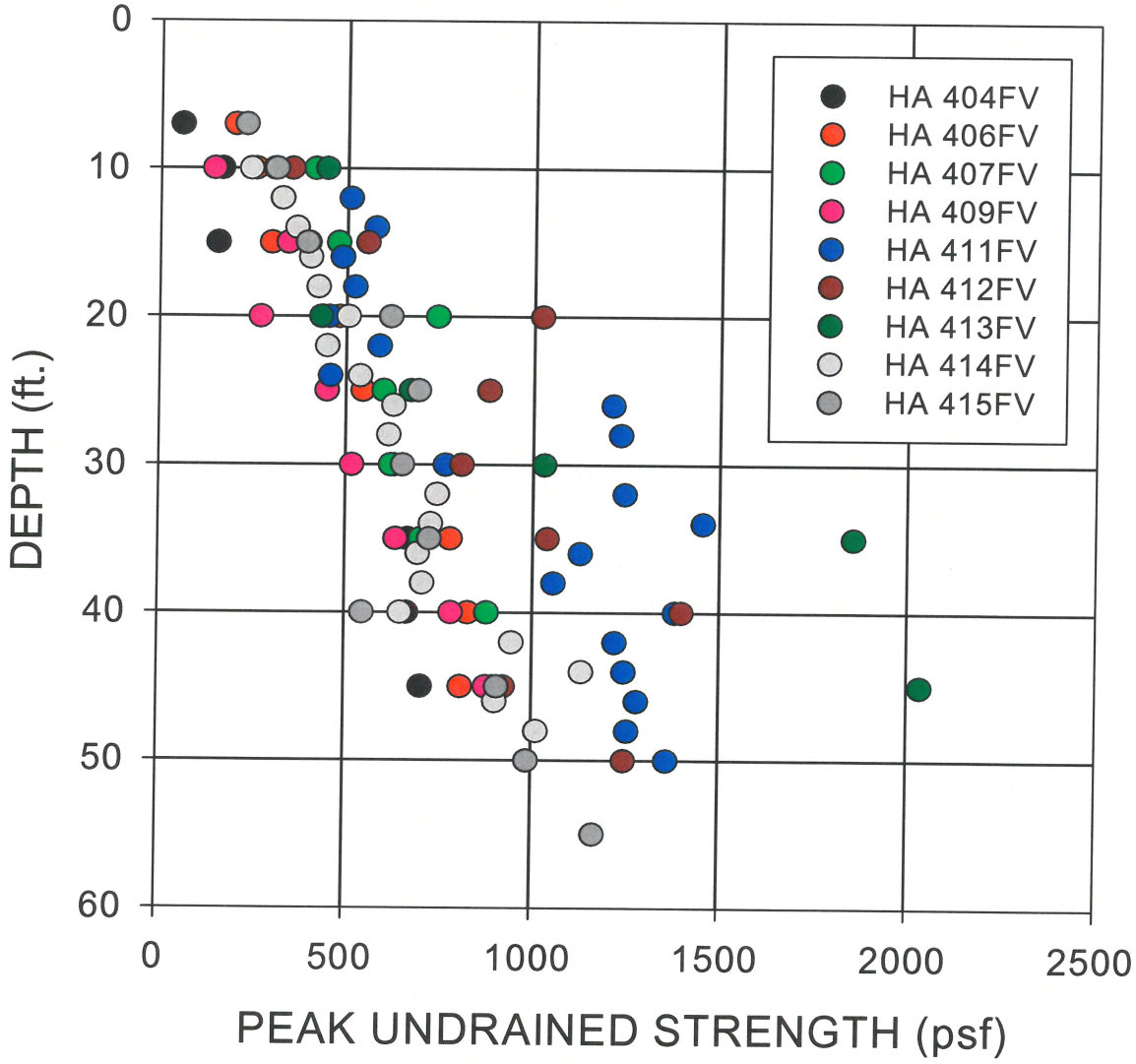


Figure 6.1 Variation in Undrained Shear Strength with Depth.

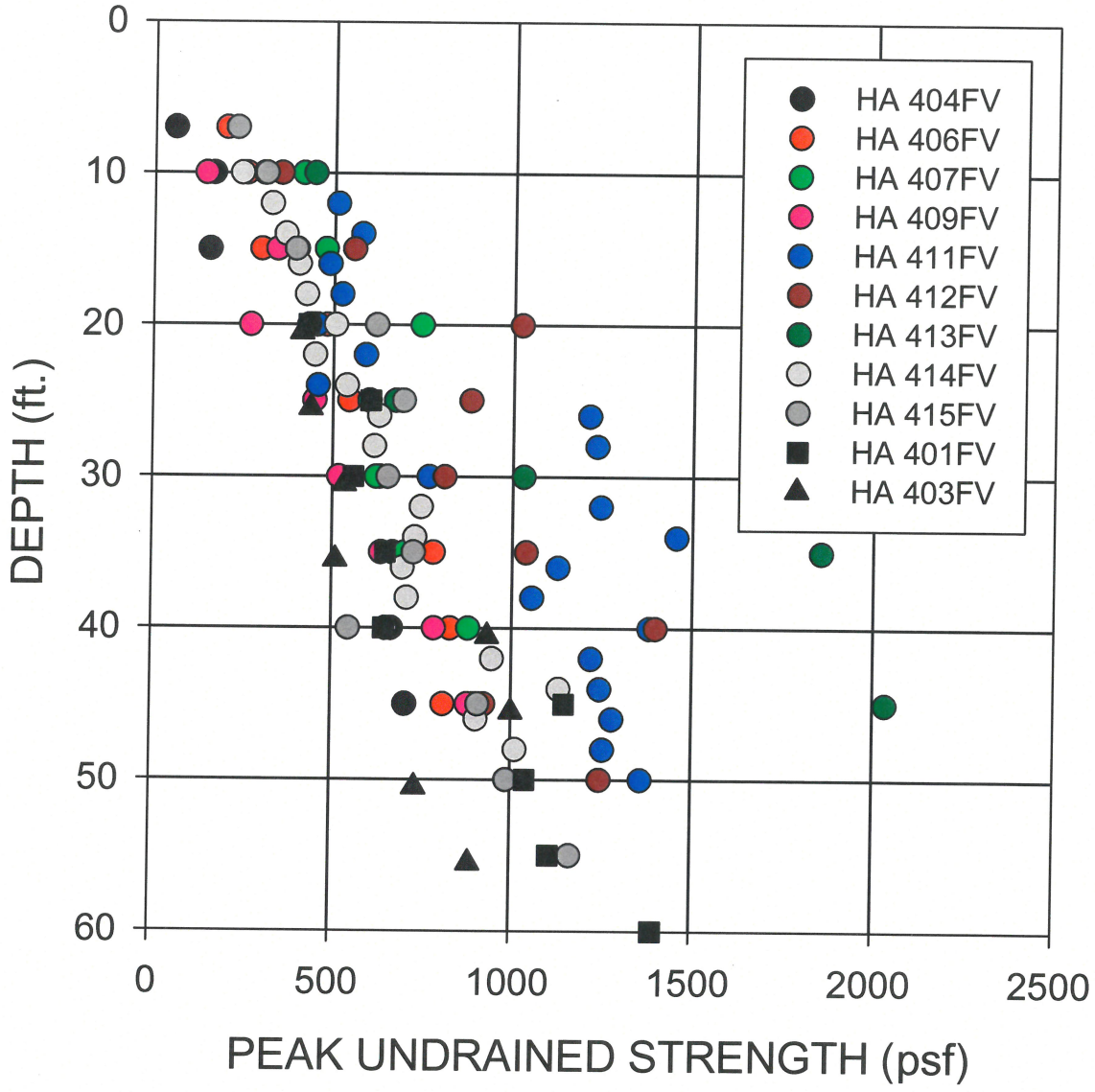


Figure 6.2 Comparison With Previous Results.

6.2 Post-Peak Strength

The post-peak strength indicates the initial residual large strain strength that is available after peak strength has been mobilized but before the soil is completely remolded and all intrinsic soil structure is lost. The reduction from peak to post-peak strength is an indication of soil behavior and may be used to determine the Undrained Brittleness Index, I_B, of the soil. Bishop (1967) defined the

TABLE I.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION USCS	SPECIFIC GRAVITY	WATER CONTENT Atterberg (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair (1)	% PASSING NO. 200 SIEVE (%)	% SILT (%)	% CLAY (%)	ORGANIC CONTENT (%)	DSS: w% initial	γd (pcf)	p	peak sh stress (psf)	Su/p	CU TRIAXIAL: w% initial	γd initial (pcf)	1/2 σdev (lab) (psf)	1/2 σdev (corrected) (psf)	% STRAIN	σ'con (psi)	UNIT WEIGHT: (TRX) (pcf)	(K) (pcf)	(DSS) (pcf)	Drv Cylndr (pcf)	Drive Cylinder w%	UNIT WT AVG	CONSOLIDATION PARAMETERS Corrected: Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	LABORATORY NOTES
																											↓ or 100.1													
RIVER TUBES - DECEMBER 2007																																								
HA-401	-16.54	T-1	27	-43.54	OH		75	61	26	35	1.4	0.67	98	70.8	27	3	62	64.9	1320	480.6	0.364	74.8	54.89	407	270	12.8	6.115	95.9		105.1			100.5	0.6	1200	0.21	0.015	8	1.4	
HA-401A	-16.14	T-1	21	-37.14	OH		60	53	24	29	1.2	0.66	86	64.1	22	2.5	64	61.7	1027	253	0.246	51	65.16	335.5	226	8.6	4.756	98.4		101.2			99.8	0.44	880	0.19	0.019	7	1.2	
HA-401A	-16.14	T-2	31	-47.14	OL		70	47	21	26	1.9	0.72	89	62.5	26	2.9	70	61.4	1516	348	0.230	53.7	65.41	395	270	7.4	7.0	100.5		104.4			102.5	0.29	580	0.21	0.025	12	0.5	
RIVER TUBES - JUNE/JULY 2008																																								
HA-404	-12.94	U-1	9.25	-22.19	CH		82	94	35	59	0.8		95	77.5	17.5	6.6	85.1	50.1	527	157.9	0.300											92.7	87.3	79.1	90.0							
HA-404	-12.94	U-2	19.25	-32.19	MH or OH		65	59	35	24	1.3					2.3	66.7	60.9	1112	328	0.295											101.5	103.5	59.8	102.5							
HA-404	-12.94	U-3	34.25	-47.19			53.04						82	64.0	17.5		53.04	68.7	1989	453.8	0.228											105.1	104.2	48.5	104.7							
HA-404	-12.94	U-4	44.25	-57.19	CL		43	37	24	13	1.5					1.6	42.8	76.2	2574	645.3	0.251											108.8	109.3	47.1	109.1	1.05	2100	0.13	0.033	8	1.1	
HA-405	-16.54	U-1	11.3	-27.84													61.4	63.5	655	192.6	0.294											102.5	99.1	61.4	100.8	0.37	740	0.174	0.012	7	1.8	
HA-405	-16.54	U-2	19.3	-35.84													60.2	62.5	1112	462.3	0.416	57.1	64.2	357.9		5.8	5.146	100.9		100.1	100.6	57.1	100.5							
HA-405	-16.54	U-3	24.3	-40.84									80	57.6	22		52.4	70.1	1422	697.5	0.491											106.8	104.4	52.4	105.6							
HA-405	-16.54	U-4	34.5	-51.04	CL or OL		50	47	25	22	1.1					1.8	52	72.4	2001	849.6	0.425												102.7	52.0	102.7	0.8	1600	0.194	0.022	7	1.2	
HA-405	-16.54	U-6	45.2	-61.74													49.9	72.9	2627	1170	0.445												107.2	49.9	107.2	0.85	1700	0.163	0.02	6.5	0.9	
HA-406	-26.74	U-1	6.25	-32.99	OH		65	53	24	29	1.4	0.68	91	73.5	17.5	2.9	67.4	59.1	351	87.8	0.250	70.3	56.6	193.8		5.5	1.623	96.4		98.9	93.8	67.4	96.4	0.255	510	0.272	0.036	4	2.5	
HA-406	-26.74	U-2	15.25	-41.99		2.66	55.1										55.1	68.6	878	199.4	0.227											106.4	104.0	58.0	105.2	0.4525	905	0.211	0.012	7	1.4	
HA-406	-26.74	U-3	25.9	-52.64	CL		55	32	21	11	3.1					1	59.7	63.8	1492	403.8	0.271											101.9	101.5	63.5	101.7							
HA-406	-26.74	U-4	31	-57.74									84	65.4	19		50.6	73.5	2088	481.5	0.231											110.7	106.5	45.8	108.6							
HA-406	-26.74	U-5	45.75	-72.49			45.8						83	62.5	20		45.8	76.6	2662	682.6	0.256											111.7	106.2	47.6	108.9							
HA-407	-14.94	U-1	13.25	-28.19	CH		70	72	32	40	1.0		87	72.0	15	5.3																96.7	67.6	96.7							
HA-407	-14.94	U-2	19.25	-34.19			59										59	64.7	1112	282.5	0.254											102.9	103.5	67.0	103.2	1	2000	0.199	0.013	3	2.7	
HA-407	-14.94	U-3	29.65	-44.59			46						63	47.5	15		46	73.7	1720	478.6	0.278											107.6	103.1	46.7	105.4	1.2	2400	0.211	0.012	4.5	2.0	
HA-407	-14.94	U-4	39.4	-54.34	CL or OL	2.57	53	39	19	20	1.7					1.4	52.5	68.7	2293	620.2	0.270	60	62.7	641.3		4.28	10.62	100.3		104.8	103.3	53.3	102.8							
HA-407	-14.94	U-5	43.65	-58.59			42.6										42.6	78	2539	604.7	0.238											111.2	106.8	38.1	109.0	1.2	2400	0.177	0.023	5.5	1.2	
HA-407	-14.94	U-6	49.5	-64.44	CL or OL		32	40	19	21	0.6					3.5	39.3	73.5	2884	645.3	0.224	39.6	75.1	753.6		3	13.36	104.8		102.4	109.1	41.1	105.4							
HA-408	-18.04	U-1	10.1	-28.14	MH or OH		60	55	26	29	1.2					7.1	59.7	65.2	579	184.5	0.319											104.1	100.0	59.7	102.1	0.9	1800	0.266	0.012	9	4.7	
HA-408	-18.04	U-2	13.1	-31.14																		57.8	61.4	315.9		8	3.466	96.9			98.0	62.7	97.4							
HA-408	-18.04	U-3	23.1	-41.14									94	67.3	26.5		61.4	62.6	1334	384.3	0.288												100.2	61.4	100.2							
HA-408	-18.04	U-5	33.6	-51.64	MH or OH		29	52	31	21	-0.1					1.6	56.2	65.3	1948	501.6	0.257												102.8	29.3	102.8							
HA-408	-18.04	U-6	38.3	-56.34									59	46.1	13		41.8	81.7	2223	893.4	0.402												96.9	61.8	96.9	1	2000	0.215	0.025	3.8	1.6	
HA-409	-23.04	U-1	13.65	-36.89			86.2										86.2	51.7	784	158.2	0.202											96.3	97.0	85.1	96.6	0.85	1700	0.315	0.019	4	3.8	
HA-409	-23.04	U-2	28.3	-51.34	NP		24									0.3	62.4	65.5	1644	376.3	0.229											106.4	113.6	42.2	110.0							*Sample determined to be NONPLASTIC
HA-409	-23.04	U-4	52.4	-75.44	CL		60	47	24	23	1.6		86	63.4	22.5	2.4	52.4	68.6	3083	726.4	0.236	65.3	61.4	707.4		4.71	14.3	101.5		104.5	102.4	59.6	102.8	0.8	1600	0.216	0.033	7.5	0.8	
HA-411	-29.84	U-1	6.6	-36.44	MH or OH		65	53	28	25	1.5	0.62	65	51.1	14	1.8	55.3	68.2	369	190.1	0.515	74.4	52.6	141.5		10.1	1.7	91.7			99.7	71.0	95.7	0.31	620	0.216	0.028	9	3.0	
HA-411	-29.84	U-3	19.3	-49.14													61.6	63.1	1112	295.1	0.265												106.5	61.6	106.5							
HA-411	-29.84	U-4	29.3	-59.14	CL or OL		65	41	18	23	2.0					1.2	50.1	69	1697	390.5	0.230												103.2	48.0	103.2	0.7	1400	0.133	0.007	4.3	1.2	
HA-411	-29.84	U-5	40.45	-70.29													60.4	63.4	2352	578.9	0.246											101.7	94.1	60.4	97.9							
HA-411	-29.84	U-6	50.3	-80.14	CL	2.66	45	35	22	13	1.8		60	43.4	16.5	1.4	45.1	68.6	2925	1220	0.417												105.7	45.1	105.7	1.05	2100	0.189	0.006	5.5	1.0	
HA-412	-35.64	U-2	14.55	-50.19													66.8	60.2	837	362.4	0.433											100.4	99.1	66.8	99.8							
HA-412	-35.64	U-3	21.65	-57.29		2.75											35.1	85.4	1252	541.2	0.432	72.7	56.8	554.3		9.5	5.81	98.1			97.8	67.5	97.9	1.65	3300	0.097	0.009	2	4.5	
HA-412	-35.64	U-5	44.65	-80.29	OH or CH		48	67	28	39	0.5	0.54	98	58.4	40	10.6	55.1	68.4	2597	572.7	0.221												102.1	55.1	102.1							
HA-413	-38.94	U-1	11.25	-50.19	CH or OH	2.63	66	58	22	36	1.2					5	88.2	50.7	644	182.4	0.283												99.5	65.0	99.5	0.255	510	0.21	0.02	5.5	1.3	
HA-413	-38.94	U-2	16.25	-55.19																																				
HA-413	-38.94	U-3	21.75	-60.69	NP											1.5	34.4	82.6	1258	362.4	0.288											111.0	103.8	34.4	107.4							*Sample determined to be NONPLASTIC
HA-413	-38.94	U-4	39.25	-78.19	NP											1.3	38.9	79.1	2282	1087	0.476											109.9	114.6	38.9	112.2	0.7	1400	0.168	0.02	9	0.7	*Sample determined to be NONPLASTIC
HA-413	-38.94	U-5	44.3	-83.24																		55.6	65.7	771.7		8.3	11.92	102.2			102.0	55.6	102.1							
HA-413	-38.94	U-6	49.25	-88.19									97	62.6	34		53.5	65.7	2867	849.6	0.296											100.8	101.1	53.4	101.0	1.55	3100	0.245	0.031	6.5	1.7	

Notes:
1. If LLoven / LLair < 0.75, soil is classified as organic
2. For CU data, "lab" designation indicates raw lab data; "corrected" indicates data corrected by Haley & Aldrich to account for in situ mean effective stress. See report text for details.

LEGEND

LLoven - liquid limit by oven-dried method
LLair - liquid limit by air-dried method
w% - water content
γd - dry unit weight
σv' - vertical effective stress
Su/p - undrained shear strength divided by vertical effective stress
σdev - deviator stress at failure
σ'con - effective confining stress
TRX - triaxial test
K - hydraulic conductivity test
Pp - preconsolidation pressure
CR - compression ratio (strain per log cycle stress)
RR - recompression ratio (strain per log cycle stress)
εvo - strain at in situ effective stress

Attachment C

Design Soil Profiles

from 2015 PDI



LEGEND

PD2-GR-009 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.

PD2-GL-001 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED ON LAND DURING PRE-DESIGN INVESTIGATION IN 2013.

PD2-TP-2 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION IN 2014.

PROPERTY LINE

RAIL ROAD

EXISTING STRUCTURES

CONCEPTUAL LOCATION OF NORTHWEST BULKHEAD EXTENSION WALL. ALIGNMENT SHOWN IS APPROXIMATE ONLY AND SUBJECT TO CHANGE.

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
3. GRID SYSTEM IS THE NEW YORK STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAD 83, U.S. SURVEY FEET.
4. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND ARE BASED ON DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2009 AND OBTAINED FROM THE NEW YORK STATE GIS CLEARINGHOUSE (NYGIS).
5. THE BATHYMETRY CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

W S N E

0 100 200 300 400

SCALE IN FEET

DRAFT

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

LOCATION PLAN - GEOTECHNICAL BORINGS AND TEST PITS

SCALE: AS SHOWN
JULY 2015

FIGURE 3.7A

POSTOLOWSKI, KEVIN Printed: 7/20/2015 11:39 AM Layout: FIGURE 7-1
\\DTRCOMMON\28612 HASTINGS\286\CAD\28612-286_008 AS-DRILLED TEST PITS R6.DWG

HUDSON RIVER

Section 01
-20' NAVD88

Section 02
-25' to -27'
NAVD88

Section 03
-5' NAVD88

WP-36A
WP-36B
WP-3F3
WP-3F2
WP-3F1
WP-3F
WP-42
WP-40
WP-24
WP-38
WP-37
WP-39
WP-31
WP-3E1
WP-20A
WP-1C3
VC-1A
VC-2B
VC-3A
WP-21
WP-20
WP-1C1
WP-3E
WP-18
WP-17
WP-32
WP-28
WP-29
WP-1B
WP-11
WP-35
WP-9/9A
WP-41
VC-311A
VC-311B
PD2-GR-002A
PD2-GR-002
WP-33A
WP-33
WP-27
WP-25
WP-34
WP-23
WP-30
WP-4
WP-26
LP-18
LP-2
LP-3
LP-16
LP-4
LP-5
LP-6
LP-7
LP-8
LP-9
LP-10
LP-11
LP-12
LP-17
LP-13
LP-14
LP-15
PLP-1
PLP-2
PLP-3
PLP-4A
PLP-4
PLP-5
VC-5A
VC-6A
VC-7A
VC-8A
VC-9A

FORMER BLDG #56
FORMER BLDG #53
FORMER BLDG #55
FORMER DOCK
GATE
RAMP
WOOD DOCK
Existing Pile Fields
RIP RAP

-35
-30
-25
-20
-15
-5

LEGEND:

PD2-GR-002 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.

WP-1C3 — DESIGNATION AND APPROXIMATE LOCATION OF PCBM AND OBSTRUCTION PROBE DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.

VC-1A — DESIGNATION AND APPROXIMATE LOCATION OF VIBRACORE EXPLORATIONS DRILLED IN THE RIVER OR OLD MARINA DURING PRE-DESIGN INVESTIGATION IN 2014.

PLP-1 — DESIGNATION AND APPROXIMATE LOCATION OF PCBM AND OBSTRUCTION PROBE DRILLED ON LAND DURING PRE-DESIGN INVESTIGATION IN 2013.

WP-32 — DESIGNATION AND APPROXIMATE LOCATION OF PCBM AND OBSTRUCTION PROBE DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2013.

APPROXIMATE ALIGNMENT OF BULKHEAD WALL FROM RFS

POTENTIAL ALIGNMENT OF BULKHEAD WALL AND DEADMAN ANCHOR BASED ON PCBM AND OBSTRUCTION DATA GATHERED FROM PDI EXPLORATIONS THROUGH 2014. ALIGNMENT IS APPROXIMATE AND SUBJECT TO CHANGE

KEY

INDICATES PROBE COMPLETED, NO PCBM OBSERVED

INDICATES, SEMI-SOLID PCBM OBSERVED AT DEPTH (NON-EXCAVATABLE)

INDICATES TRACE PCBM OBSERVED

INDICATES PROBE COMPLETED, SEMI-SOLID PCBM OBSERVED SHALLOW (EXCAVATABLE)

INDICATES OBSTRUCTIONS ENCOUNTERED

W S Z E

0 50 100
SCALE IN FEET

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

HALEY ALDRICH

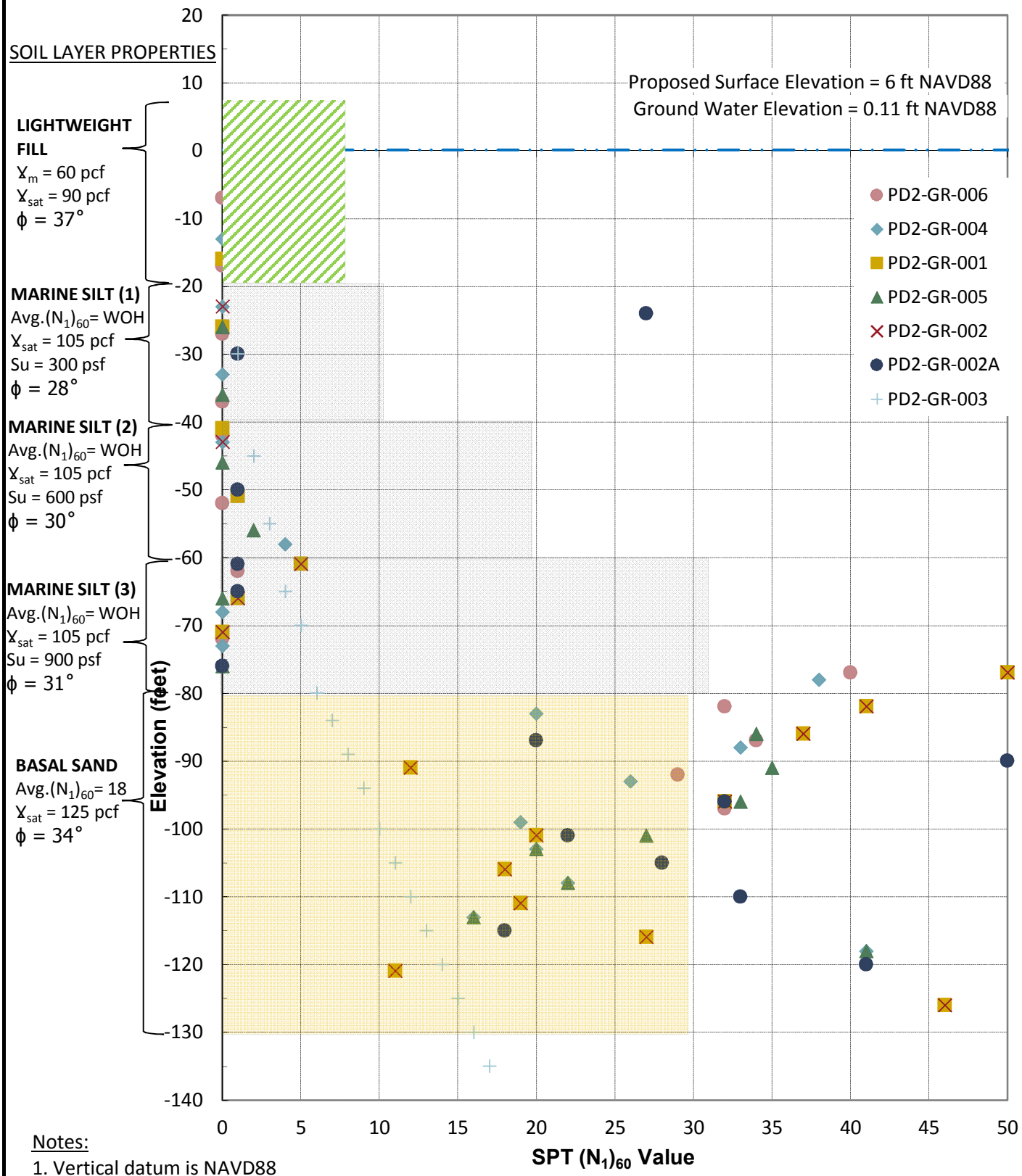
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

LOCATION PLAN - EXTENSION ALIGNMENT BORINGS AND PROBES

SCALE: AS SHOWN
AUGUST 2015

FIGURE 3.4A

POSTOLOWSKI, KEVIN Printed: 7/29/2015 11:00 AM Layout: FIG 3.4A
\\ROCCIFS01\COMMON\PROJECTS\28612\250 - RFS\CAD\PLAN VIEWS & SECTIONS\28612-362-0012 AS-DRILLED LOCS (JULY-2015).DWG



Notes:

1. Vertical datum is NAVD88
2. SPT values have been adjusted from the field value to account for a loss in freefall energy and sample method.
3. SPTs with (N1)60 Values > 50 are shown as 50
4. SPT = Standard Penetration Test; pcf = pounds per cubic foot; psf = pounds per square foot
5. Soil layer properties estimated using US Army Corps of Engineers, No. 15, Design of Sheet Piles Walls. 1996.

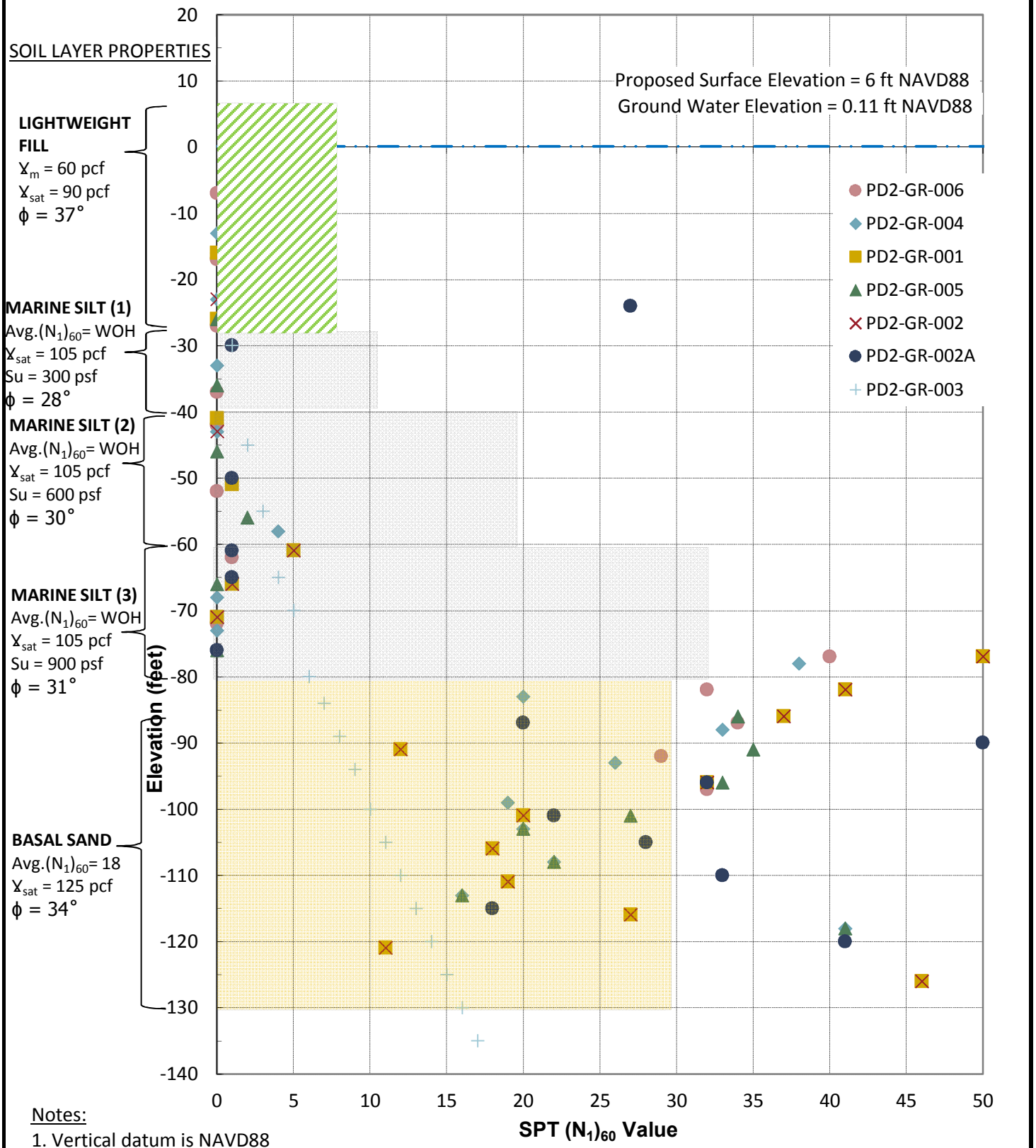
Atlantic Richfield Company
Former Anaconda Wire and Cable Plant Site
Hastings-on-Hudson, New York
Basis of Design

Bulkhead Soil Profile 01 - SPT Data

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

ms_In-Water Soil Profile_092917_Soil Profile 01_9/29/2017



Notes:

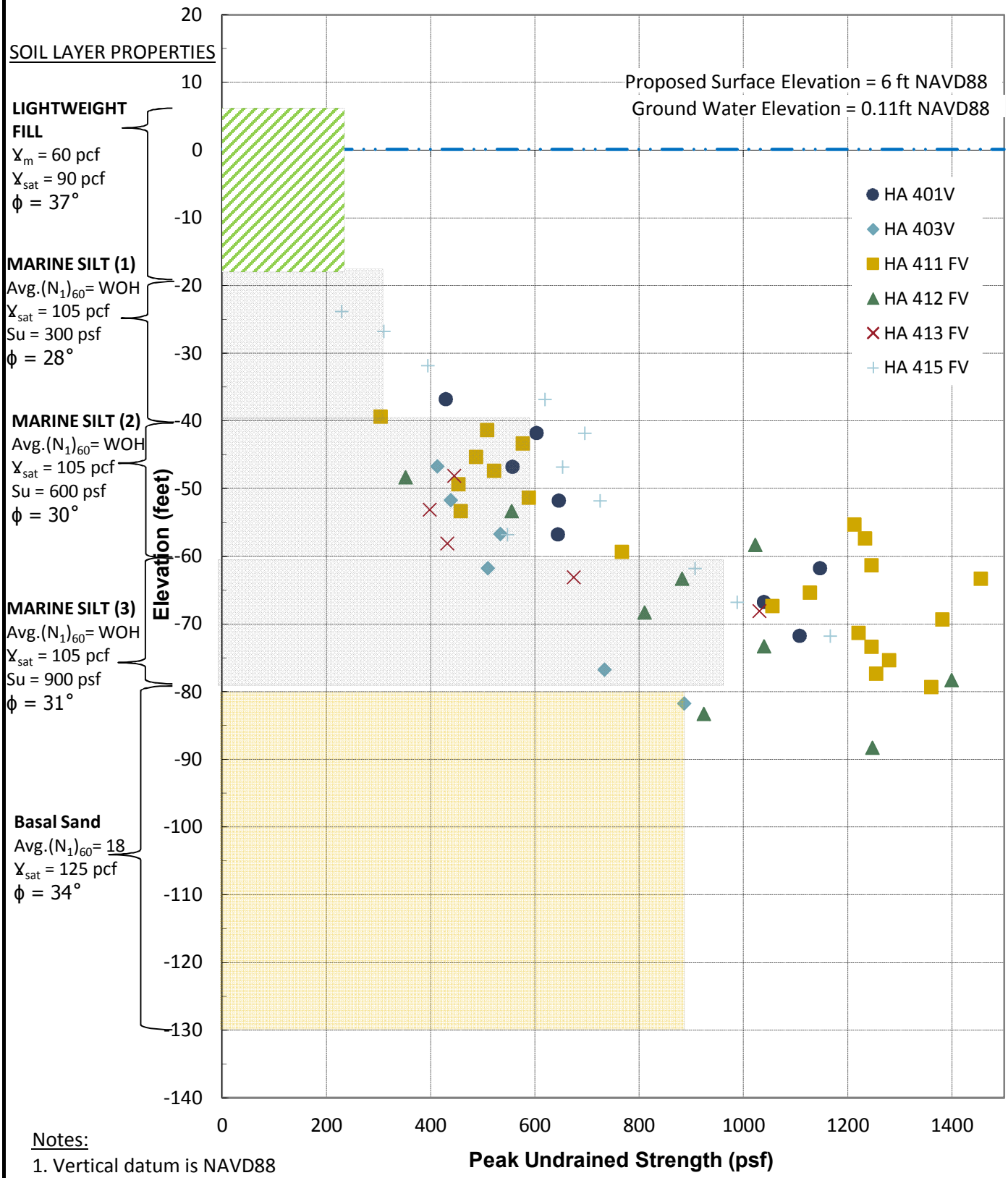
1. Vertical datum is NAVD88
2. SPT values have been adjusted from the field value to account for a loss in freefall energy and sample method.
3. SPTs with (N1)60 Values > 50 are shown as 50
4. SPT = Standard Penetration Test; pcf = pounds per cubic foot; psf = pounds per square foot
5. Soil layer properties estimated using US Army Corps of Engineers, No. 15, Design of Sheet Piles Walls. 1996.

Atlantic Richfield Company
Former Anaconda Wire and Cable Plant Site
Hastings-on-Hudson, New York
Basis of Design

Bulkhead Soil Profile 02 - SPT Data

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2



Notes:

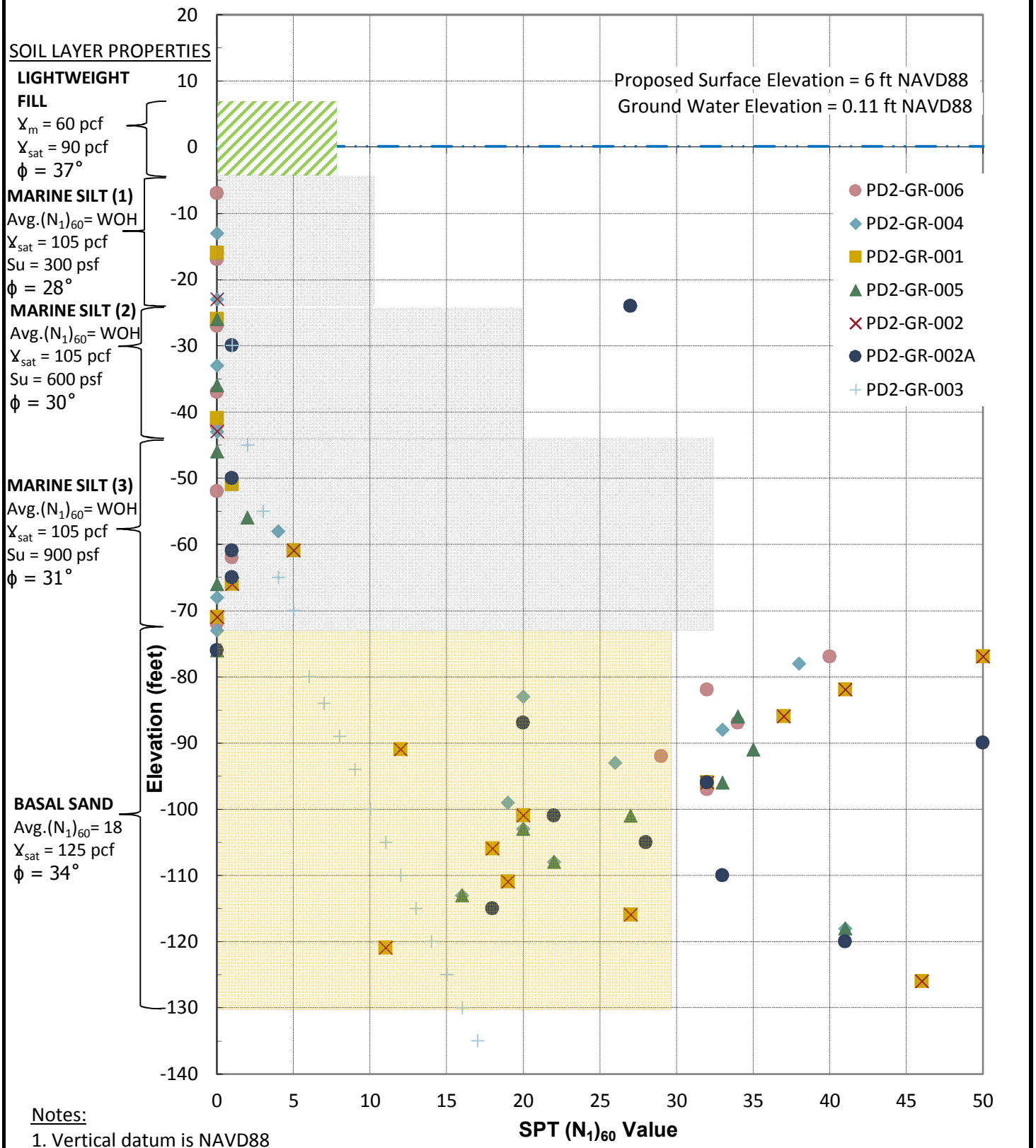
1. Vertical datum is NAVD88
2. pcf = pounds per cubic foot; psf = pounds per square foot
3. Soil layer properties estimated using US Army Corps of Engineers, No. 15, Design of Sheet Piles Walls. 1996.
4. Field vane shear tests collected by Alan J. Lutenegger. Ph.D. as part of Geotechnical Data Report for 2007-2008 .

Atlantic Richfield Company
Former Anaconda Wire and Cable Plant Site
Hastings-on-Hudson, New York
Basis of Design

Bulkhead Soil Profile - Vane Shear Data

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2B



Notes:

1. Vertical datum is NAVD88
2. SPT values have been adjusted from the field value to account for a loss in freefall energy and sample method.
3. SPTs with (N1)60 Values > 50 are shown as 50
4. SPT = Standard Penetration Test; pcf = pounds per cubic foot; psf = pounds per square foot
5. Soil layer properties estimated using US Army Corps of Engineers, No. 15, Design of Sheet Piles Walls. 1996.

Atlantic Richfield Company
Former Anaconda Wire and Cable Plant Site
Hastings-on-Hudson, New York
Basis of Design

Bulkhead Soil Profile 03 - SPT Data

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

ARCADIS Design & Consultancy for natural and built assets

Attachment D

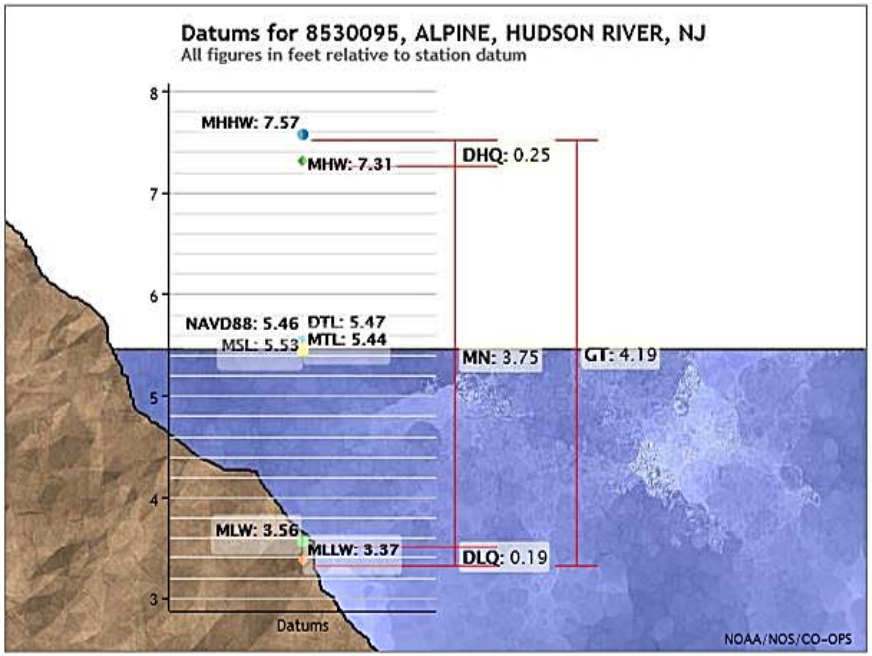
Groundwater References and Data Summary

Datums for 8530095, ALPINE, HUDSON RIVER NJ

Elevations on Station Datum

Station: 8530095, ALPINE, HUDSON RIVER, NJ
Status: Accepted (May 24 2004)
Units: Feet
T.M.: 75
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	7.57	Mean Higher-High Water
MHW	7.31	Mean High Water
MTL	5.44	Mean Tide Level
MSL	5.53	Mean Sea Level
DTL	5.47	Mean Diurnal Tide Level
MLW	3.56	Mean Low Water
MLLW	3.37	Mean Lower-Low Water
NAVD88	5.46	North American Vertical Datum of 1988
STND	0.00	Station Datum
GT	4.19	Great Diurnal Range
MN	3.75	Mean Range of Tide
DHQ	0.25	Mean Diurnal High Water Inequality
DLQ	0.19	Mean Diurnal Low Water Inequality
HWI	1.92	Greenwich High Water Interval (in hours)
LWI	8.25	Greenwich Low Water Interval (in hours)
Maximum		Highest Observed Water Level
Max Date & Time		Highest Observed Water Level Date and Time
Minimum		Lowest Observed Water Level
Min Date & Time		Lowest Observed Water Level Date and Time
HAT		Highest Astronomical Tide
HAT Date & Time		HAT Date and Time
LAT		Lowest Astronomical Tide



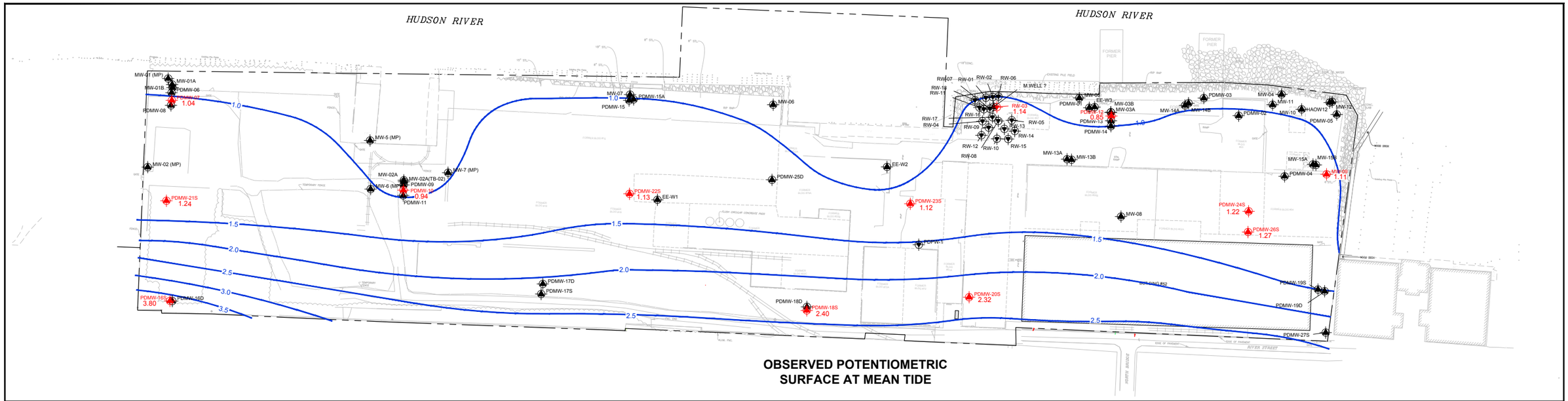
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8530095 ALPINE, HUDSON...

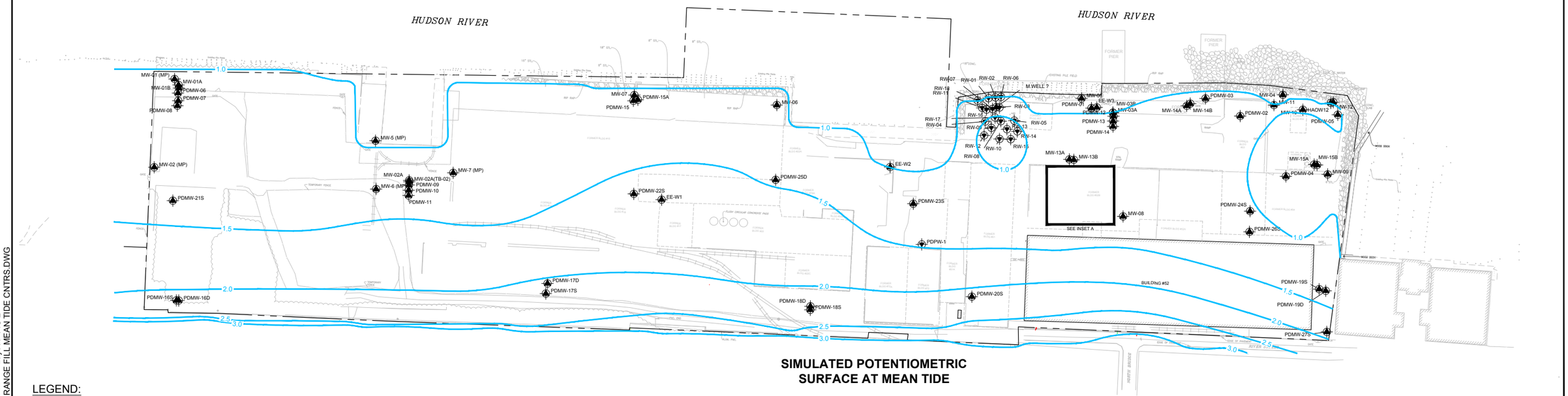
Data Units ◉ Feet ○ Meters

Epoch ◉ Present (1983-2001) ○ Superseded (1960-1978)

Submit



OBSERVED POTENTIOMETRIC SURFACE AT MEAN TIDE



SIMULATED POTENTIOMETRIC SURFACE AT MEAN TIDE

LEGEND:

- MONITORING WELL USED AS CALIBRATION POINT
- EXISTING MONITORING WELL
- 3.80 GROUNDWATER ELEVATION AT WELL
- 1.5 POTENTIOMETRIC SURFACE AT MEAN TIDE CONTOUR (0.5 FT. INTERVAL)
- 1.0 POTENTIOMETRIC SURFACE AT MEAN TIDE CONTOUR (0.5 FT. INTERVAL)
- PROPERTY LINE
- EXISTING STRUCTURES
- FORMER STRUCTURES
- FENCE
- RIP RAP

NOTES:

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. HISTORICAL SURVEY INFORMATION PROVIDED BY PARSONS IN JULY 2005.
3. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

N

0 100 200 300 400
SCALE IN FEET

HALEY ALDRICH

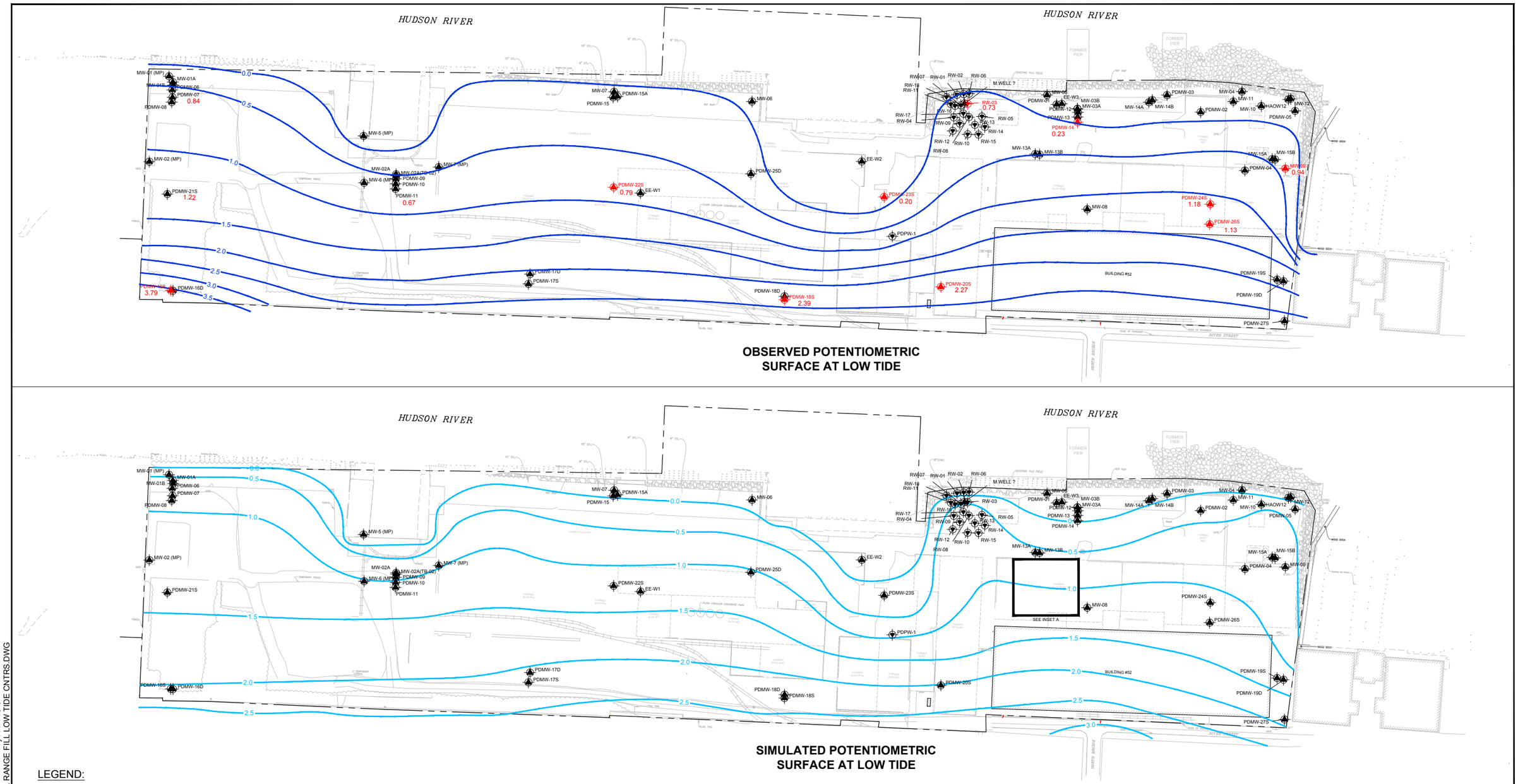
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

POTENTIOMETRIC SURFACE AT MEAN TIDE - FILL UNIT SIMULATED VS. OBSERVED JULY 1, 2014

SCALE: AS SHOWN
FEBRUARY 2016

FIGURE 2

POSTOLOWSKI, KEVIN Printed: 2/18/2016 3:21 PM Layout: FIG 2
G:\28612\GLOBAL\CAD\28612_358_0033_TIDAL RANGE FILL MEAN TIDE CNTRS.DWG



OBSERVED POTENTIOMETRIC SURFACE AT LOW TIDE

SIMULATED POTENTIOMETRIC SURFACE AT LOW TIDE

LEGEND:

- MONITORING WELL USED AS CALIBRATION POINT
- EXISTING MONITORING WELL
- 3.79 GROUNDWATER ELEVATION AT WELL
- 1.5 POTENTIOMETRIC SURFACE AT LOW TIDE CONTOUR (0.5 FT. INTERVAL)
- 1.0 POTENTIOMETRIC SURFACE AT LOW TIDE CONTOUR (0.5 FT. INTERVAL)
- PROPERTY LINE
- EXISTING STRUCTURES
- FORMER STRUCTURES
- FENCE
- RIP RAP

NOTES:

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. HISTORICAL SURVEY INFORMATION PROVIDED BY PARSONS IN JULY 2005.
3. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

N

0 100 200 300 400

SCALE IN FEET

HALEY ALDRICH

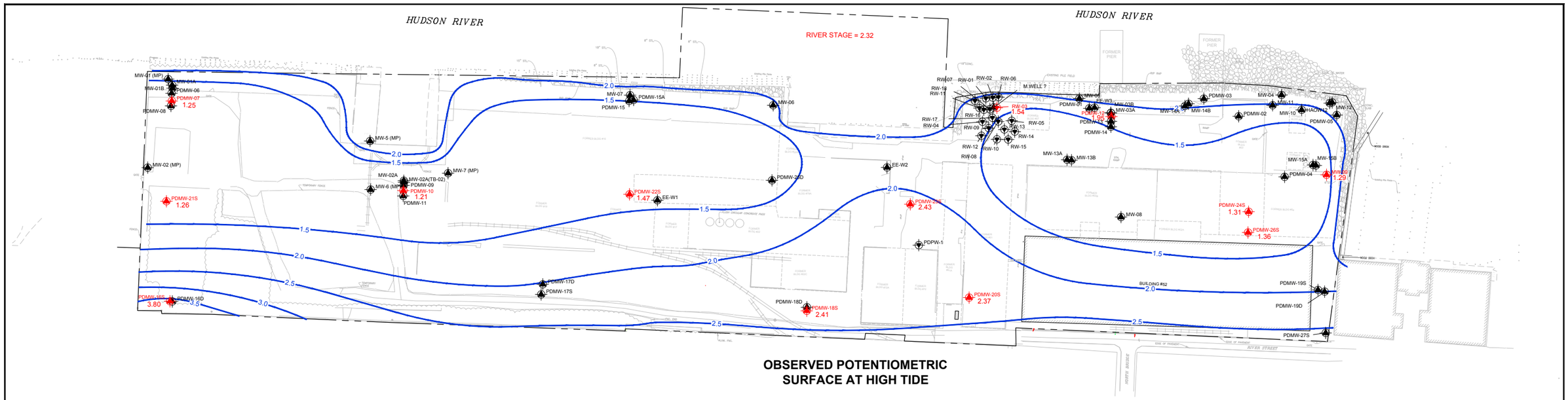
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

POTENTIOMETRIC SURFACE AT LOW TIDE - FILL UNIT SIMULATED VS. OBSERVED JULY 1, 2014

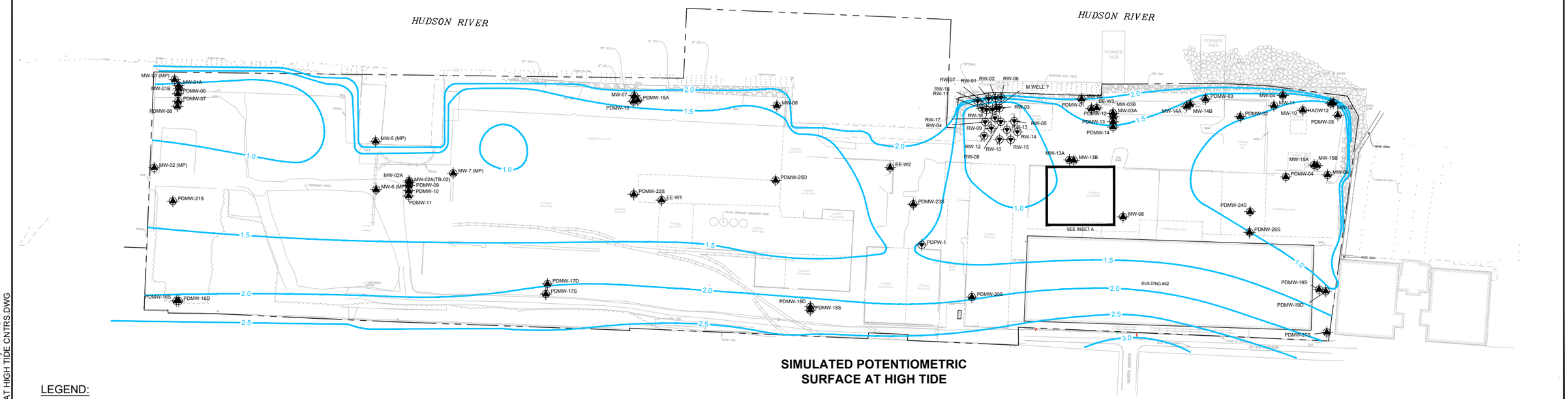
SCALE: AS SHOWN
FEBRUARY 2016

FIGURE 3

POSTOLOWSKI, KEVIN Printed: 2/18/2016 3:57 PM Layout: FIG 3
G:\28612\GLOBAL\CAD\28612_358_0034_TIDAL RANGE FILL LOW TIDE CNTRS.DWG



OBSERVED POTENTIOMETRIC SURFACE AT HIGH TIDE



SIMULATED POTENTIOMETRIC SURFACE AT HIGH TIDE

LEGEND:

- MONITORING WELL USED AS CALIBRATION POINT
- EXISTING MONITORING WELL
- 3.80 GROUNDWATER ELEVATION AT WELL
- 1.5 POTENTIOMETRIC SURFACE AT HIGH TIDE CONTOUR (0.5 FT. INTERVAL)
- 1.0 POTENTIOMETRIC SURFACE AT HIGH TIDE CONTOUR (0.5 FT. INTERVAL)
- PROPERTY LINE
- EXISTING STRUCTURES
- FORMER STRUCTURES
- FENCE
- RIP RAP

NOTES:

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. HISTORICAL SURVEY INFORMATION PROVIDED BY PARSONS IN JULY 2005.
3. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

N

0 100 200 300 400

SCALE IN FEET

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

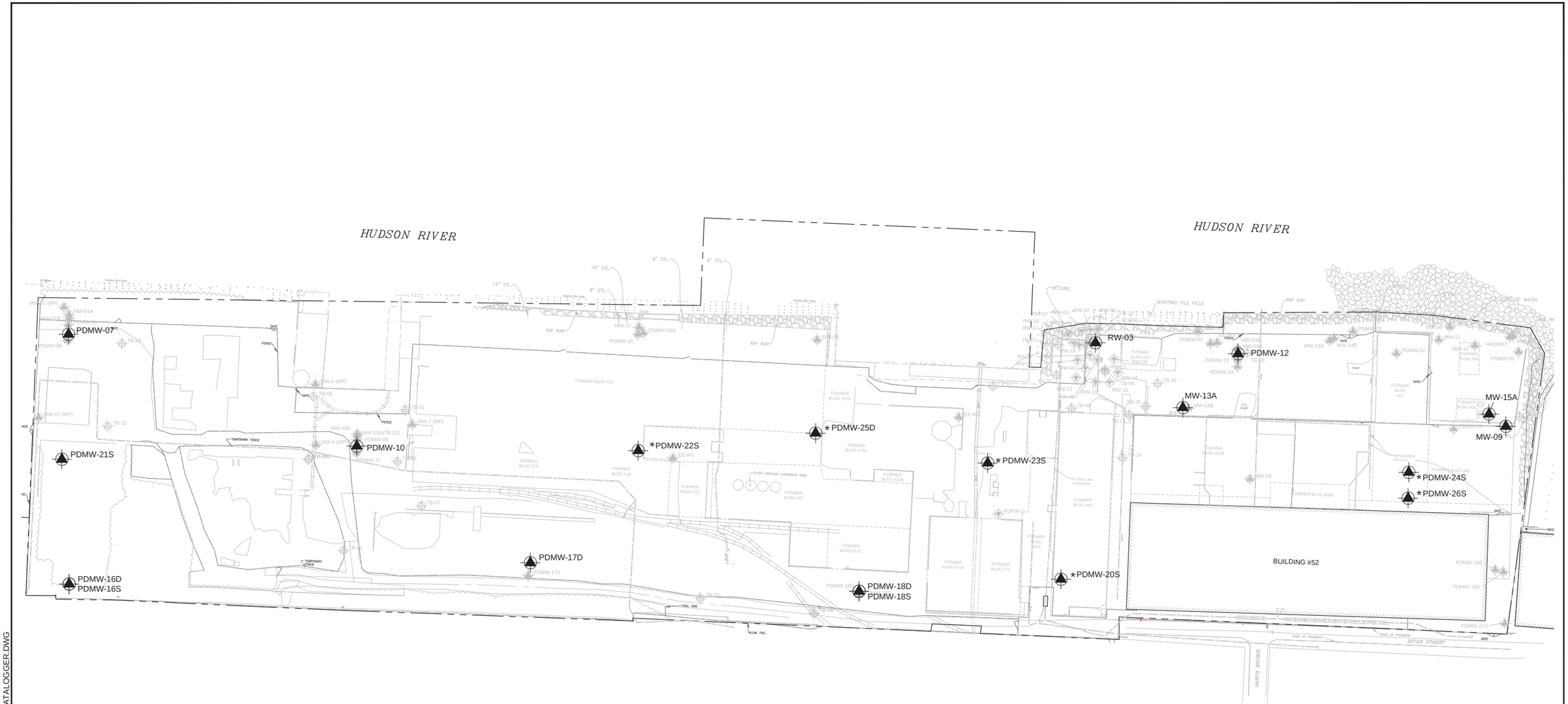
POTENTIOMETRIC SURFACE AT HIGH TIDE - FILL UNIT SIMULATED VS. OBSERVED JULY 1, 2014

SCALE: AS SHOWN
FEBRUARY 2016

FIGURE 4

POSTOLOWSKI, KEVIN Printed: 2/18/2016 3:55 PM Layout: FIG 4
G:\28612\GLOBAL\CAD\28612_358_0035_FILL AT HIGH TIDE CNTRS.DWG

2015 PDI, H&A



LEGEND

- PROPERTY LINE
- RAIL ROAD
- EXISTING STRUCTURES
- FORMER STRUCTURES
- FENCE
- RETAINING WALL
- WOODED AREA
- EXISITNG STORM SEWER OUTFALLS
- EXISITNG SANITARY SEWER FORCE MAIN
- MONITORING WELL
- PIEZOMETER
- RECOVERY WELL
- EXISITNG MONITORING WELL (PART OF DATA LOGGER INSTALLATION PLAN)
- NEWLY INSTALLED MONITORING WELL (PART OF DATA LOGGER INSTALLATION PLAN)

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

N

0 80 160 240 320

SCALE IN FEET

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

DATA LOGGER INSTALLATION PLAN

SCALE: AS SHOWN
AUGUST 2015

FIGURE 3.2A

POSTOLOWSKI, KEVIN Printed: 8/3/2015 3:20 PM Layout: FIG 3.2A
\\DTRCOMMON\28612_HASTINGS\293\CAD\28612-293-008 BATH CONT DATALOGGER.DWG

TABLE 3.2B
RECORDED HIGH AND LOW GROUNDWATER ELEVATIONS
FORMER ANACONDA WIRE & CABLE COMPANY
HASTINGS ON HUDSON, NEW YORK

		Low			High		
		Date	Time	GW Elev	Date	Time	GW Elev
Shallow Fill	MW-09	3/6/2014	9:15	0.45	5/1/2014	0:45	3.77
	PDMW-07	2/12/2014	3:30	0.04	5/1/2014	1:00	4.03
	PDMW-10	1/28/2014	4:30	-0.06	5/1/2014	1:15	2.96
	PDMW-12	1/30/2014	5:45	-0.91	4/29/2014	23:15	3.78
	PDMW-16S	9/30/2014	15:00	2.53	5/1/2014	2:00	5.48
	PDMW-18S	9/24/2014	20:00	1.87	5/1/2014	1:30	4.61
	PDMW-20S	9/24/2014	15:30	1.89	5/1/2014	2:30	4.03
	PDMW-21S	9/25/2014	10:00	0.62	5/1/2014	0:45	4.65
	PDMW-22S	1/28/2014	4:30	0.21	5/1/2014	1:15	3.70
	PDMW-23S	9/4/2014	12:30	-0.50	4/29/2014	23:30	9.65
	PDMW-24S	3/6/2014	10:15	0.69	5/1/2014	3:45	3.21
	PDMW-26S	2/12/2014	5:45	0.47	5/1/2014	3:30	3.21
	RW-03	1/28/2014	2:15	-0.24	5/1/2014	0:15	3.35
Basal Sand	MW-01B	12/14/2013	0:30	2.49	5/3/2014	1:00	5.90
	MW-13A	1/7/2014	22:15	1.14	5/17/2014	0:30	5.28
	MW-15A	1/7/2014	22:15	1.53	5/7/2014	0:30	5.26
	PDMW-16D	12/14/2013	1:30	3.09	5/17/2014	1:30	6.57
	PDMW-17D	12/14/2013	1:30	3.18	5/17/2014	0:30	6.32
	PDMW-18D	11/4/2014	1:00	3.11	5/1/2014	1:15	5.46
	PDMW-25D	11/4/2014	1:00	2.67	5/1/2014	0:30	5.53

2006 PDI (Appendix D of 50% Design)



LEGEND:
- MONITORING WELL
  PIEZOMETRIC ELEVATION (ft. NAVD88)
- ELEVATION CONTOUR (0.5-ft. INTERVAL)
- ESTIMATED ELEVATION CONTOUR (0.5-ft. INTERVAL)

NOTES:
1. DIGITAL ORTHOQUADS PROVIDED BY THE NEW YORK STATE GIS CLEARING HOUSE. THE DATASET CONTAINS REPROCESSED DIGITAL ORTHOPHOTOGRAPHY BASED ON DIGITAL ORTHOQUADS (DOQQ) FROM THE NATIONAL AERIAL PHOTOGRAPHY PROGRAM (NAPP) 1994-1998 (2000). NOTE THAT AERIAL NOT REPRESENTATIVE OF CONDITIONS DURING PDI.
2. GROUNDWATER LEVEL MONITORING CONDUCTED BY HALEY & ALDRICH OF NEW YORK ON 9 NOVEMBER 2005.
3. REFERENCED NORTH AMERICAN VERTICAL DATUM 1988.
4. PIEZOMETRIC ELEVATION CONTOURS INTERPRETED BY HALEY & ALDRICH OF NEW YORK. CONTOUR INTERVAL IS 0.5-ft.
5. AVERAGE HUDSON RIVER ELEVATION STAGE WAS 0.184-ft. DURING MONITORING EVENT AND ACCOUNTED FOR DURING INTERPRETATION.

N
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0 150 300
SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION NYSDEC SITE#3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

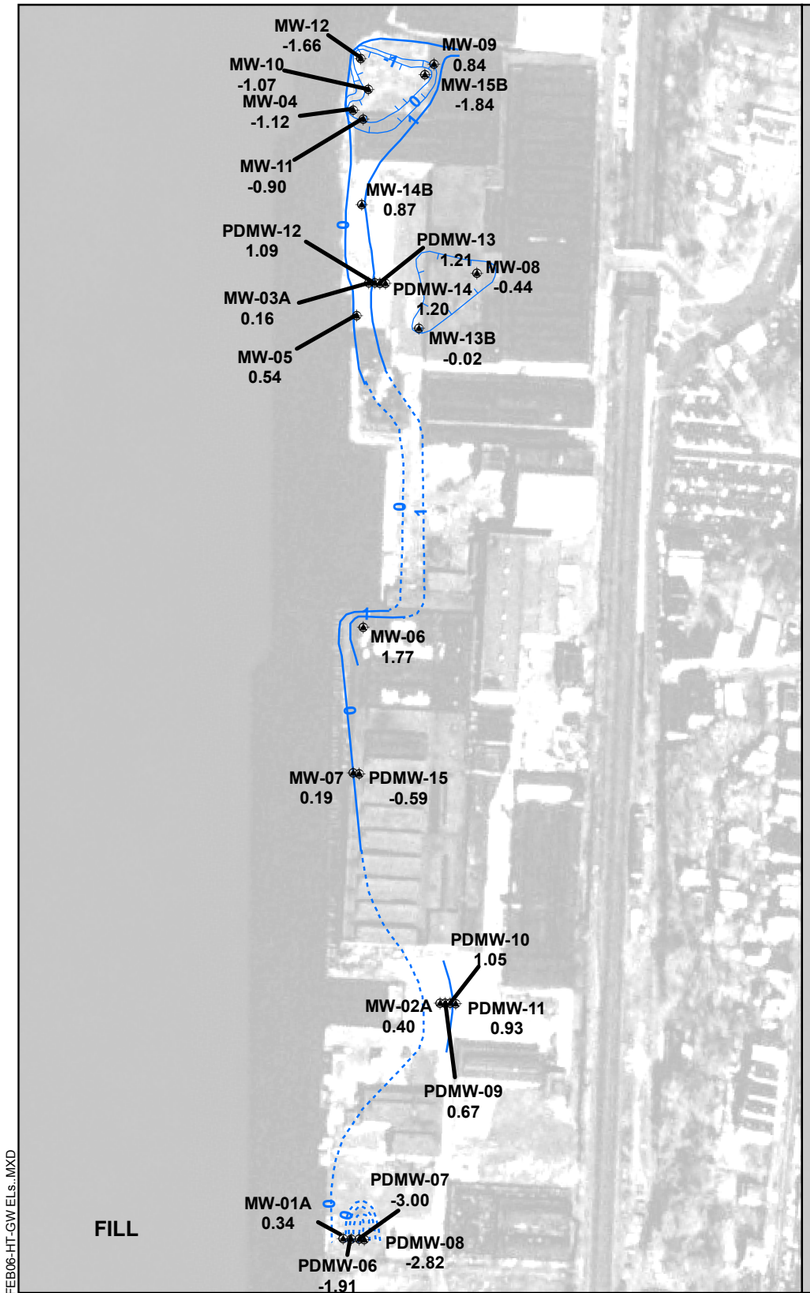
ENSR | AECOM

QUARTER 1
GROUNDWATER ELEVATION CONTOURS
(9 NOVEMBER 2005 LOW TO MID-TIDE)

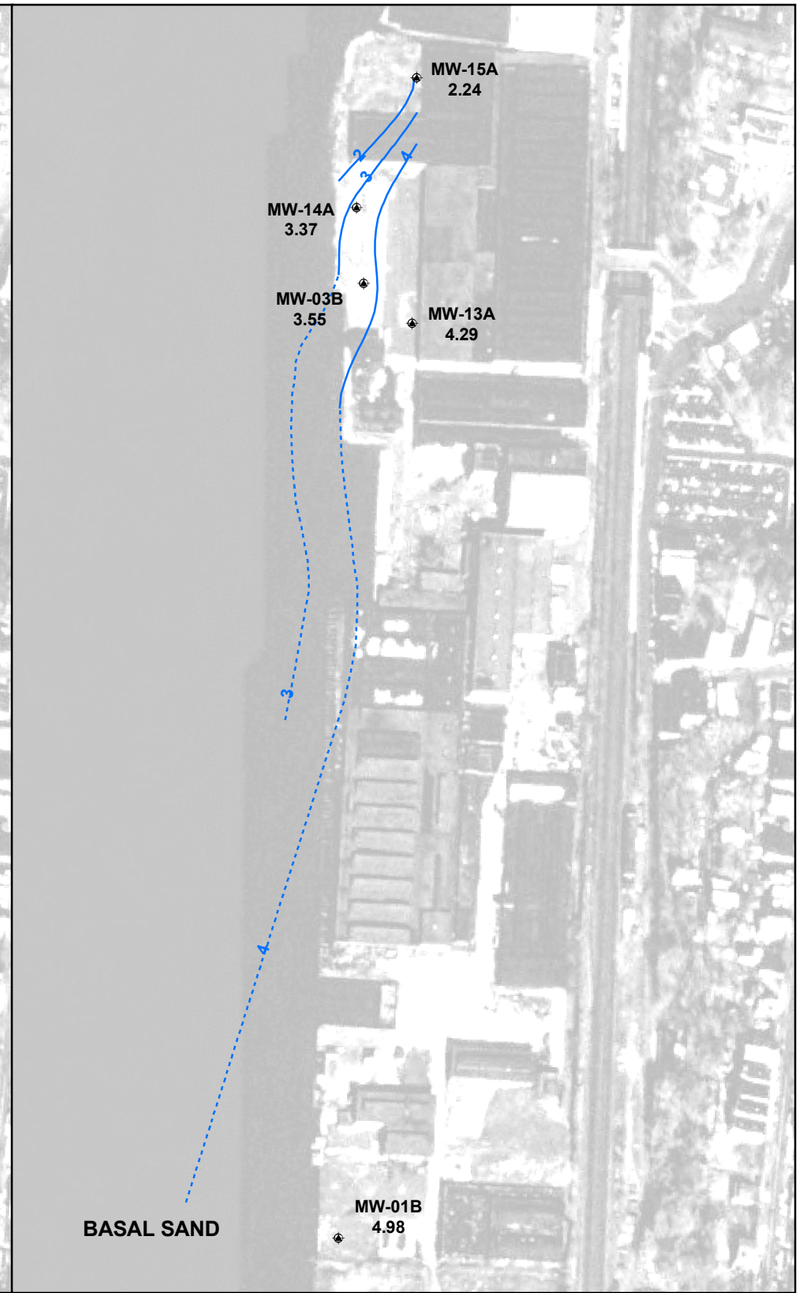
SCALE: AS SHOWN
JULY 2006

FIGURE D6.1

G:\PROJECTS\28612\GIS\FIGURES\9NOVE05-GE ELs.MXD







LEGEND:
- MONITORING WELL PIEZOMETRIC ELEVATION (ft. NAVD88)
- ELEVATION CONTOUR (1.0-ft. INTERVAL)
- ESTIMATED ELEVATION CONTOUR (1.0-ft. INTERVAL)

NOTES:
1. DIGITAL ORTHOQUADS PROVIDED BY THE NEW YORK STATE GIS CLEARING HOUSE. THE DATASET CONTAINS REPROCESSED DIGITAL ORTHOPHOTOGRAPHY BASED ON DIGITAL ORTHOQUADS (DOQQ) FROM THE NATIONAL AERIAL PHOTOGRAPHY PROGRAM (NAPP) 1994-1998 (2000). NOTE THAT AERIAL NOT REPRESENTATIVE OF CONDITIONS DURING PDI.
2. GROUNDWATER LEVEL MONITORING CONDUCTED BY HALEY & ALDRICH OF NEW YORK ON 20 FEBRUARY 2006.
3. REFERENCED NORTH AMERICAN VERTICAL DATUM 1988.
4. PIEZOMETRIC ELEVATION CONTOURS INTERPRETED BY HALEY & ALDRICH OF NEW YORK. CONTOUR INTERVAL IS 0.5-ft.
5. AVERAGE HUDSON RIVER ELEVATION STAGE WAS 0.49-ft. DURING MONITORING EVENT AND ACCOUNTED FOR DURING INTERPRETATION.

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SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION NYSDEC SITE#3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

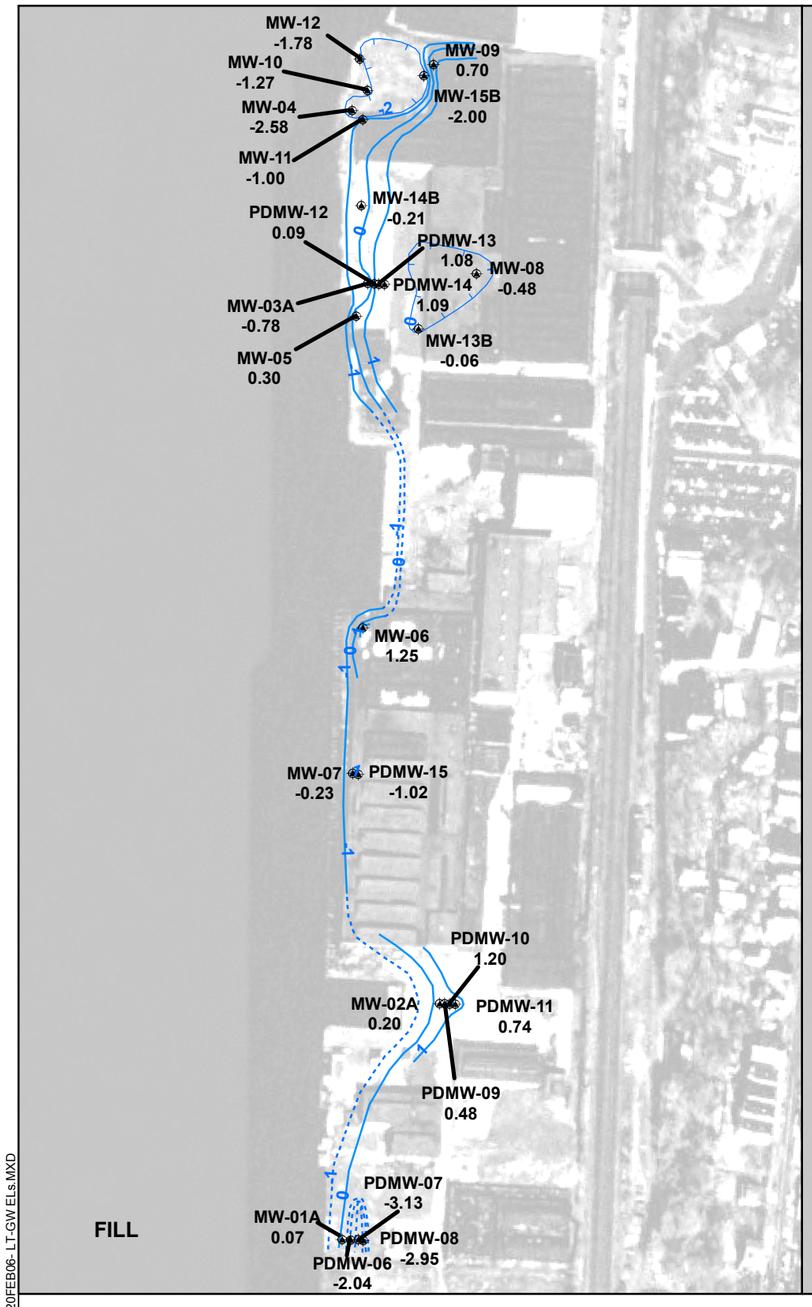
ENSR | AECOM

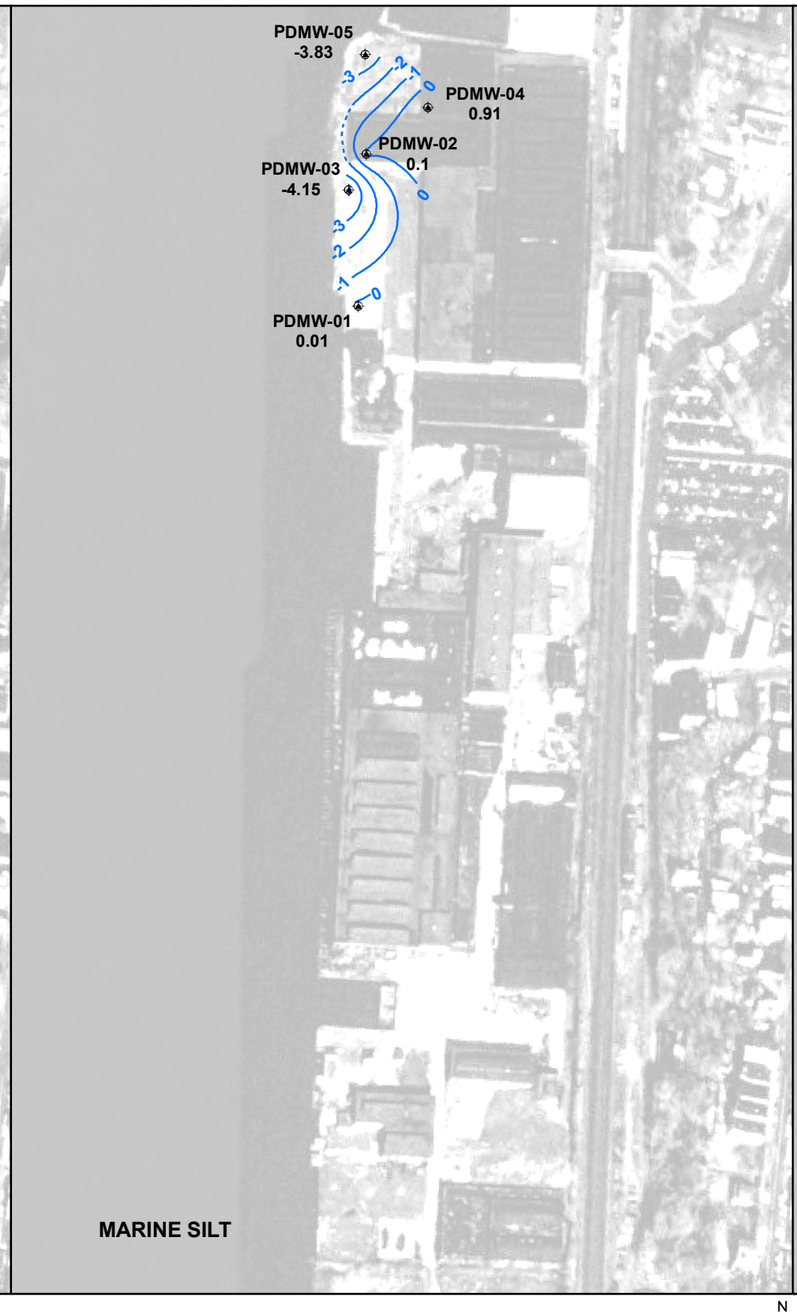
QUARTER 2 GROUNDWATER ELEVATION CONTOURS (20 FEBRUARY 2006- HIGH TIDE)

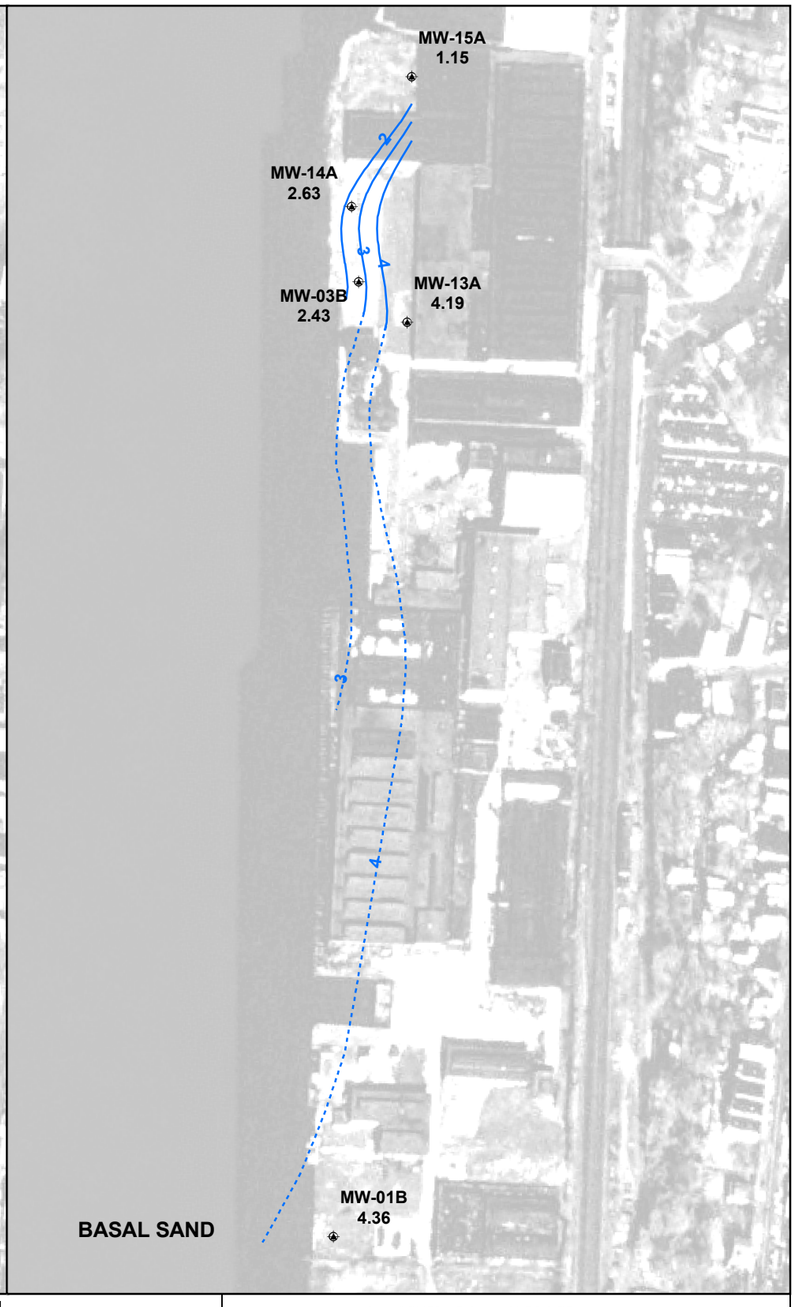
SCALE: AS SHOWN
JULY 2006

FIGURE D6.2

G:\PROJECTS\28612\GIS\FIGURES\20FEB06-HT-GW ELs.MXD







LEGEND:
- MONITORING WELL
  PIEZOMETRIC ELEVATION (ft. NAVD88)
- ELEVATION CONTOUR (1.0-ft. INTERVAL)
- ESTIMATED ELEVATION CONTOUR (1.0-ft. INTERVAL)

NOTES:
1. DIGITAL ORTHOQUADS PROVIDED BY THE NEW YORK STATE GIS CLEARING HOUSE. THE DATASET CONTAINS REPROCESSED DIGITAL ORTHOPHOTOGRAPHY BASED ON DIGITAL ORTHOQUADS (DOQQ) FROM THE NATIONAL AERIAL PHOTOGRAPHY PROGRAM (NAPP) 1994-1998 (2000). NOTE THAT AERIAL NOT REPRESENTATIVE OF CONDITIONS DURING PDI.
2. GROUNDWATER LEVEL MONITORING CONDUCTED BY HALEY & ALDRICH OF NEW YORK ON 20 FEBRUARY 2006.
3. REFERENCED NORTH AMERICAN VERTICAL DATUM 1988.
4. PIEZOMETRIC ELEVATION CONTOURS INTERPRETED BY HALEY & ALDRICH OF NEW YORK. CONTOUR INTERVAL IS 1.0-ft.
5. AVERAGE HUDSON RIVER ELEVATION STAGE WAS -1.47-ft. DURING MONITORING EVENT AND ACCOUNTED FOR DURING INTERPRETATION.

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0 150 300
SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION NYSDEC SITE#3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

QUARTER 2 GROUNDWATER ELEVATION CONTOURS (20 FEBRUARY 2006- LOW TIDE)

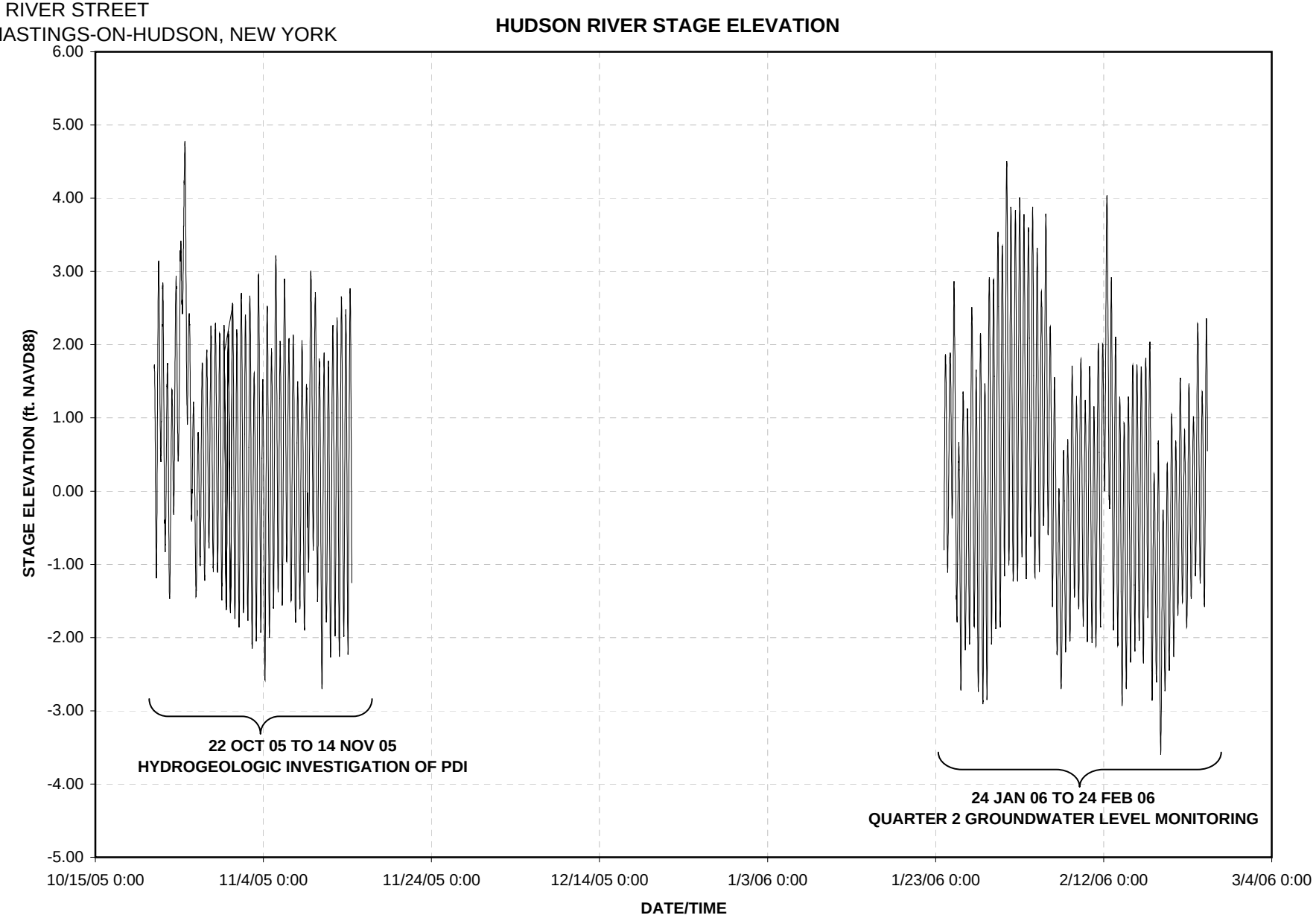
SCALE: AS SHOWN
JULY 2006

FIGURE D6.3

G:\PROJECTS\28612\GIS\FIGURES\20FEB06- LT-GW ELs.MXD

2006 PDI

FIGURE D6.4
HUDSON RIVER STAGE
OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK



HALEY & ALDRICH OF NEW YORK
TABLE 6_2- HUDSON RIVER.xls

7/19/2006

Attachment E

Boussinesq Surcharge Estimate

EXCAVATORS

COMPARE MODELS

< Back



349F L (2017)



336F L XE (2017)



349F L XE (2017)

	349F L (2017)	336F L XE (2017)	349F L XE (2017)
ENGINE			
Engine Model	Cat C13 ACERT	Cat C9.3 ACERT	Cat C13 ACERT
Net Flywheel Power	417.0 hp	306.0 hp	408.0 hp
Bore	5.12 in	4.53 in	5.12 in
Stroke	6.18 in	5.87 in	6.18 in
Displacement	763.0 in3	568.0 in3	763.0 in3

Engine Power – ISO 14396		
317 kW/425 hp/431 PS	234 kW (314 hp/318 PS)	317 kW (425 hp/431 PS)
Net Power – SAE J1349/ISO 9249		
311 kW/417 hp/423 PS	228 kW (306 hp/310 PS)	—
Net Power – SAE J1349		
—	—	304 kW (408 hp/413 PS)
Gross Power – SAE J1995		
322 kW/432 hp/438 PS	238 kW (319 hp/324 PS)	322 kW (432 hp/438 PS)
MACHINE WEIGHT		
Operating Weight**		
—	85100.0 lb	—
Note		
*349F L with long fix undercarriage, HD R6.9m (22'8") boom, R3.35m (11'0") stick, 3.1 m3 (4.1 yd3) GP bucket, 600 mm (24") DG shoes.	• *336F L XE with 5.1 mt (5.6 t) counterweight, HD reach boom, R3.2DB (10'6") stick, 2.28 m3 (2.98 yd3) GP bucket, 800 mm (32") TG shoes. • **336F L XE with 6.1 mt (6.7 t) counterweight, HD reach boom, R3.2DB (10'6") stick, 2.28 m3 (2.98 yd3) GP bucket, 800 mm (32") TG shoes.	*349F L XE with Long FIX undercarriage, 6.9 m (22'8") reach boom, R3.35TB (11'0") HD stick, 9.0 mt (9.9 t) counterweight, 3.1 m3 (4.1 yd3) bucket, 600 mm (24") DG shoes.
Operating Weight*		
107145.0 lb	81800.0 lb	108300.0 lb
WEIGHTS		
Operating Weight		
107145.0 lb	85100.0 lb	108300.0 lb
SWING MECHANISM		

DEF Tank		
—	11.0 gal	10.8 gal
DEF Tank Capacity		
11.0 gal	—	—
DIMENSIONS – LONG FIX UNDERCARRIAGE: HEAVY-DUTY R6.9M (22'8") BOOM; R3.35TB HD (11'0") STICK		
Shipping Length		
39.0 ft	—	—
Ground Clearance without Shoe Lug Height		
1.67 ft	—	—
Length to Center of Rollers		
14.33 ft	—	—
Track Gauge		
9.0 ft	—	—
Counterweight Clearance*		
4.17 ft	—	—
Transport Width – 750 mm (30") Shoes		
11.42 ft	—	—
Tail Swing Radius		
12.17 ft	—	—
Transport Width – 600 mm (24") Shoes		
10.92 ft	—	—
Note		
*Without shoe lug height.	—	—

SIZES:

Standard size crane mats include the following; 12” x 4’ x 16’, 12” x 4’ x 20’, 12” x 4’ x 24’, 12” x 4’ or 5’ x 30’. We can make 6” thick – whatever thickness you desire (X) whatever width (X) up to 100’ in length.

INVENTORY:

We try to regularly house a few hundred mats at a time of 12” x 4’ x 16’ and/or 12” x 4’ x 20’. We know mats are the last item on the jobsite so we have the inventory to cover your job site needs. Call us to get a current inventory.

USED MATS “GRADED”:

Used mats (http://selllumber.com/used-mats/) are new crane mats which have been used. The wear and usage per mat determines the quality of each mat which is categorized in 3 grades; “A” grade – still in excellent condition with minimal cosmetic damage, “B” grade – still a good mat with cosmetic damage, “C” grade – this guy has been run over quite a few times, literally but has a couple more uses out of it. Pictures are available upon request.

ENTRY / RAMP / TRANSITION MATS:

Hence the name, these mats are used to transition from ground level up onto the trestle, crane mat dance floor, or whatever you are transitioning onto. Standard size is 2”-12” taper x 4’ x 16’. Custom sizes available.

RENTAL / BUYBACK PROGRAMS:

We also rent crane mats and offer a buyback. We are easy to work with, just tell us what you are after. Call for current pricing.

LONGEVITY:

We treat the ends of our mats which increases the life of them. Ask anyone who has used our mats and they will tell you they are the best mats they have ever used.

DESIGN VALUES & WEIGHTS:

(see chart)

MAT SIZE	PER TRUCK LOAD
8″x4’x8′	60
8″x4’x10′	48
8″x4’x16′	30
8″x4’x20′	24
12″x4’x16′	20
12″x4’x20′	16
12″x4’x24′	13
12″x4’x30′	10
12″x5’x16′	16
12″x5’x20′	12
12″x5’x24′	10
12″x5’x30′	8

GRADE	Extreme fiber in bending F-b	Tension parallel to grain F-t	Comp. Parallel to grain F-c	Horizontal shear F-v	Comp. perp. To grain F-c	Modulus of Elasticity E
Dense Select Str.	1,750	1,150	1,350	170	730	1,700,000
Select Structural	1,500	1000	1,150	170	625	1,600,000
Dense No.1	1,400	950	1,200	170	730	1,700,000
No. 1	1,200	825	1,000	170	625	1,600,000
No. 2	750	475	700	170	625	1,300,000

(http://selllumber.com/wp-content/uploads/2012/05/CHART-2.jpg)

Operating Weight (lb)

CAT 349F L	107,145	lbs
Wick equipment	10,000	lbs
total	117,145	lb

Excavator Dimension and Ground Pressure Estimate

track length =	171.96	in	*14.33*	*ft*
shoe width (x2) =	60	in	*5*	*ft*
Contact Area =	10317.6	in^2		
Ground load =	11.35	psi		
	1635	psf		
Ka (0.314) x Q = uniform wall load =	513	psf		

Boussinesq Input

total, Q =	117,145	*lb*
y =	16	*ft length mats*
x =	16	*ft of 4x 4ft mats*
Q/(x*y) =	458	*psf*

y =	**20**	***ft length mats***
x =	**16**	***ft of 4x 4ft mats***
Q/(x*y) =	**366**	***psf***

Check: equivalent uniform load

Q/(x*y) = Q_2 =	458	*psf*
Ka (0.314) x Q_2 =	144	*psf*

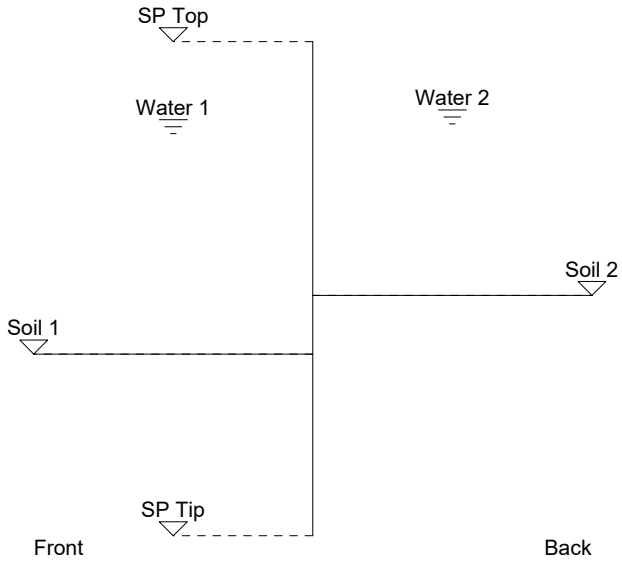
Q/(x*y) = Q_2 =	366	*psf*
Ka (0.314) x Q_2 =	115	*psf*

Attachment F

Bulkhead ProSheet Outputs

Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	50.611
Soil Level in Front [ft]	32.000
Soil Level behind [ft]	26.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

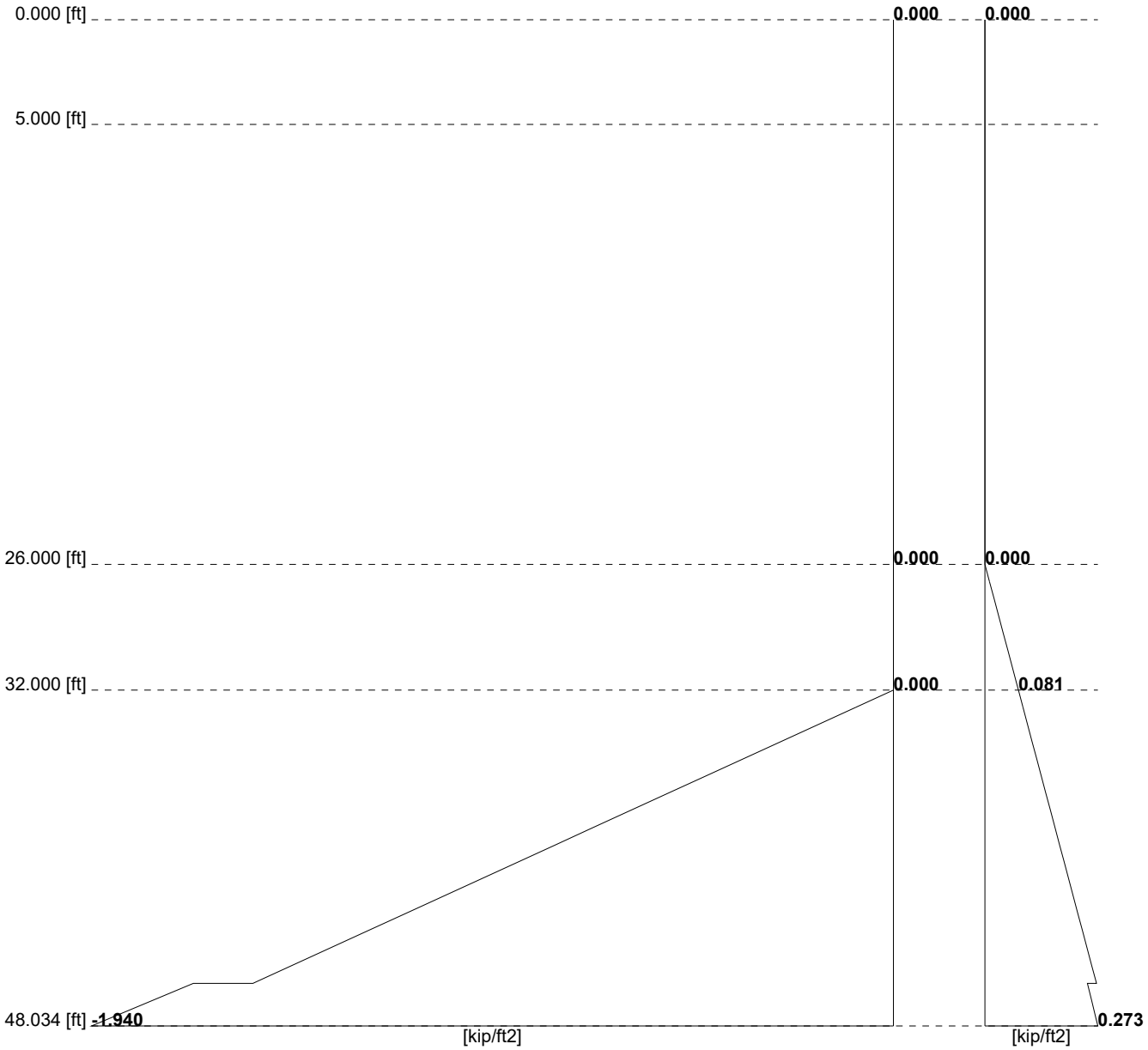
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 2	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 3	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

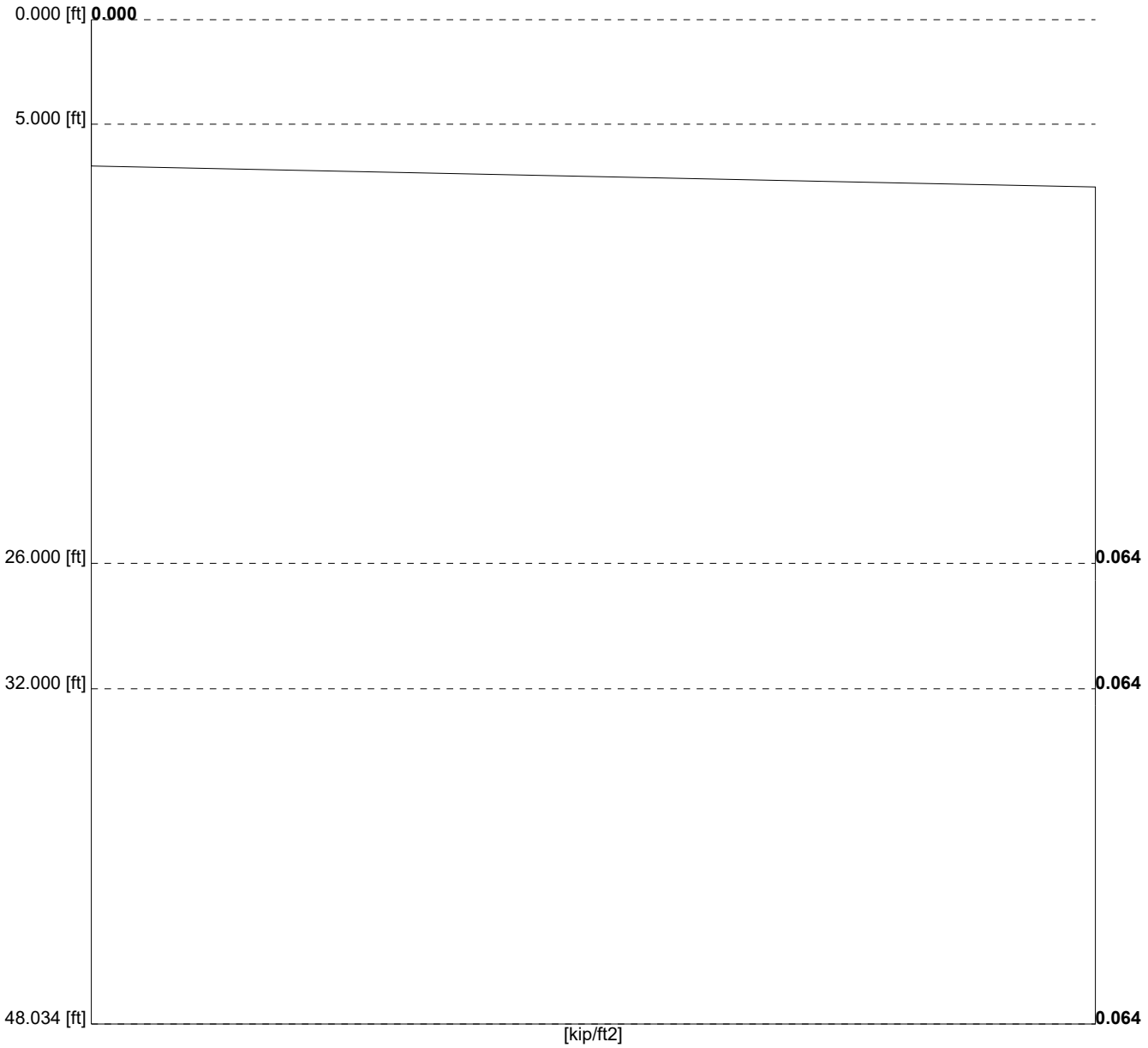
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.342	48.067
Maxmimal Moment [kipft/ft]	30.312	39.382
Normal Forces at Max. Moment [kip/ft]	-1.877	48.067
Normal Forces at Min. Moment [kip/ft]	-0.235	39.382
Deflection at Min. Moment [ft]	0.000	48.067
Deflection at Max. Moment [ft]	-0.004	39.382
Min. Stress at Min. Moment [lb/in2]	-186.338	48.067
Max. Stress at Min. Moment [lb/in2]	-90.473	48.067
Min. Stress at Max. Moment [lb/in2]	-4263.779	39.382
Max. Stress at Max. Moment [lb/in2]	4229.169	39.382
Safety > Req. Safety = 1.500	11.727	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	50.611	
Sheet Pile Length [ft]	50.611	
Included OverLength [ft]	2.577	
Vertical Equilibrium [kip/ft]	0.660	
Anchor Force (horiz.) [kip/ft]	0.000	

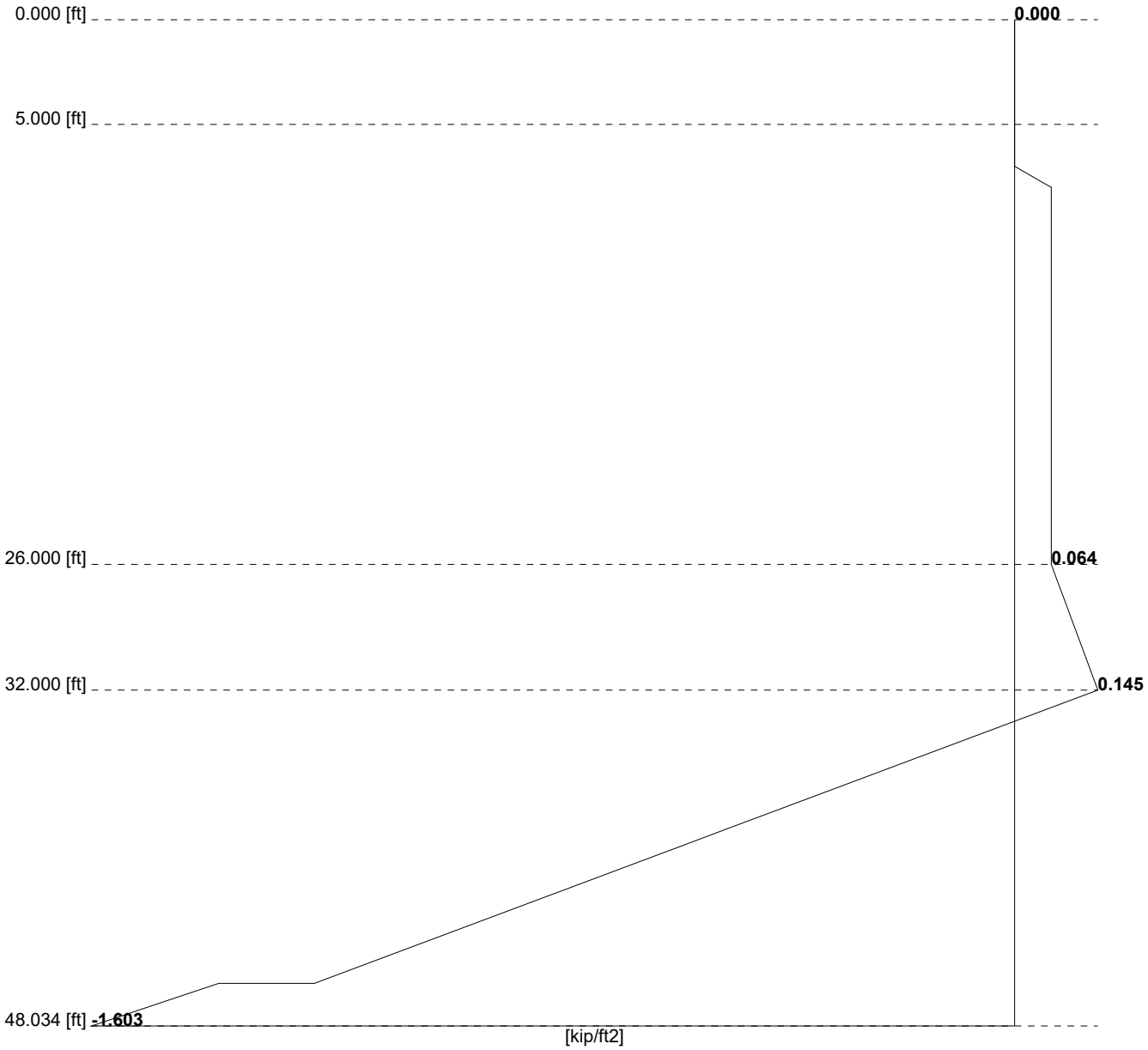
Earth Pressure Diagram



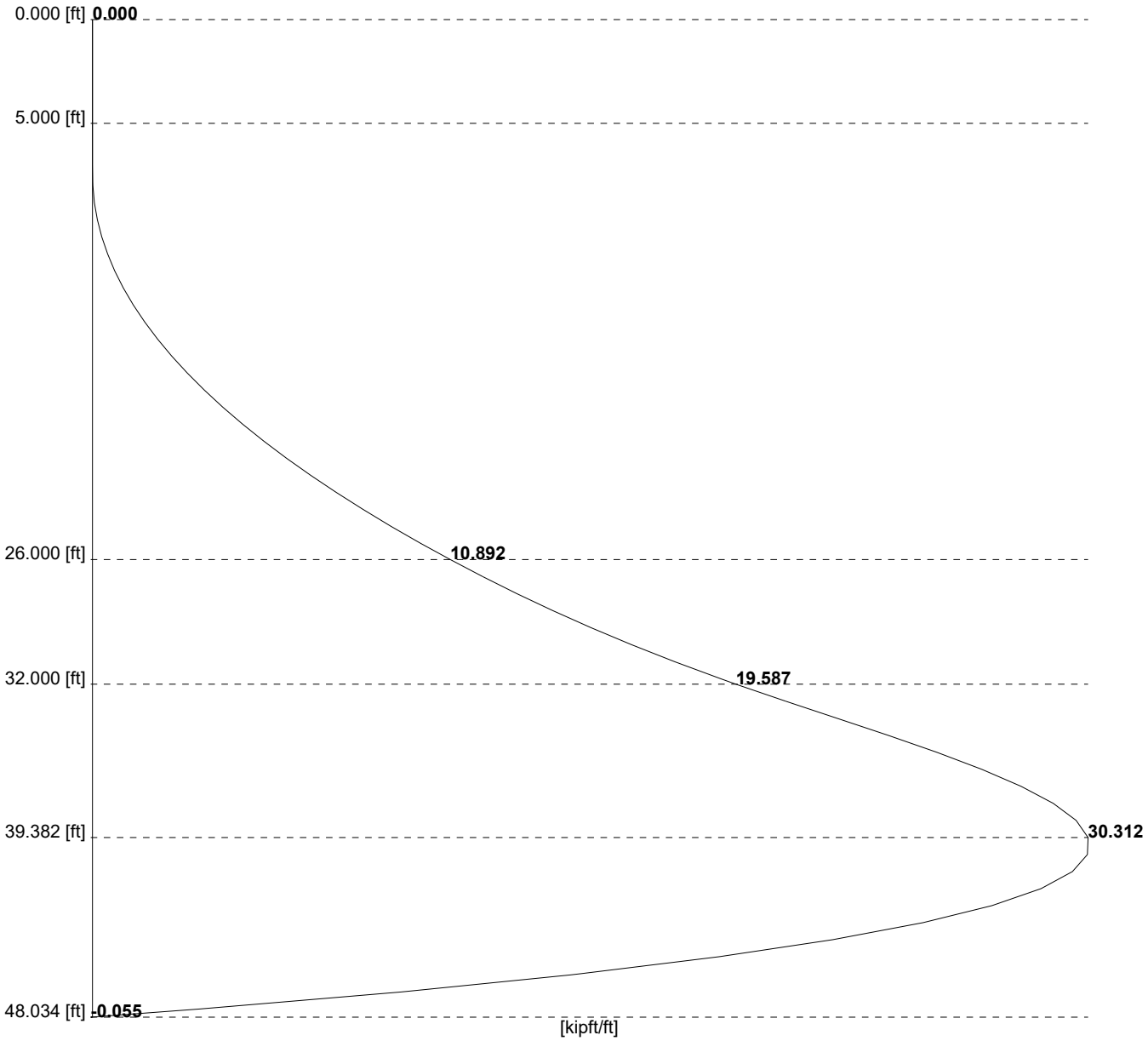
Water Pressure Diagram



Total Pressure Diagram

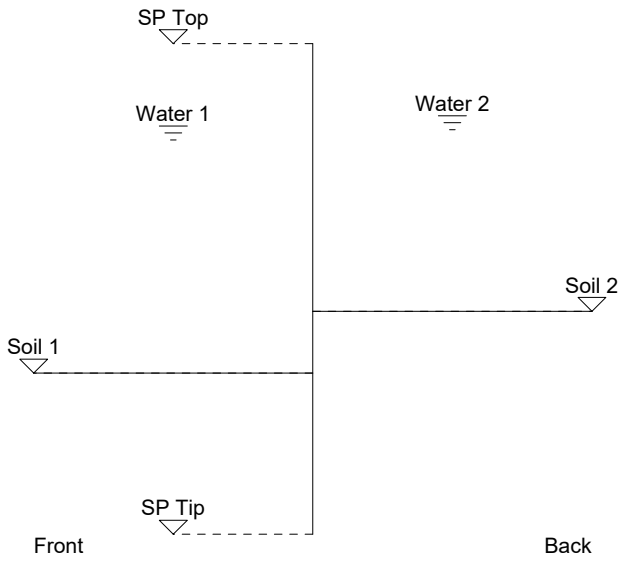


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	47.653
Soil Level in Front [ft]	32.000
Soil Level behind [ft]	26.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 2	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 3	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

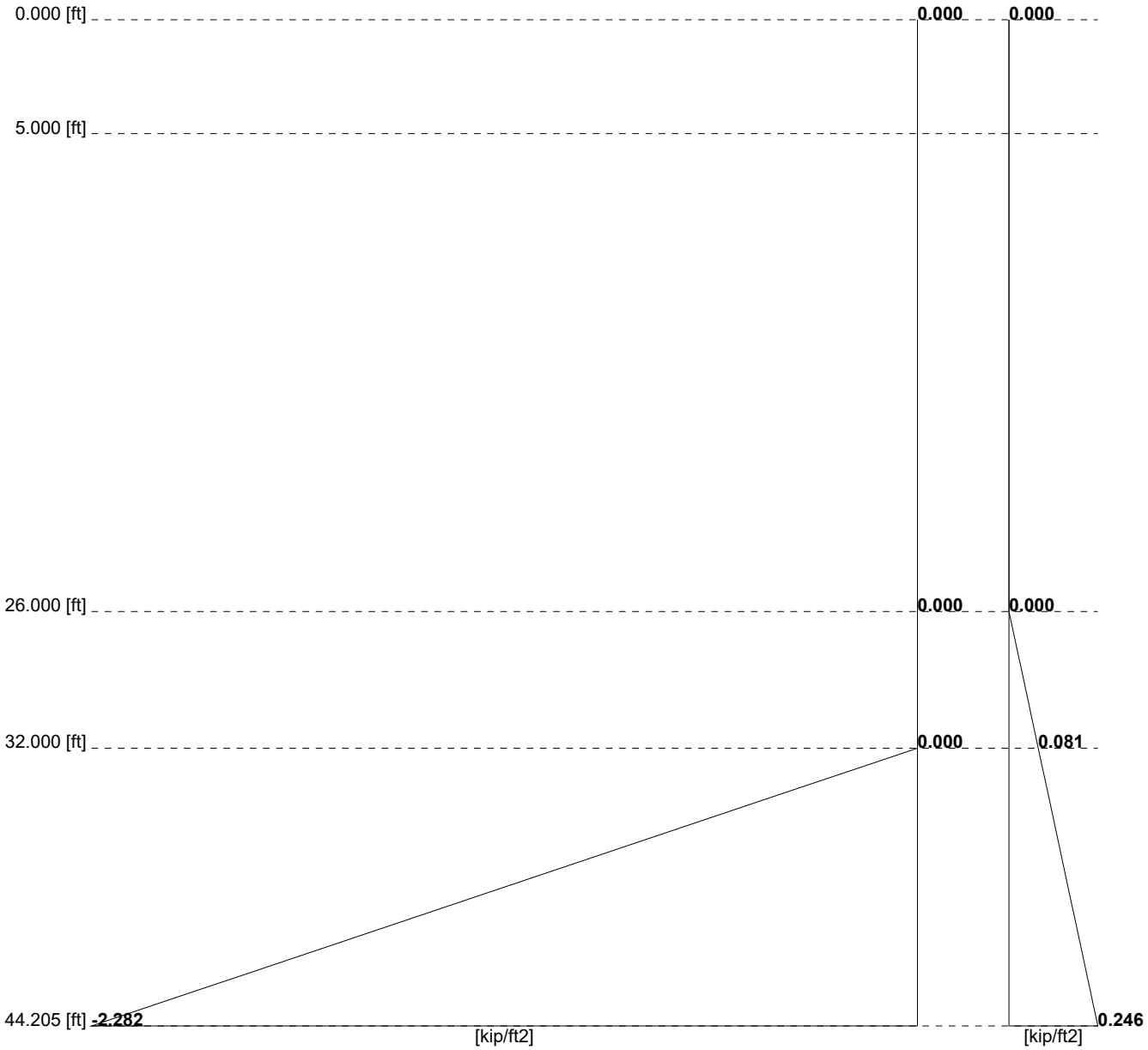
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

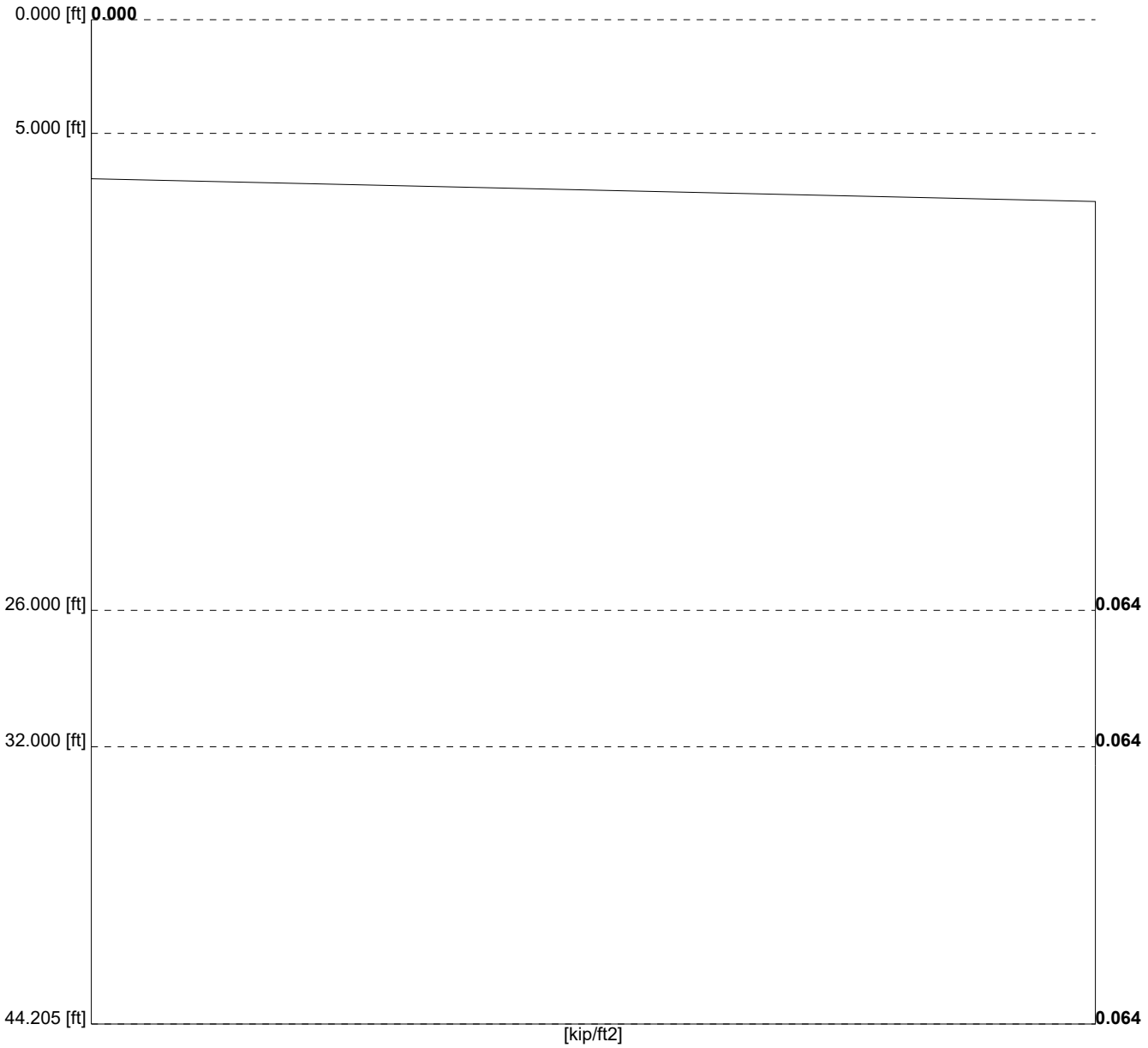
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.526	44.238
Maxmimal Moment [kipft/ft]	26.874	37.479
Normal Forces at Max. Moment [kip/ft]	-3.150	44.238
Normal Forces at Min. Moment [kip/ft]	-0.581	37.479
Deflection at Min. Moment [ft]	0.000	44.238
Deflection at Max. Moment [ft]	-0.002	37.479
Min. Stress at Min. Moment [lb/in2]	-305.964	44.238
Max. Stress at Min. Moment [lb/in2]	-158.586	44.238
Min. Stress at Max. Moment [lb/in2]	-3807.542	37.479
Max. Stress at Max. Moment [lb/in2]	3721.782	37.479
Safety > Req. Safety = 1.500	13.132	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	47.653	
Sheet Pile Length [ft]	47.653	
Included OverLength [ft]	3.448	
Vertical Equilibrium [kip/ft]	-0.622	
Anchor Force (horiz.) [kip/ft]	0.000	

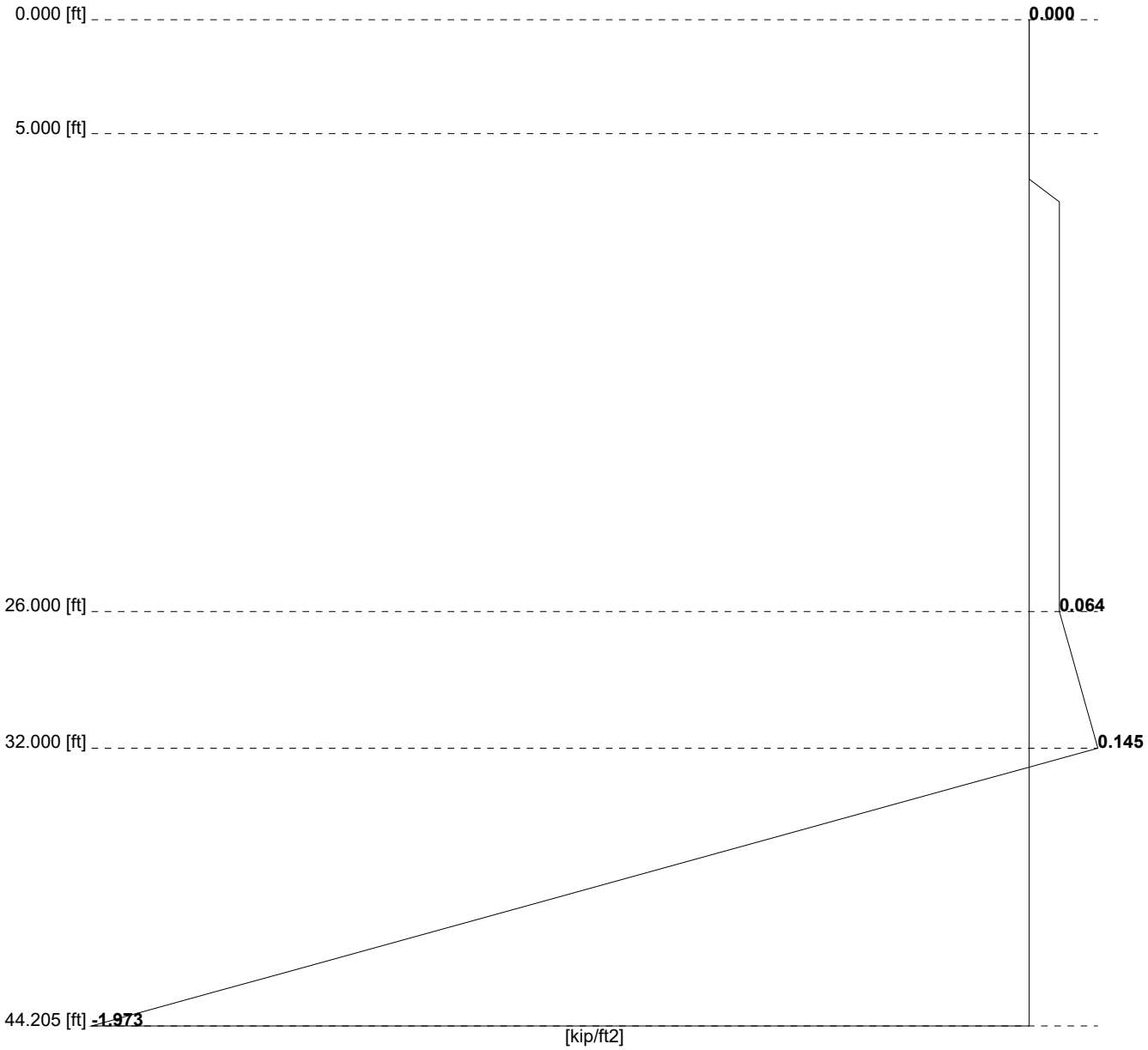
Earth Pressure Diagram



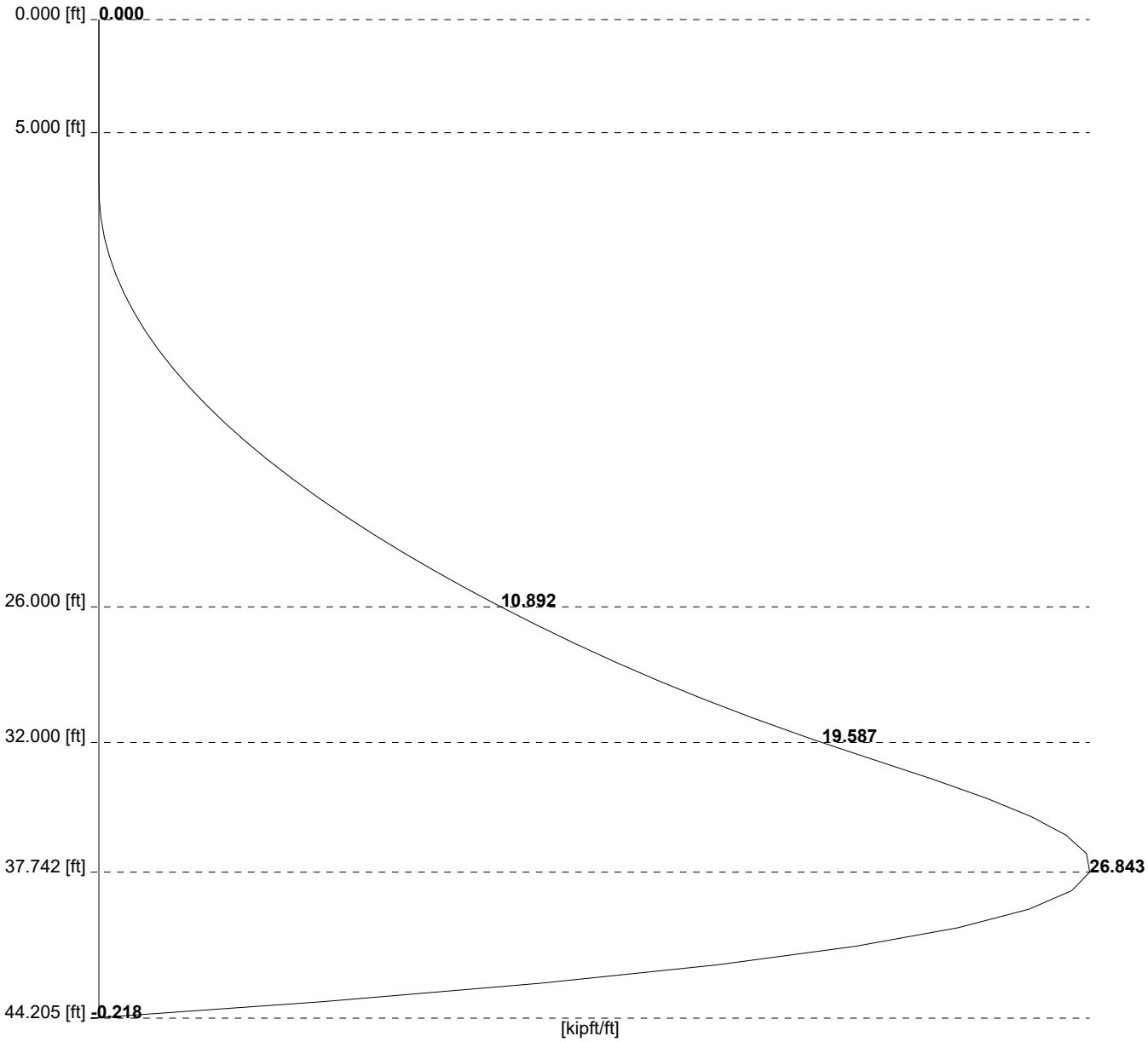
Water Pressure Diagram



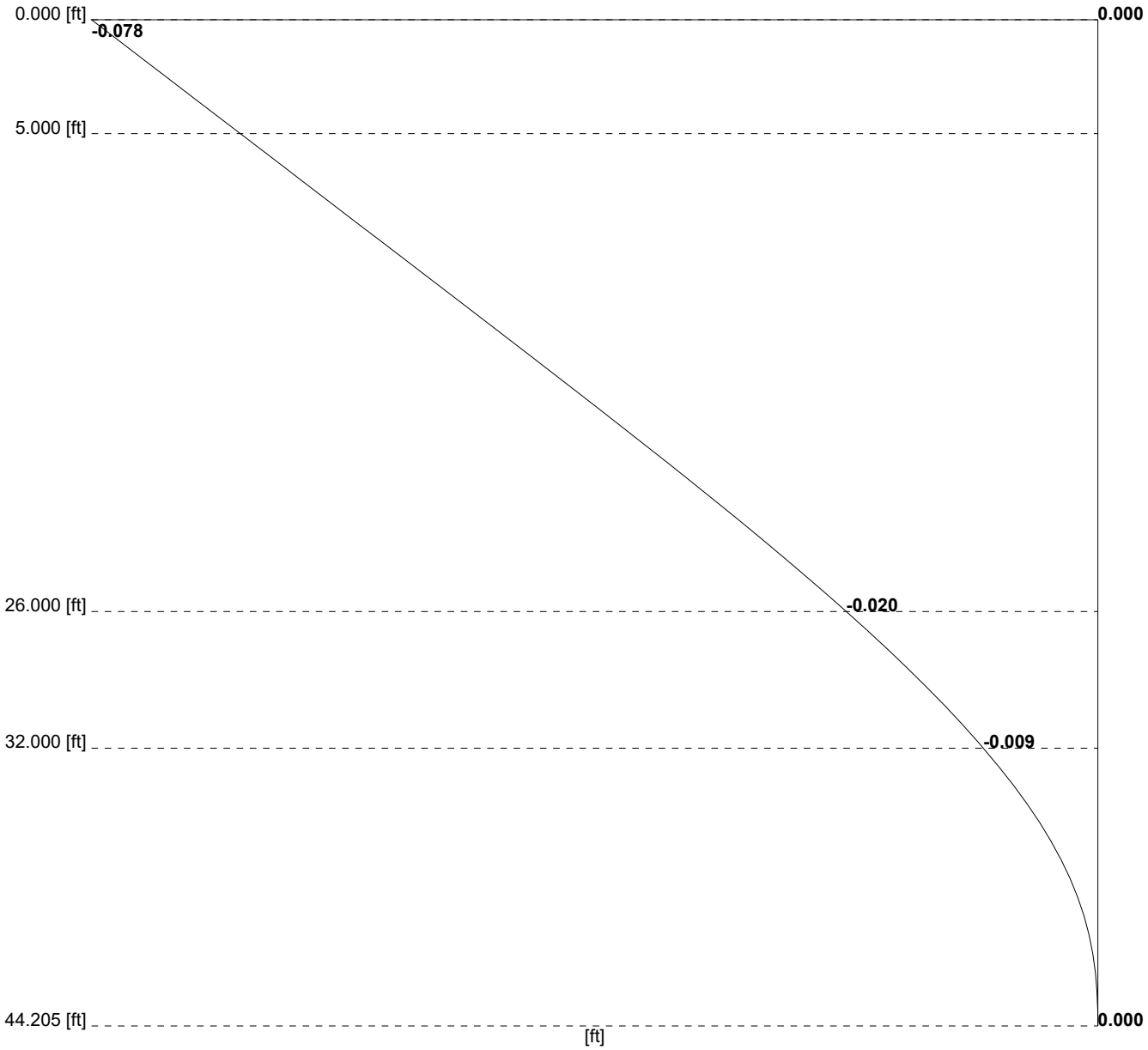
Total Pressure Diagram



Moment Diagram

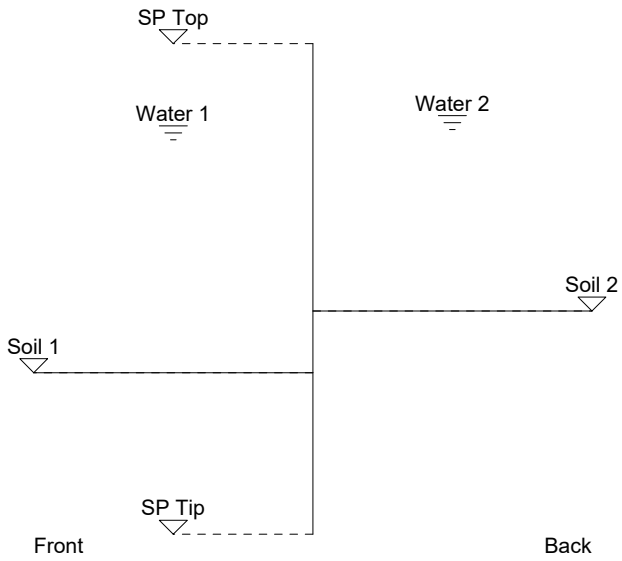


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	47.708
Soil Level in Front [ft]	32.000
Soil Level behind [ft]	26.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

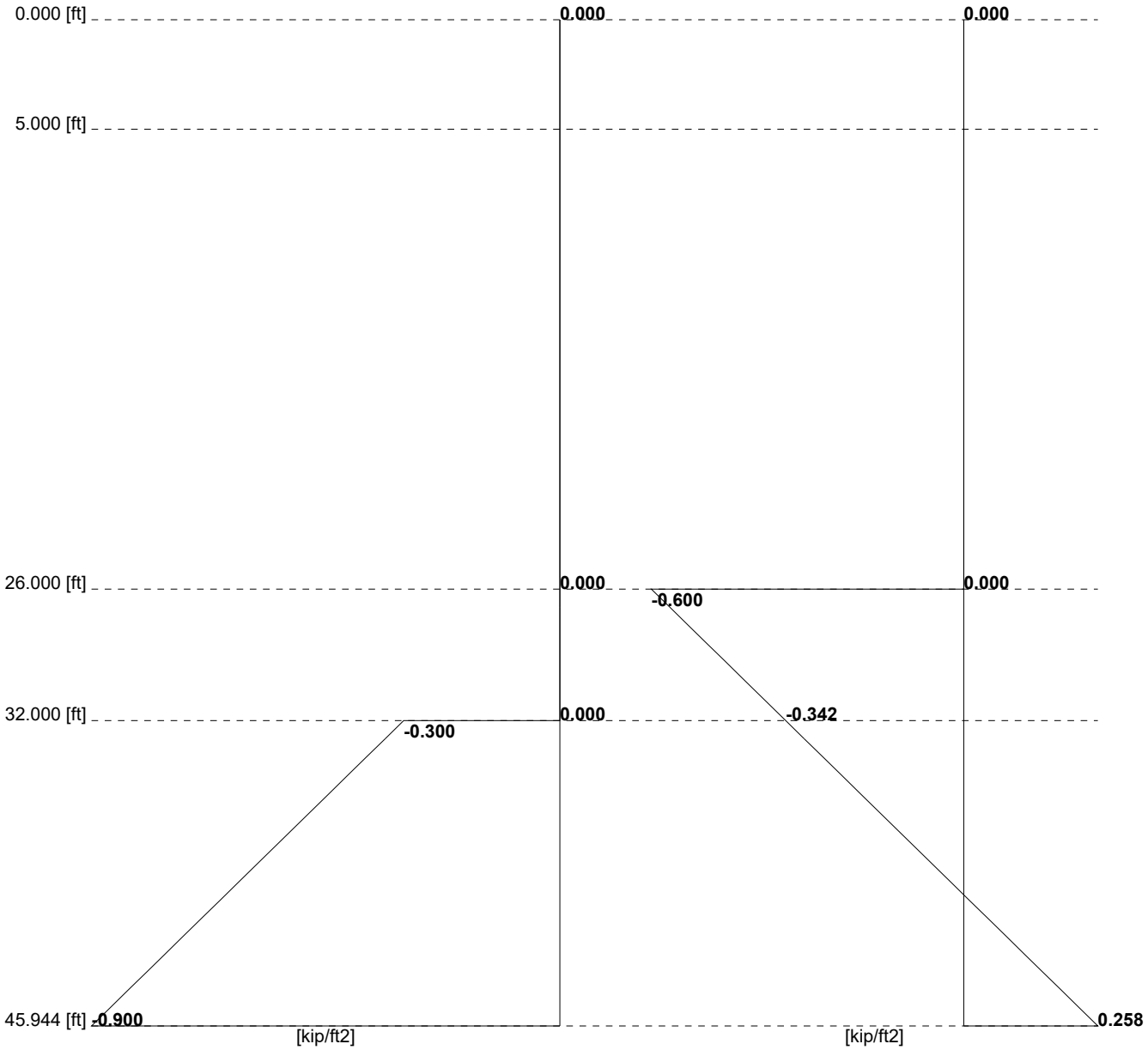
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

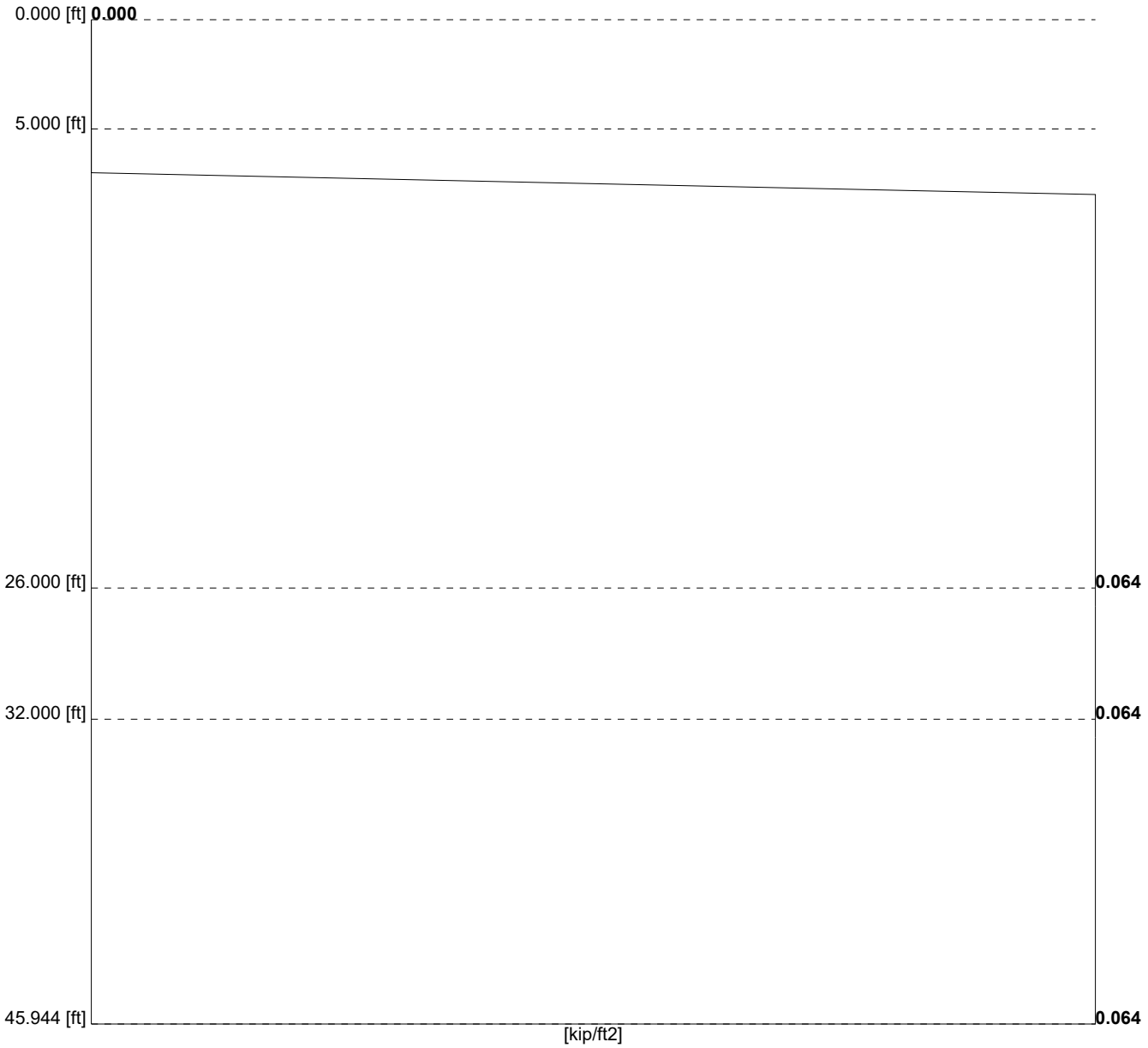
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.176	45.976
Maxmimal Moment [kipft/ft]	23.075	36.659
Normal Forces at Max. Moment [kip/ft]	0.000	45.976
Normal Forces at Min. Moment [kip/ft]	0.000	36.659
Deflection at Min. Moment [ft]	0.000	45.976
Deflection at Max. Moment [ft]	-0.003	36.659
Min. Stress at Min. Moment [lb/in2]	-24.590	45.976
Max. Stress at Min. Moment [lb/in2]	24.590	45.976
Min. Stress at Max. Moment [lb/in2]	-3232.688	36.659
Max. Stress at Max. Moment [lb/in2]	3232.688	36.659
Safety > Req. Safety = 1.500	15.467	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	47.708	
Sheet Pile Length [ft]	47.708	
Included OverLength [ft]	1.764	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

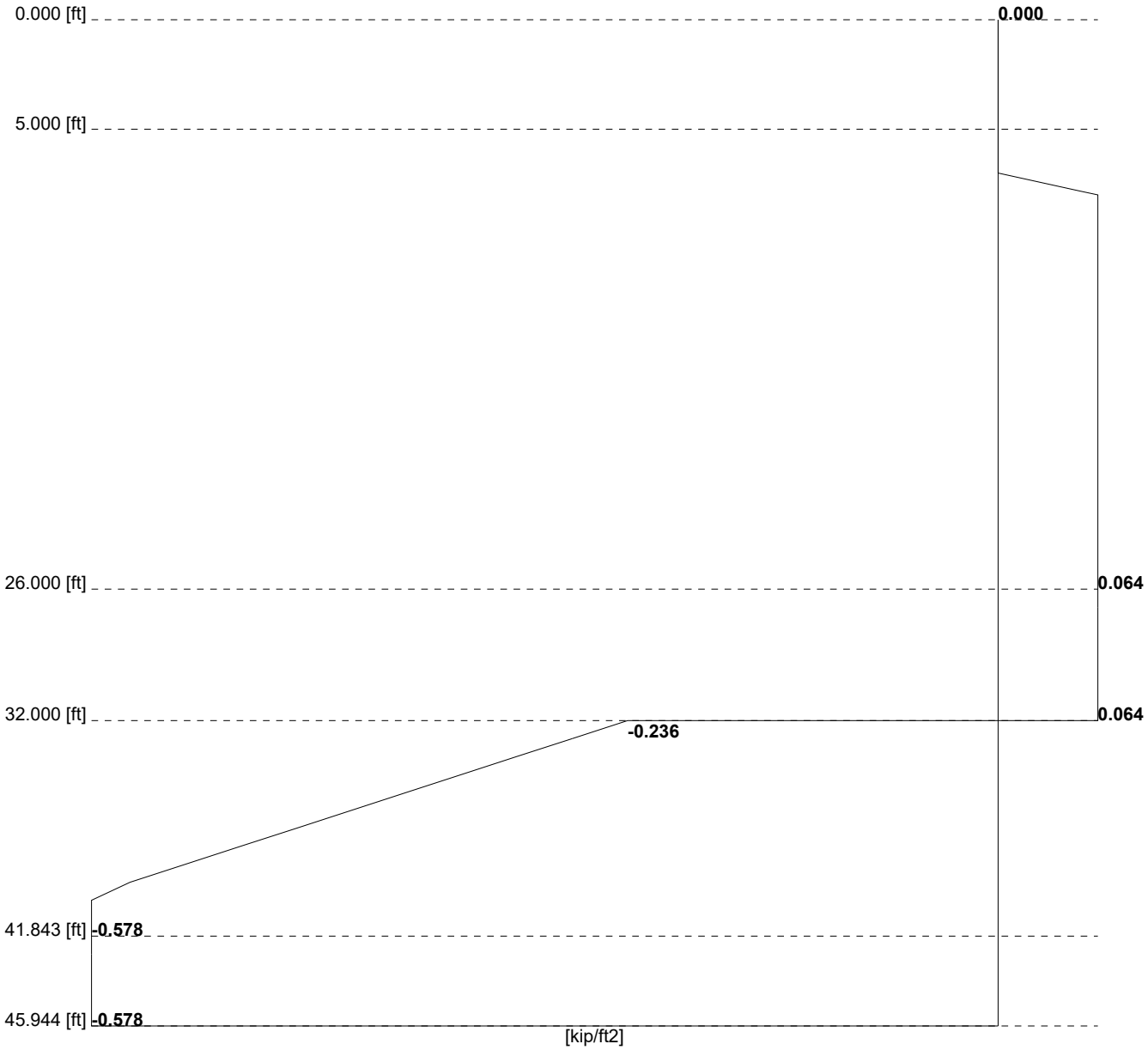
Earth Pressure Diagram



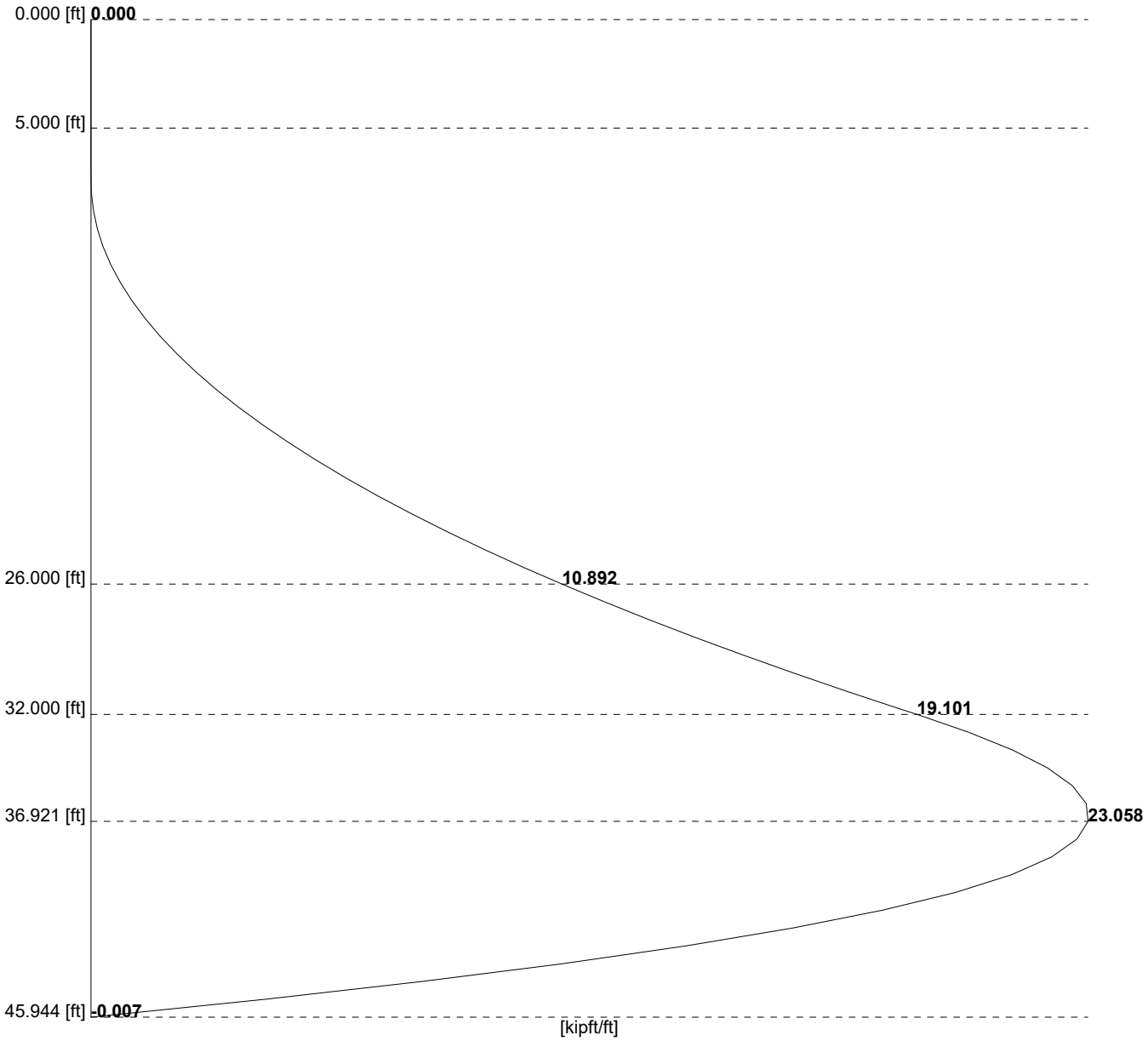
Water Pressure Diagram



Total Pressure Diagram

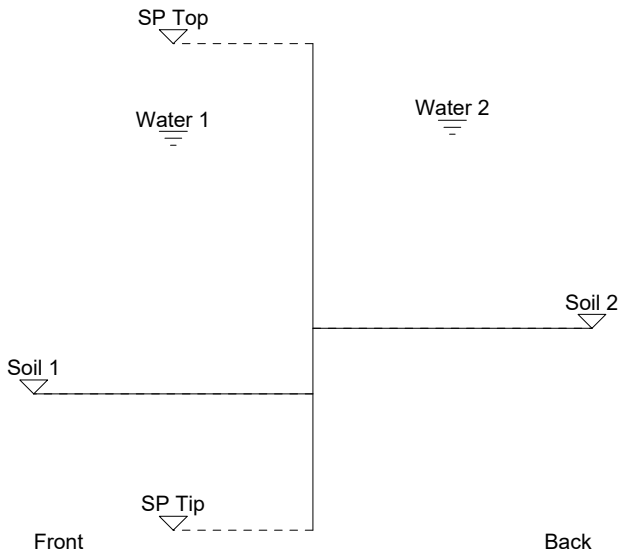


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	44.450
Soil Level in Front [ft]	32.000
Soil Level behind [ft]	26.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

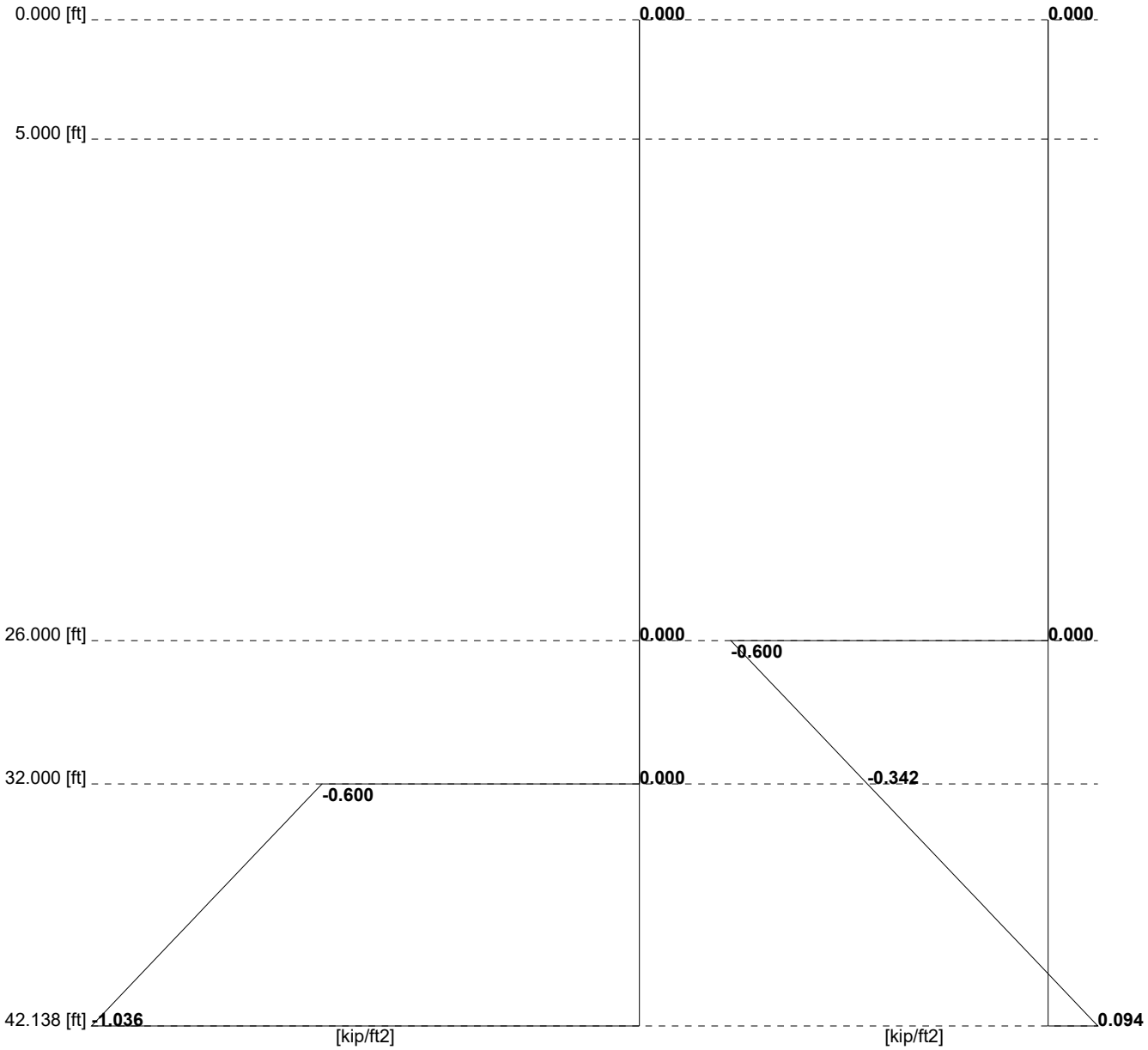
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

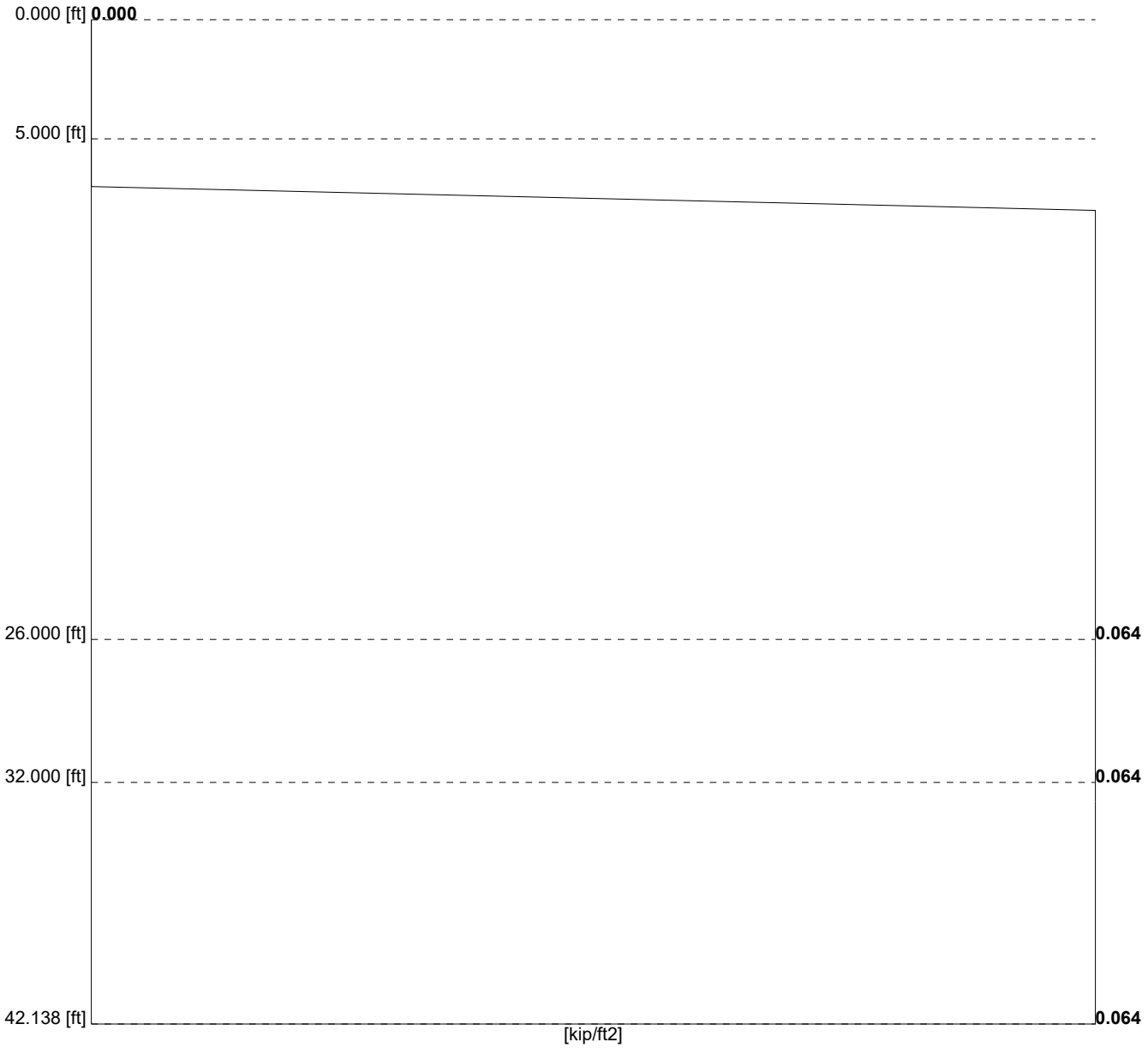
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.238	42.171
Maxmimal Moment [kipft/ft]	21.207	34.461
Normal Forces at Max. Moment [kip/ft]	0.000	42.171
Normal Forces at Min. Moment [kip/ft]	0.000	34.461
Deflection at Min. Moment [ft]	0.000	42.171
Deflection at Max. Moment [ft]	-0.002	34.461
Min. Stress at Min. Moment [lb/in2]	-33.288	42.171
Max. Stress at Min. Moment [lb/in2]	33.288	42.171
Min. Stress at Max. Moment [lb/in2]	-2971.002	34.461
Max. Stress at Max. Moment [lb/in2]	2971.002	34.461
Safety > Req. Safety = 1.500	16.829	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	44.450	
Sheet Pile Length [ft]	44.450	
Included OverLength [ft]	2.312	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

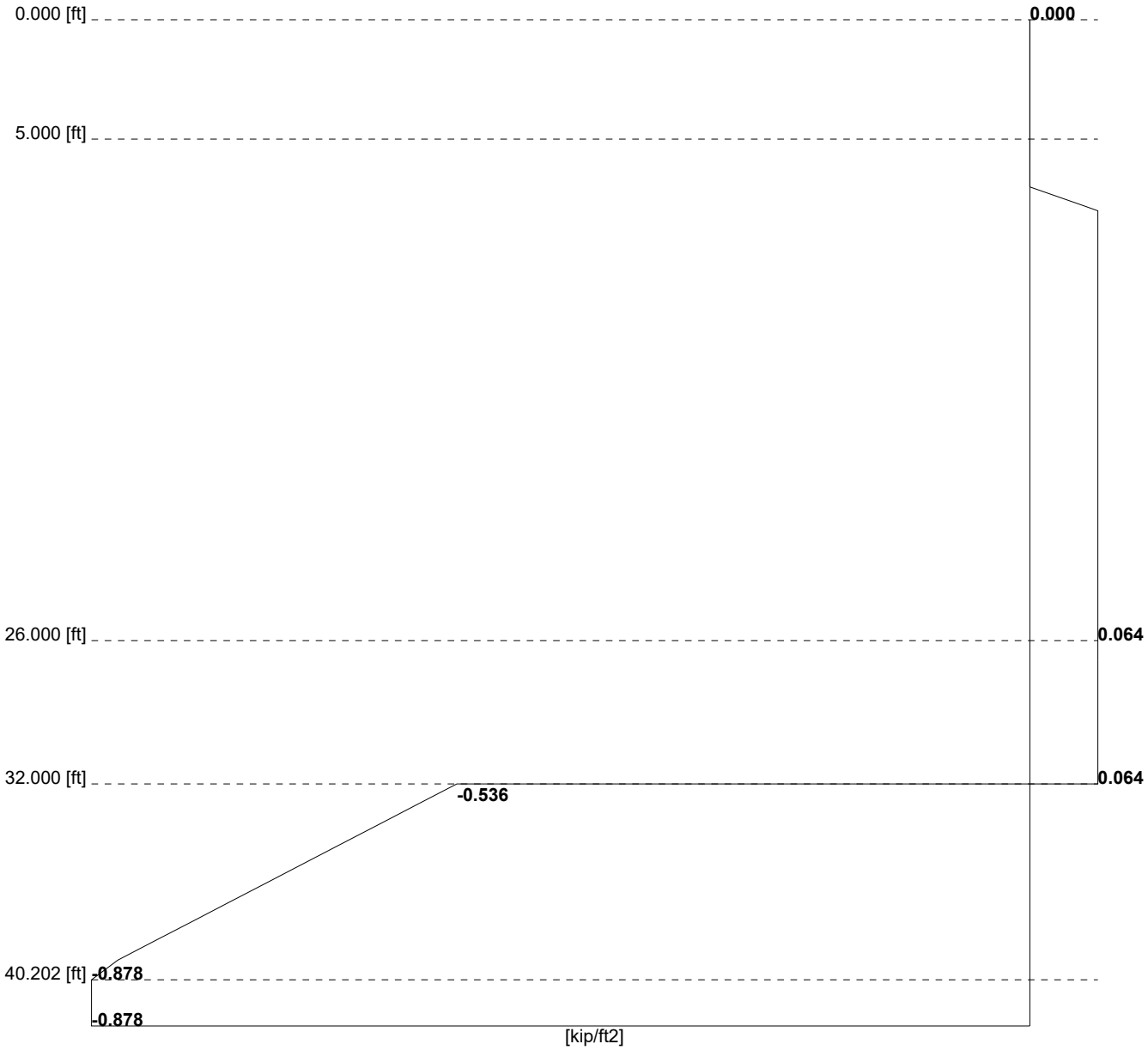
Earth Pressure Diagram



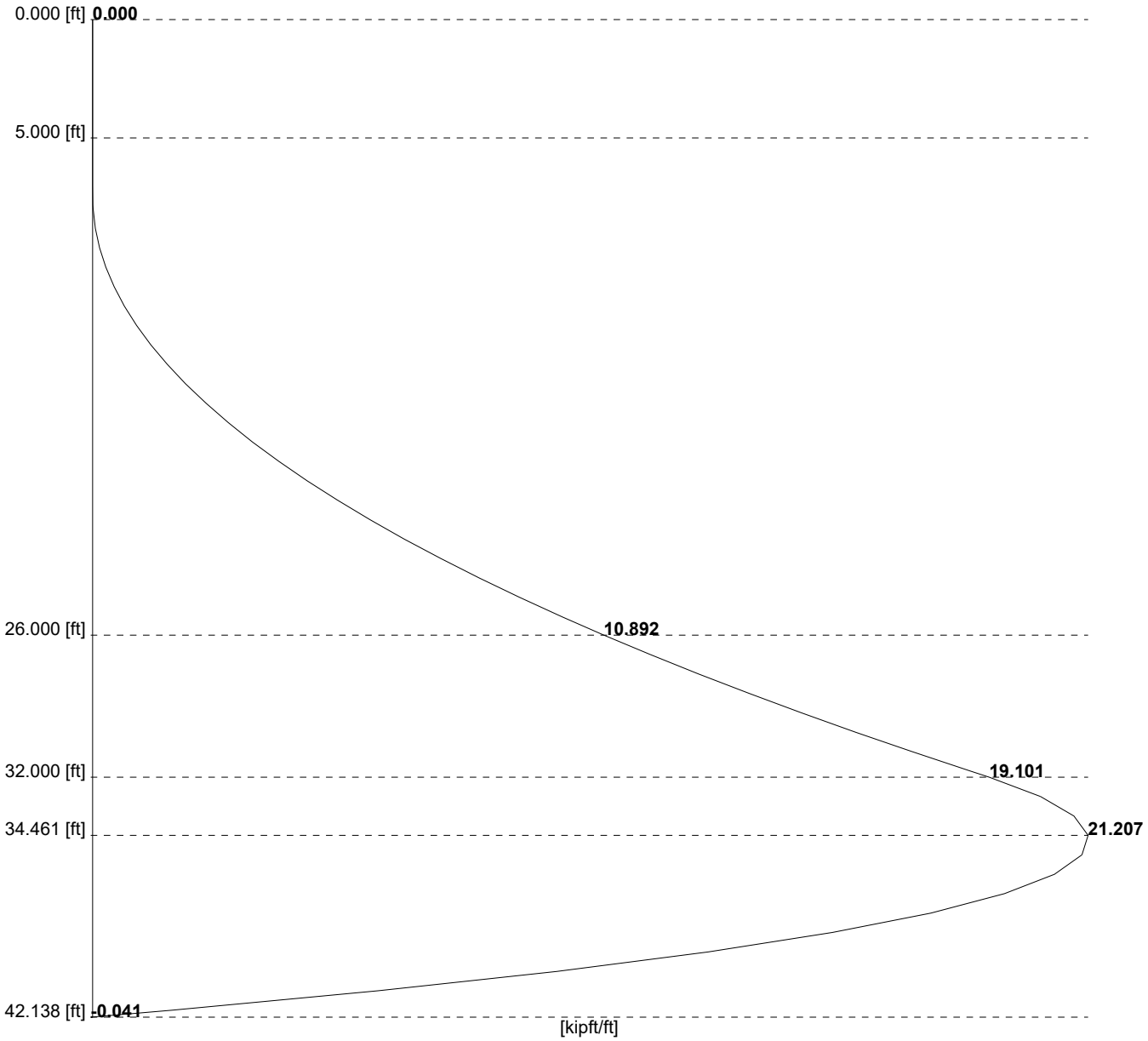
Water Pressure Diagram



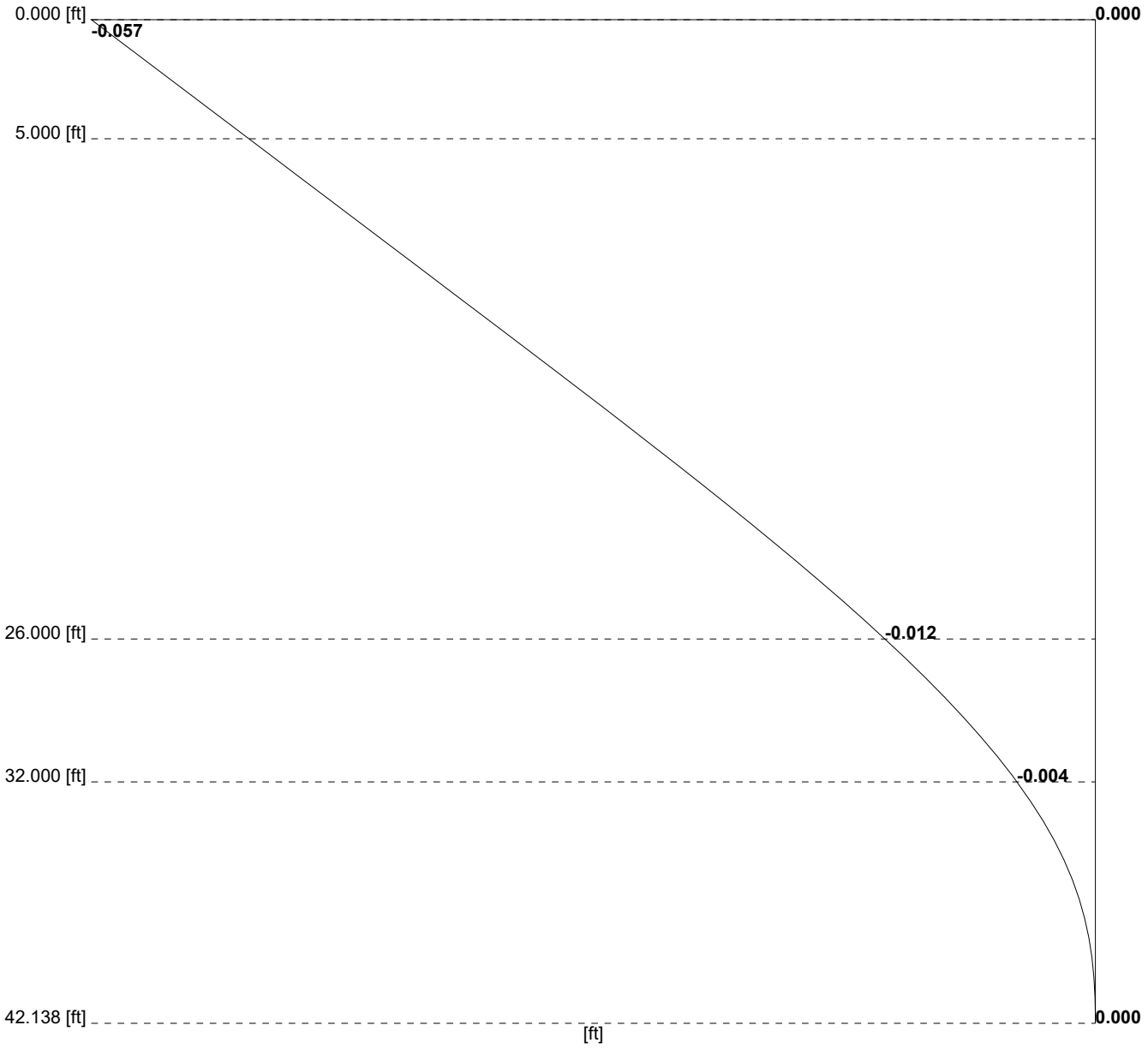
Total Pressure Diagram



Moment Diagram

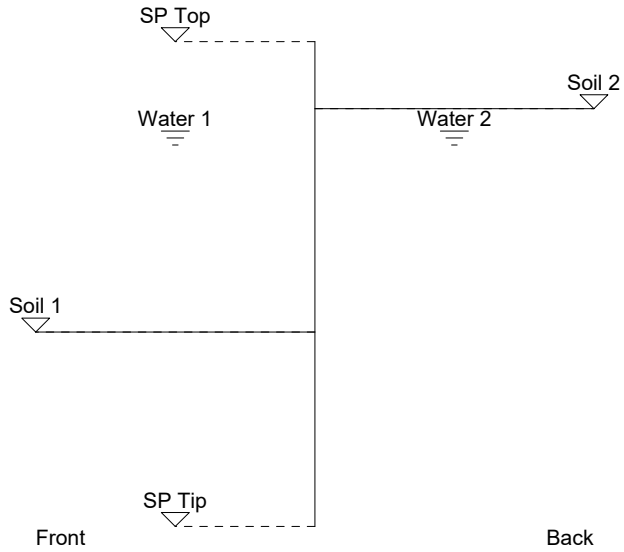


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	43.412
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

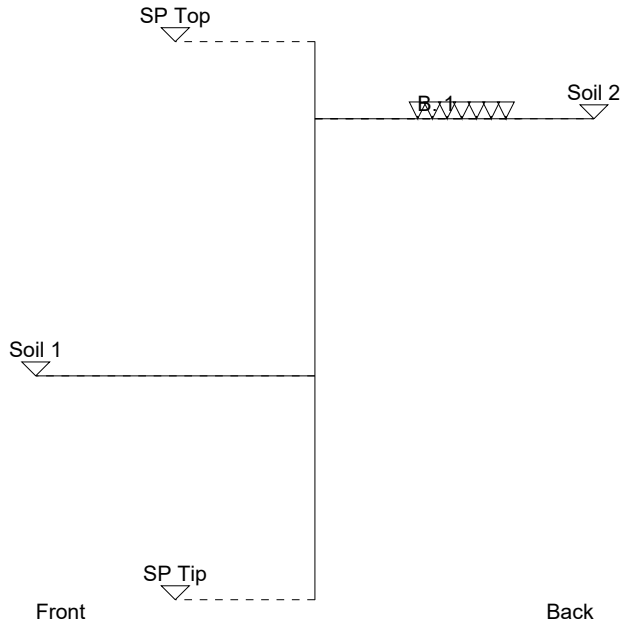
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

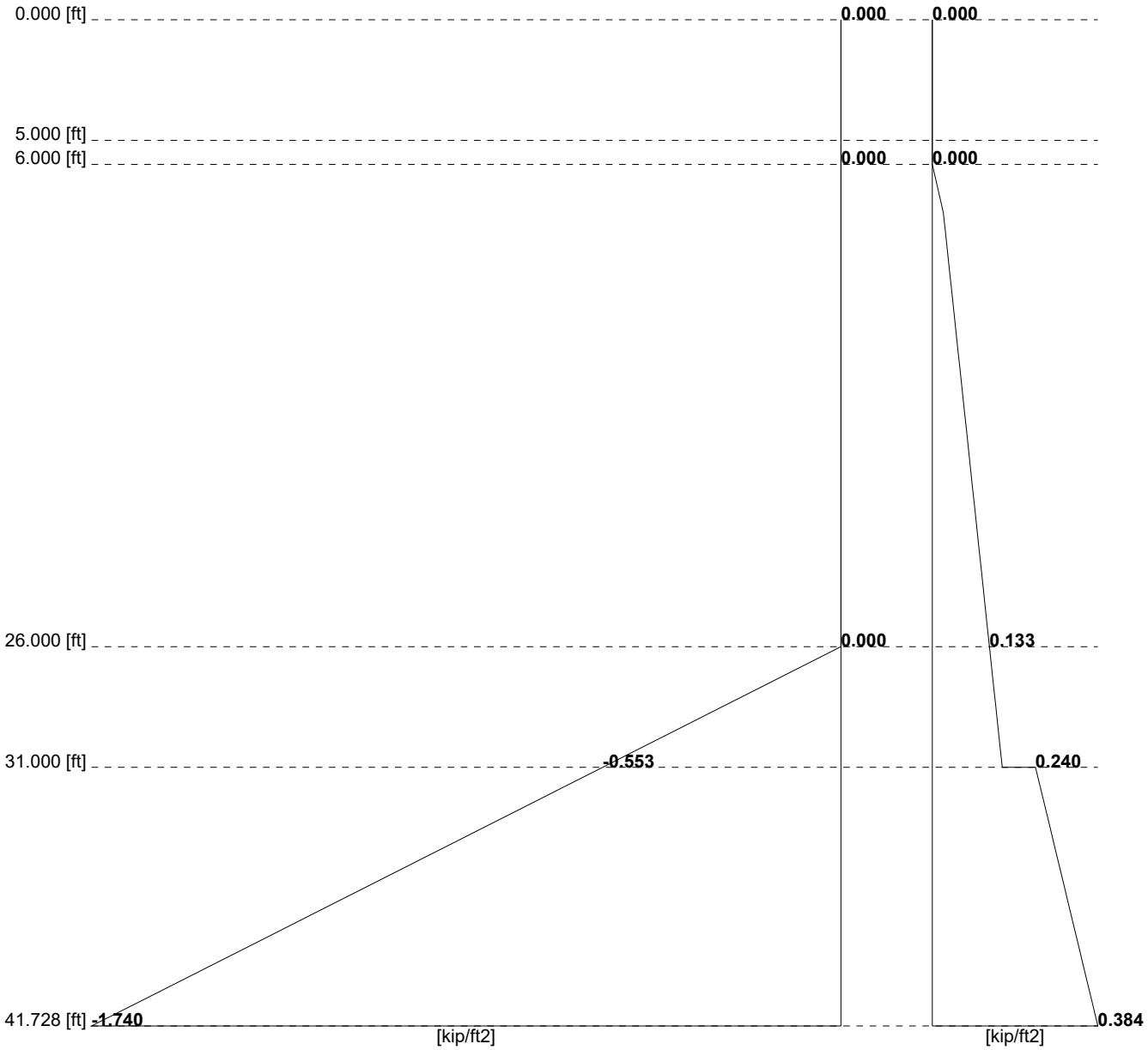
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



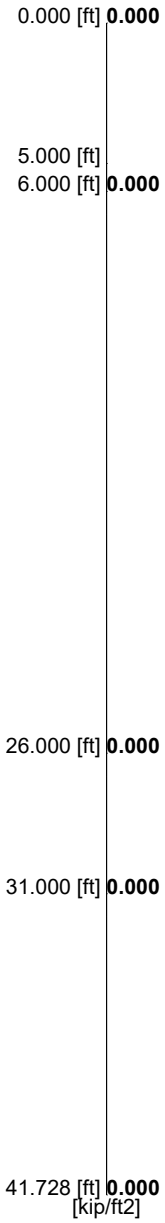
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.389	41.761
Maxmimal Moment [kipft/ft]	23.479	34.117
Normal Forces at Max. Moment [kip/ft]	-0.511	41.761
Normal Forces at Min. Moment [kip/ft]	0.553	34.117
Deflection at Min. Moment [ft]	0.000	41.761
Deflection at Max. Moment [ft]	-0.002	34.117
Min. Stress at Min. Moment [lb/in2]	-92.286	41.761
Max. Stress at Min. Moment [lb/in2]	16.842	41.761
Min. Stress at Max. Moment [lb/in2]	-3248.725	34.117
Max. Stress at Max. Moment [lb/in2]	3330.302	34.117
Safety > Req. Safety = 1.500	15.014	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	43.412	
Sheet Pile Length [ft]	43.412	
Included OverLength [ft]	1.684	
Vertical Equilibrium [kip/ft]	1.421	
Anchor Force (horiz.) [kip/ft]	0.000	

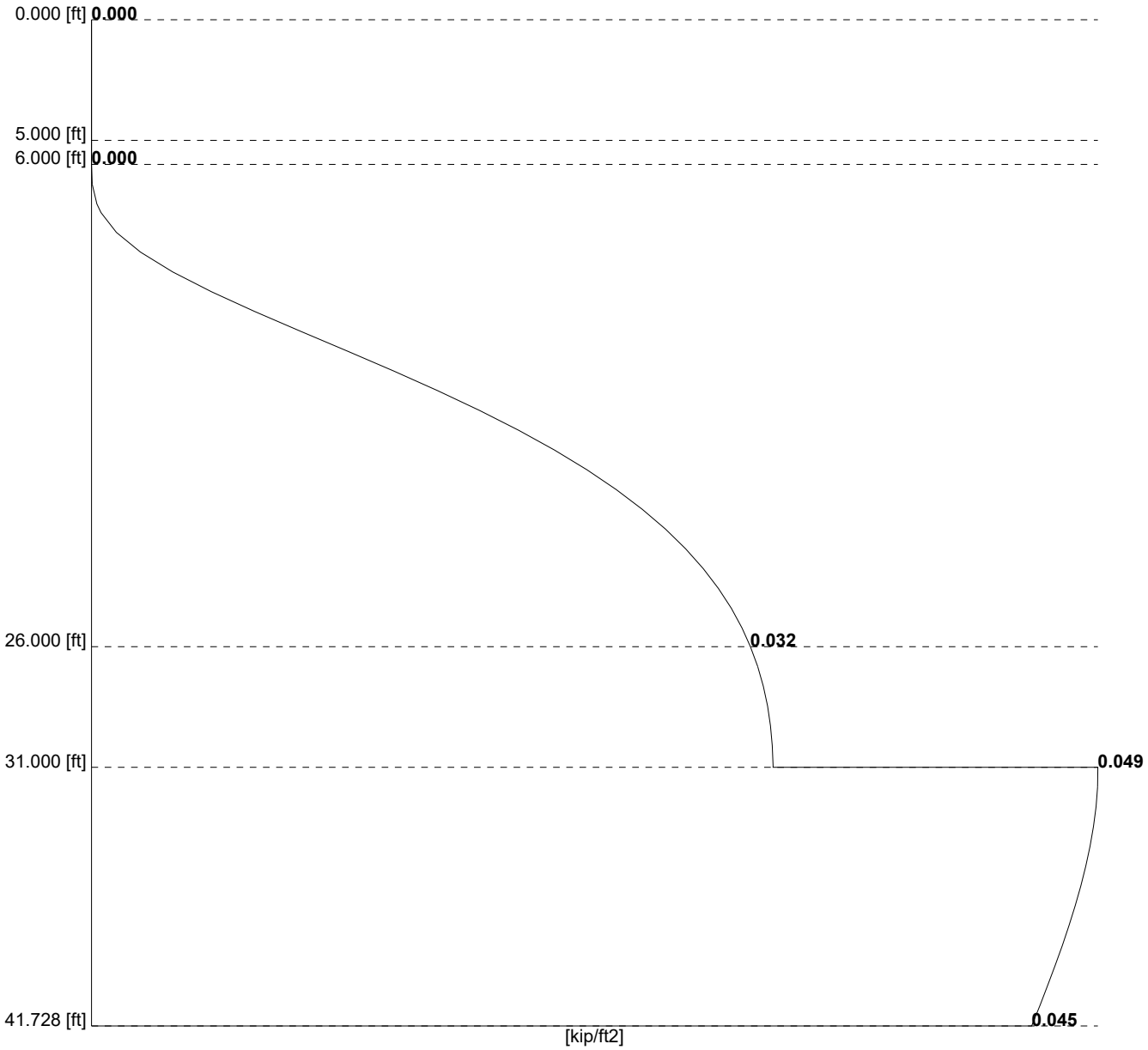
Earth Pressure Diagram



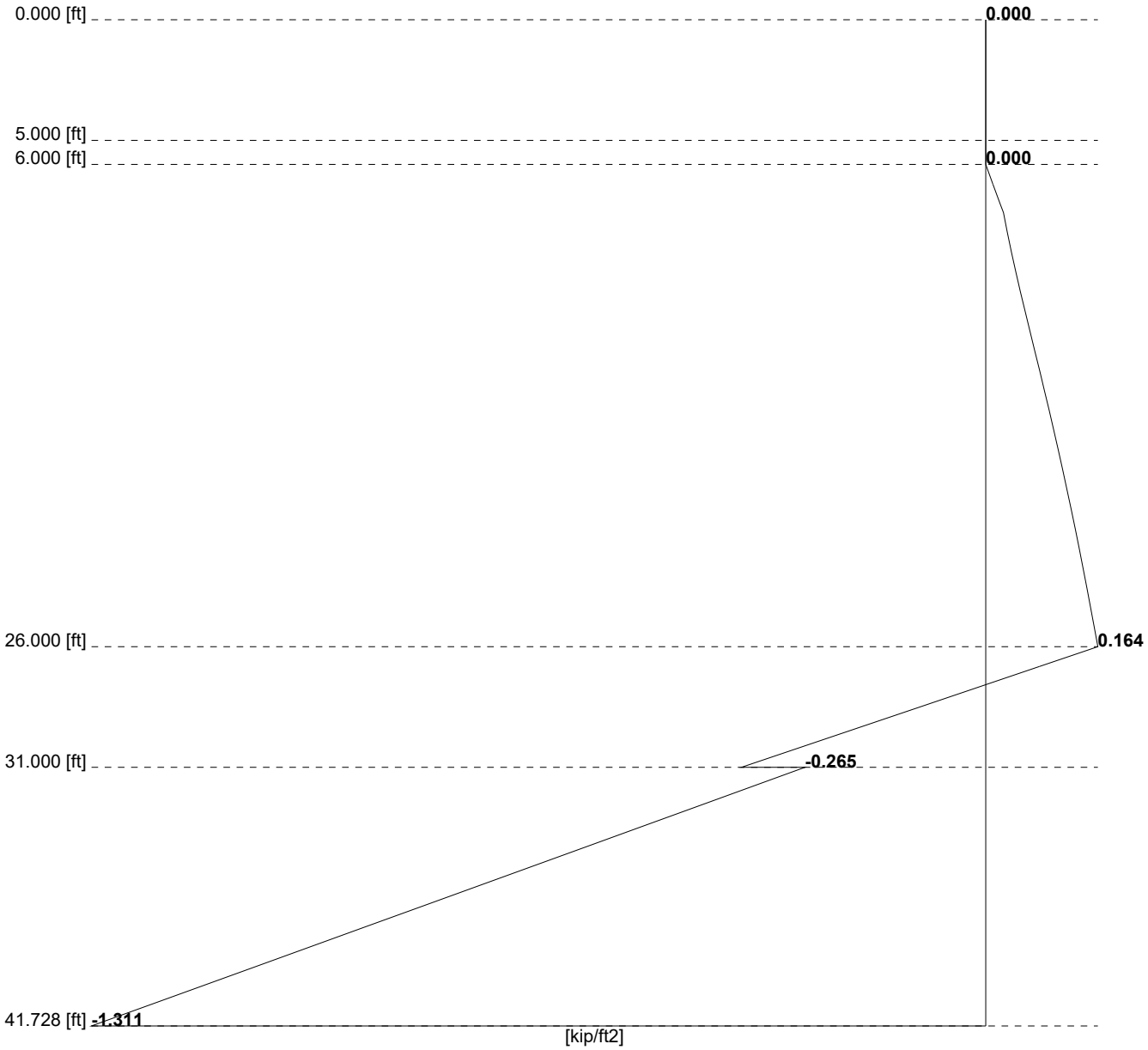
Water Pressure Diagram



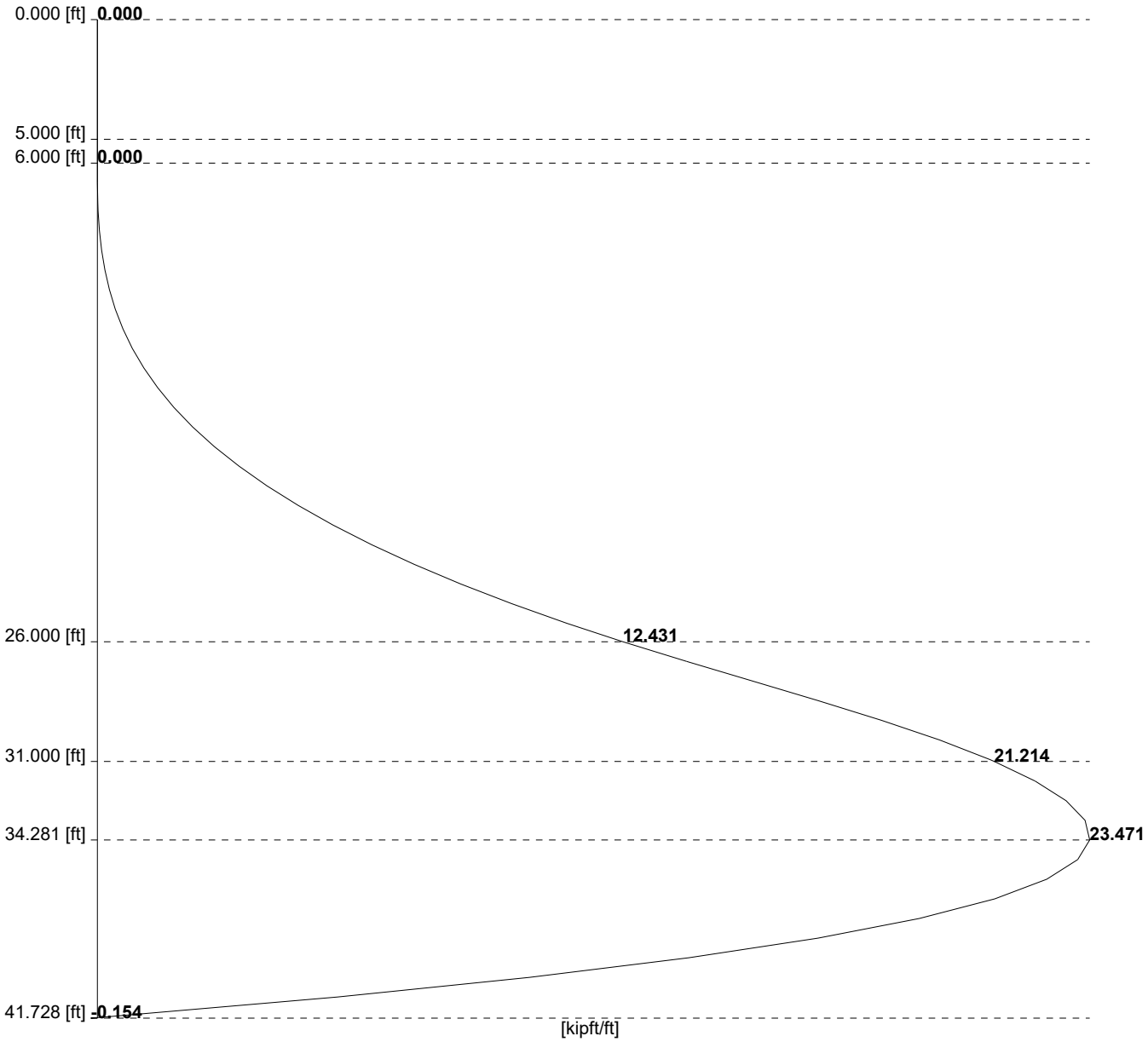
Boussinesq Diagram



Total Pressure Diagram

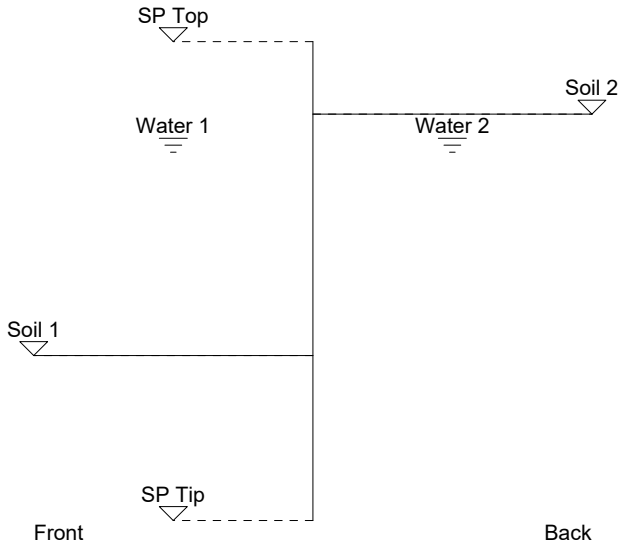


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	39.668
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

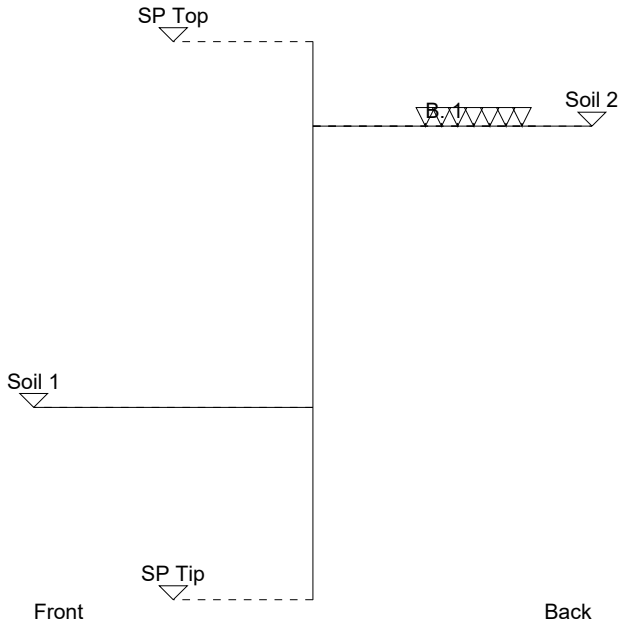
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



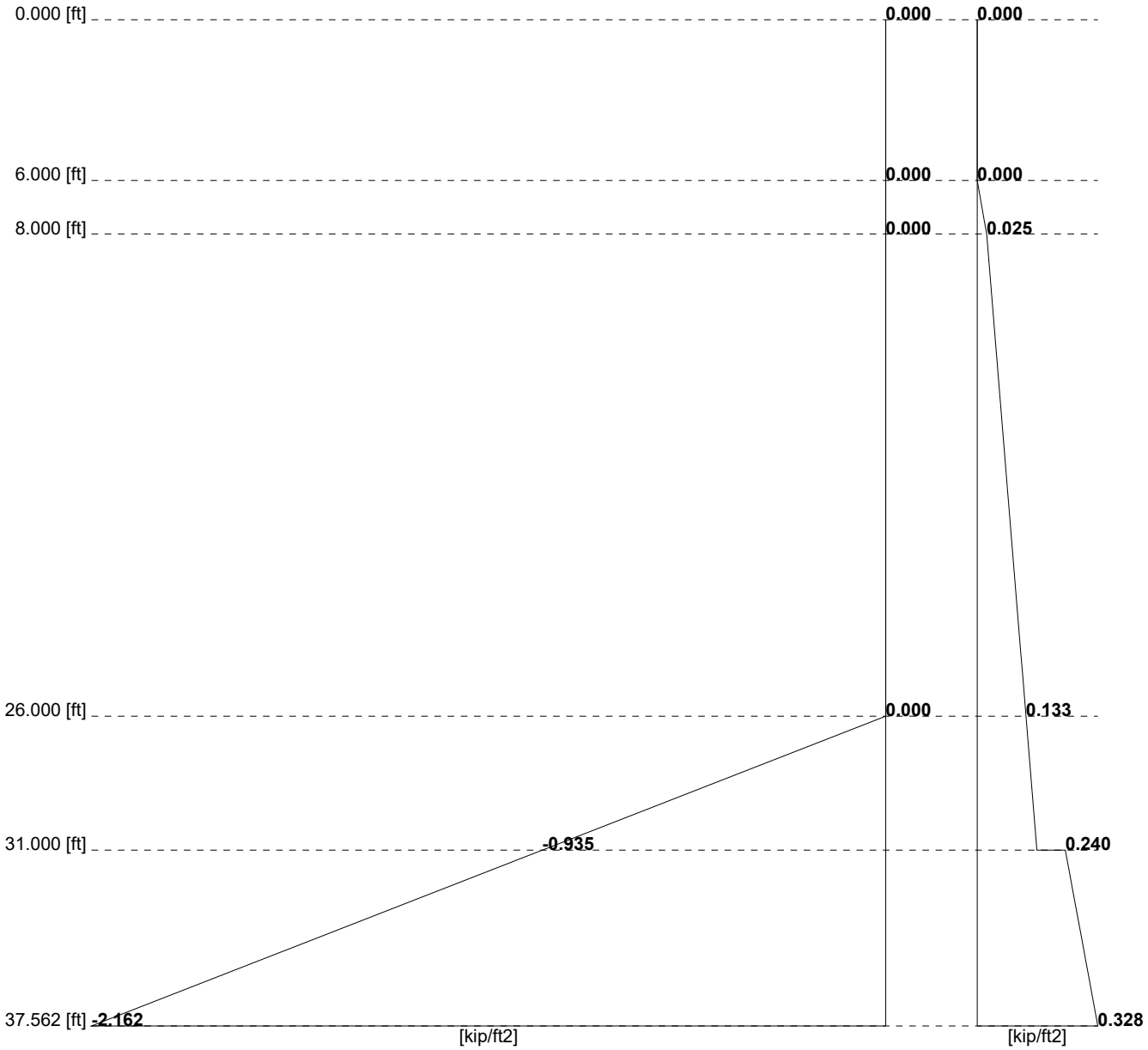
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

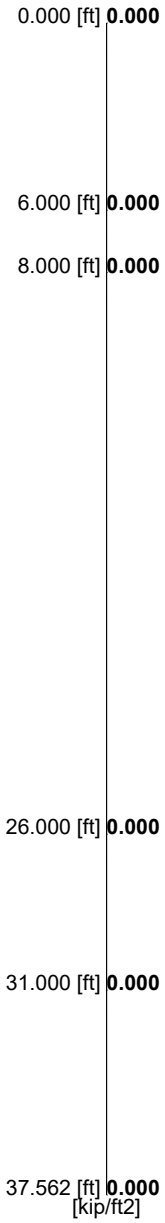
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.468	37.595
Maxmimal Moment [kipft/ft]	19.711	31.525
Normal Forces at Max. Moment [kip/ft]	0.000	37.595
Normal Forces at Min. Moment [kip/ft]	0.193	31.525
Deflection at Min. Moment [ft]	0.000	37.595
Deflection at Max. Moment [ft]	-0.001	31.525
Min. Stress at Min. Moment [lb/in2]	-65.602	37.595
Max. Stress at Min. Moment [lb/in2]	65.602	37.595
Min. Stress at Max. Moment [lb/in2]	-2747.202	31.525
Max. Stress at Max. Moment [lb/in2]	2775.734	31.525
Safety > Req. Safety = 1.500	18.013	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	39.668	
Sheet Pile Length [ft]	39.668	
Included OverLength [ft]	2.107	
Vertical Equilibrium [kip/ft]	0.269	
Anchor Force (horiz.) [kip/ft]	0.000	

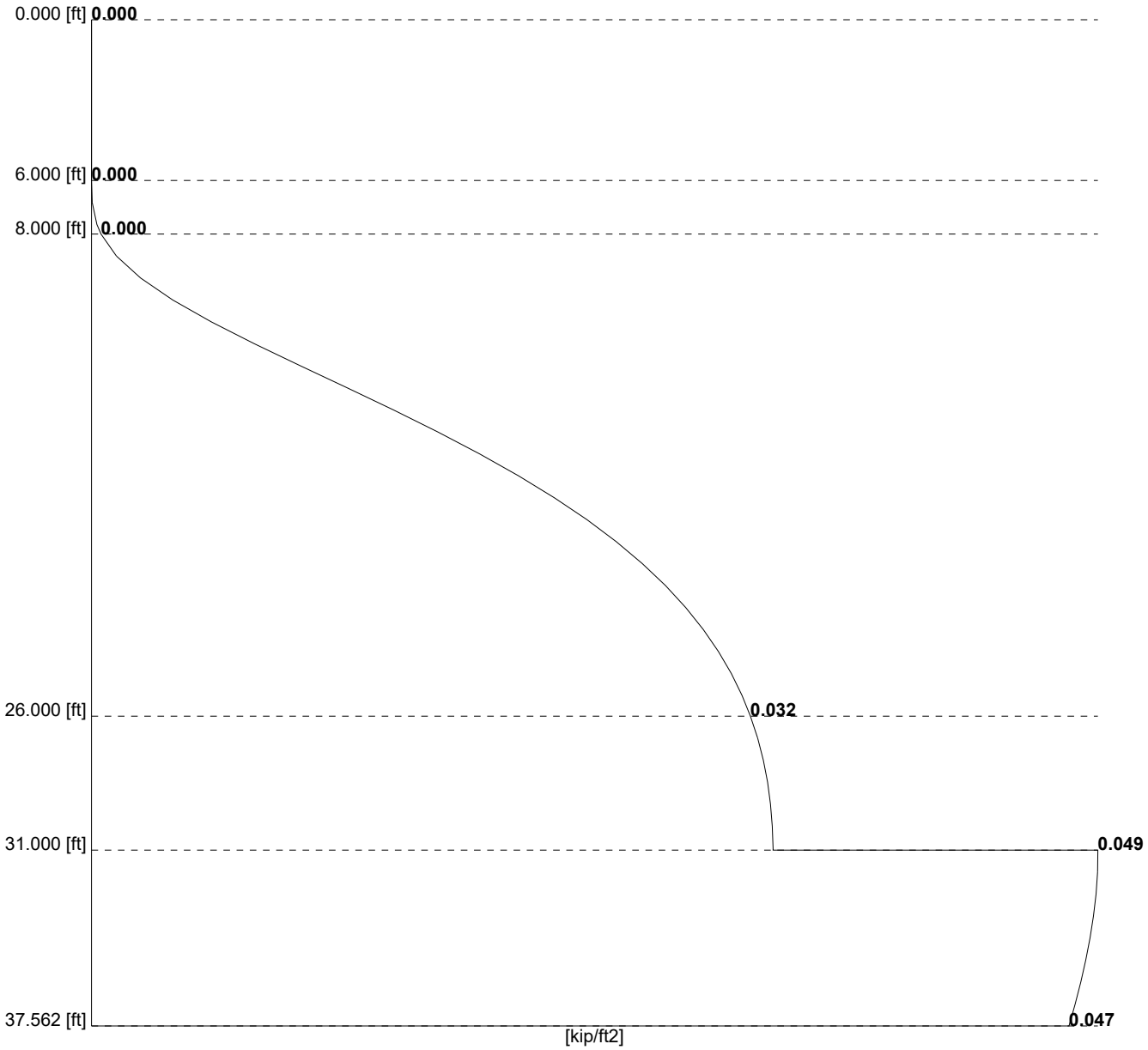
Earth Pressure Diagram



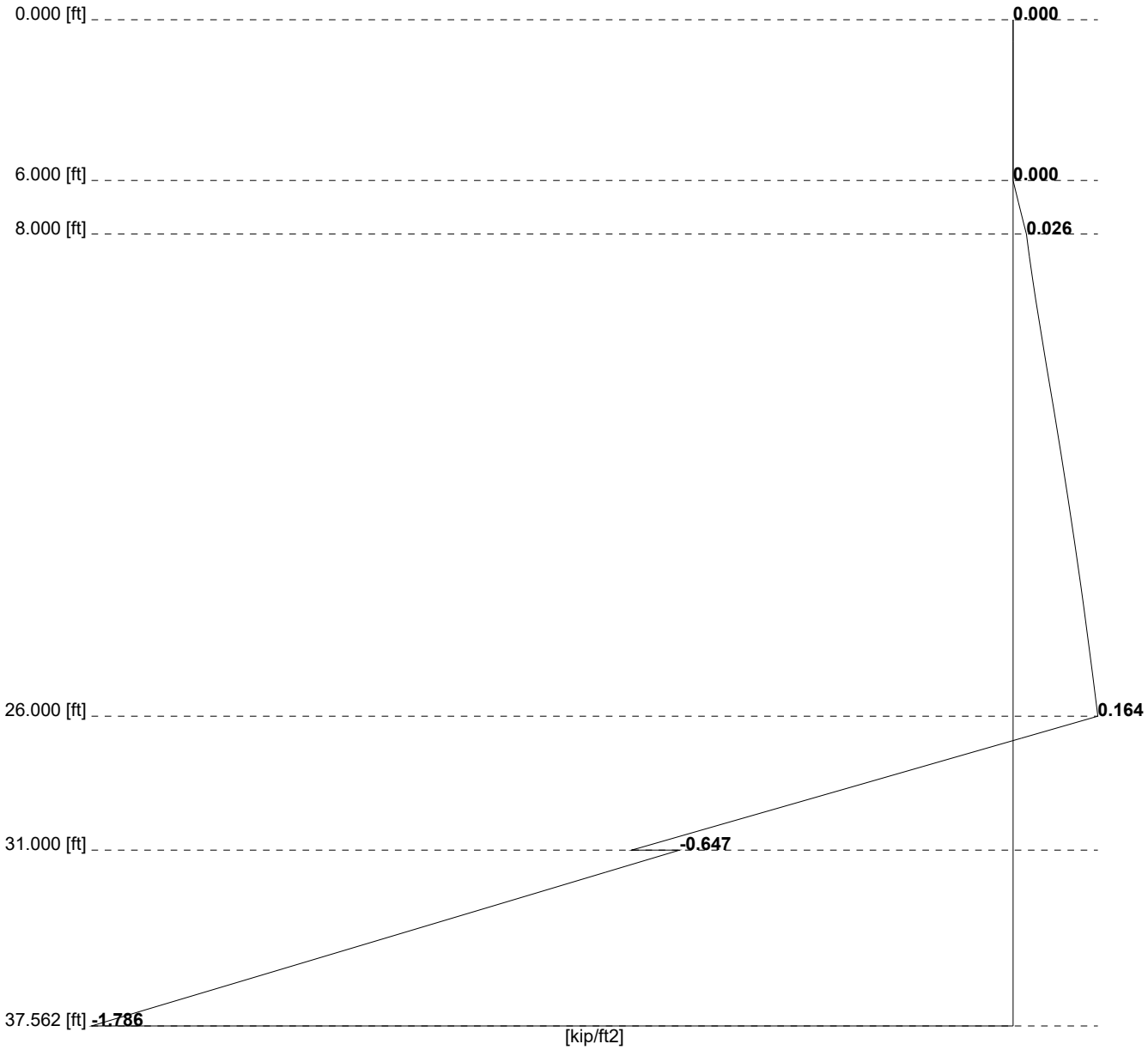
Water Pressure Diagram



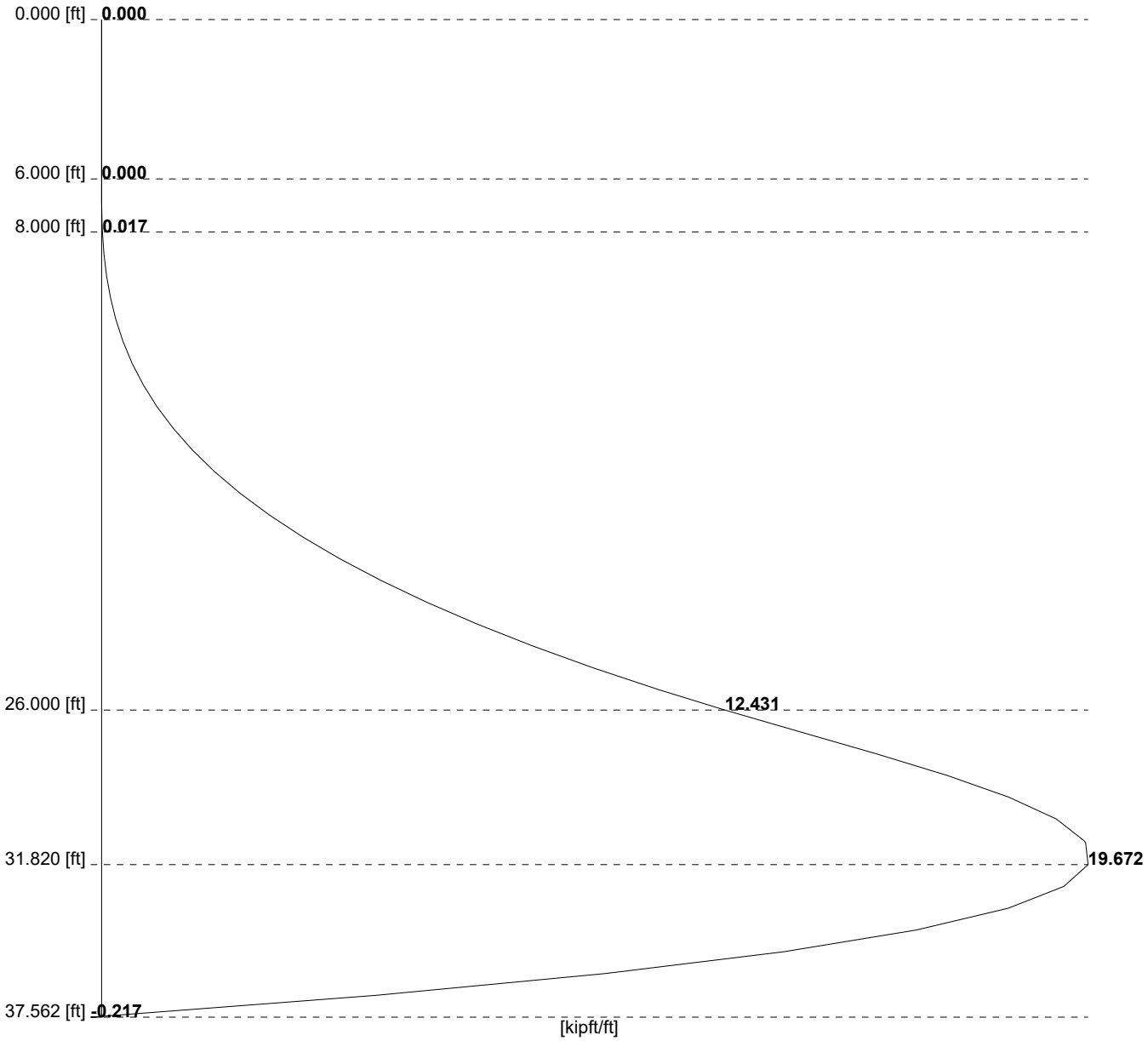
Boussinesq Diagram



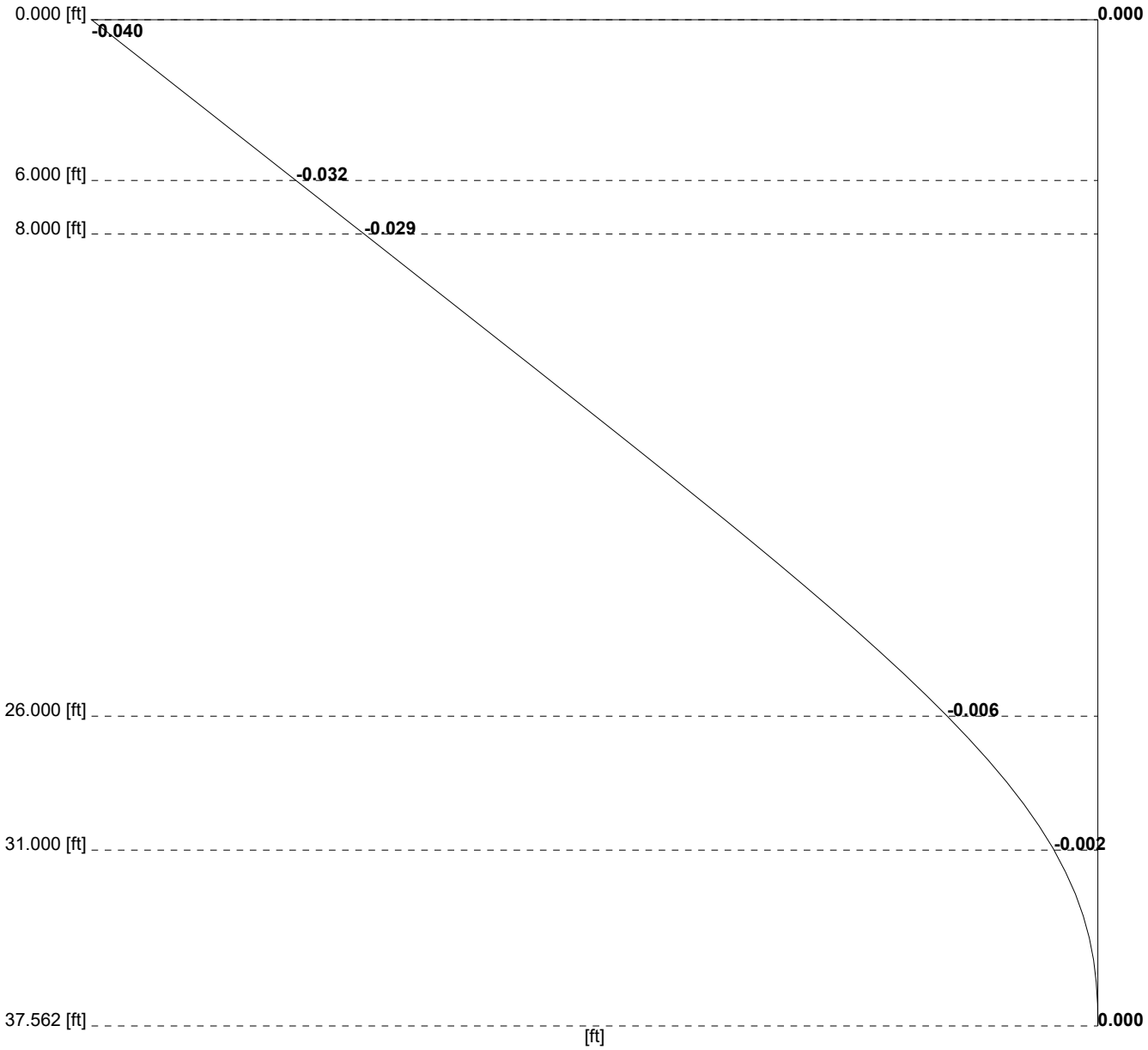
Total Pressure Diagram



Moment Diagram

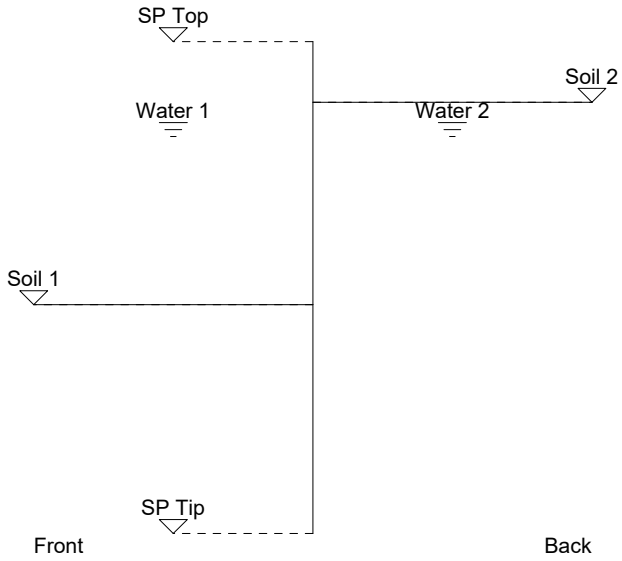


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	48.625
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

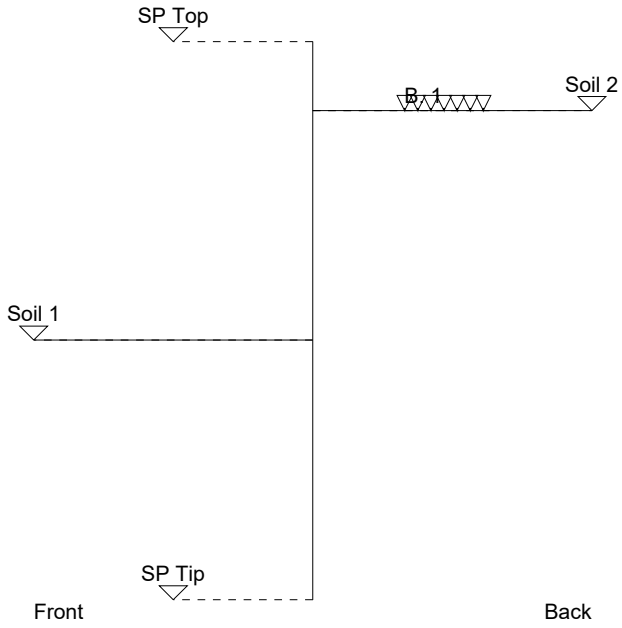
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

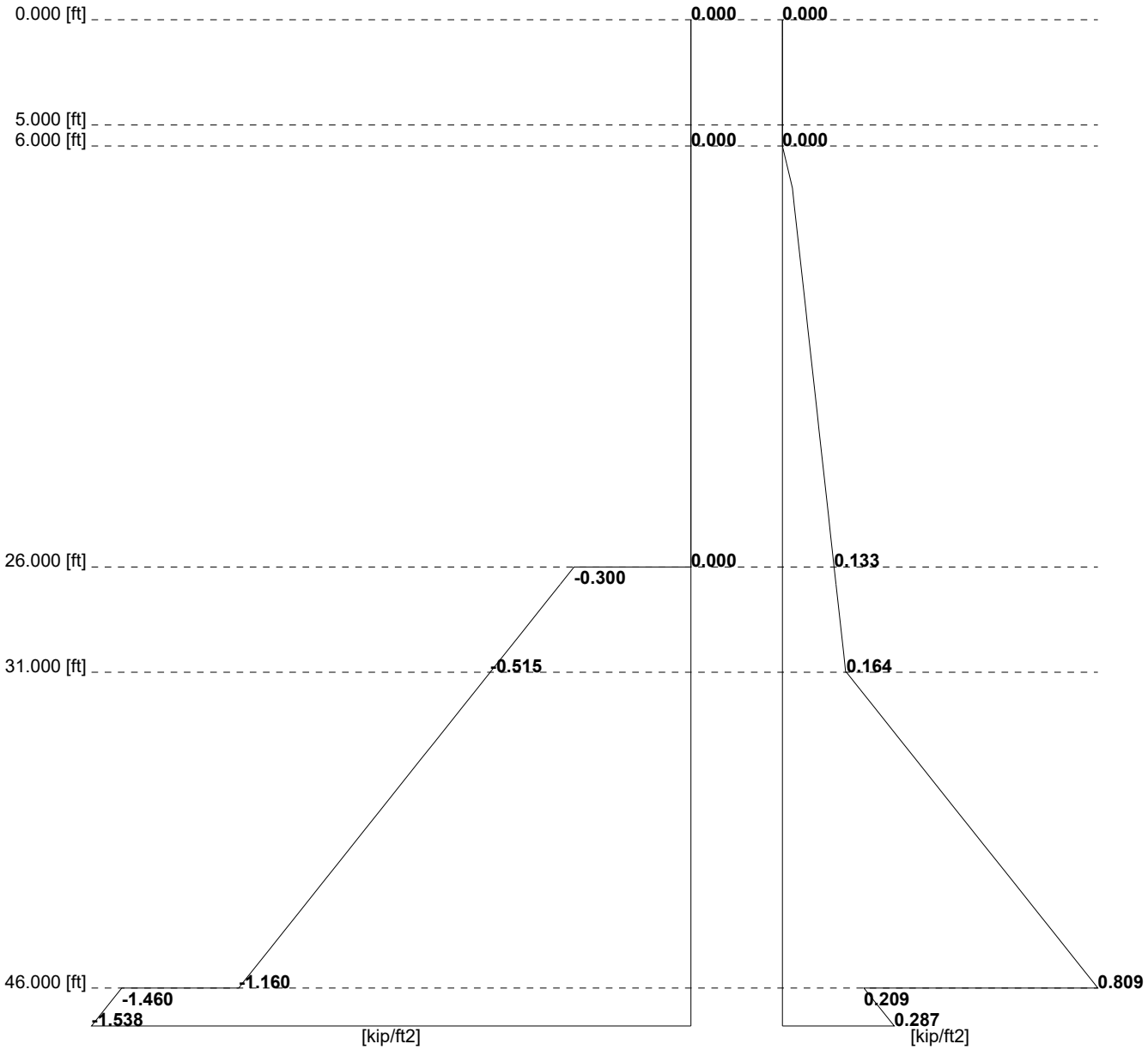
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



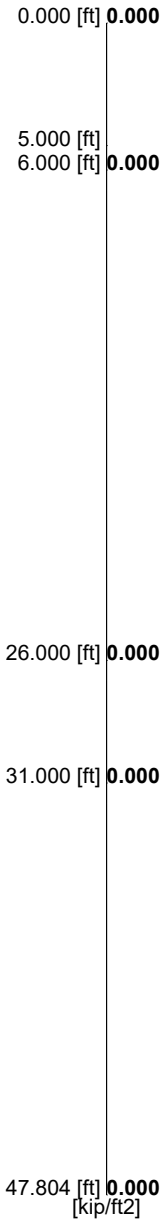
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.233	47.837
Maxmimal Moment [kipft/ft]	19.926	34.281
Normal Forces at Max. Moment [kip/ft]	0.984	47.837
Normal Forces at Min. Moment [kip/ft]	0.984	34.281
Deflection at Min. Moment [ft]	0.000	47.837
Deflection at Max. Moment [ft]	-0.006	34.281
Min. Stress at Min. Moment [lb/in2]	39.871	47.837
Max. Stress at Min. Moment [lb/in2]	105.261	47.837
Min. Stress at Max. Moment [lb/in2]	-2719.815	34.281
Max. Stress at Max. Moment [lb/in2]	2864.946	34.281
Safety > Req. Safety = 1.500	17.452	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	48.625	
Sheet Pile Length [ft]	48.625	
Included OverLength [ft]	0.820	
Vertical Equilibrium [kip/ft]	0.984	
Anchor Force (horiz.) [kip/ft]	0.000	

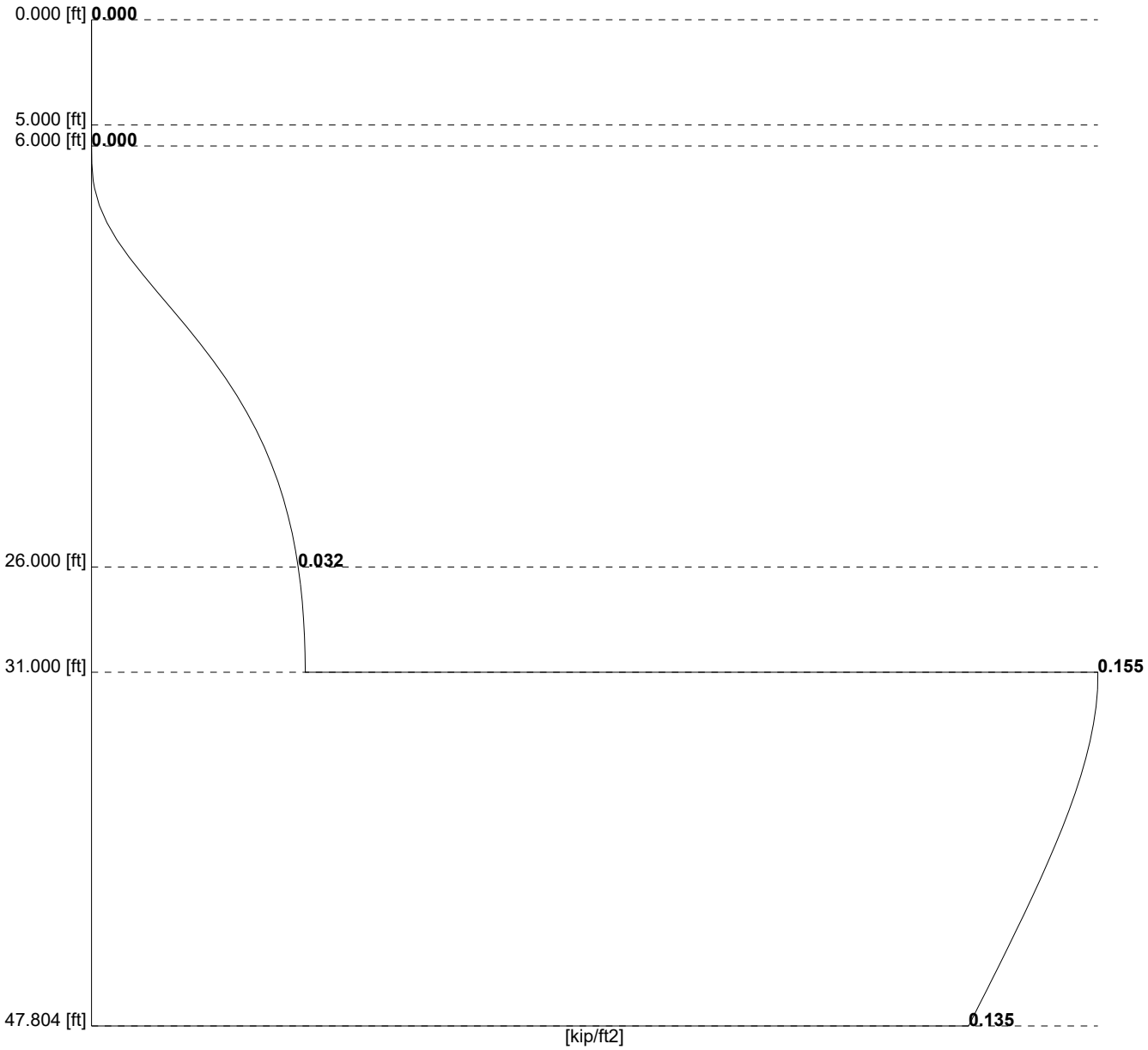
Earth Pressure Diagram



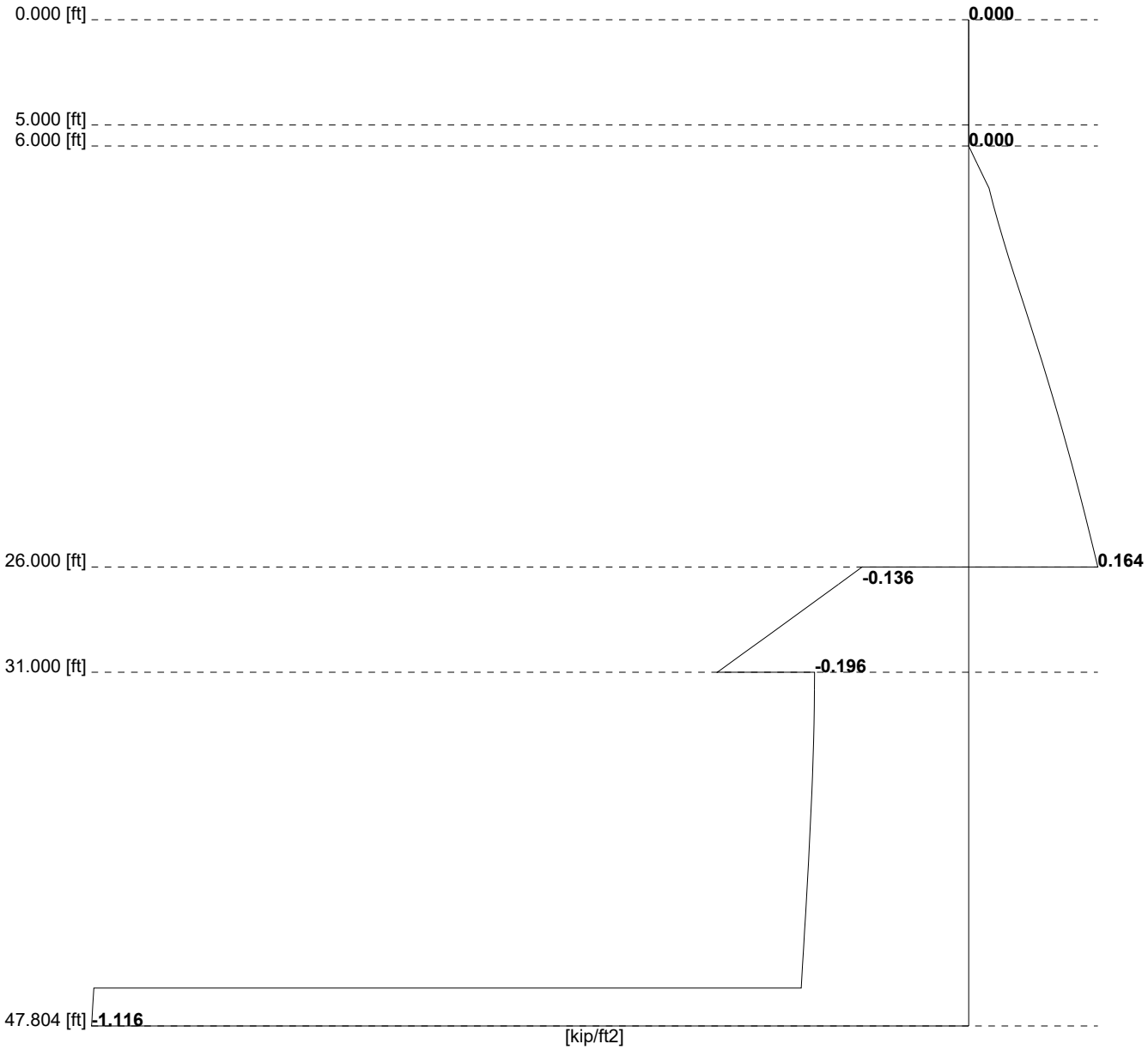
Water Pressure Diagram



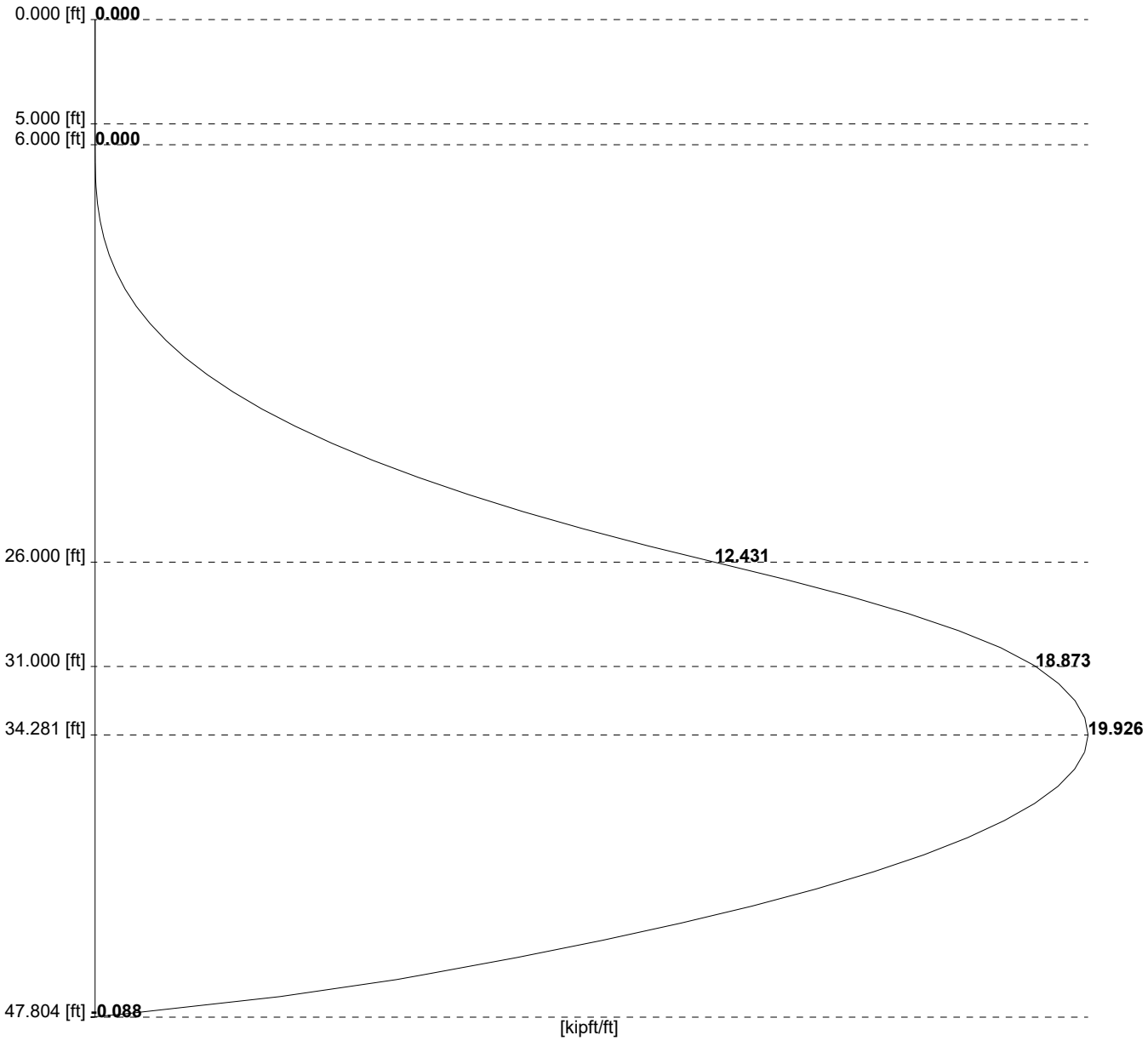
Boussinesq Diagram



Total Pressure Diagram

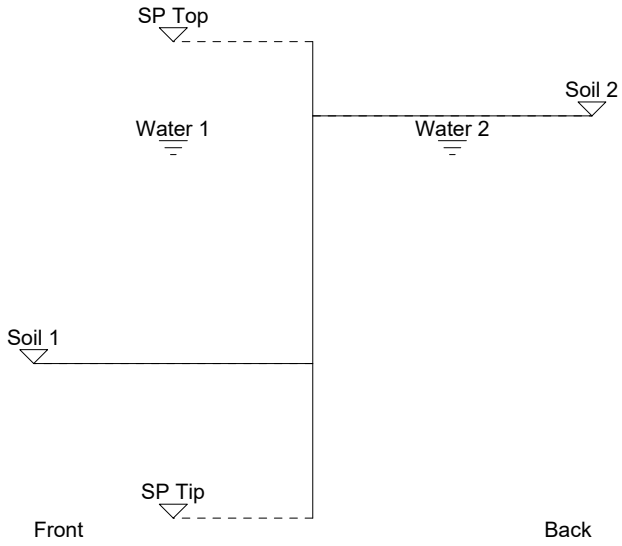


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	38.483
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

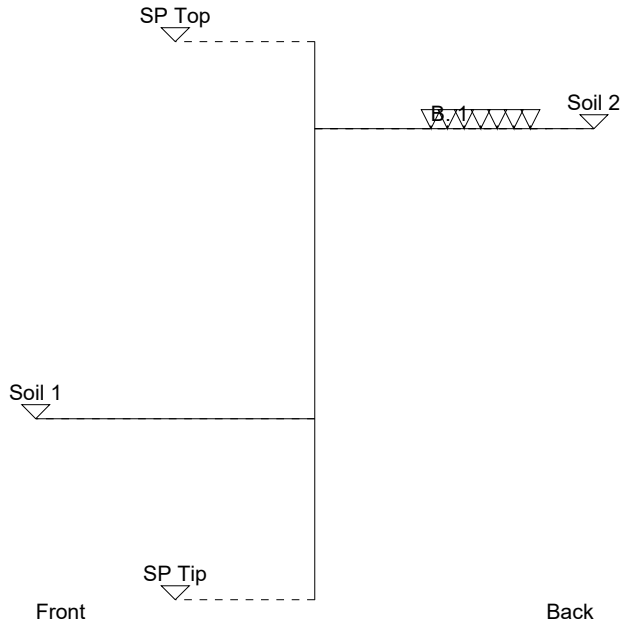
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



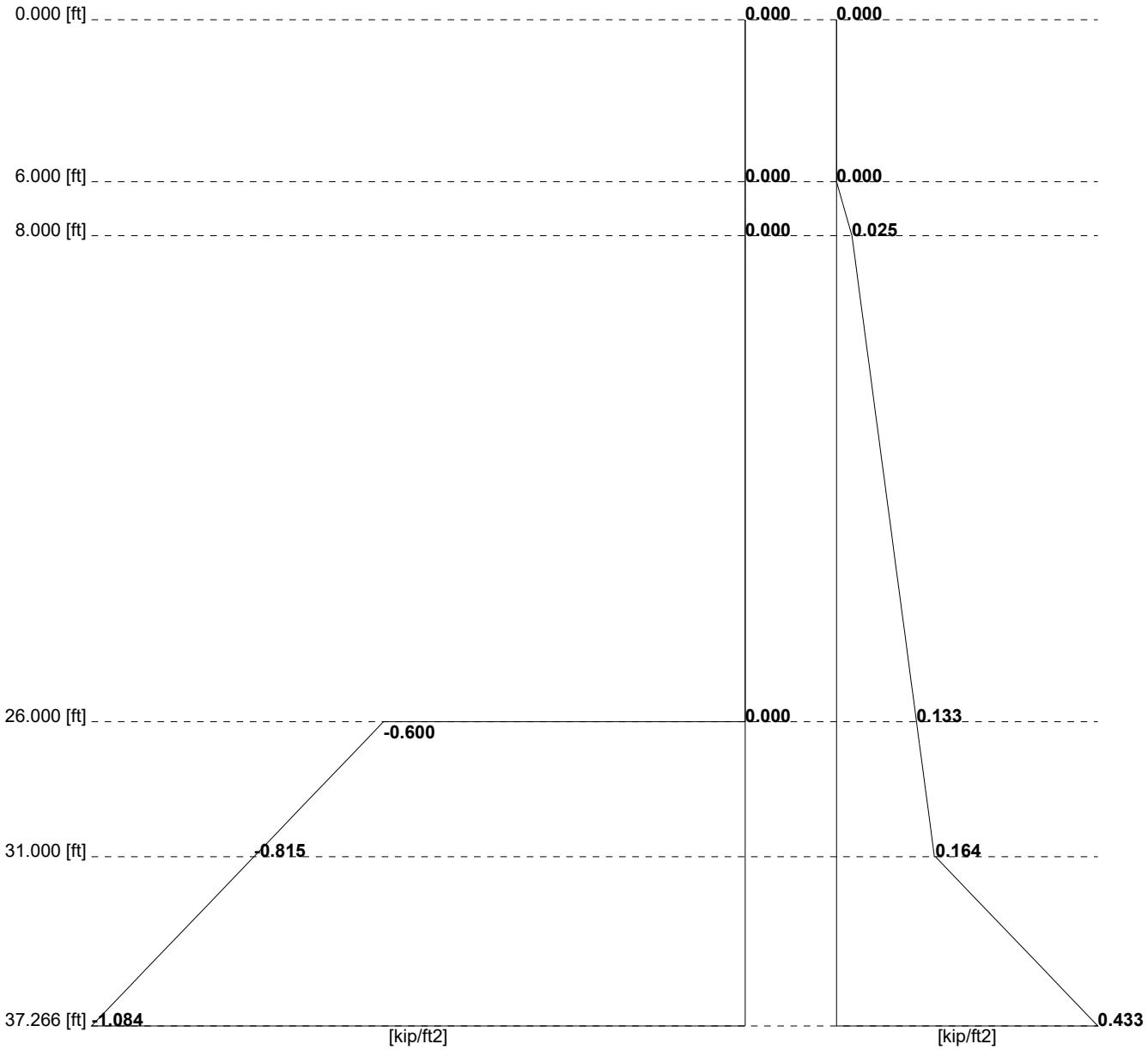
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

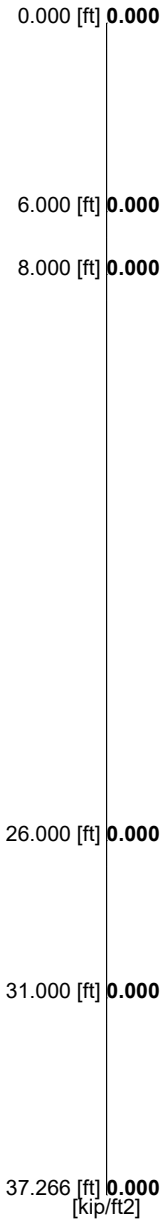
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.134	37.299
Maxmimal Moment [kipft/ft]	15.712	29.281
Normal Forces at Max. Moment [kip/ft]	0.984	37.299
Normal Forces at Min. Moment [kip/ft]	0.856	29.281
Deflection at Min. Moment [ft]	0.000	37.299
Deflection at Max. Moment [ft]	-0.002	29.281
Min. Stress at Min. Moment [lb/in2]	53.832	37.299
Max. Stress at Min. Moment [lb/in2]	91.299	37.299
Min. Stress at Max. Moment [lb/in2]	-2138.293	29.281
Max. Stress at Max. Moment [lb/in2]	2264.597	29.281
Safety > Req. Safety = 1.500	22.079	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	38.483	
Sheet Pile Length [ft]	38.483	
Included OverLength [ft]	1.217	
Vertical Equilibrium [kip/ft]	0.984	
Anchor Force (horiz.) [kip/ft]	0.000	

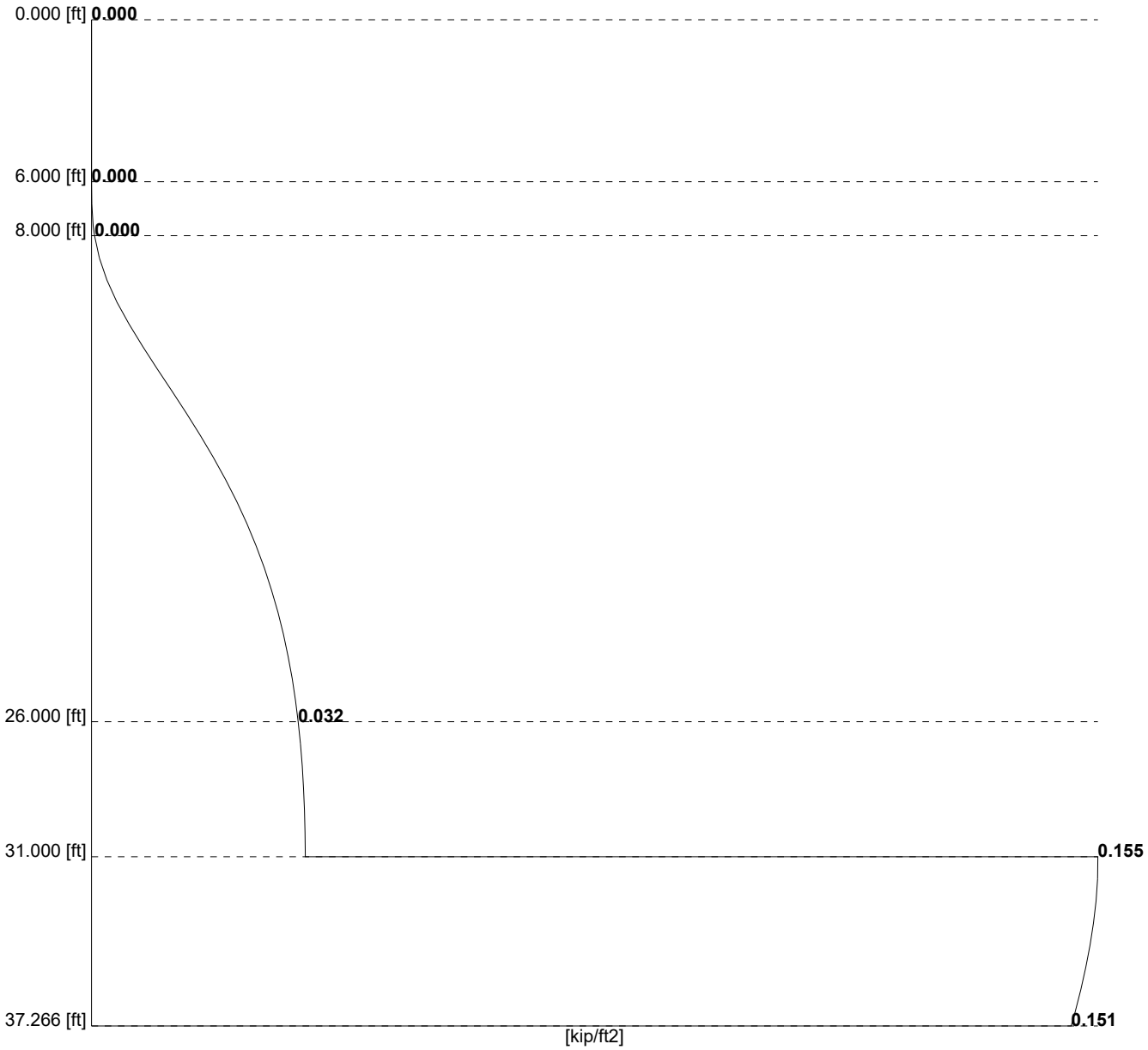
Earth Pressure Diagram



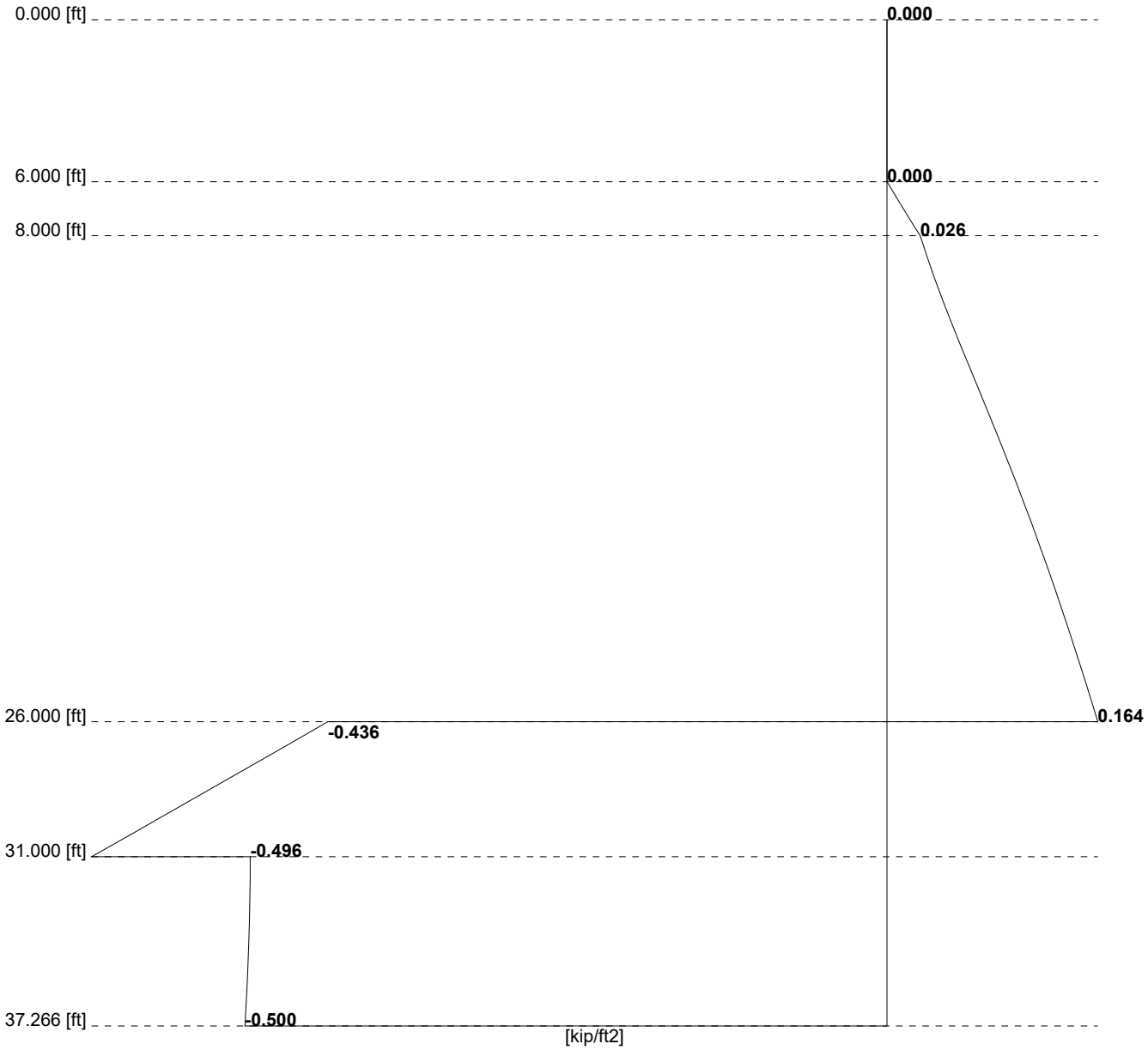
Water Pressure Diagram



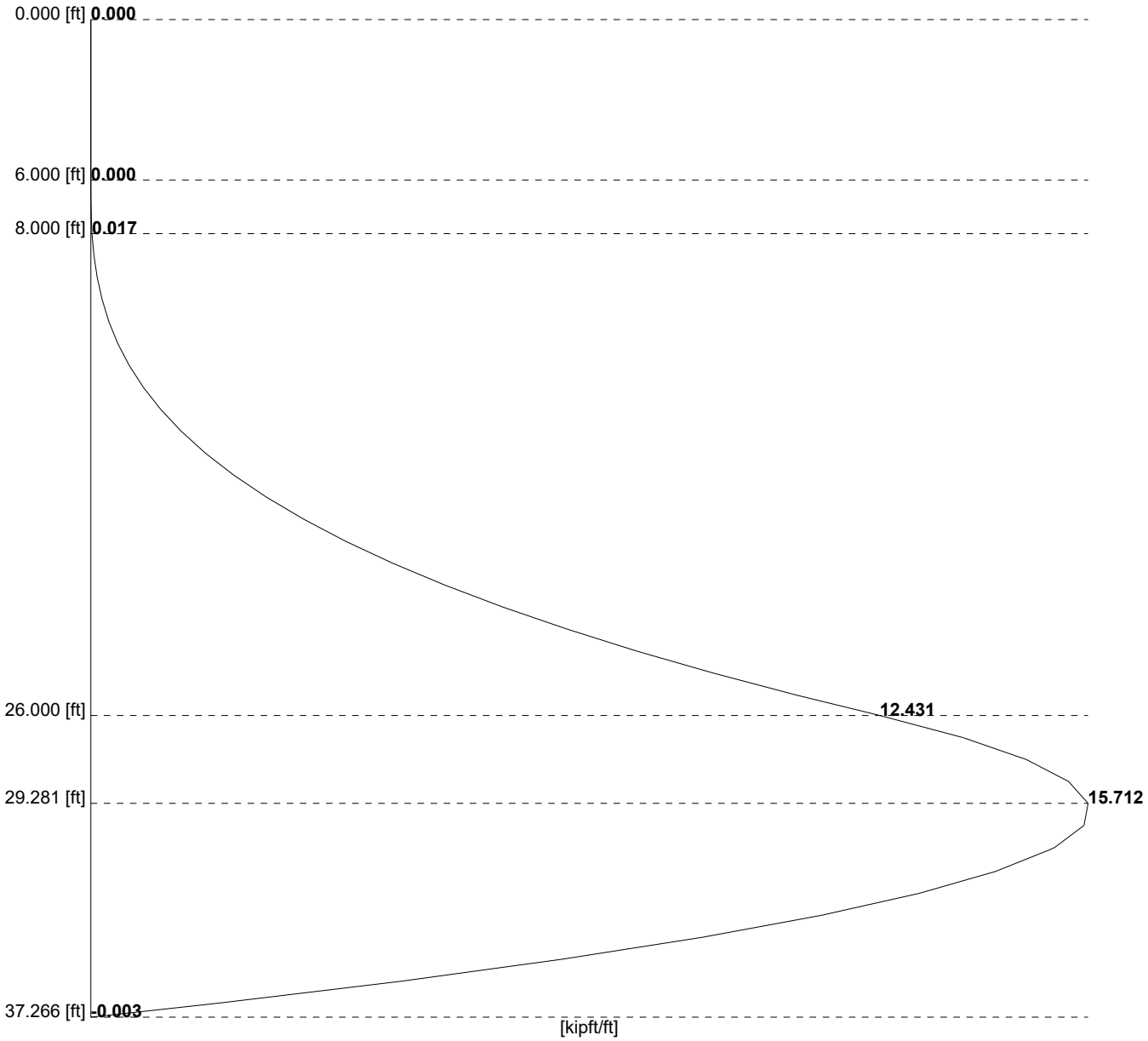
Boussinesq Diagram



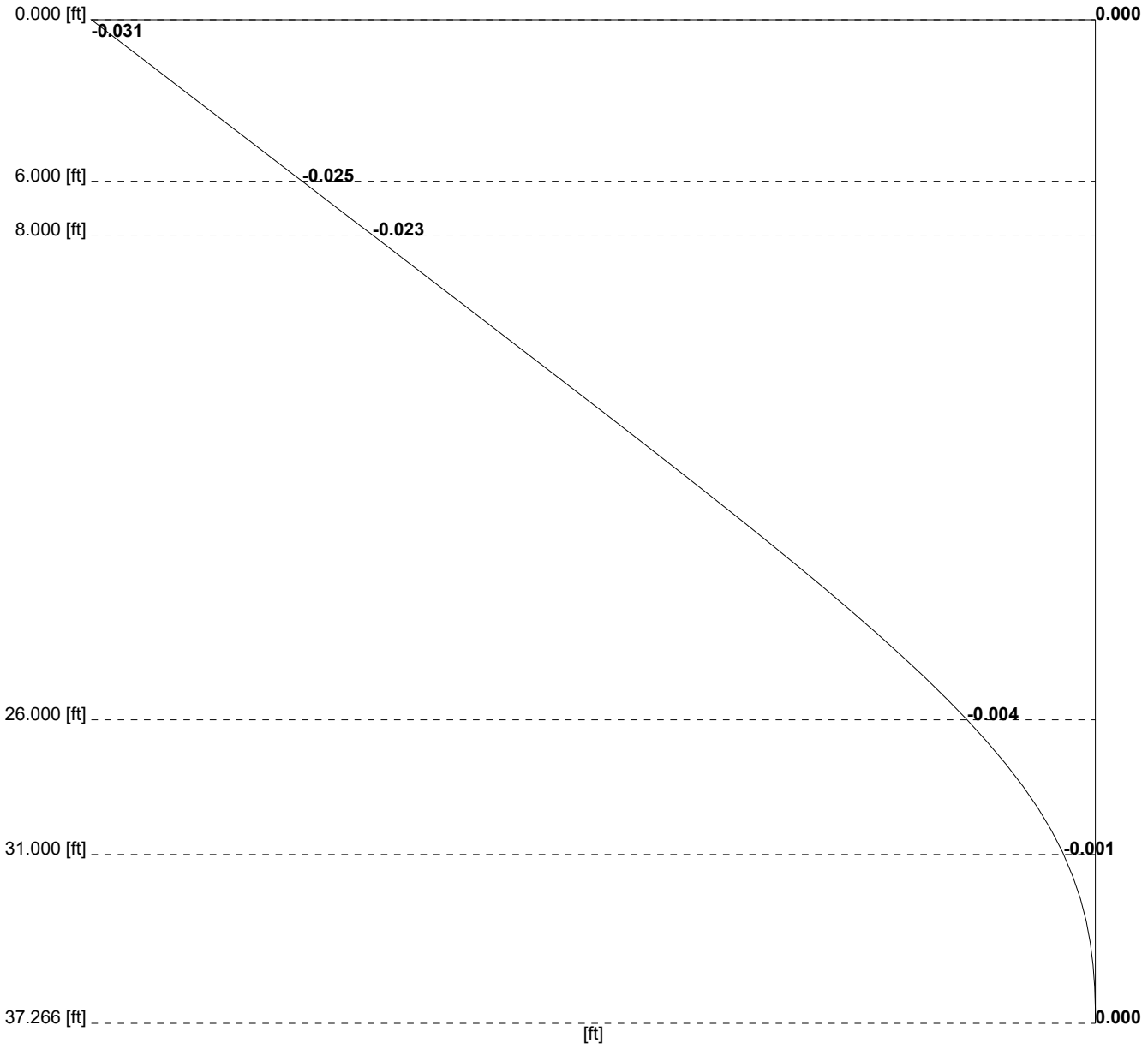
Total Pressure Diagram



Moment Diagram

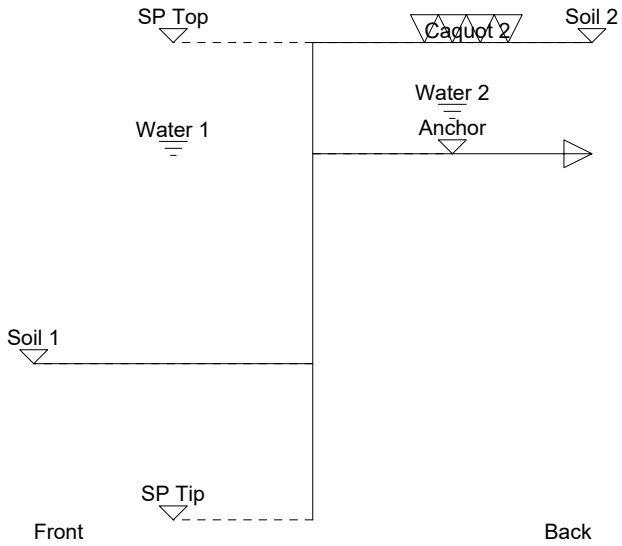


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	38.644
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

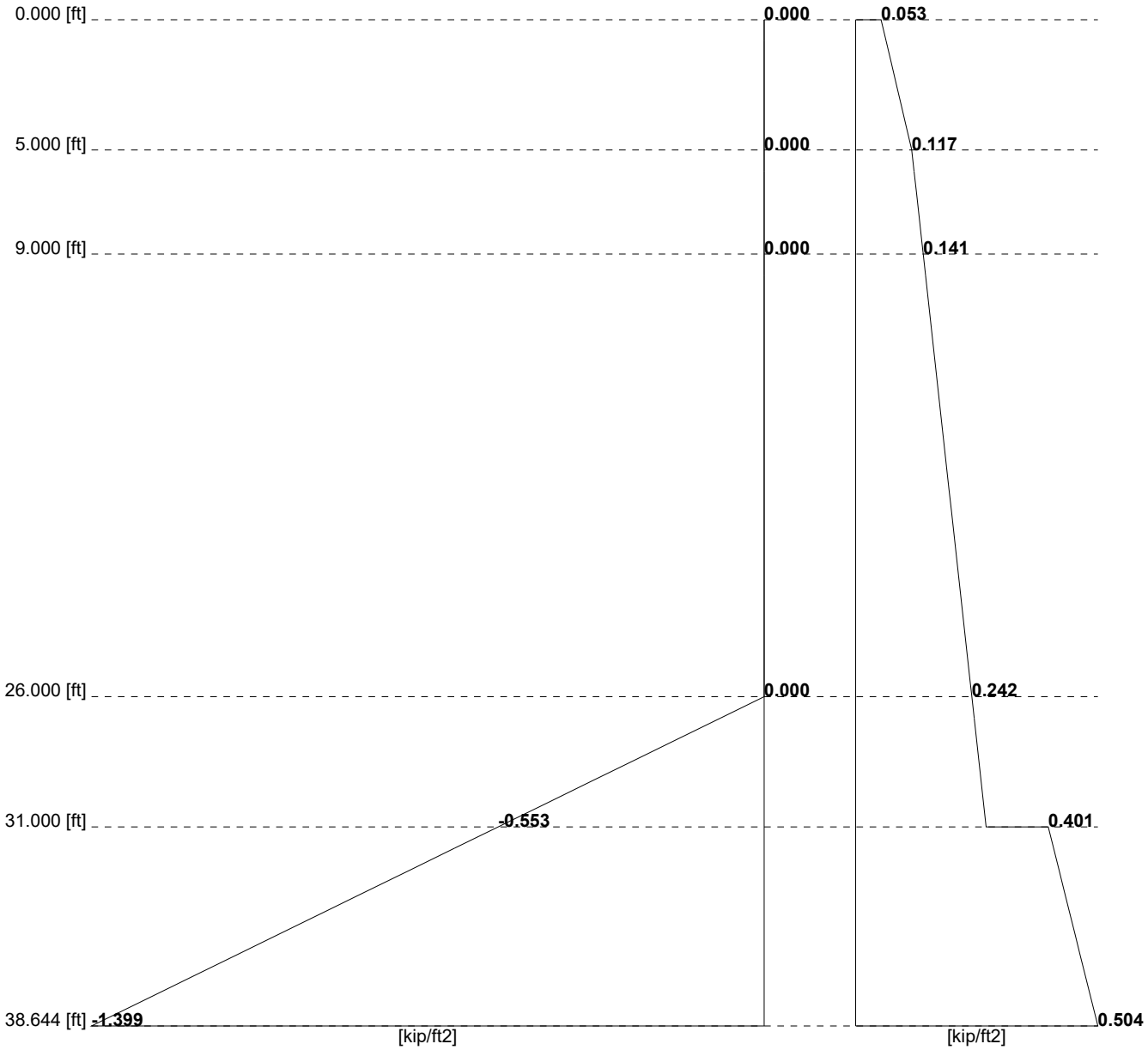
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

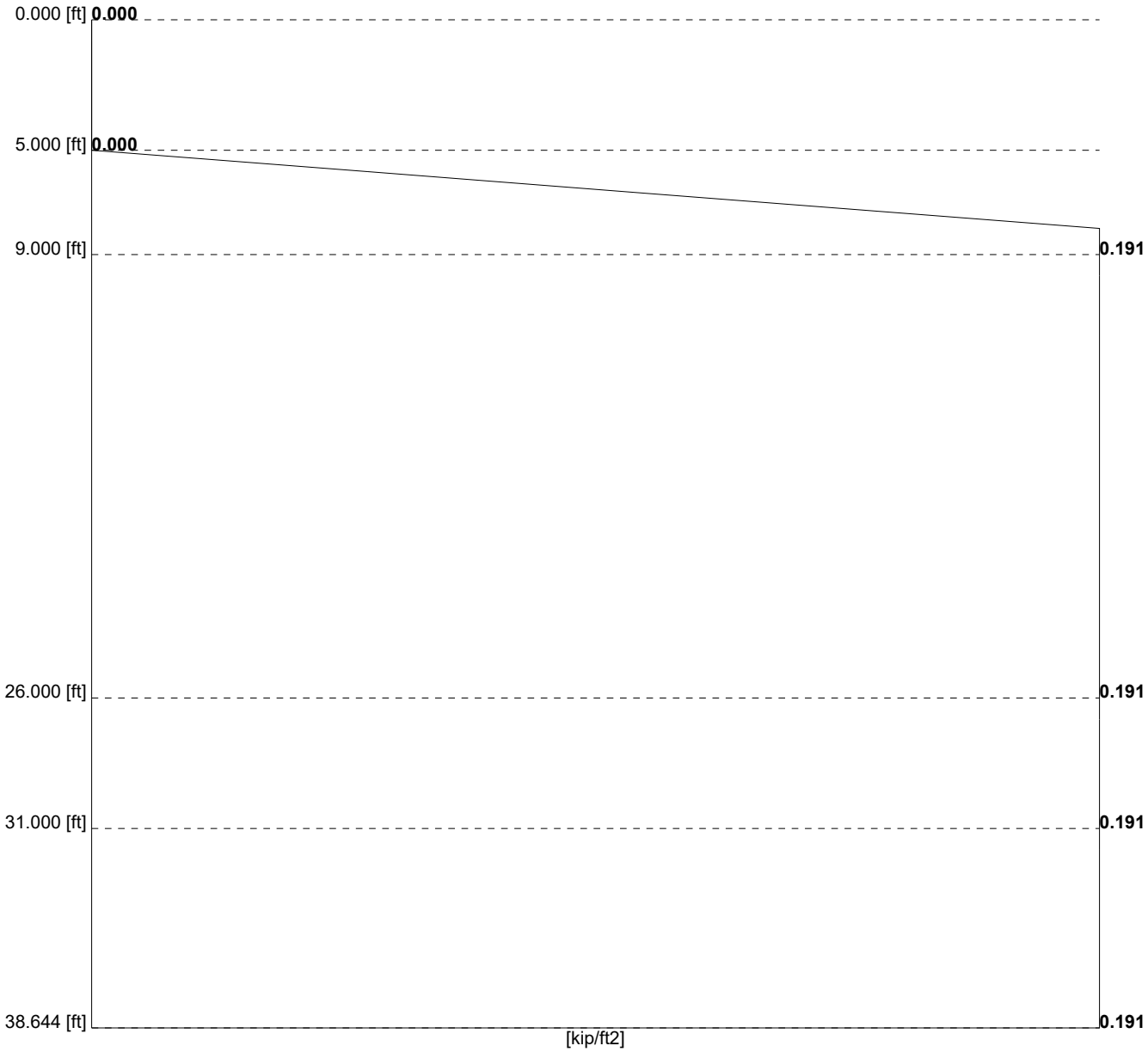
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-28.159	22.025
Maxmimal Moment [kipft/ft]	4.295	9.000
Normal Forces at Max. Moment [kip/ft]	1.199	22.025
Normal Forces at Min. Moment [kip/ft]	0.342	9.000
Deflection at Min. Moment [ft]	-0.012	22.025
Deflection at Max. Moment [ft]	0.000	9.000
Min. Stress at Min. Moment [lb/in2]	-3858.519	22.025
Max. Stress at Min. Moment [lb/in2]	4035.355	22.025
Min. Stress at Max. Moment [lb/in2]	-576.529	9.000
Max. Stress at Max. Moment [lb/in2]	626.927	9.000
Safety > Req. Safety = 1.500	12.390	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	38.644	
Sheet Pile Length [ft]	38.644	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.278	
Anchor Force (horiz.) [kip/ft]	-6.236	

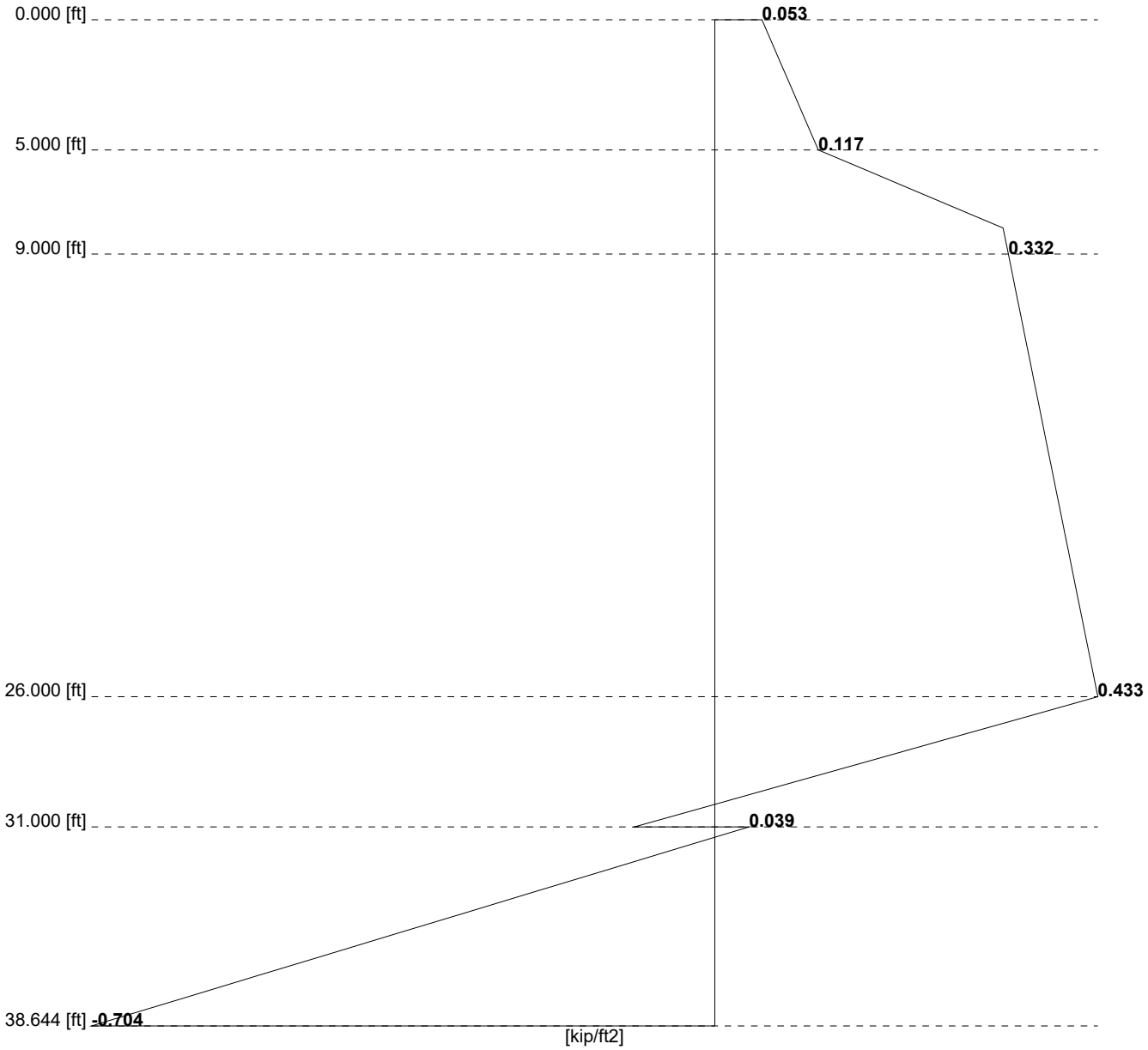
Earth Pressure Diagram



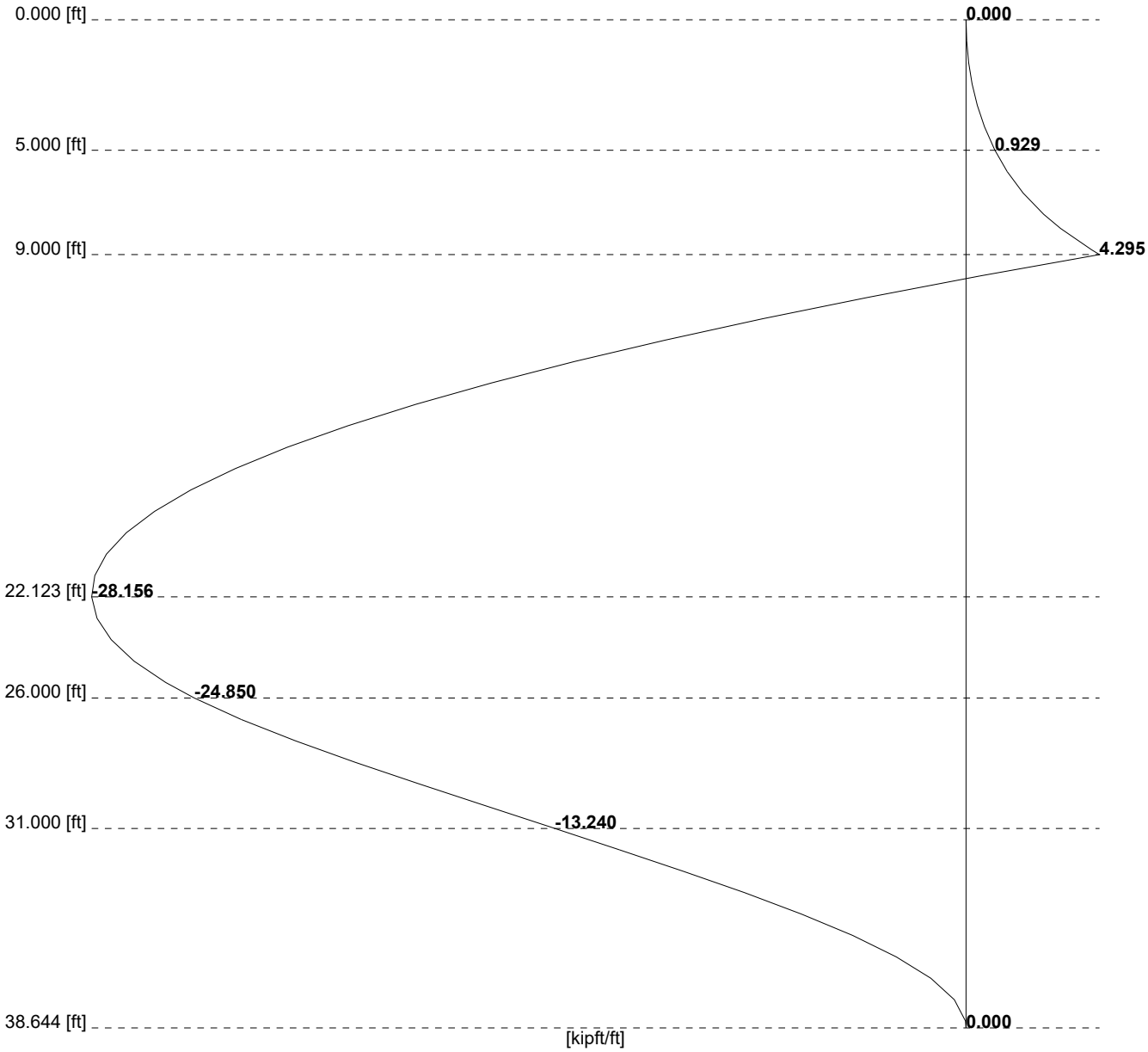
Water Pressure Diagram



Total Pressure Diagram

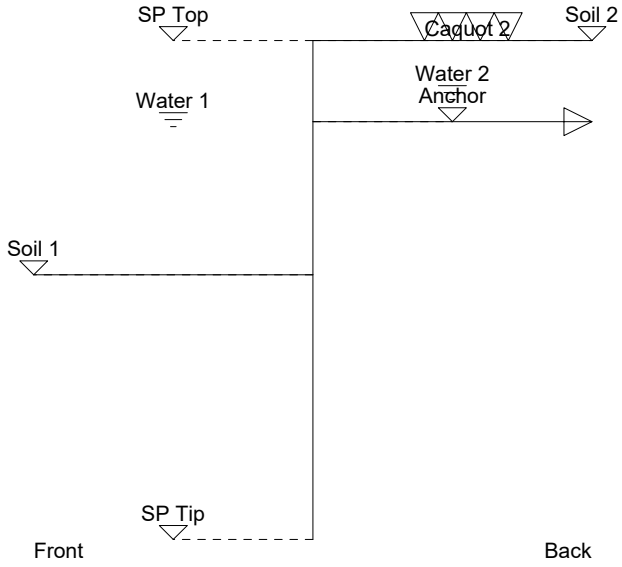


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	55.383
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

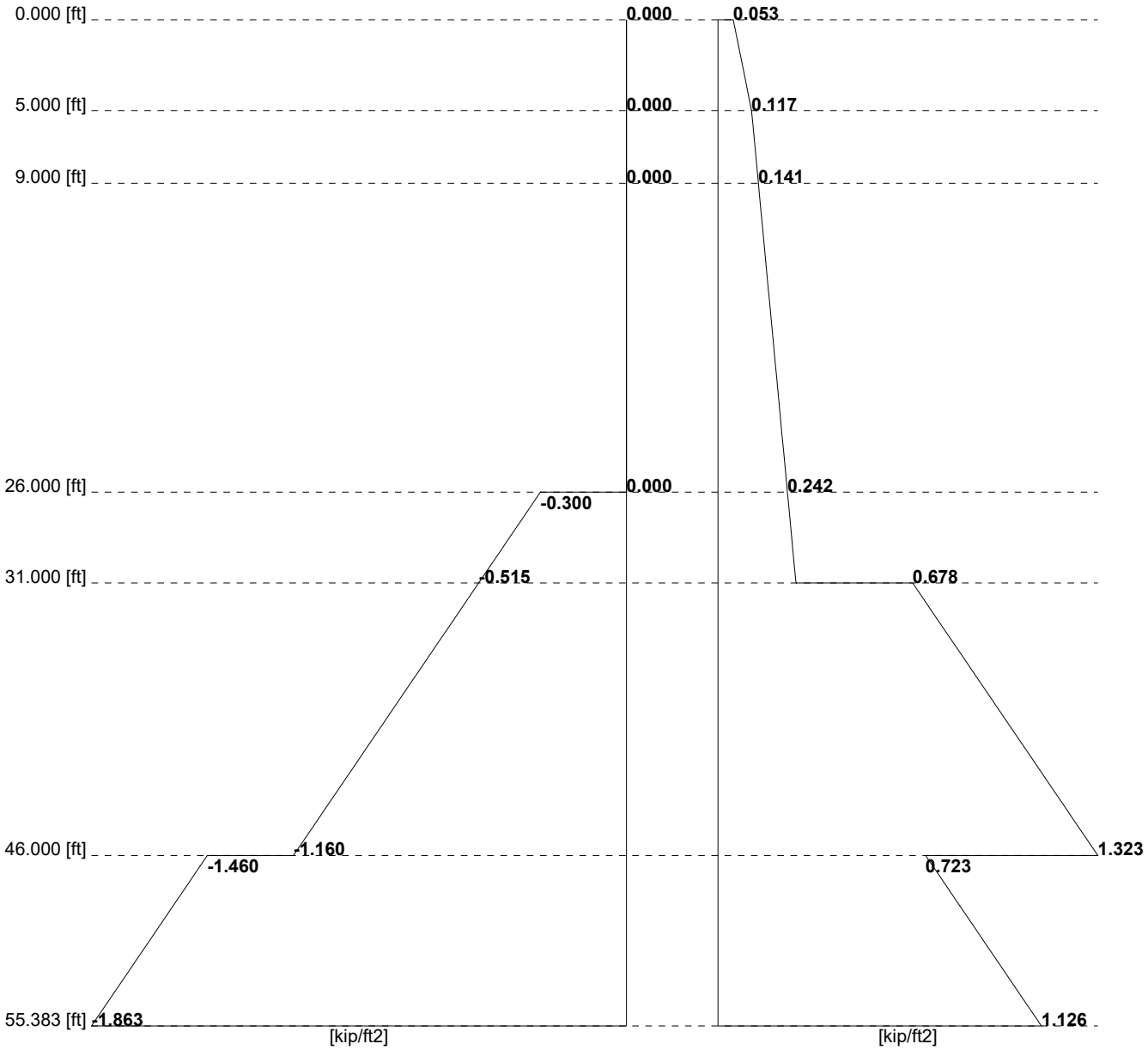
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

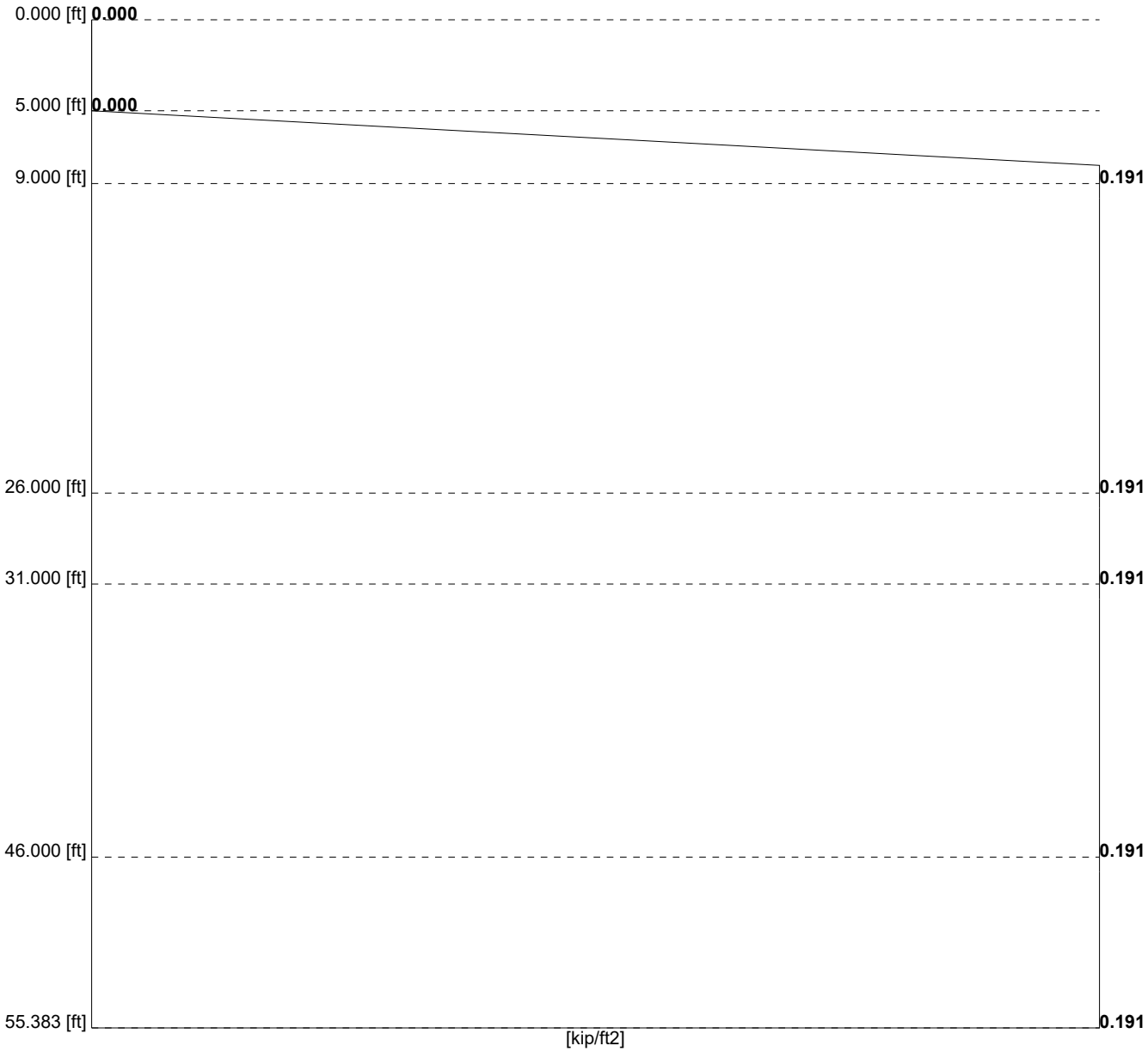
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-61.053	31.558
Maxmimal Moment [kipft/ft]	4.295	9.000
Normal Forces at Max. Moment [kip/ft]	1.990	31.558
Normal Forces at Min. Moment [kip/ft]	0.342	9.000
Deflection at Min. Moment [ft]	-0.073	31.558
Deflection at Max. Moment [ft]	0.000	9.000
Min. Stress at Min. Moment [lb/in2]	-8426.658	31.558
Max. Stress at Min. Moment [lb/in2]	8720.161	31.558
Min. Stress at Max. Moment [lb/in2]	-576.529	9.000
Max. Stress at Max. Moment [lb/in2]	626.927	9.000
Safety > Req. Safety = 1.500	5.734	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	55.383	
Sheet Pile Length [ft]	55.383	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-8.301	

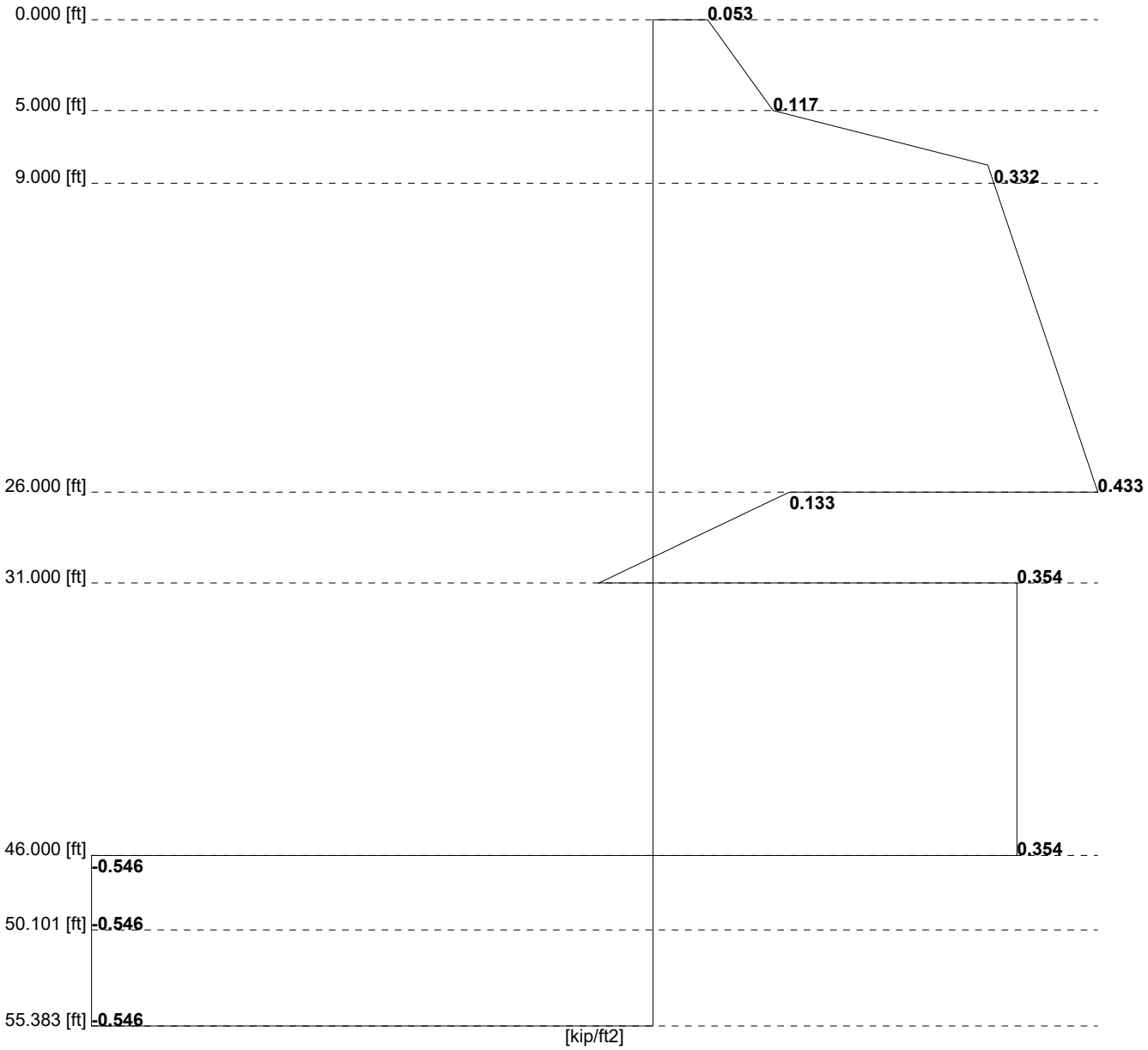
Earth Pressure Diagram



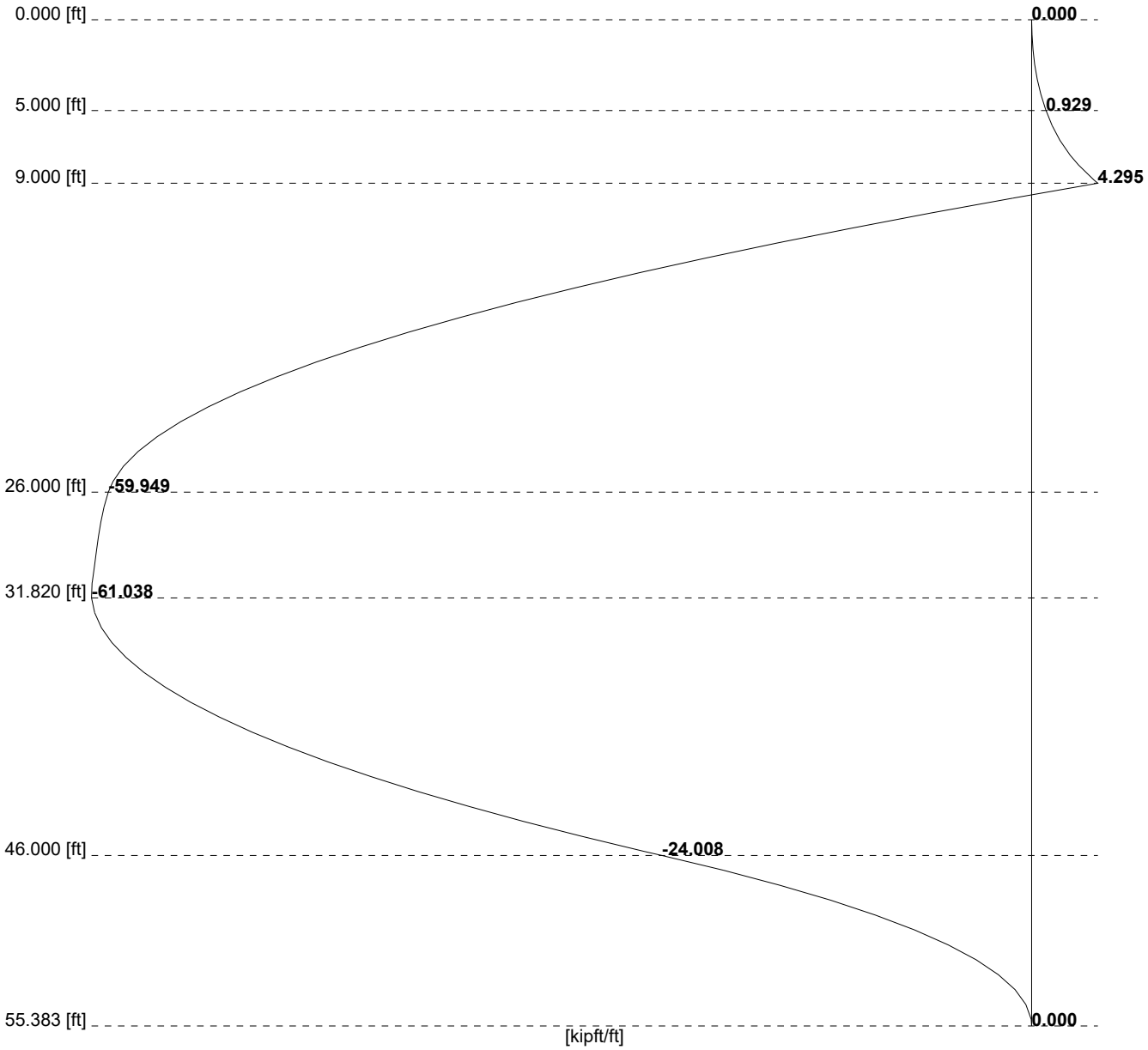
Water Pressure Diagram



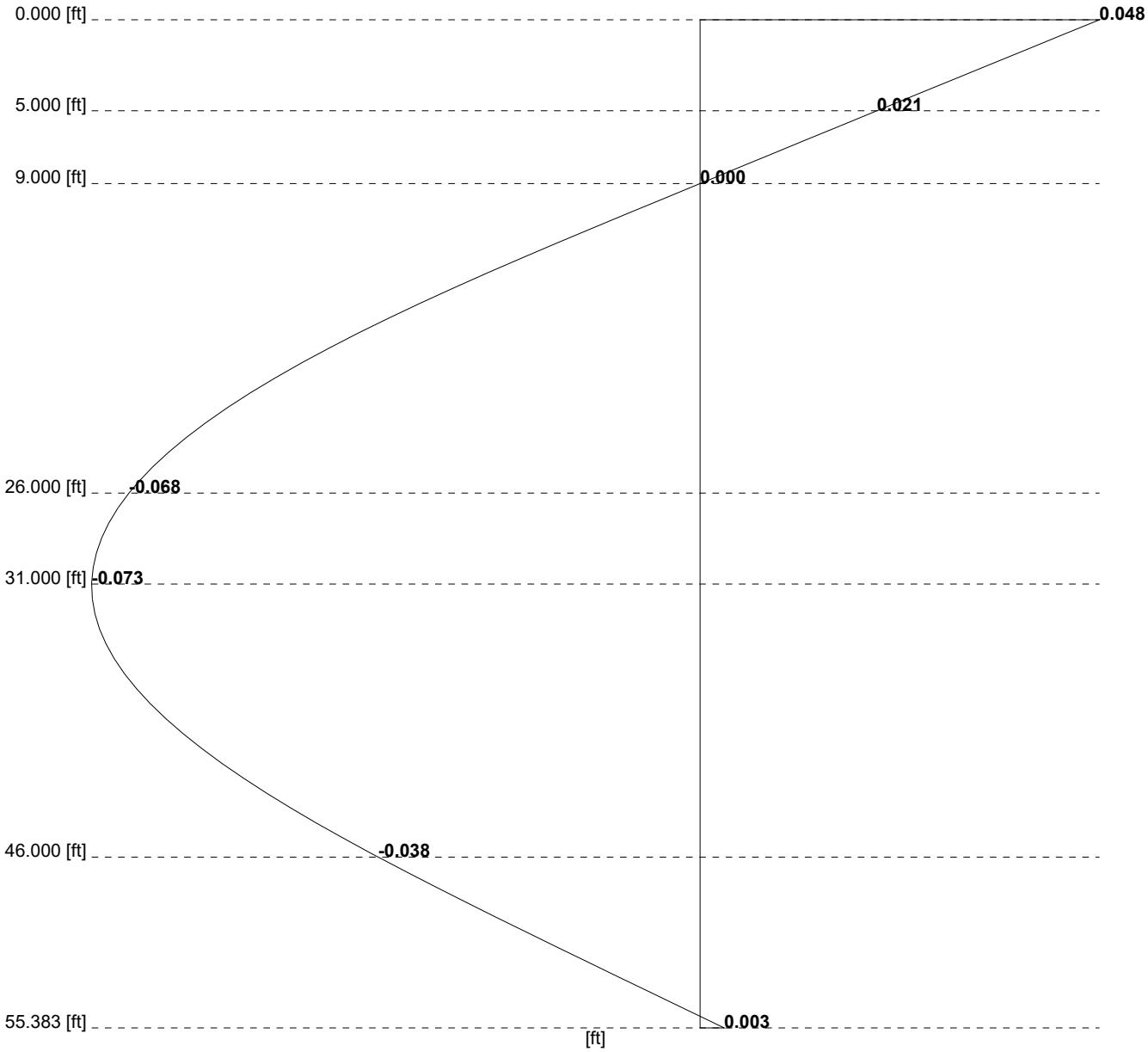
Total Pressure Diagram



Moment Diagram

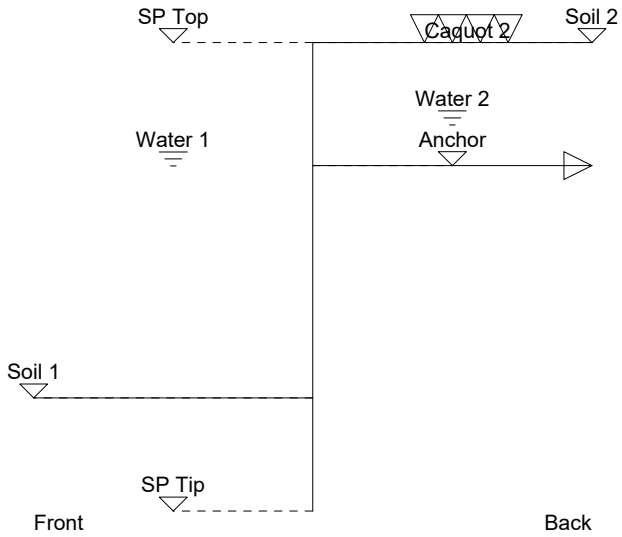


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	34.281
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

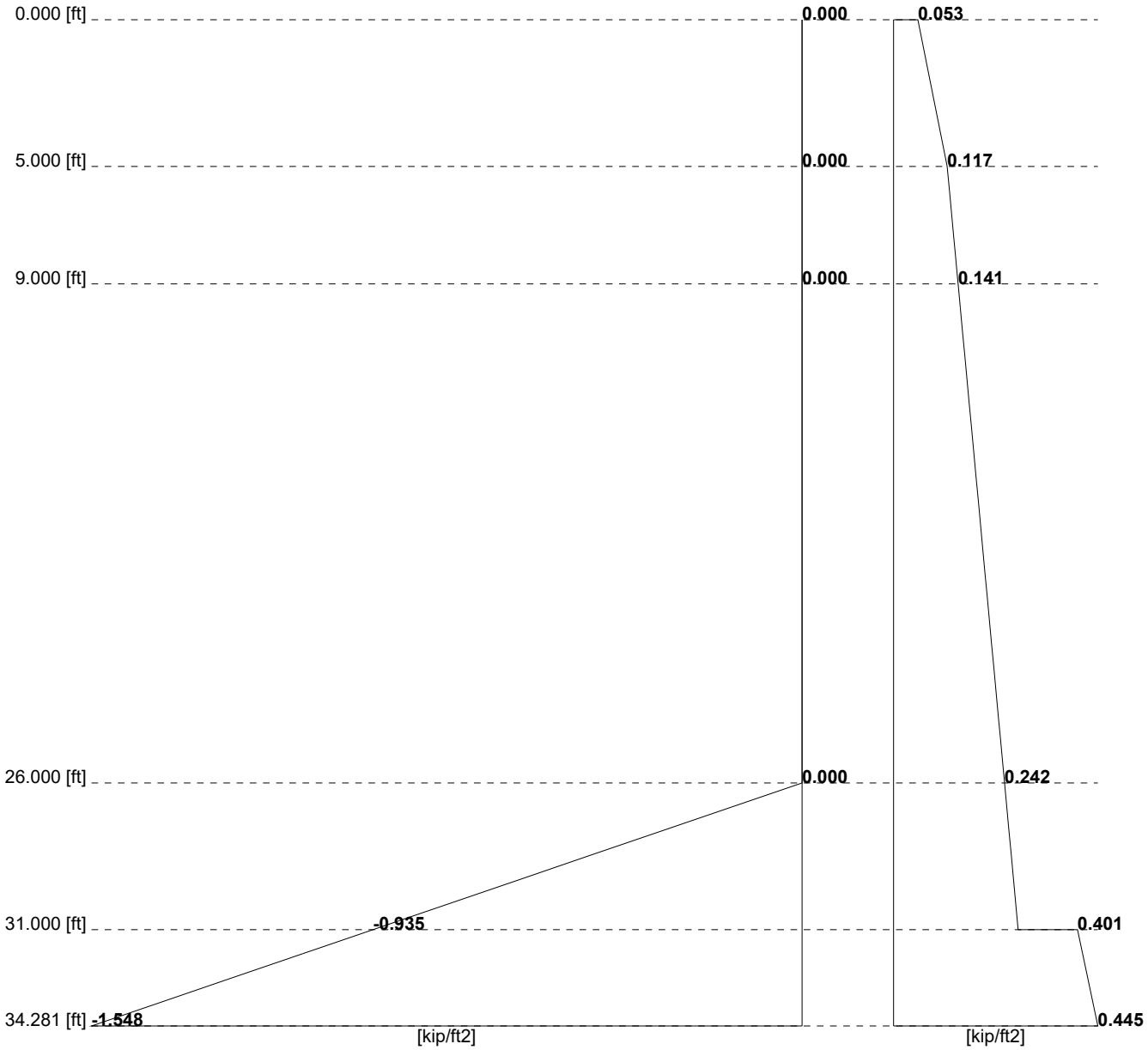
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

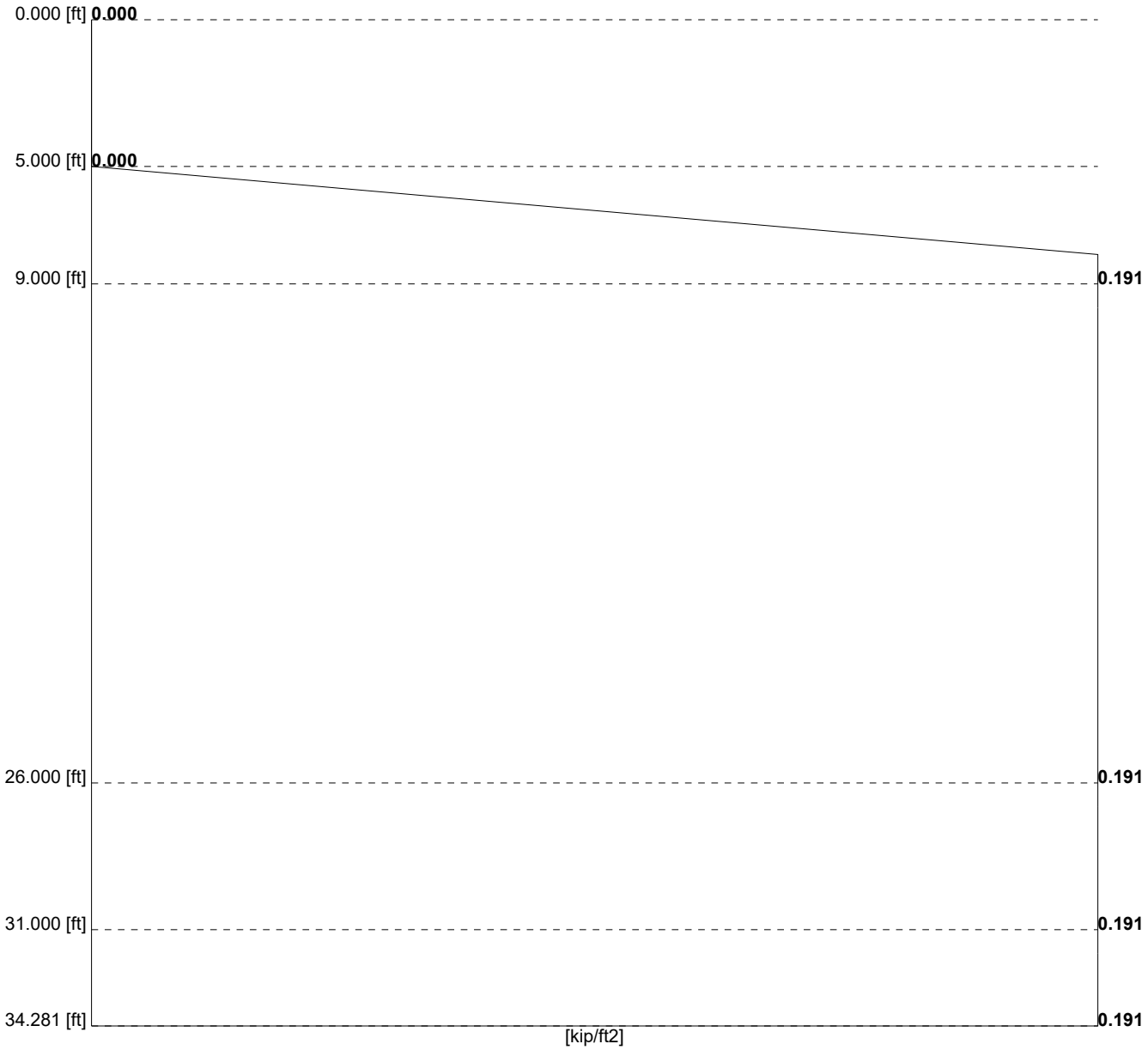
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-21.994	20.483
Maxmimal Moment [kipft/ft]	4.295	9.000
Normal Forces at Max. Moment [kip/ft]	1.071	20.483
Normal Forces at Min. Moment [kip/ft]	0.342	9.000
Deflection at Min. Moment [ft]	-0.021	20.483
Deflection at Max. Moment [ft]	0.000	9.000
Min. Stress at Min. Moment [lb/in2]	-8039.951	20.483
Max. Stress at Min. Moment [lb/in2]	8380.958	20.483
Min. Stress at Max. Moment [lb/in2]	-1547.333	9.000
Max. Stress at Max. Moment [lb/in2]	1656.087	9.000
Safety > Req. Safety = 1.500	5.966	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	34.281	
Sheet Pile Length [ft]	34.281	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.633	
Anchor Force (horiz.) [kip/ft]	-5.741	

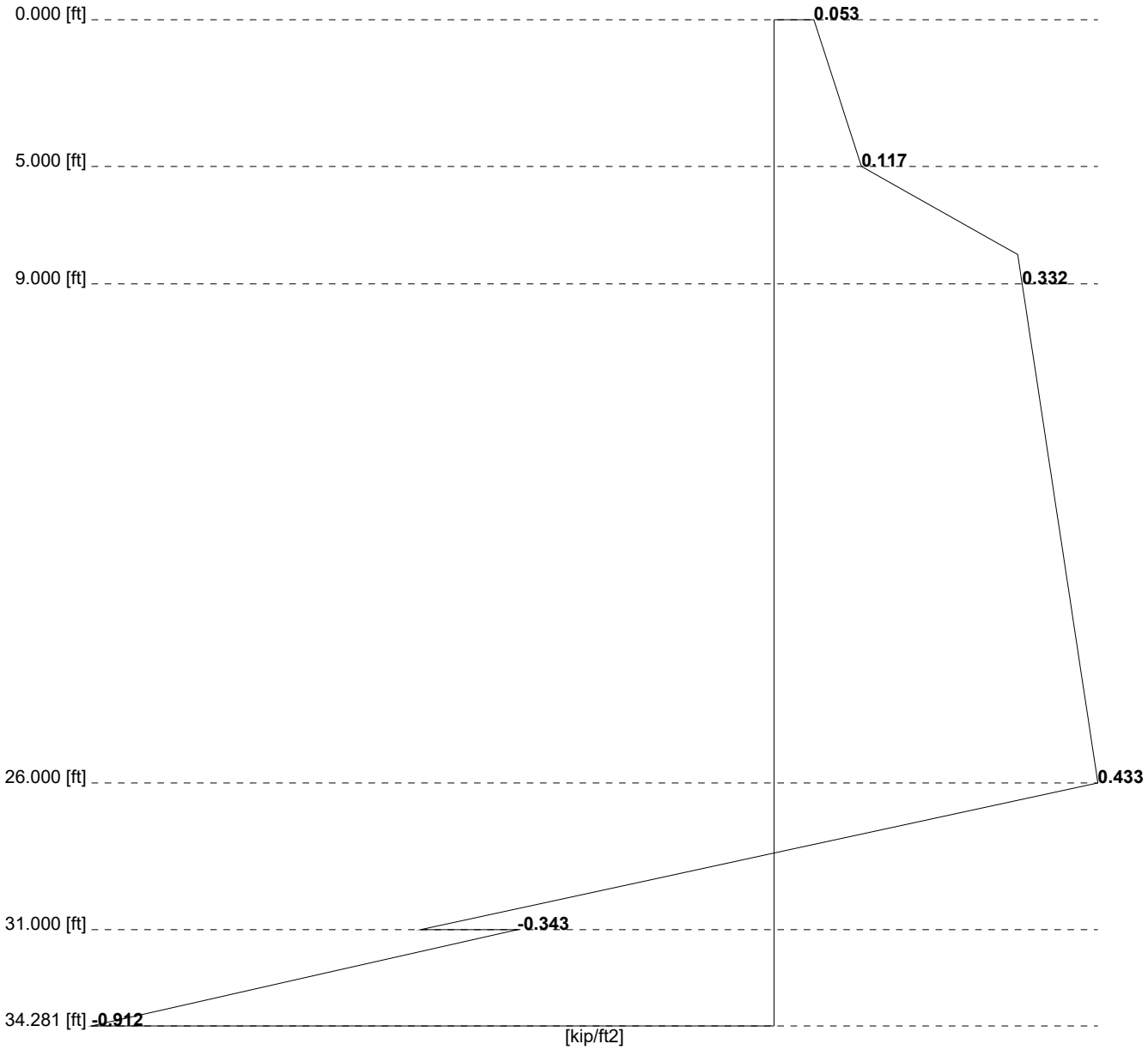
Earth Pressure Diagram



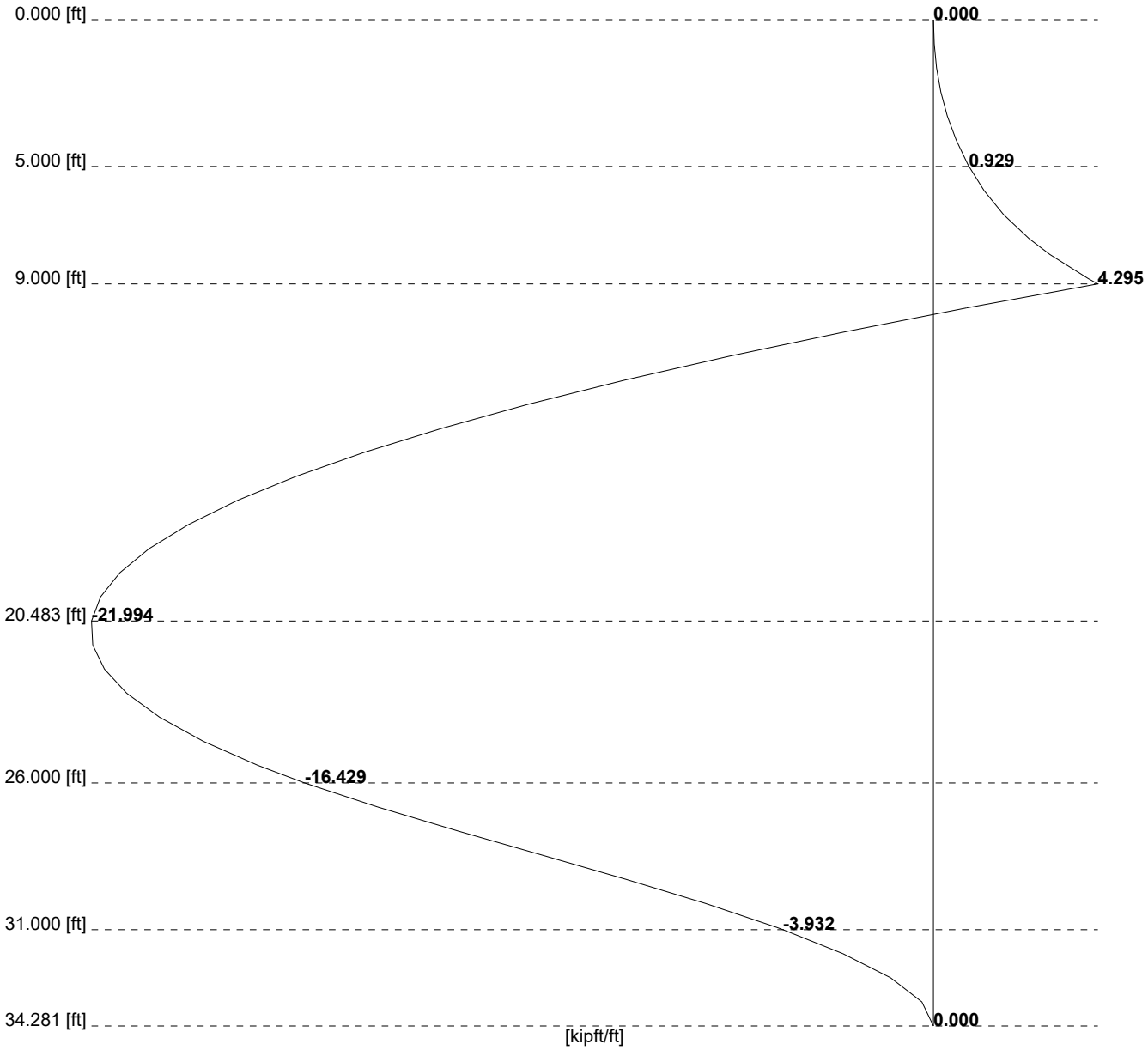
Water Pressure Diagram



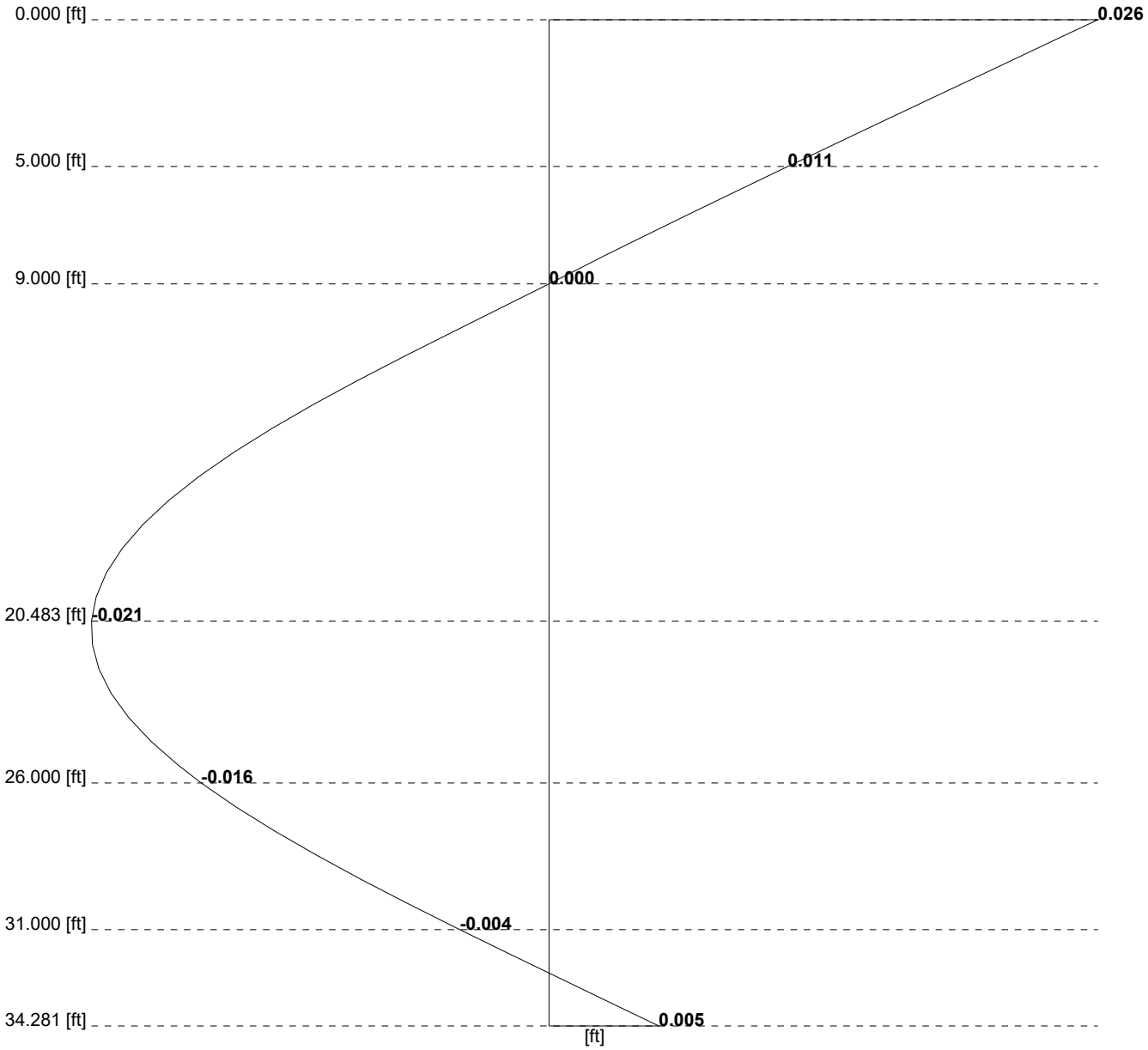
Total Pressure Diagram



Moment Diagram

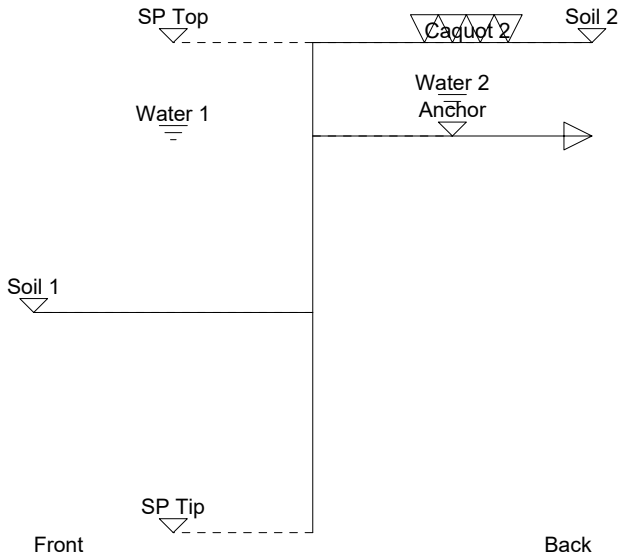


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	47.214
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

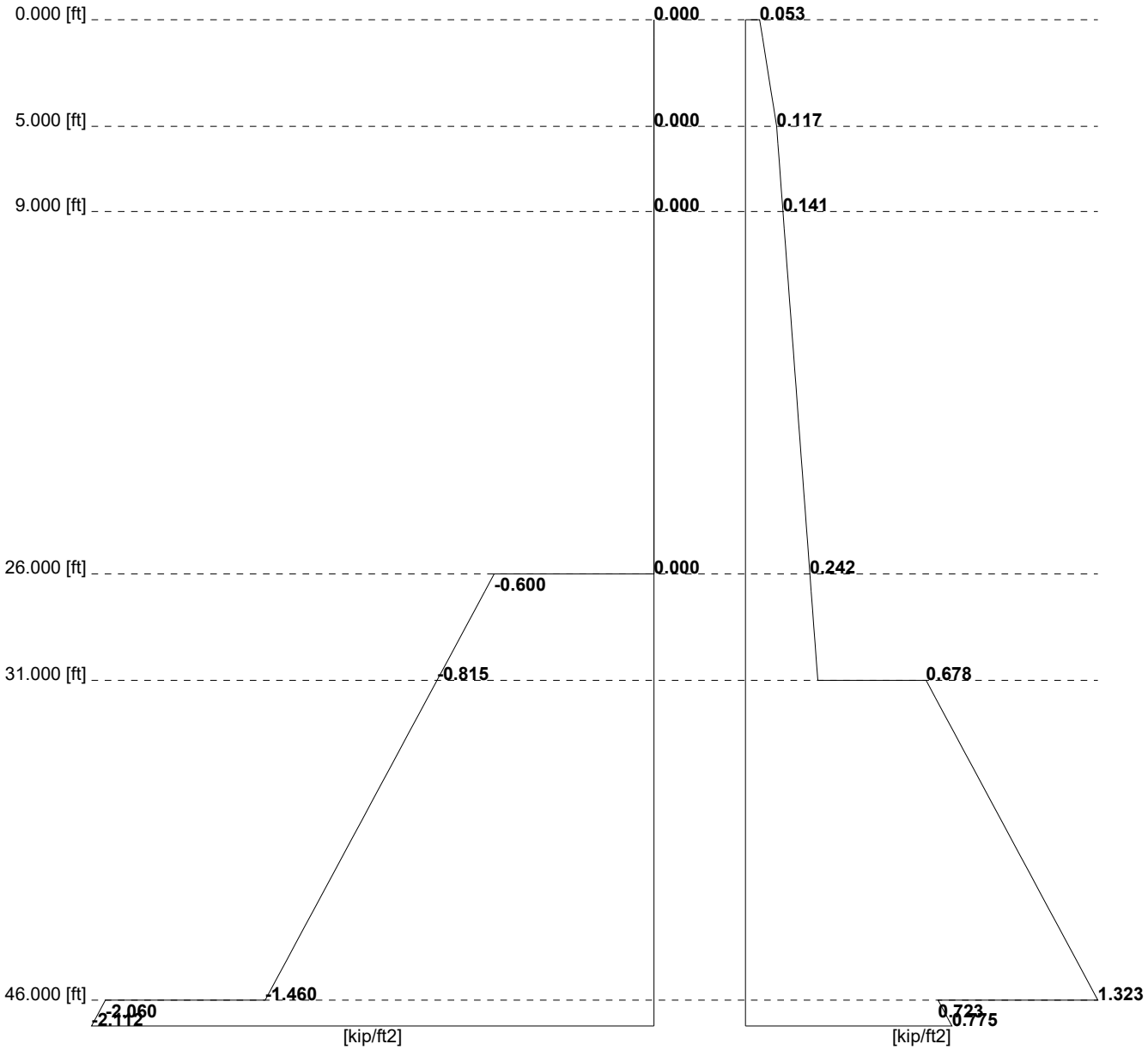
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

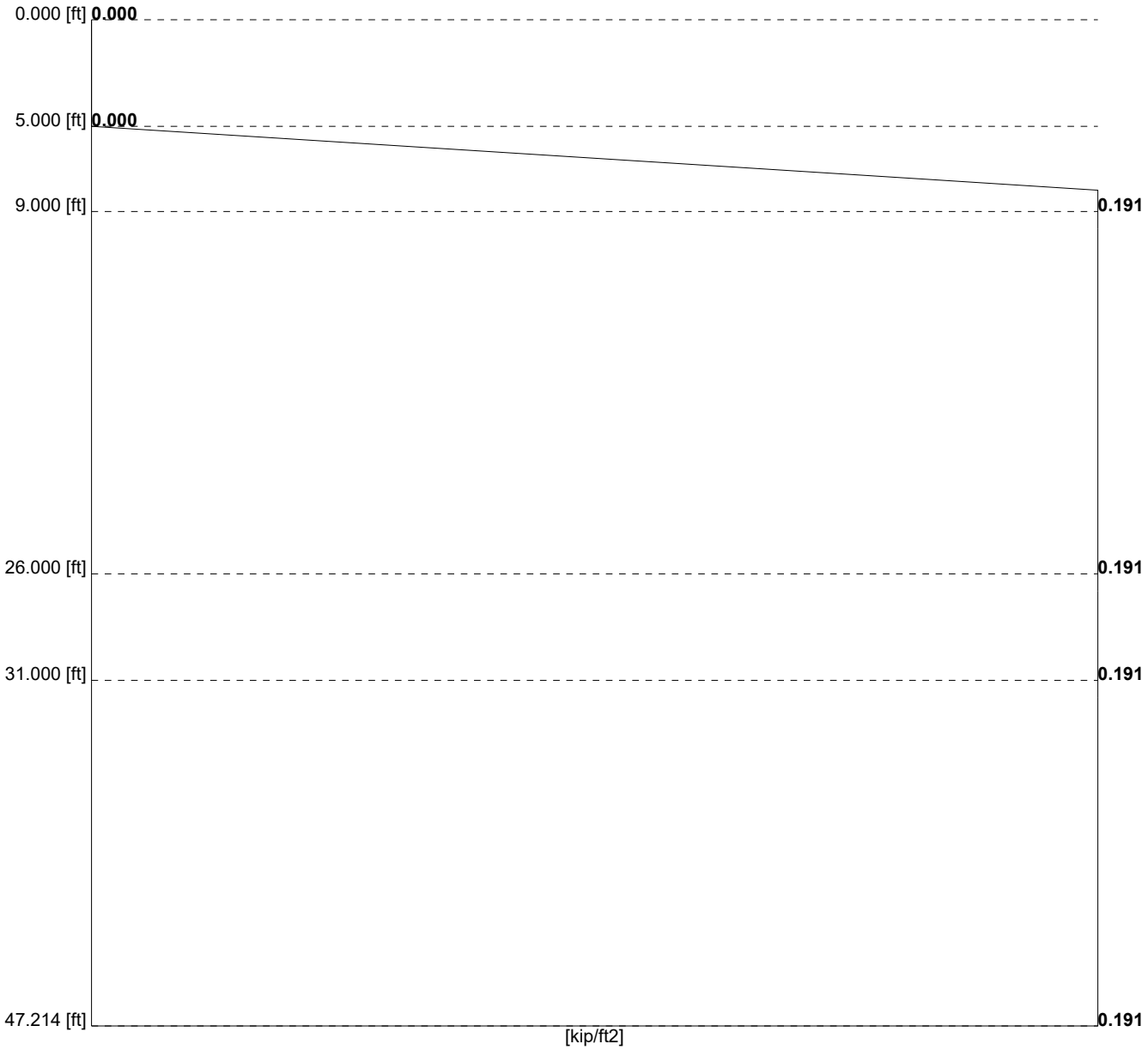
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-25.795	21.303
Maxmimal Moment [kipft/ft]	4.295	9.000
Normal Forces at Max. Moment [kip/ft]	1.134	21.303
Normal Forces at Min. Moment [kip/ft]	0.342	9.000
Deflection at Min. Moment [ft]	-0.050	21.303
Deflection at Max. Moment [ft]	0.000	9.000
Min. Stress at Min. Moment [lb/in2]	-9459.920	21.303
Max. Stress at Min. Moment [lb/in2]	9820.989	21.303
Min. Stress at Max. Moment [lb/in2]	-1547.333	9.000
Max. Stress at Max. Moment [lb/in2]	1656.087	9.000
Safety > Req. Safety = 1.500	5.091	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	47.214	
Sheet Pile Length [ft]	47.214	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-6.052	

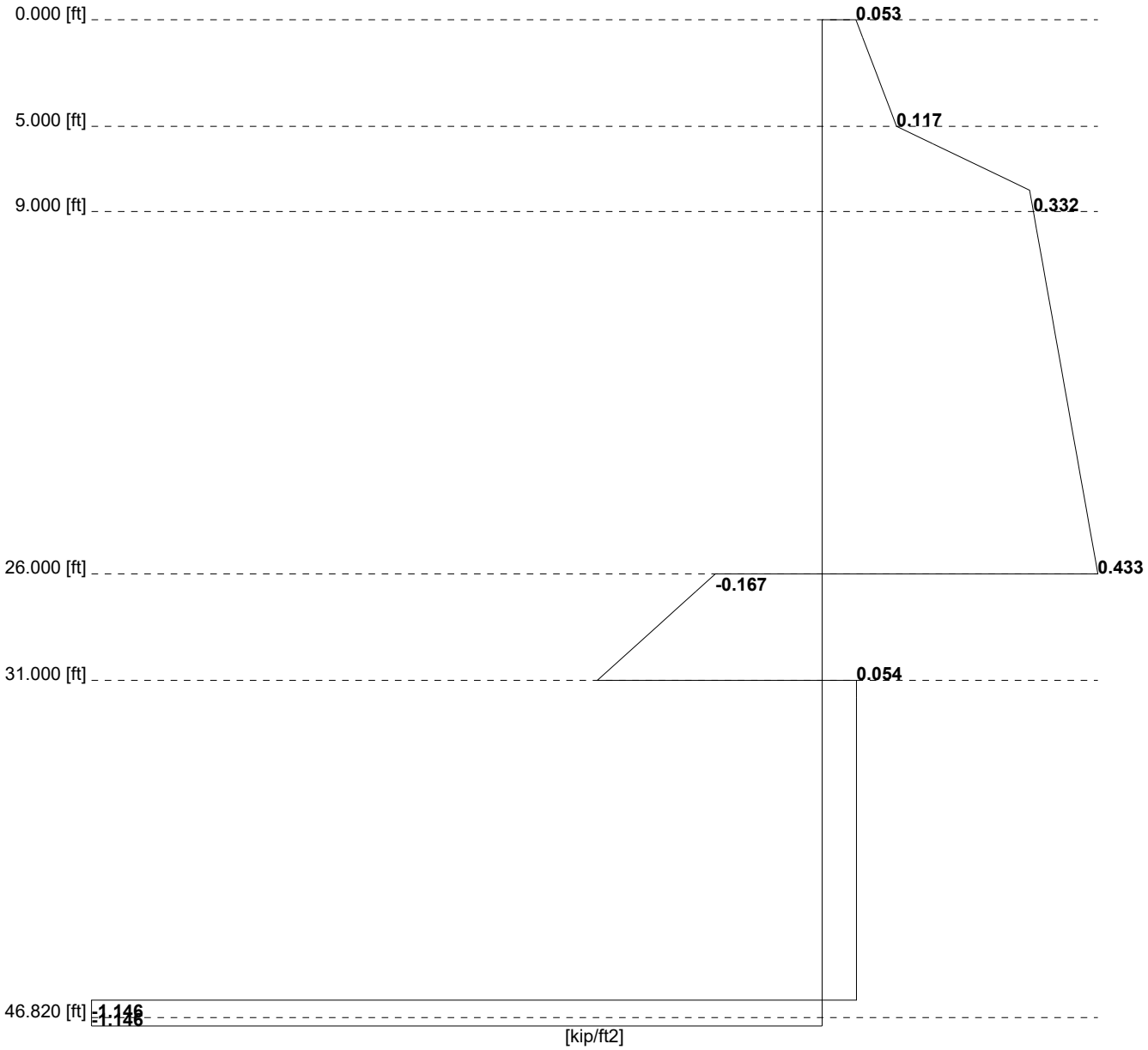
Earth Pressure Diagram



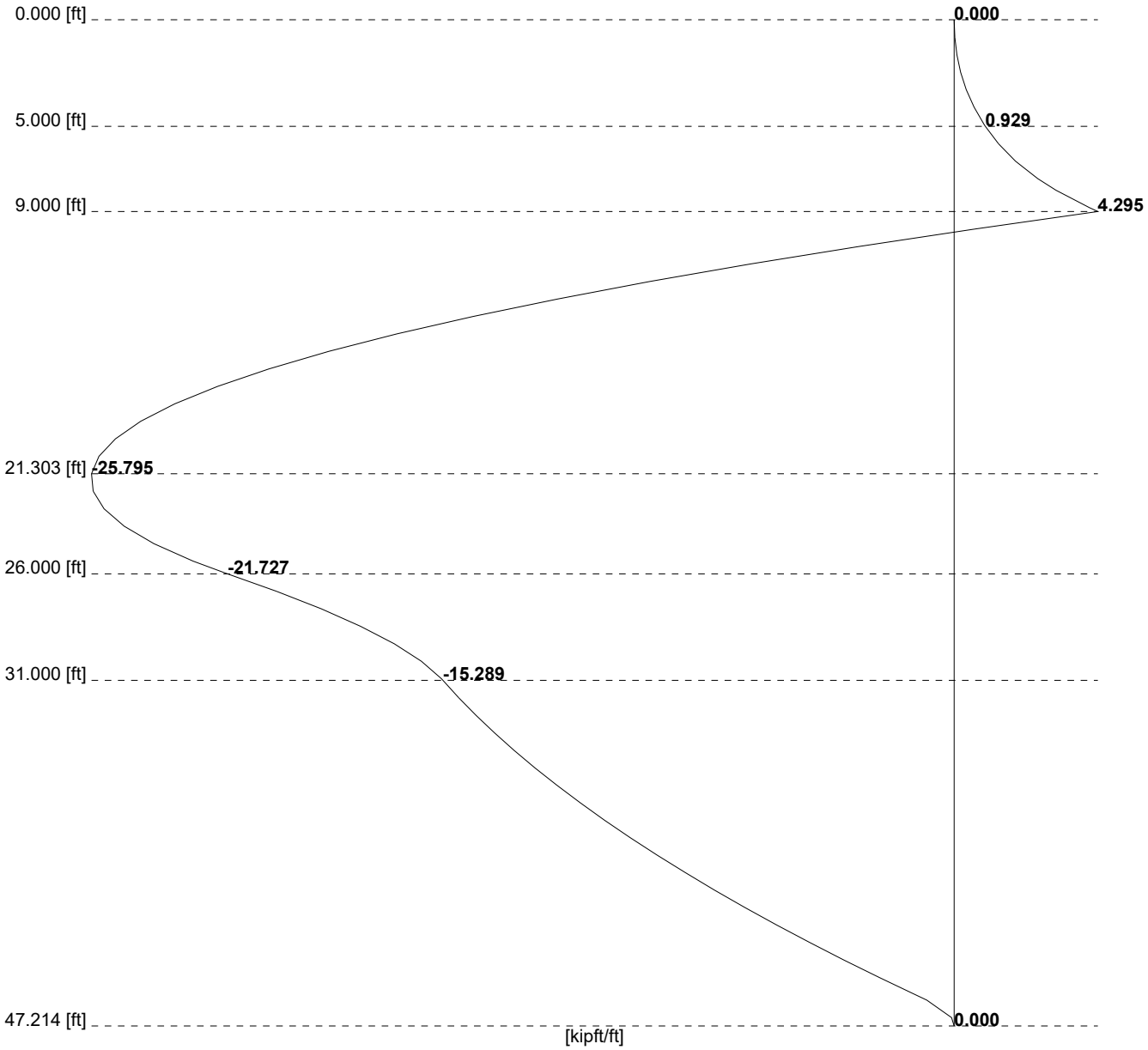
Water Pressure Diagram



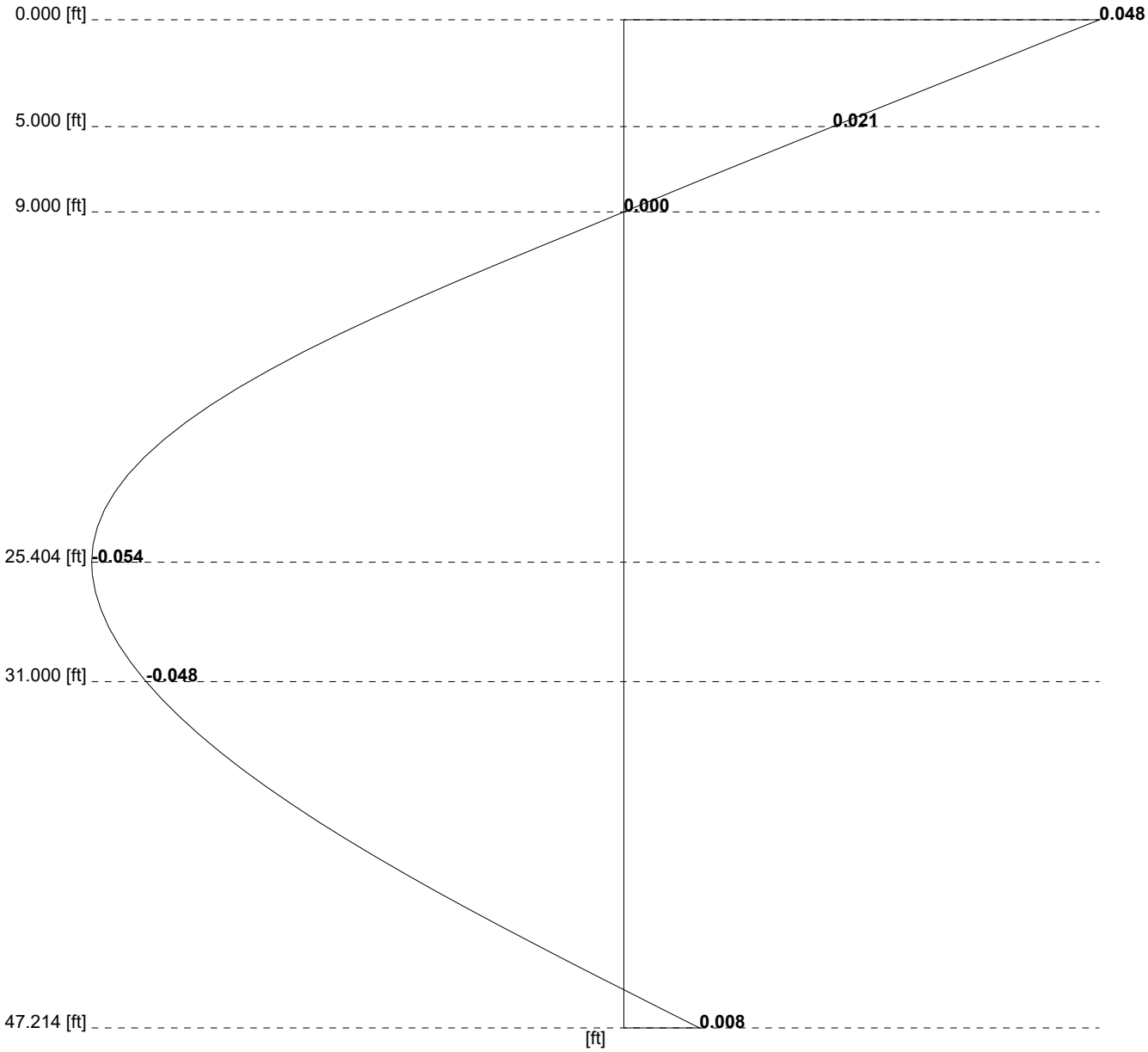
Total Pressure Diagram



Moment Diagram

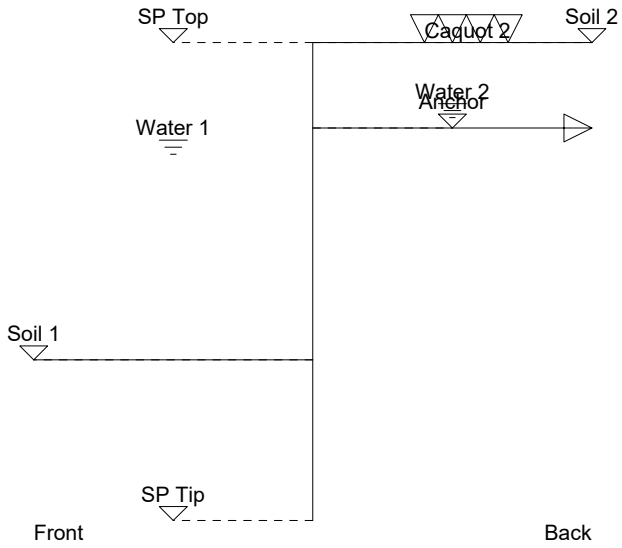


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	39.169
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

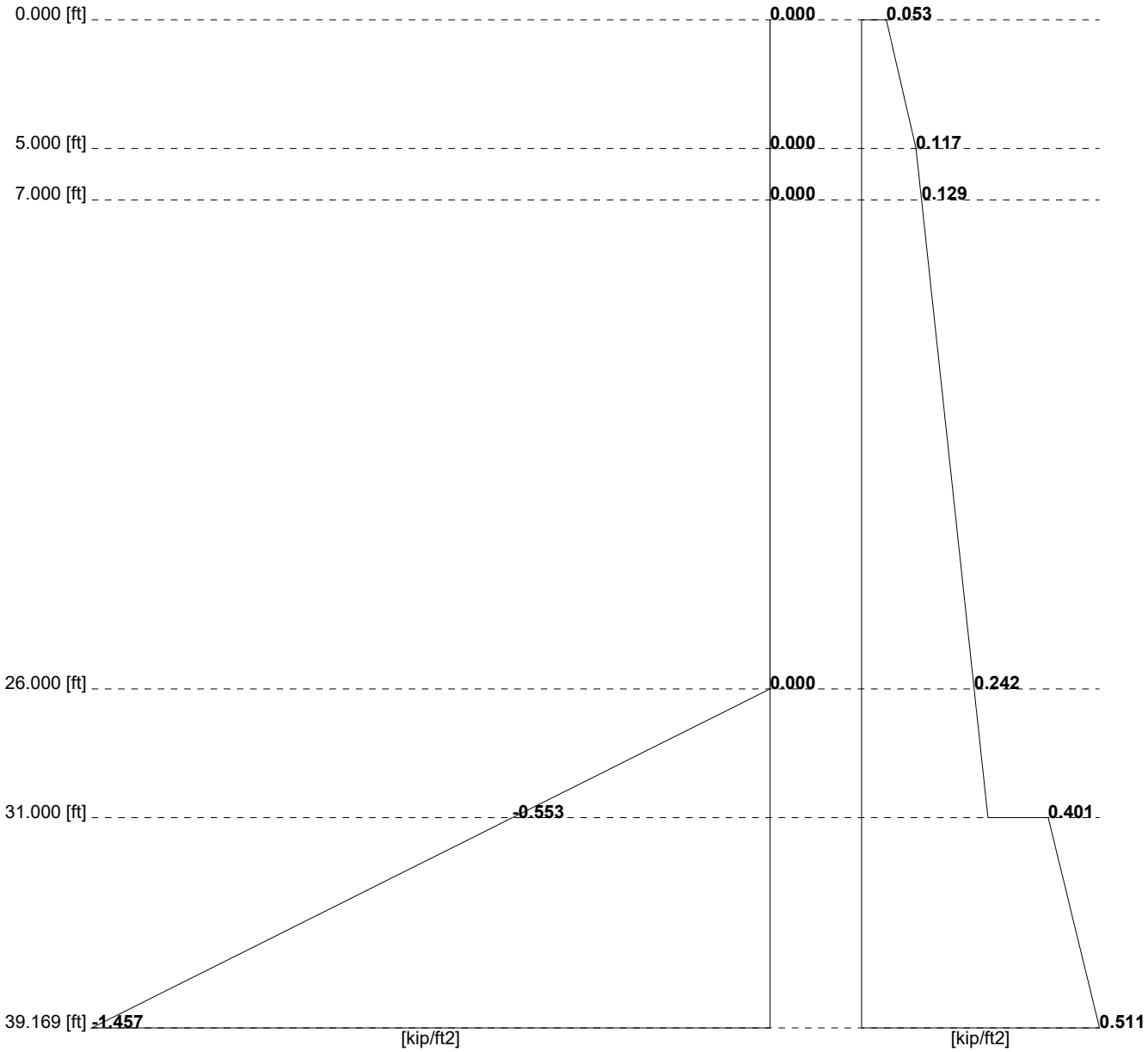
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

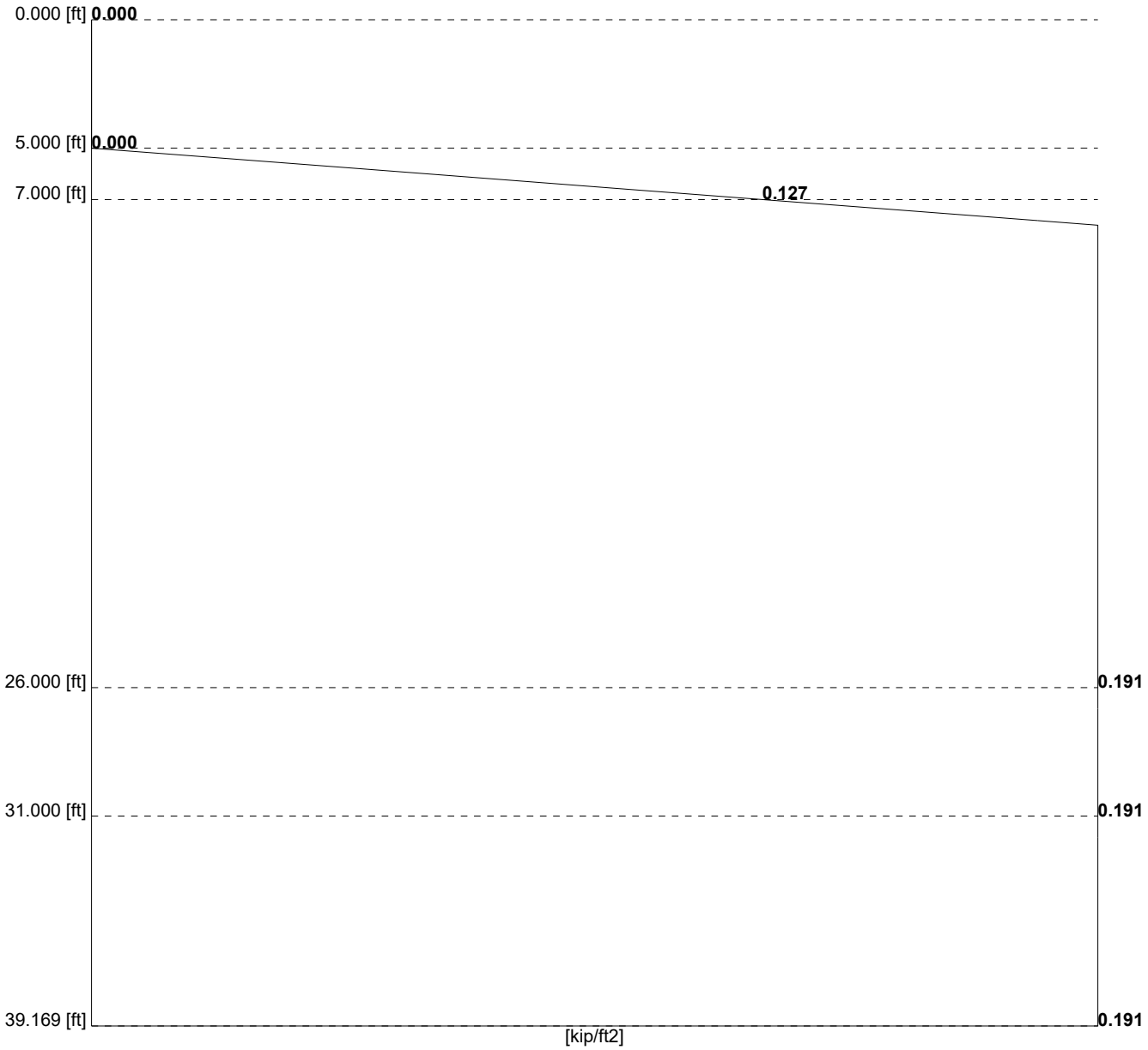
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-34.947	21.058
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.120	21.058
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.019	21.058
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-4816.266	21.058
Max. Stress at Min. Moment [lb/in2]	4981.534	21.058
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	10.037	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	39.169	
Sheet Pile Length [ft]	39.169	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.211	
Anchor Force (horiz.) [kip/ft]	-5.845	

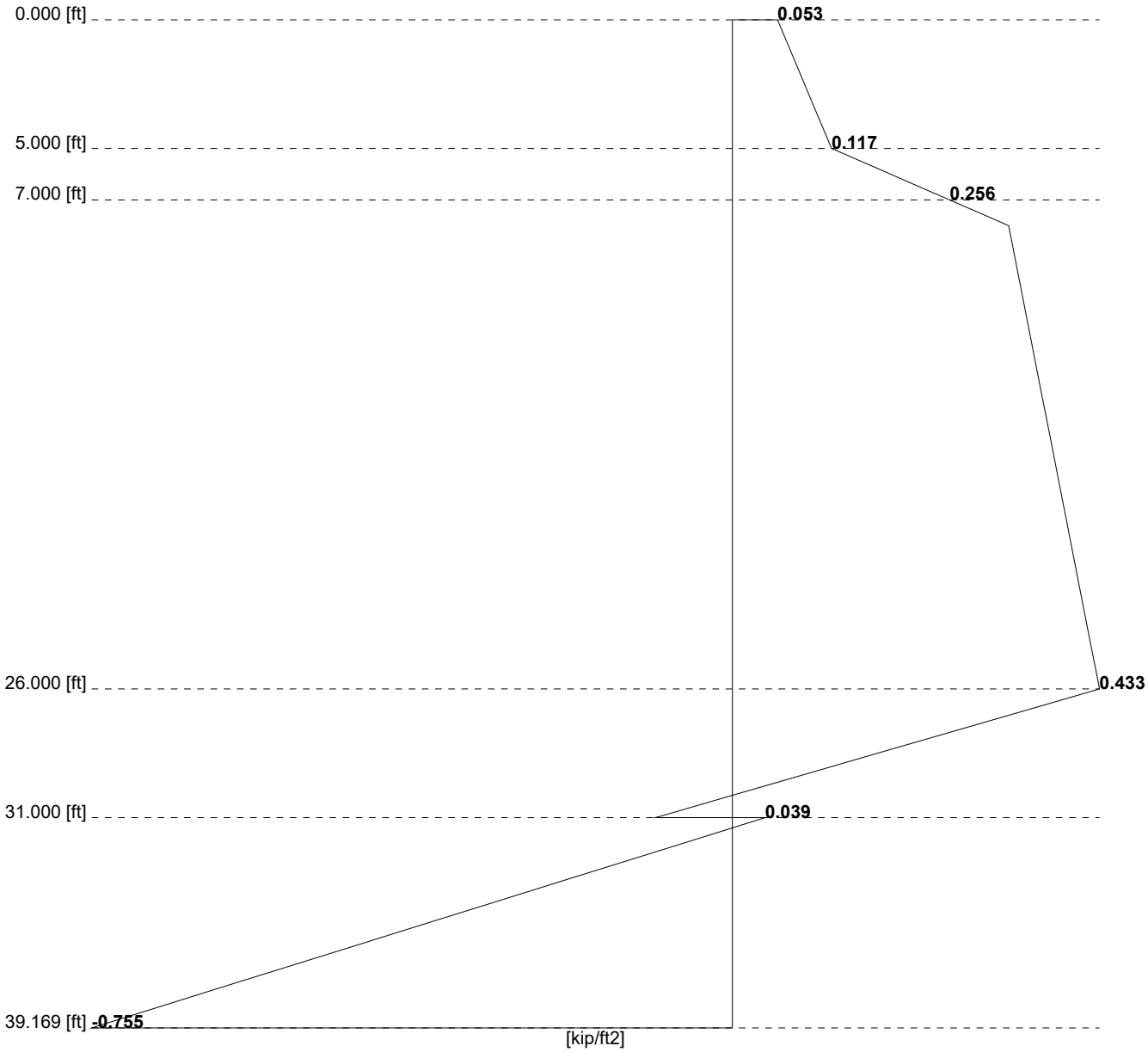
Earth Pressure Diagram



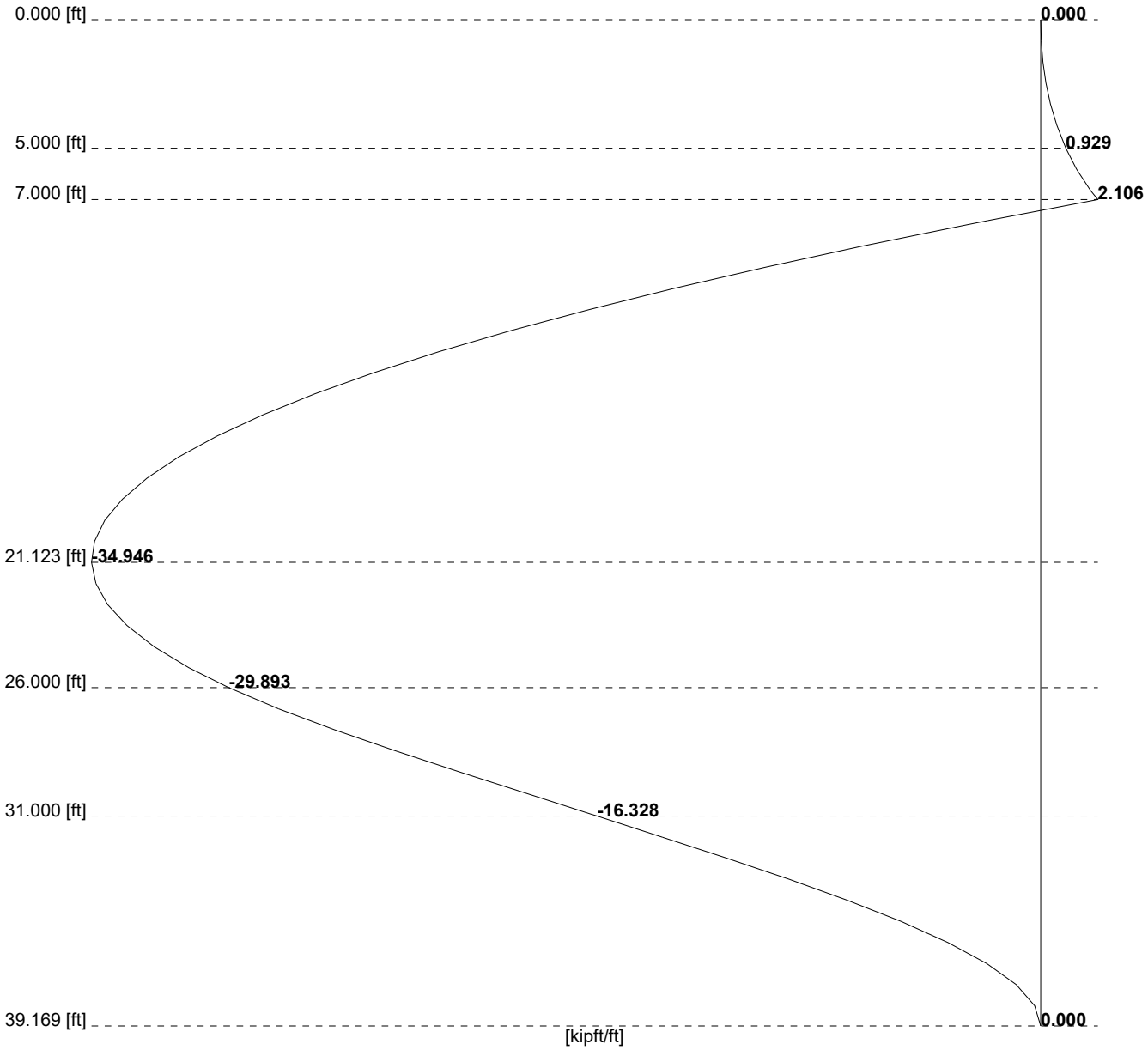
Water Pressure Diagram



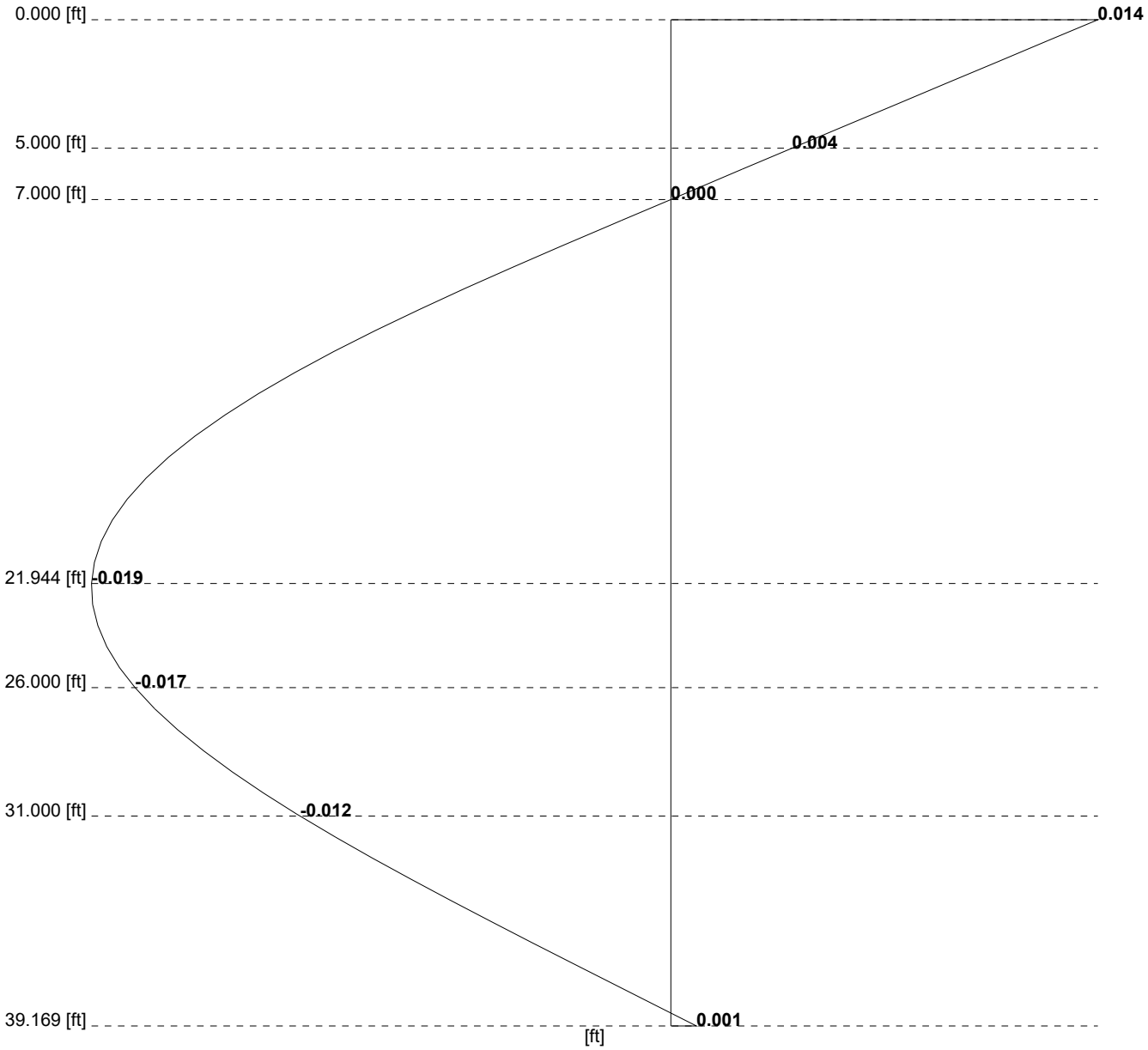
Total Pressure Diagram



Moment Diagram

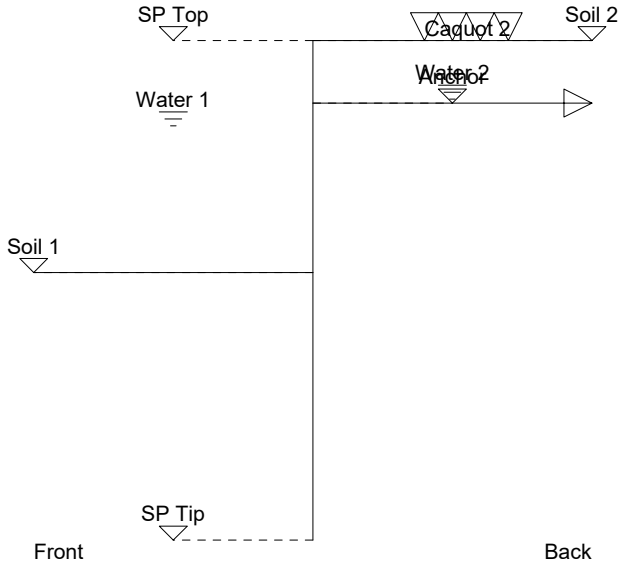


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	56.007
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

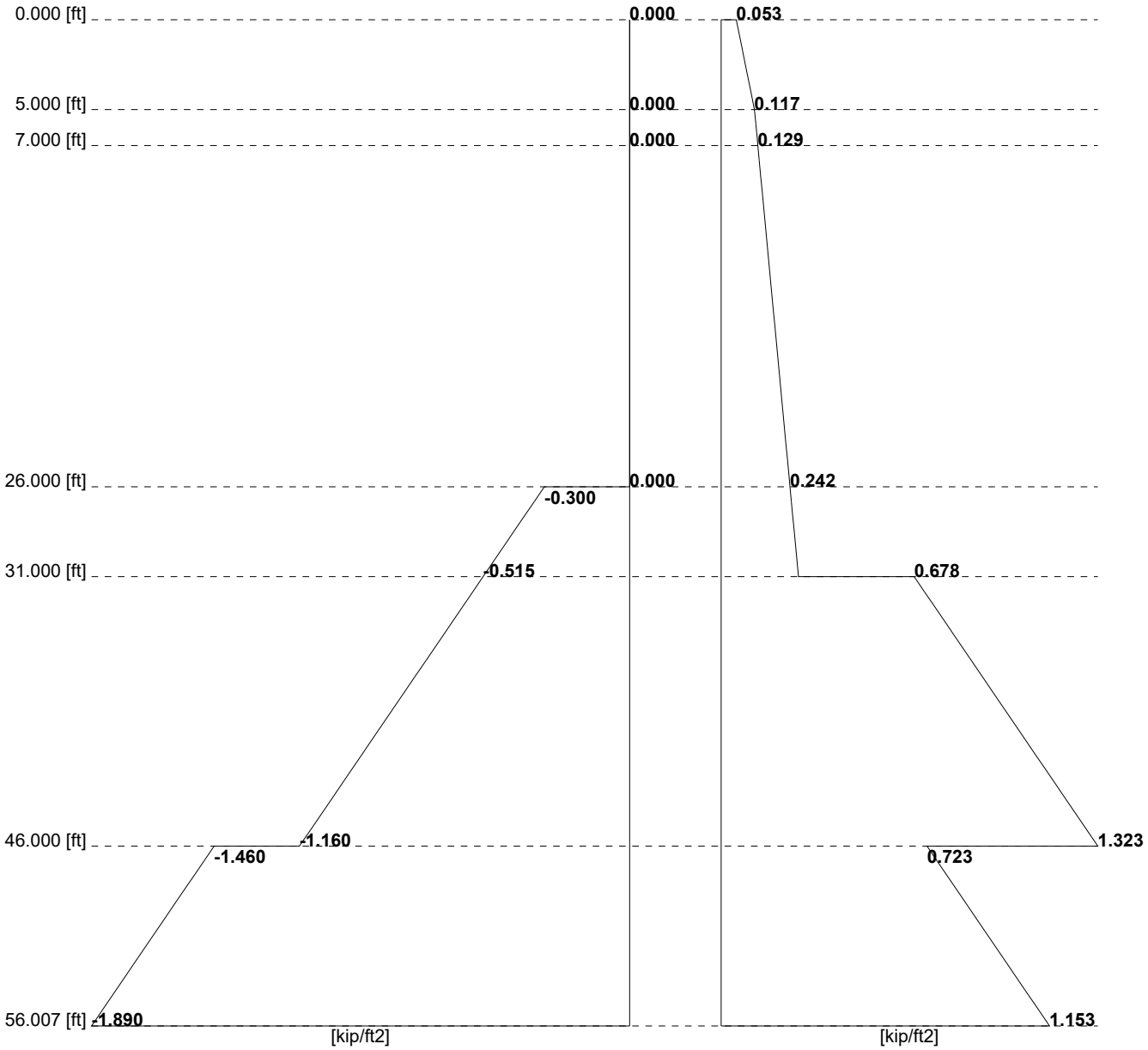
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

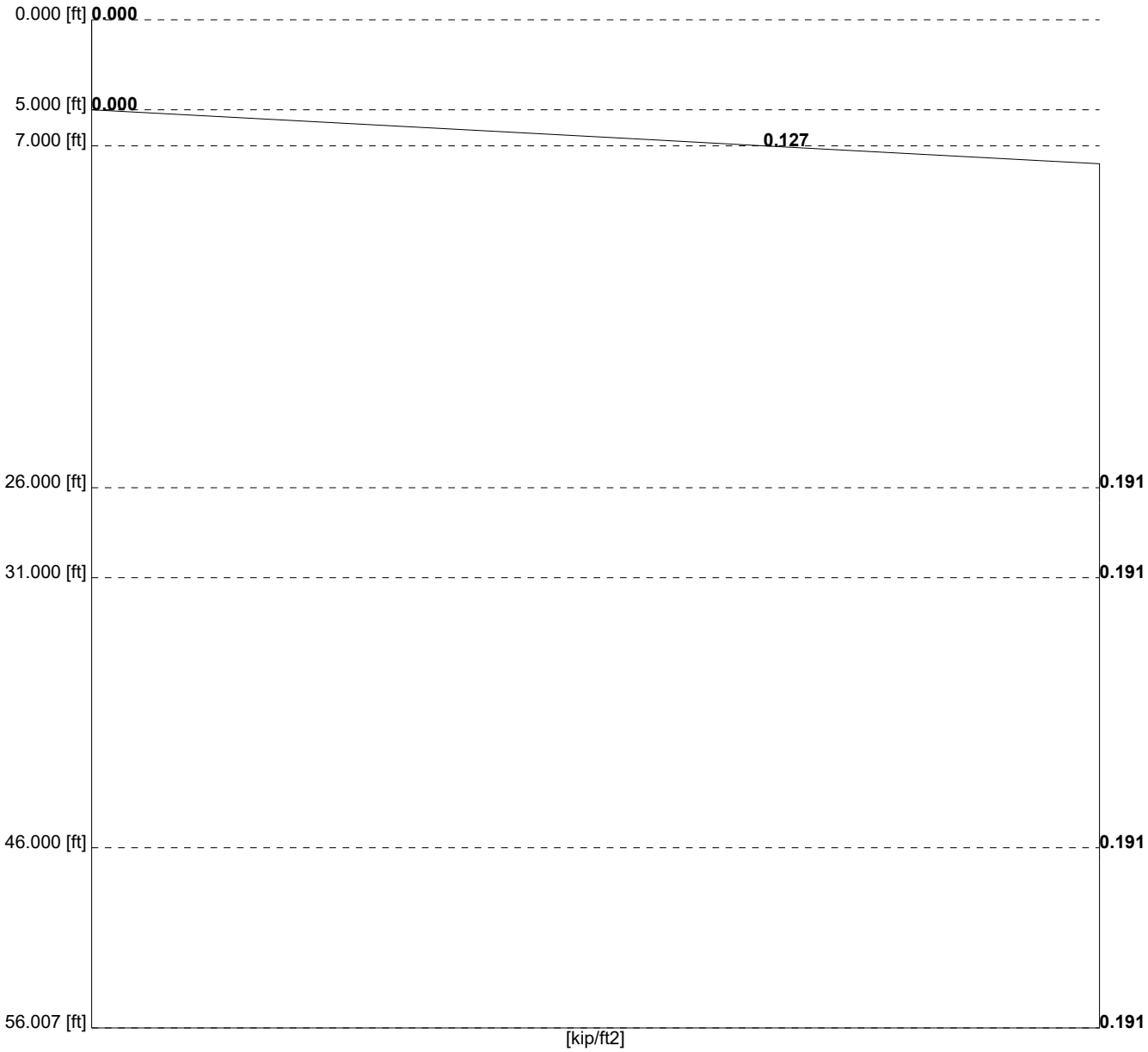
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-70.073	26.012
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.596	26.012
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.092	26.012
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-9719.623	26.012
Max. Stress at Min. Moment [lb/in2]	9955.059	26.012
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	5.023	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	56.007	
Sheet Pile Length [ft]	56.007	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-7.960	

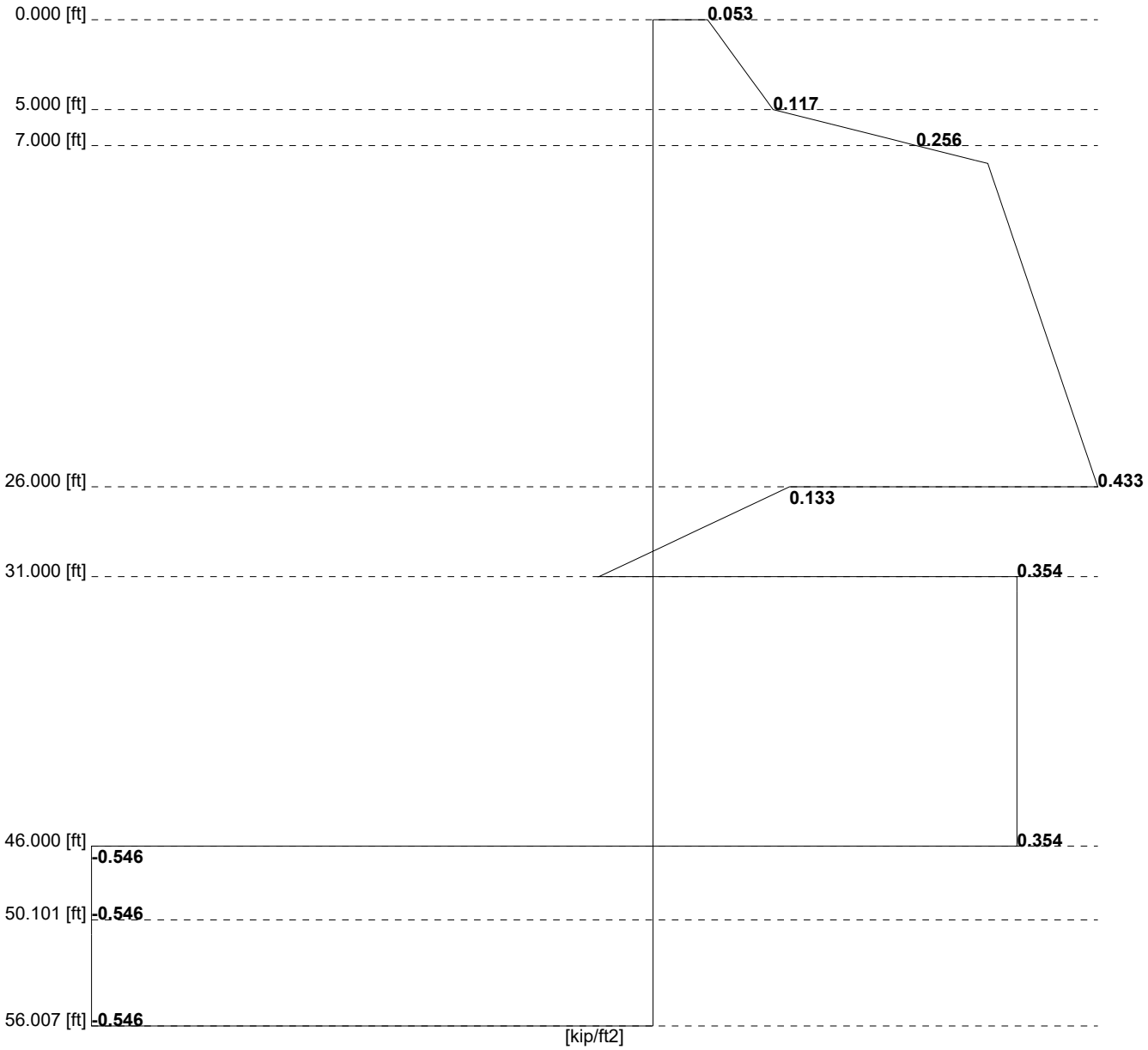
Earth Pressure Diagram



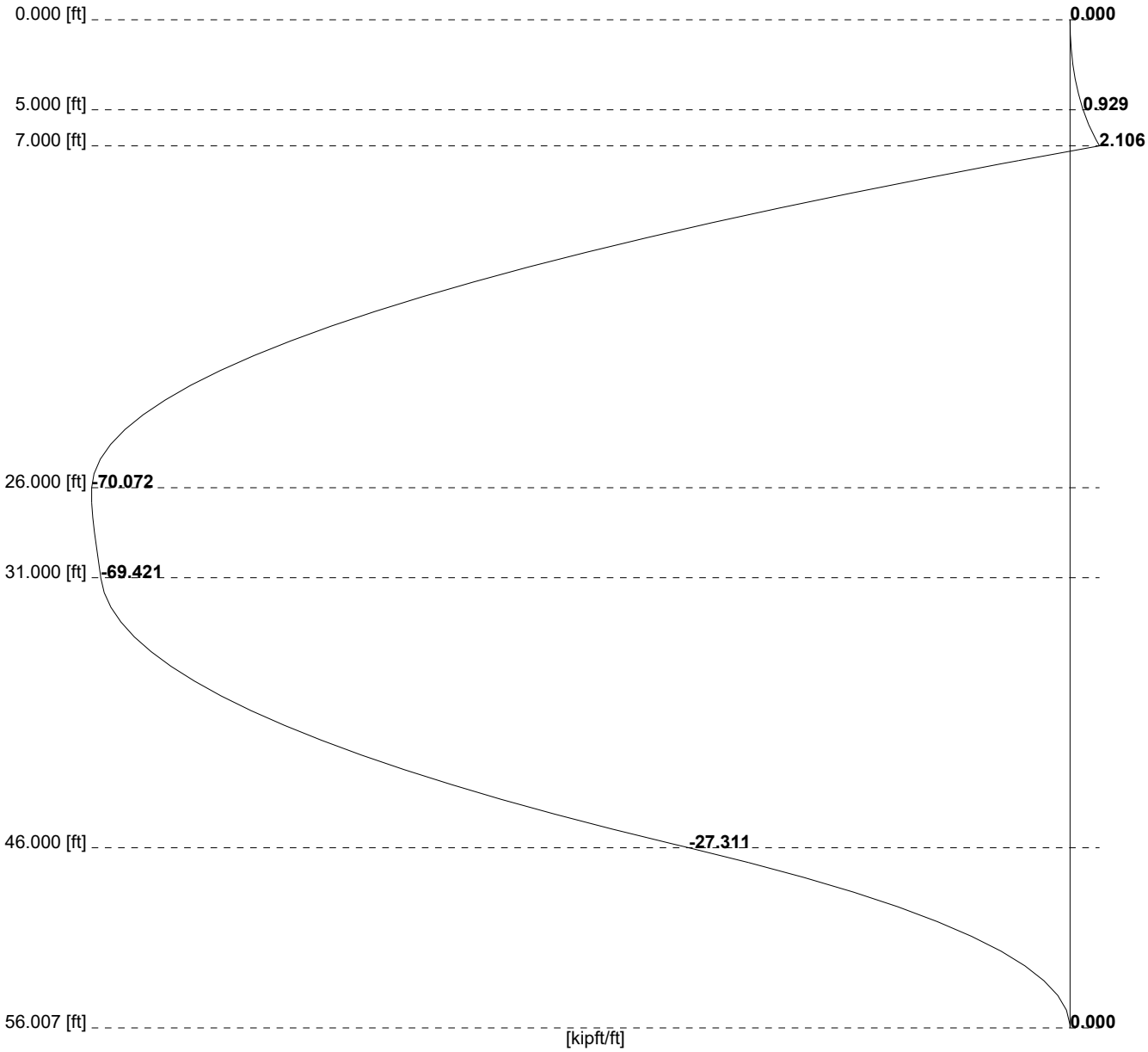
Water Pressure Diagram



Total Pressure Diagram

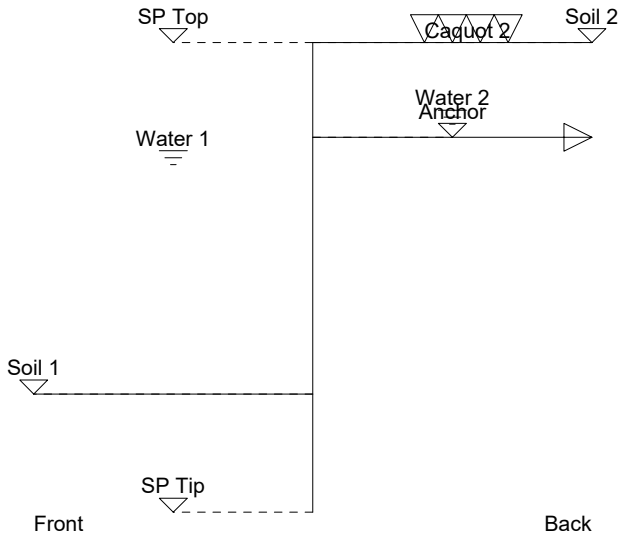


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	34.740
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

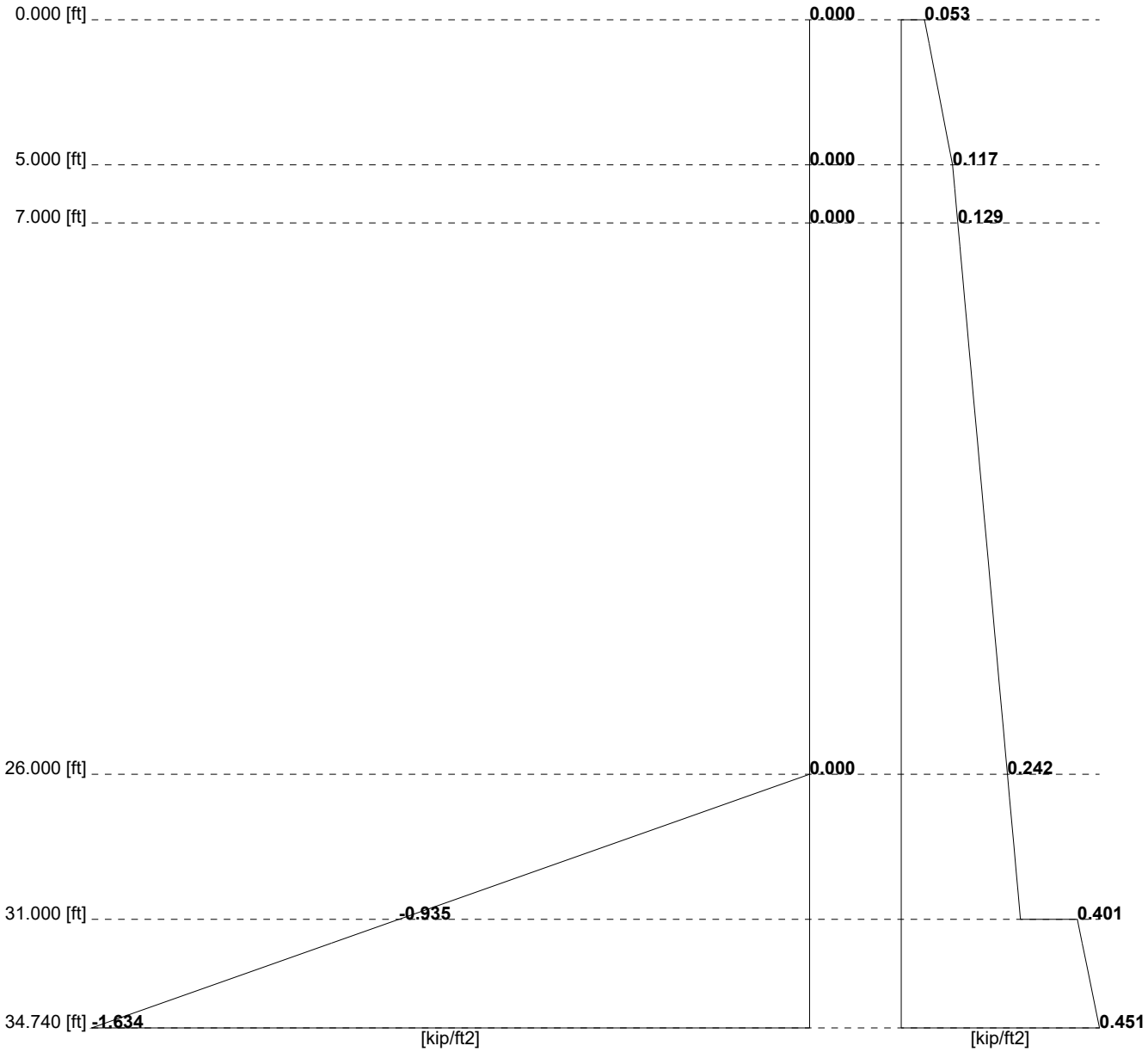
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

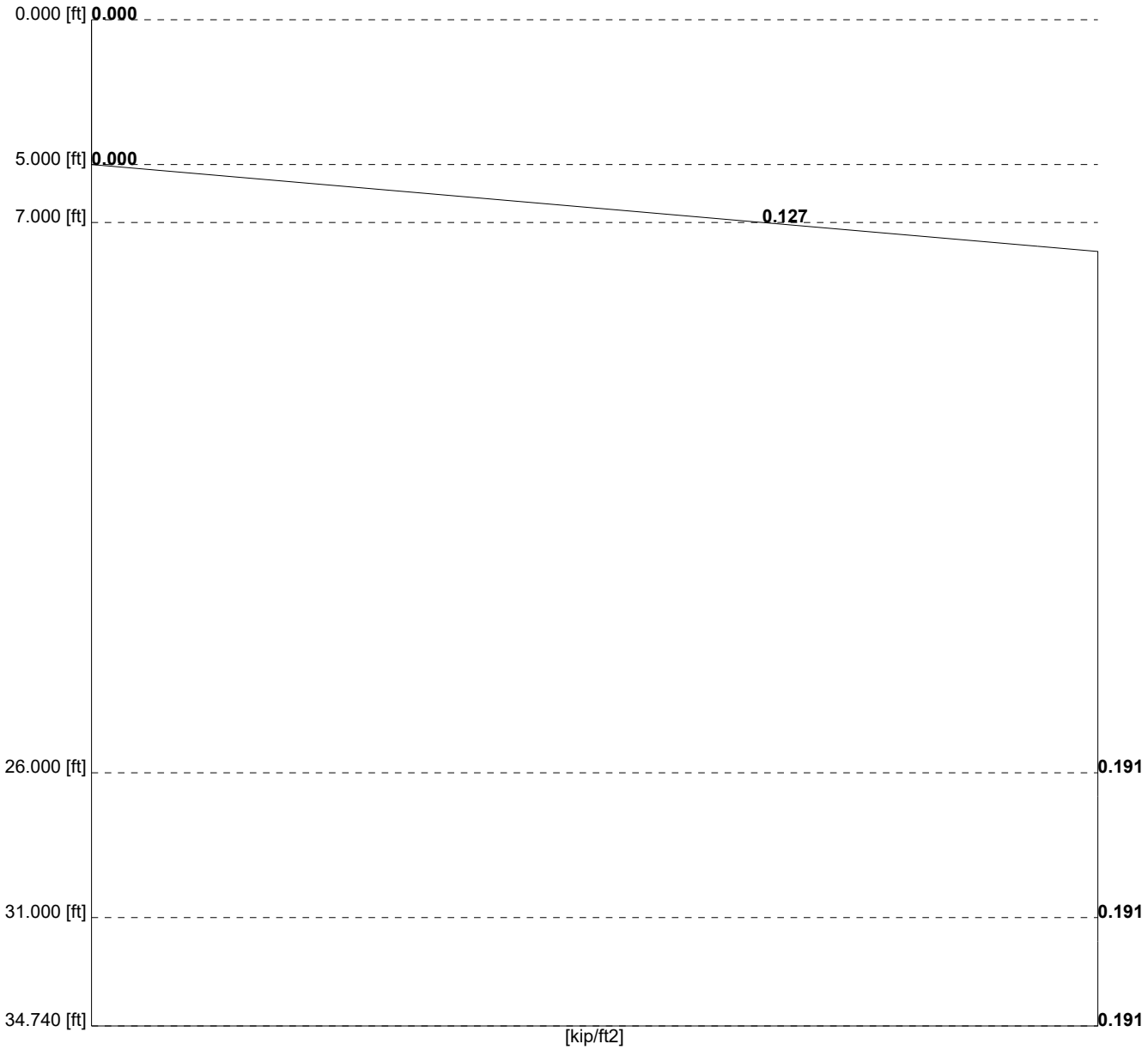
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-27.944	19.483
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	0.997	19.483
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.036	19.483
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-10275.317	19.483
Max. Stress at Min. Moment [lb/in2]	10592.491	19.483
Min. Stress at Max. Moment [lb/in2]	-746.397	7.000
Max. Stress at Max. Moment [lb/in2]	823.980	7.000
Safety > Req. Safety = 1.500	4.720	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	34.740	
Sheet Pile Length [ft]	34.740	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.494	
Anchor Force (horiz.) [kip/ft]	-5.323	

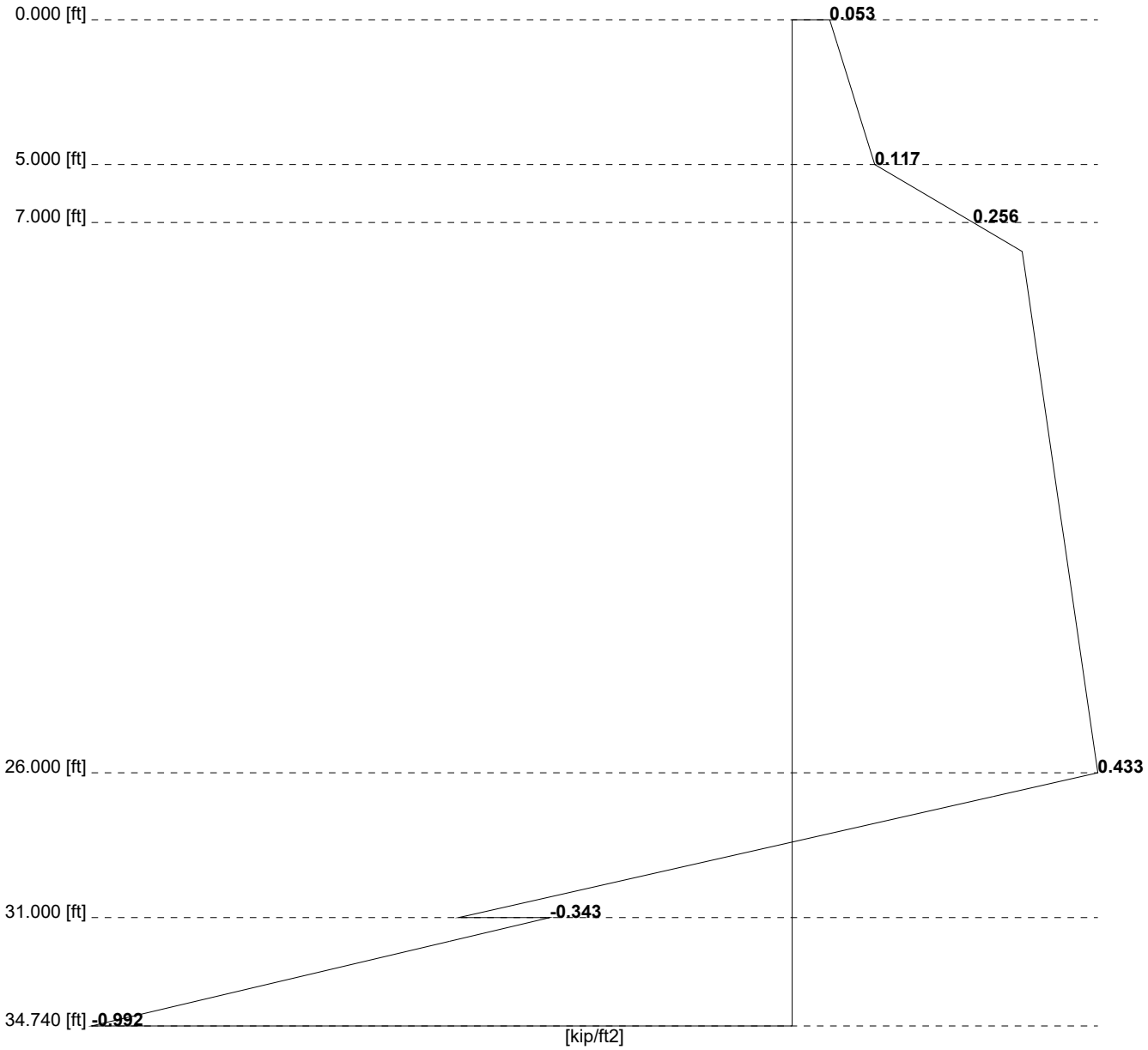
Earth Pressure Diagram



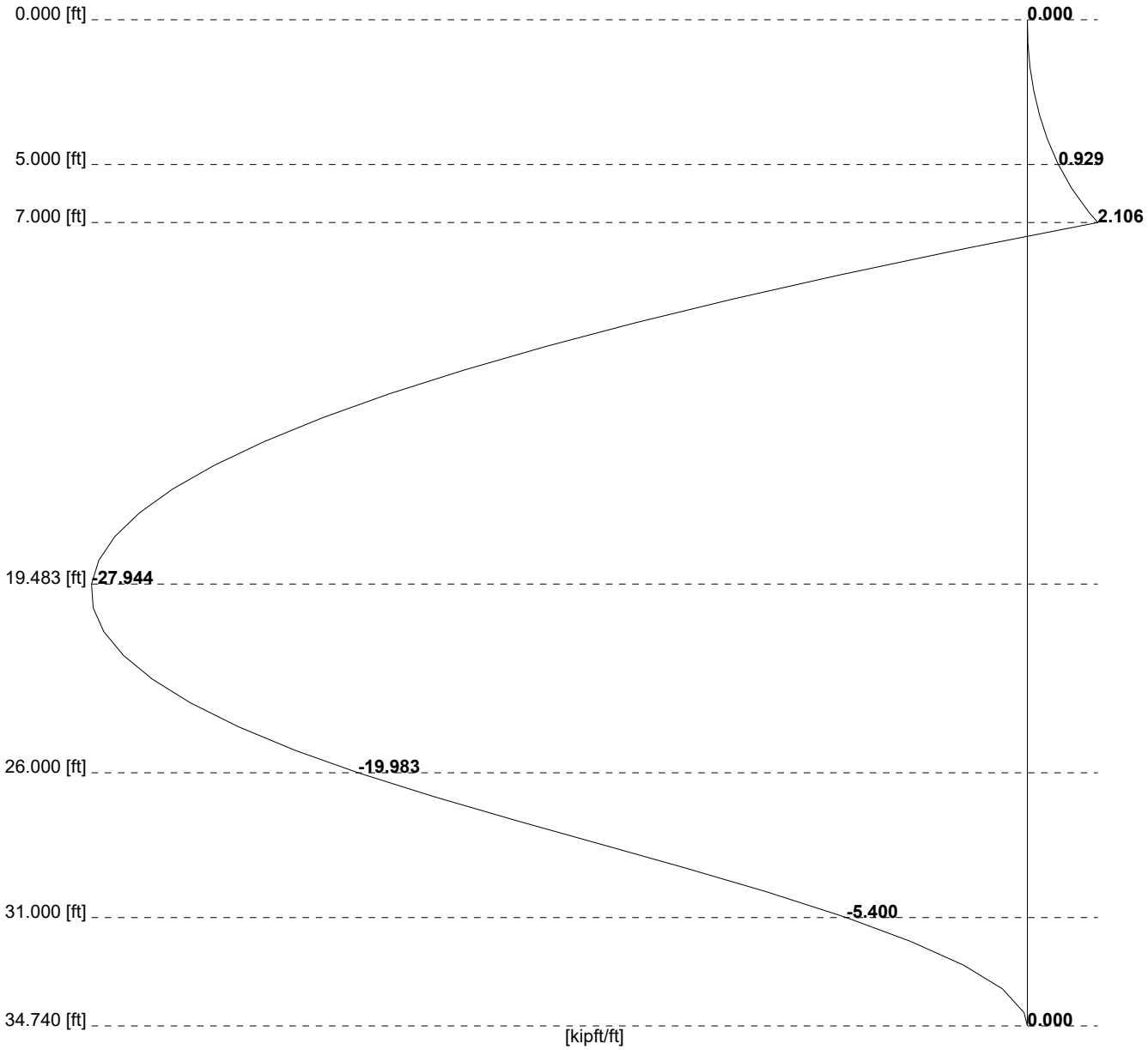
Water Pressure Diagram



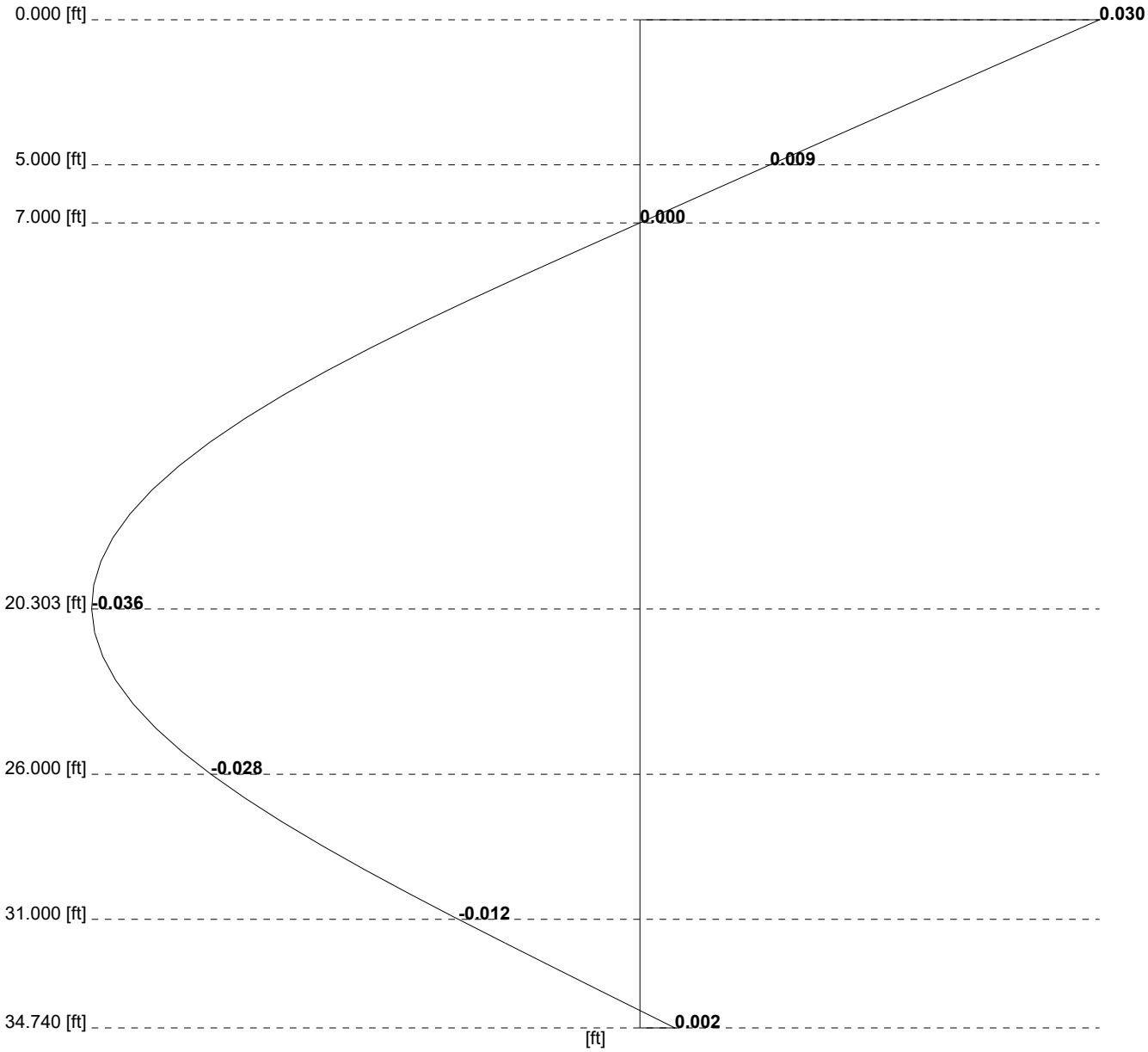
Total Pressure Diagram



Moment Diagram

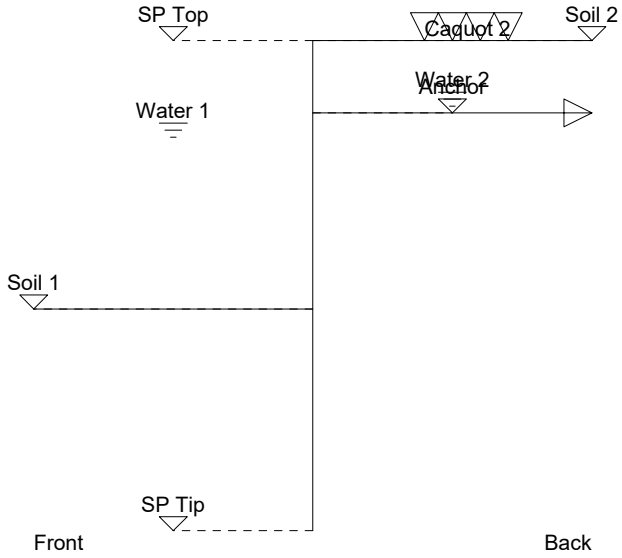


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	47.476
Soil Level in Front [ft]	26.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

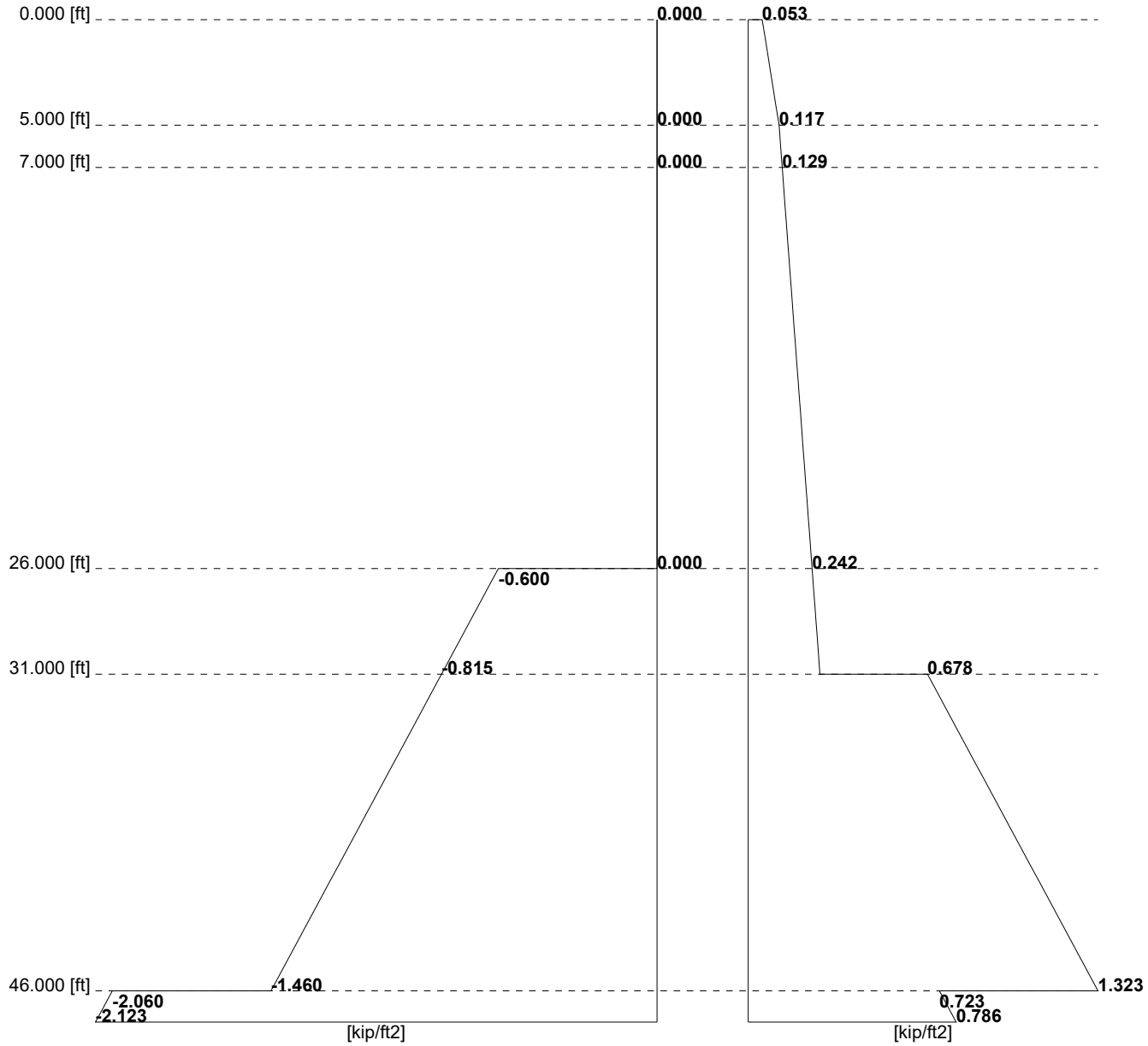
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

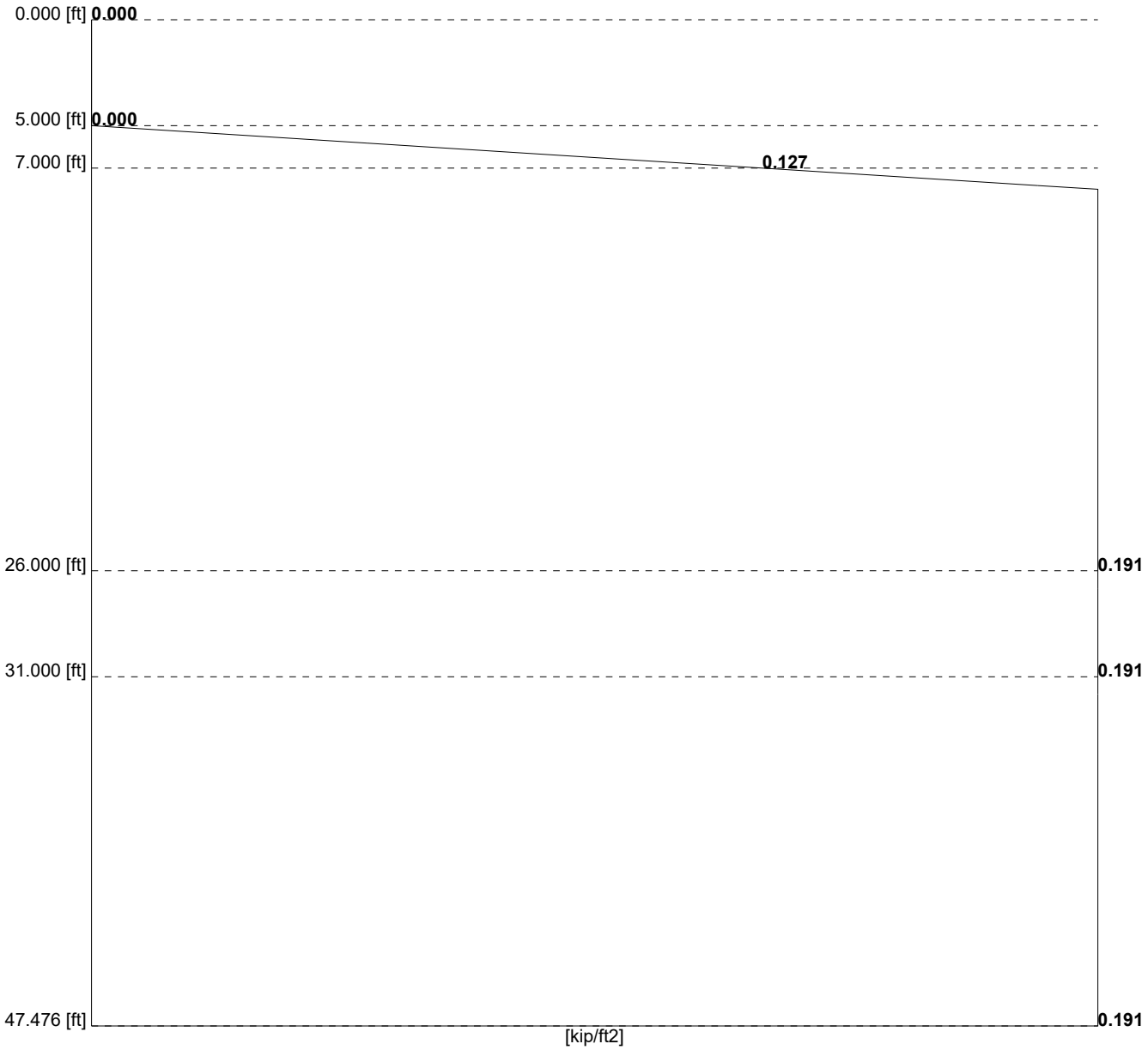
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-33.653	20.828
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.120	20.828
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.080	20.828
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-12404.761	20.828
Max. Stress at Min. Moment [lb/in2]	12761.394	20.828
Min. Stress at Max. Moment [lb/in2]	-746.397	7.000
Max. Stress at Max. Moment [lb/in2]	823.980	7.000
Safety > Req. Safety = 1.500	3.918	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	47.476	
Sheet Pile Length [ft]	47.476	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-5.752	

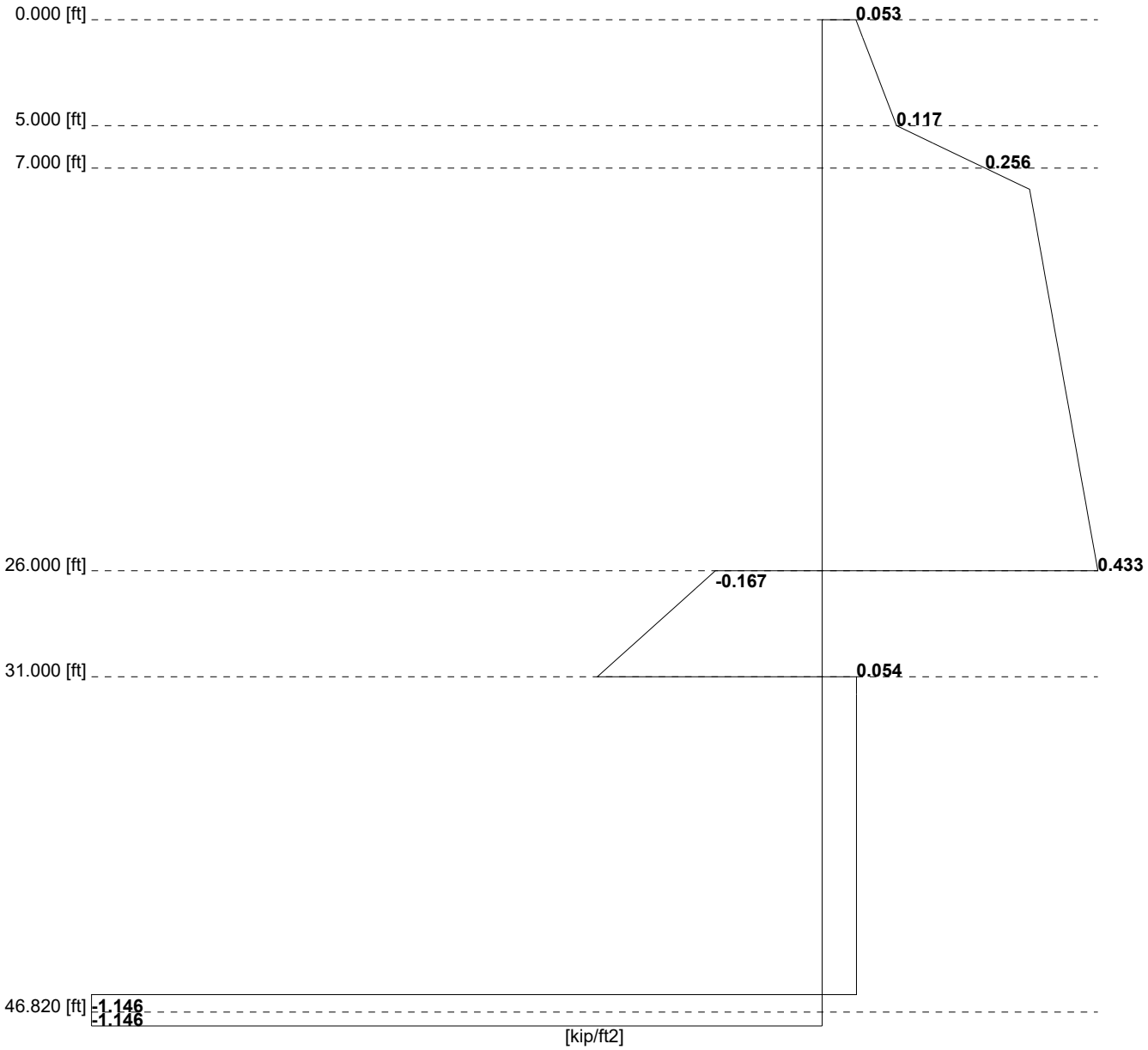
Earth Pressure Diagram



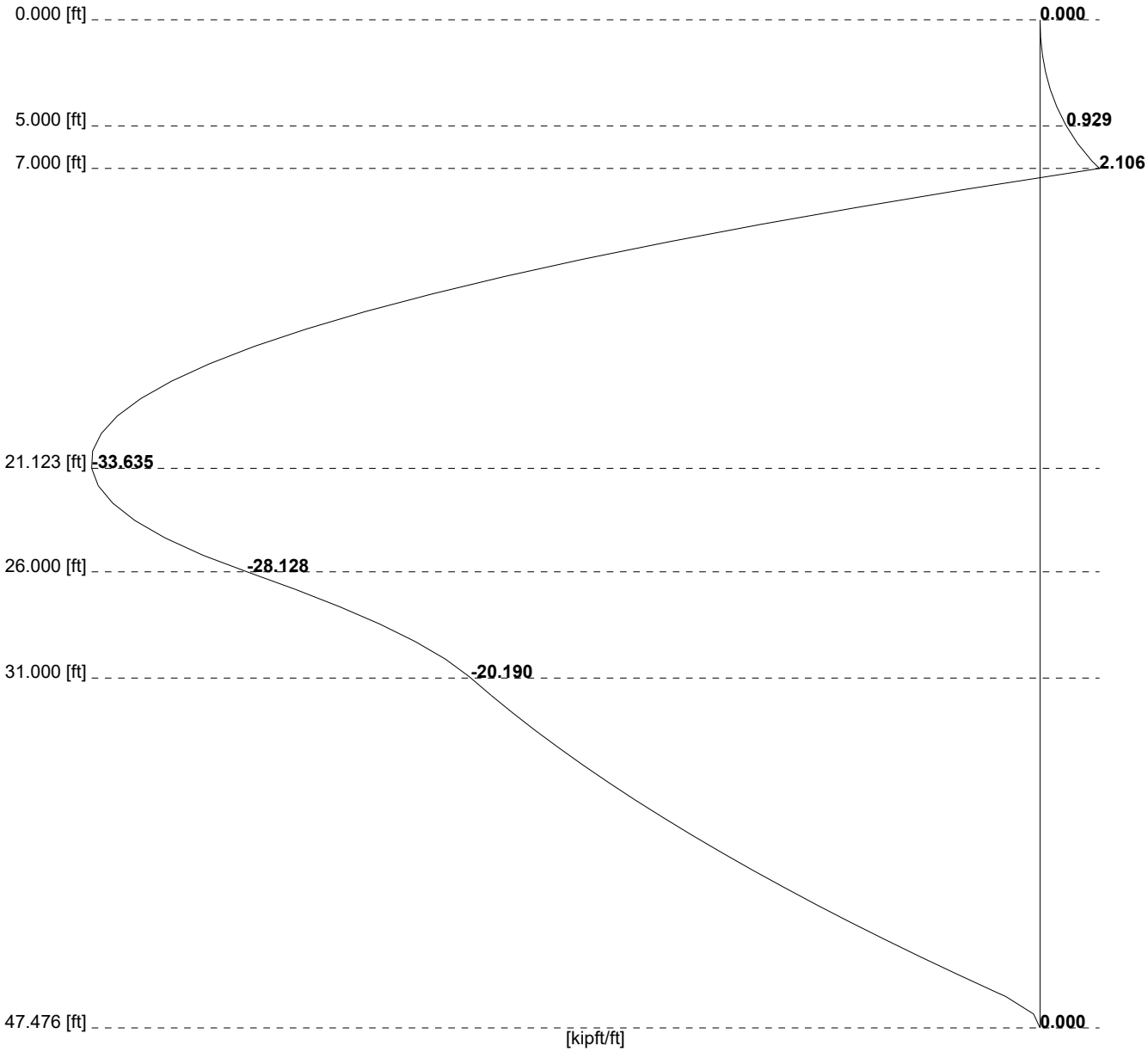
Water Pressure Diagram



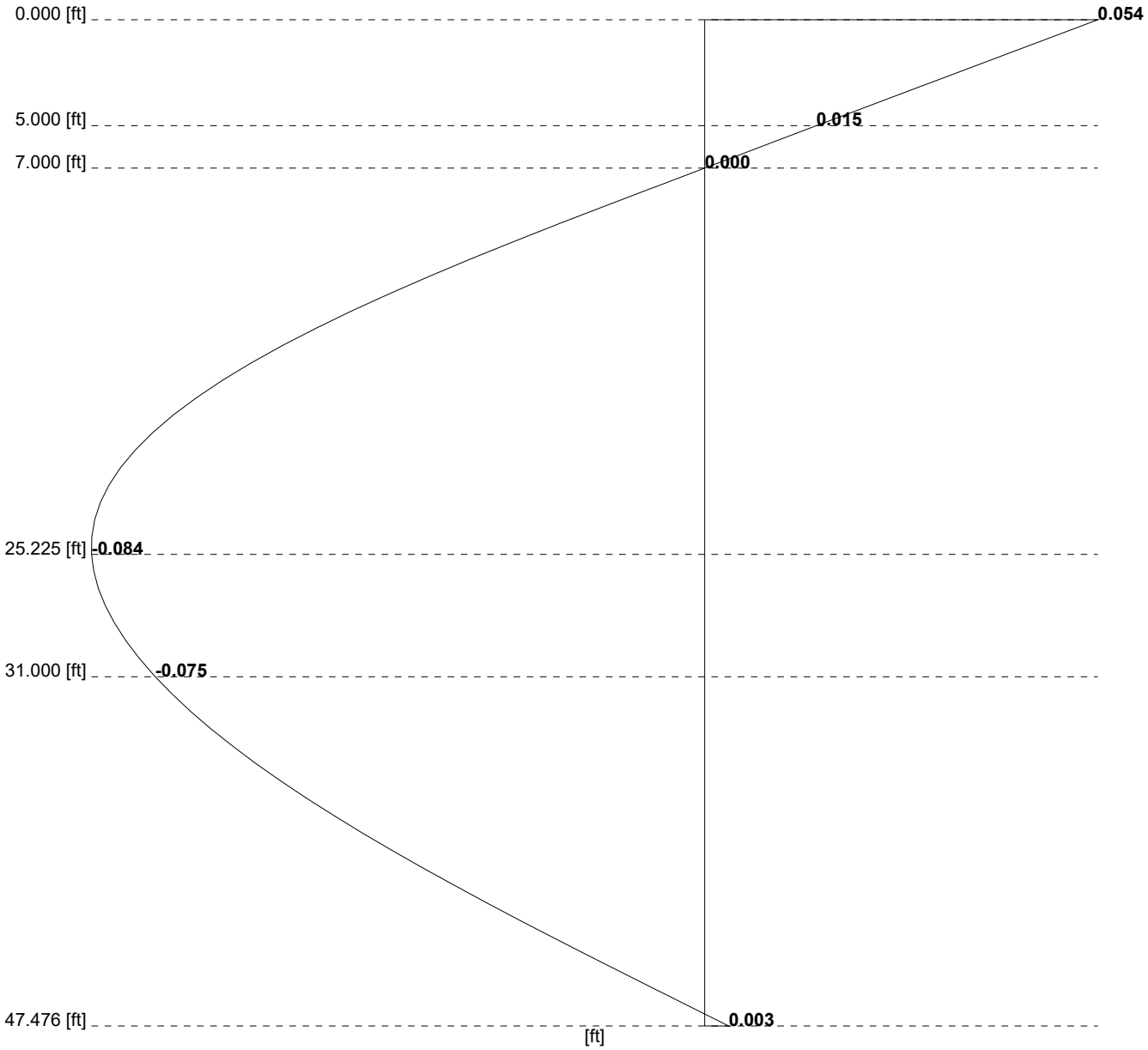
Total Pressure Diagram



Moment Diagram

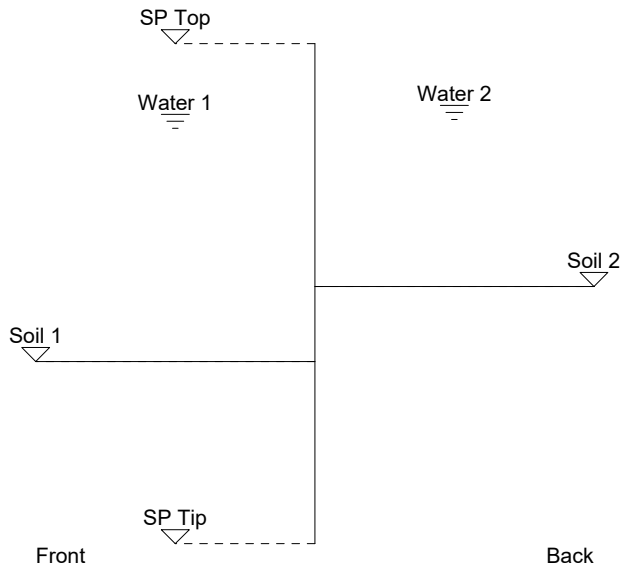


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	56.631
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	27.500
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	135.000	0.125	0.063	3.401	24.210	-13.070	0.000

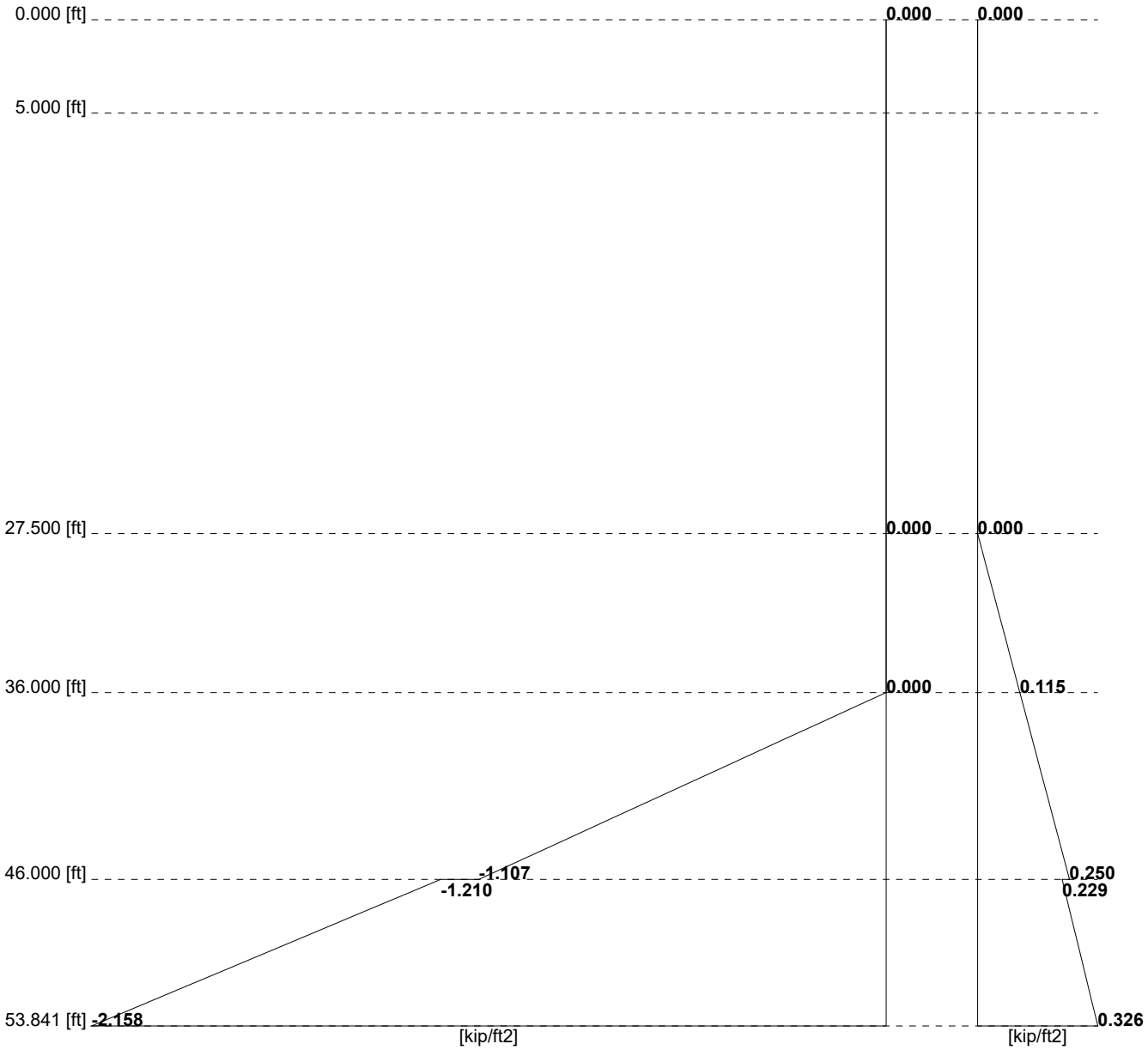
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 2	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 3	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 4	135.000	0.125	0.063	0.243	34.000	18.360	0.000

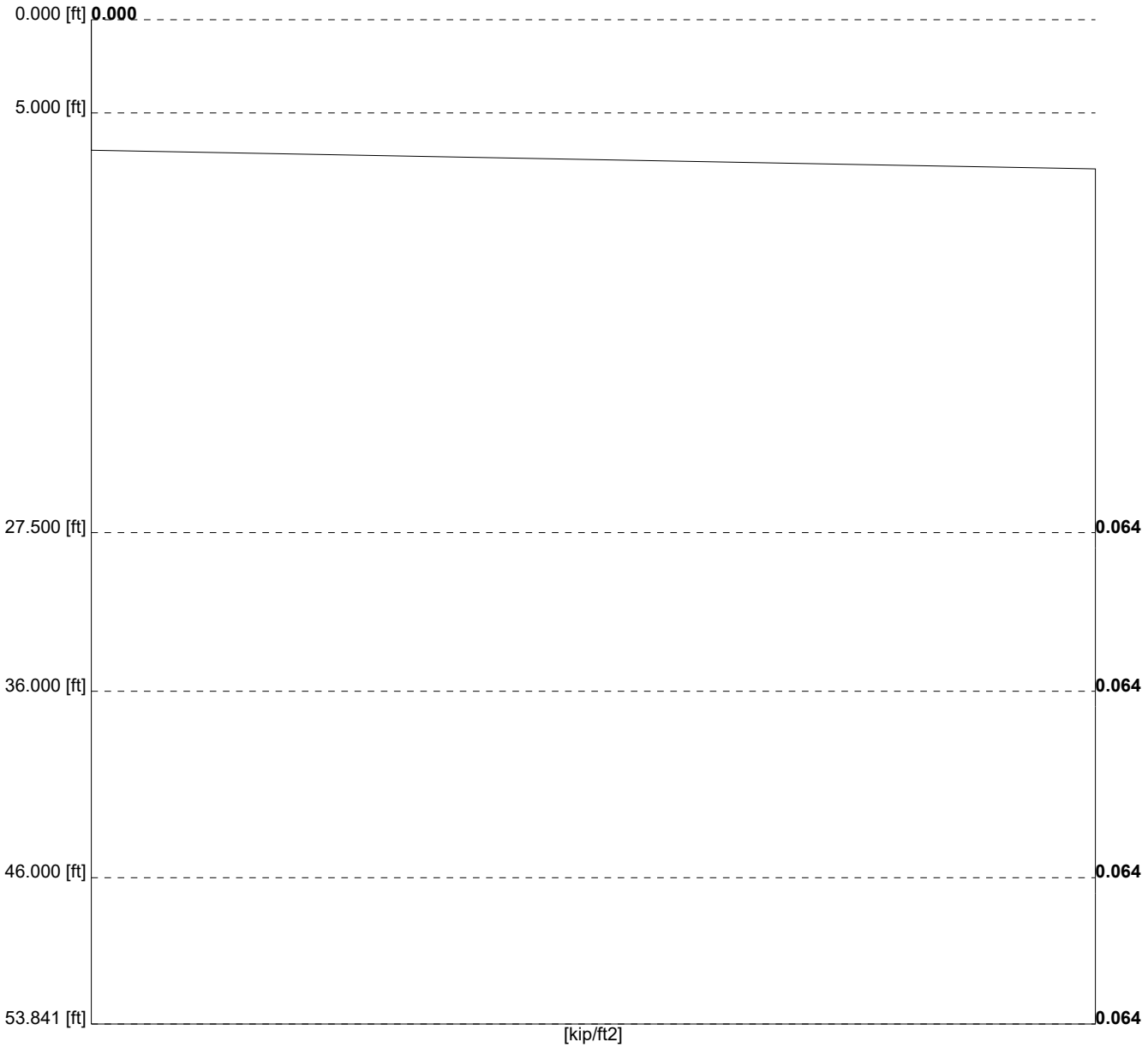
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.397	53.874
Maxmimal Moment [kipft/ft]	43.350	44.990
Normal Forces at Max. Moment [kip/ft]	-2.427	53.874
Normal Forces at Min. Moment [kip/ft]	-0.279	44.990
Deflection at Min. Moment [ft]	0.000	53.874
Deflection at Max. Moment [ft]	-0.006	44.990
Min. Stress at Min. Moment [lb/in2]	-234.538	53.874
Max. Stress at Min. Moment [lb/in2]	-123.369	53.874
Min. Stress at Max. Moment [lb/in2]	-6093.387	44.990
Max. Stress at Max. Moment [lb/in2]	6052.307	44.990
Safety > Req. Safety = 1.500	8.206	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	56.631	
Sheet Pile Length [ft]	56.631	
Included OverLength [ft]	2.789	
Vertical Equilibrium [kip/ft]	0.857	
Anchor Force (horiz.) [kip/ft]	0.000	

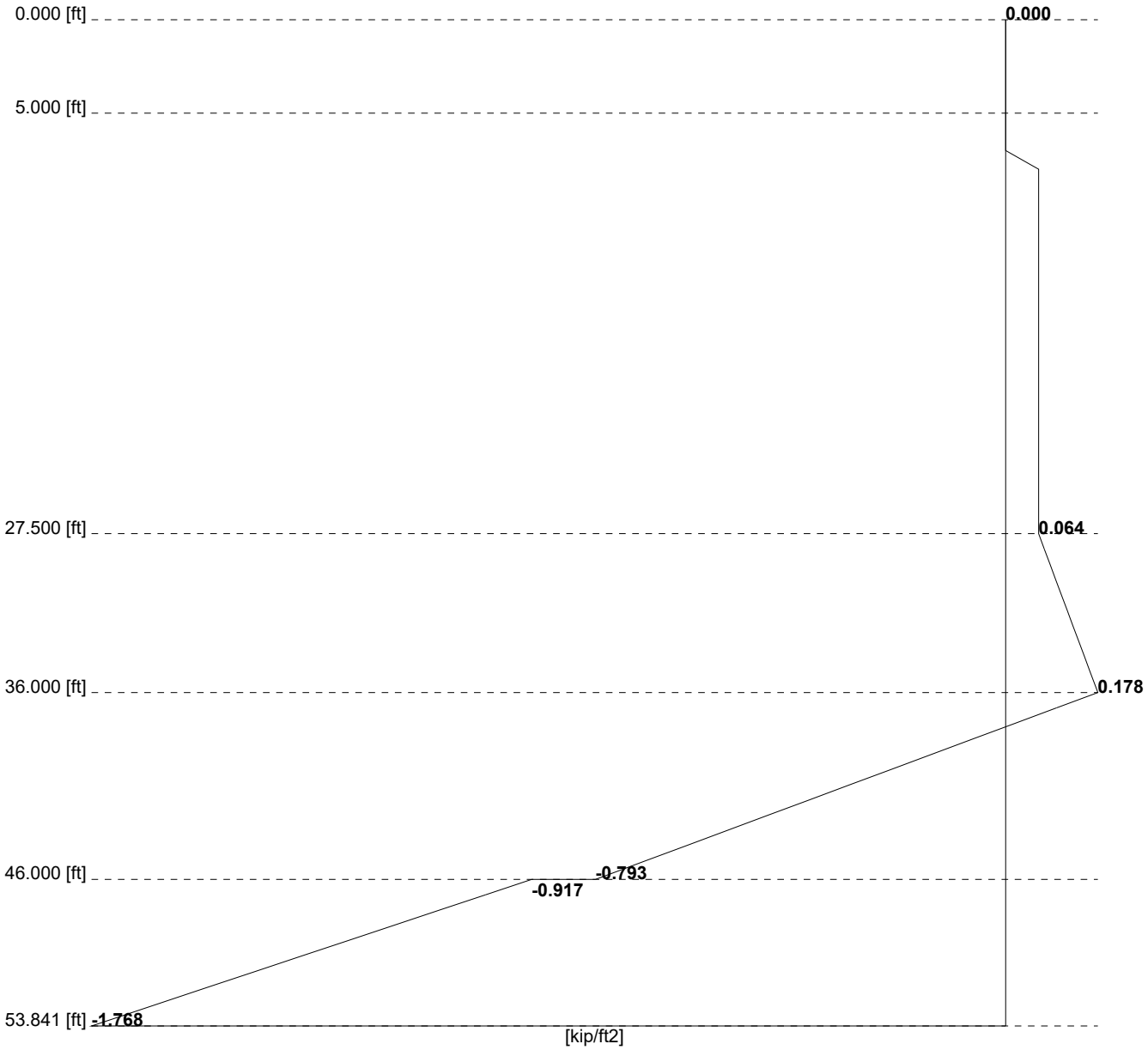
Earth Pressure Diagram



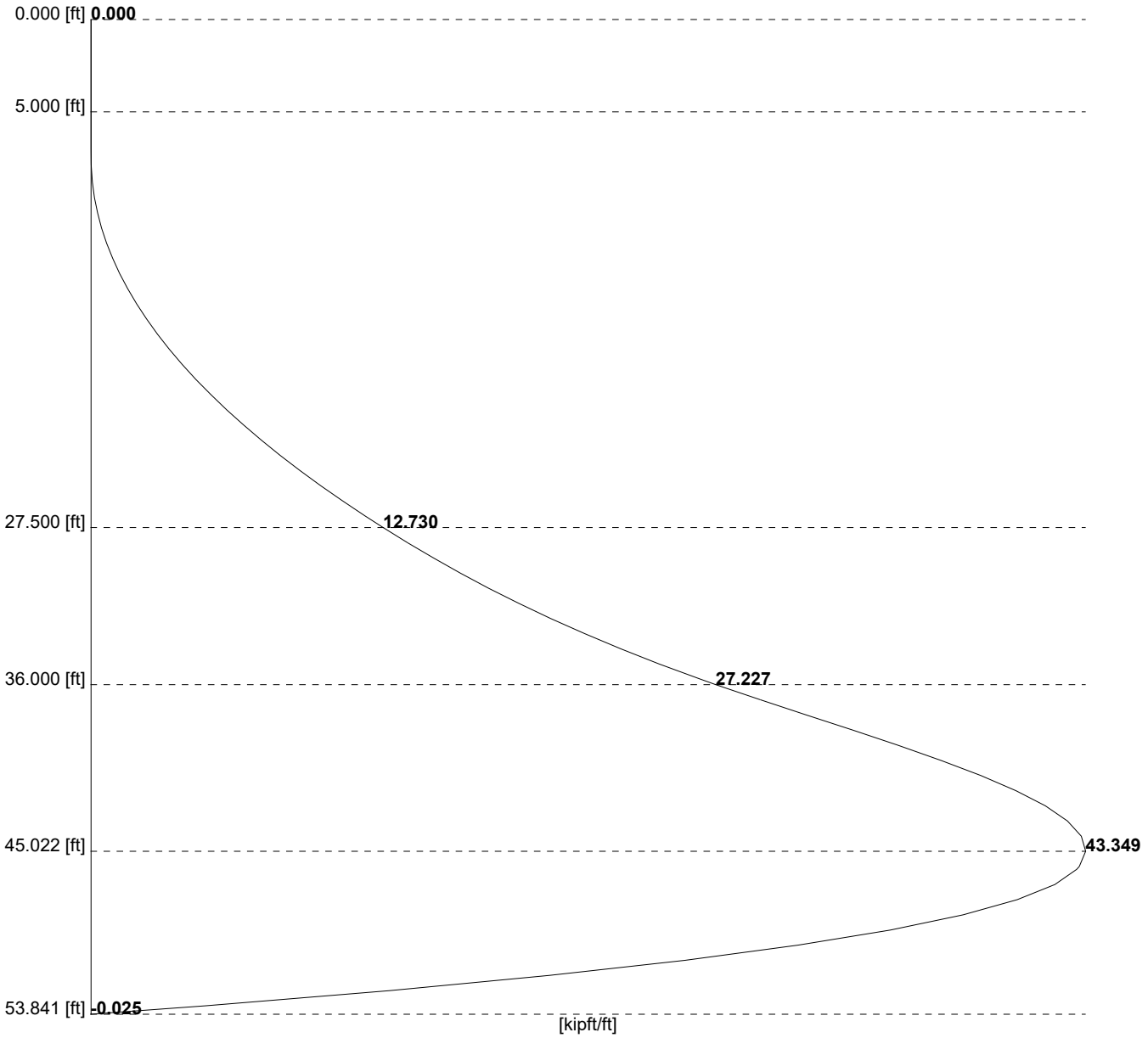
Water Pressure Diagram



Total Pressure Diagram

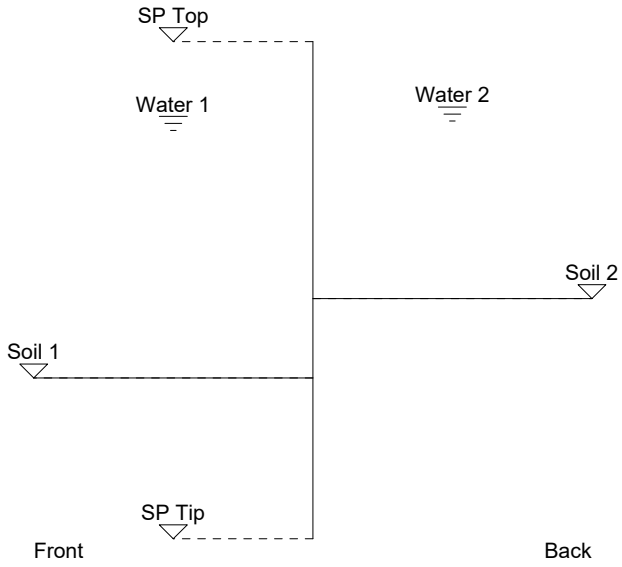


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	53.203
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	27.500
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	135.000	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	135.000	0.125	0.063	0.243	34.000	18.360	0.000

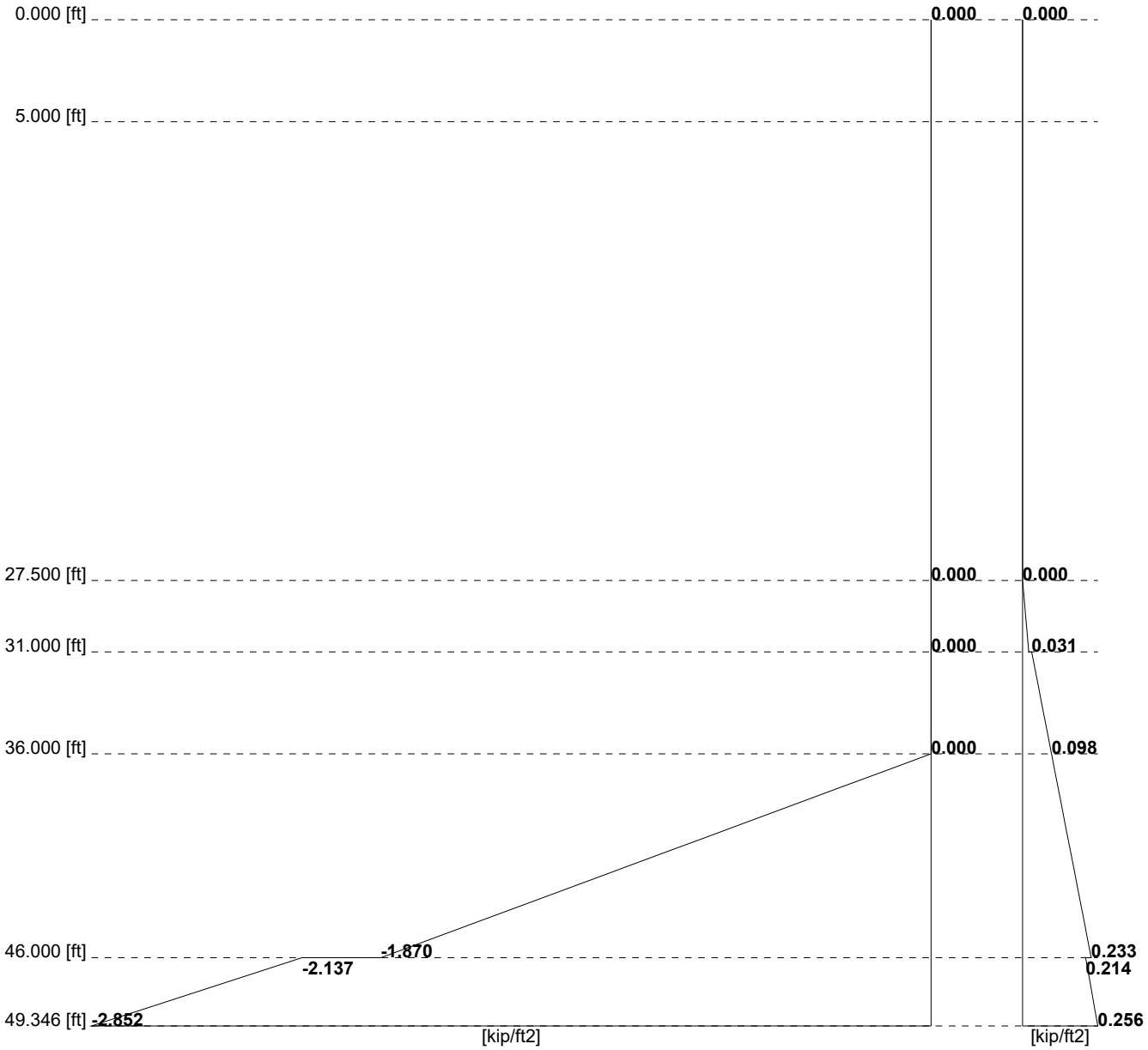
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

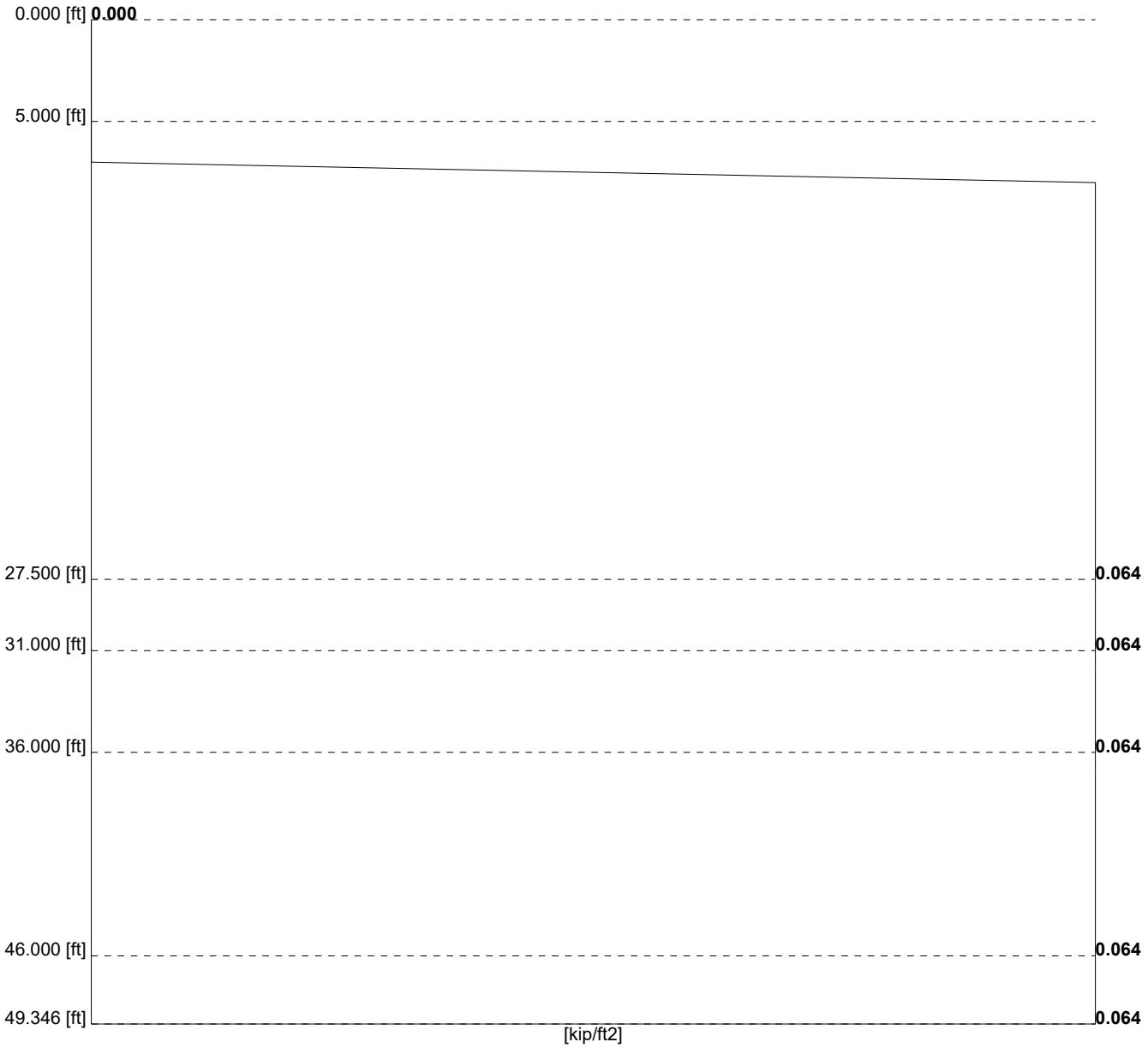
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.776	49.379
Maxmimal Moment [kipft/ft]	36.404	41.742
Normal Forces at Max. Moment [kip/ft]	-4.174	49.379
Normal Forces at Min. Moment [kip/ft]	-0.520	41.742
Deflection at Min. Moment [ft]	0.000	49.379
Deflection at Max. Moment [ft]	-0.004	41.742
Min. Stress at Min. Moment [lb/in2]	-416.519	49.379
Max. Stress at Min. Moment [lb/in2]	-199.124	49.379
Min. Stress at Max. Moment [lb/in2]	-5138.027	41.742
Max. Stress at Max. Moment [lb/in2]	5061.336	41.742
Safety > Req. Safety = 1.500	9.731	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	53.203	
Sheet Pile Length [ft]	53.203	
Included OverLength [ft]	3.856	
Vertical Equilibrium [kip/ft]	-0.620	
Anchor Force (horiz.) [kip/ft]	0.000	

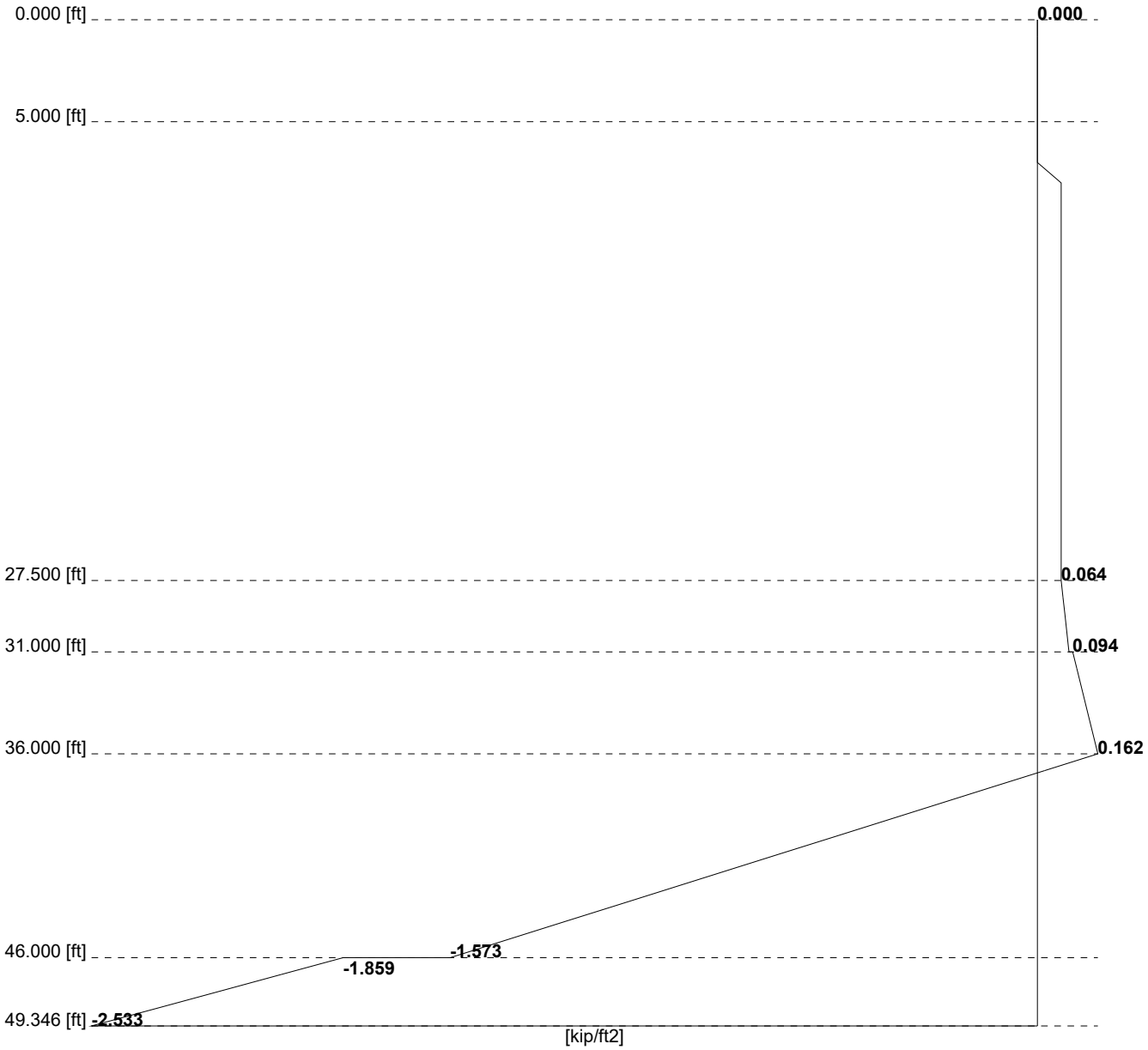
Earth Pressure Diagram



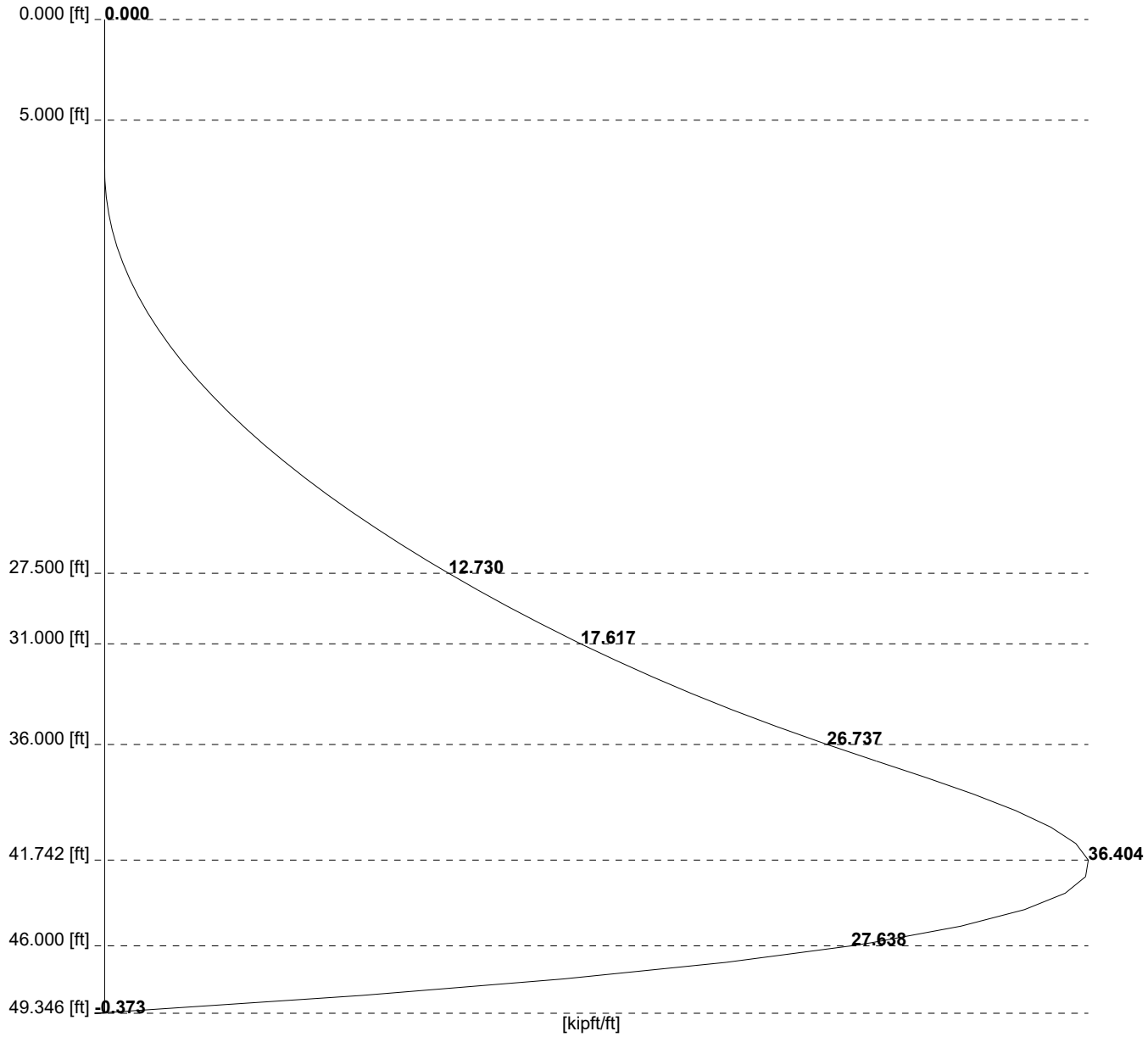
Water Pressure Diagram



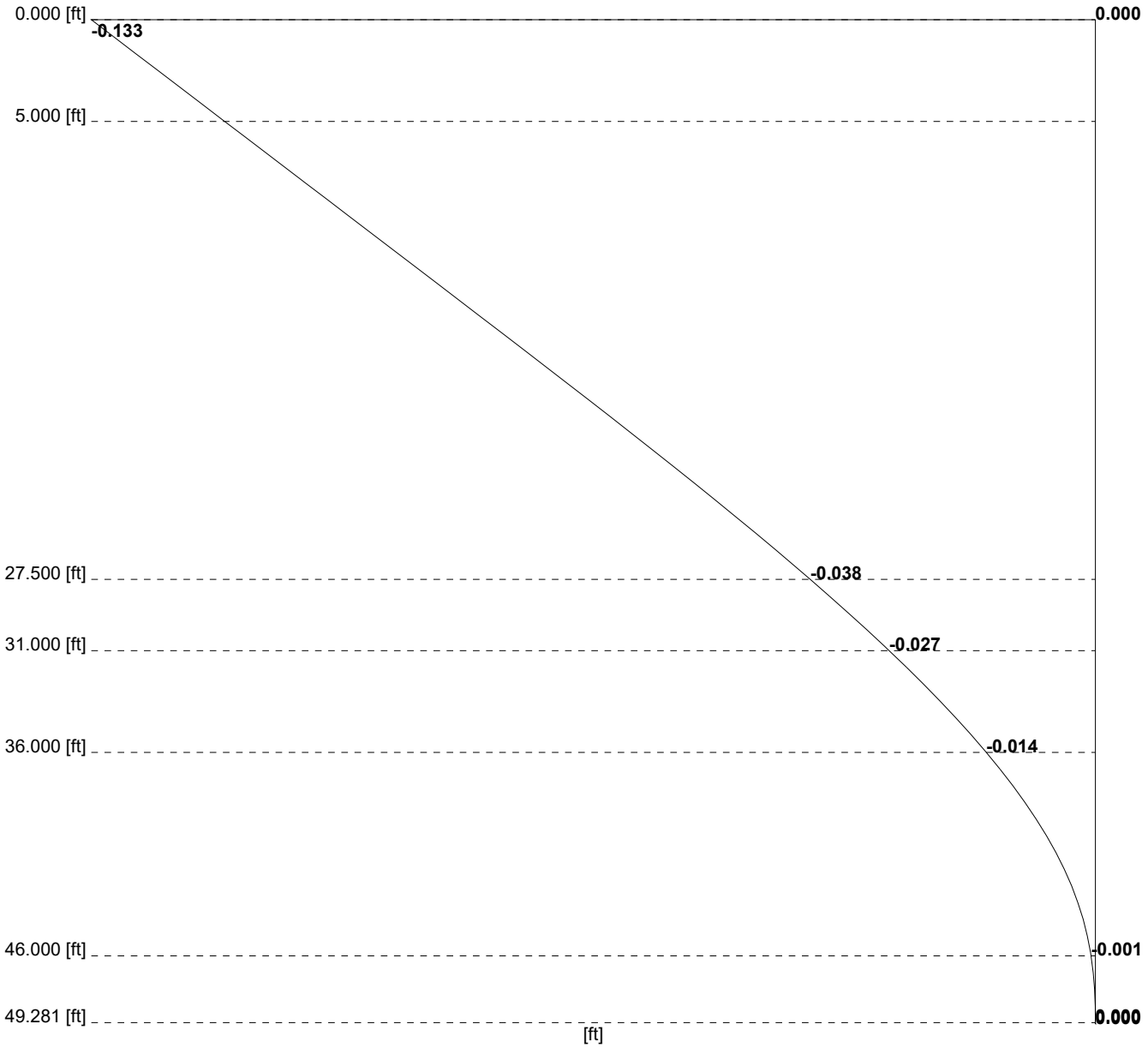
Total Pressure Diagram



Moment Diagram

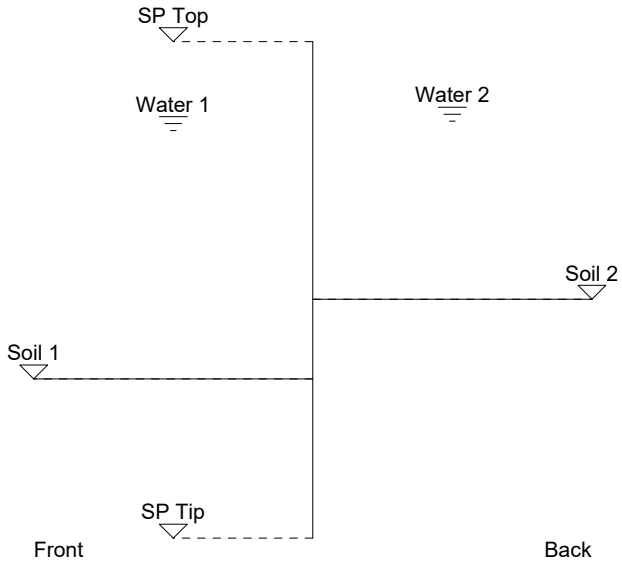


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	52.991
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	27.500
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

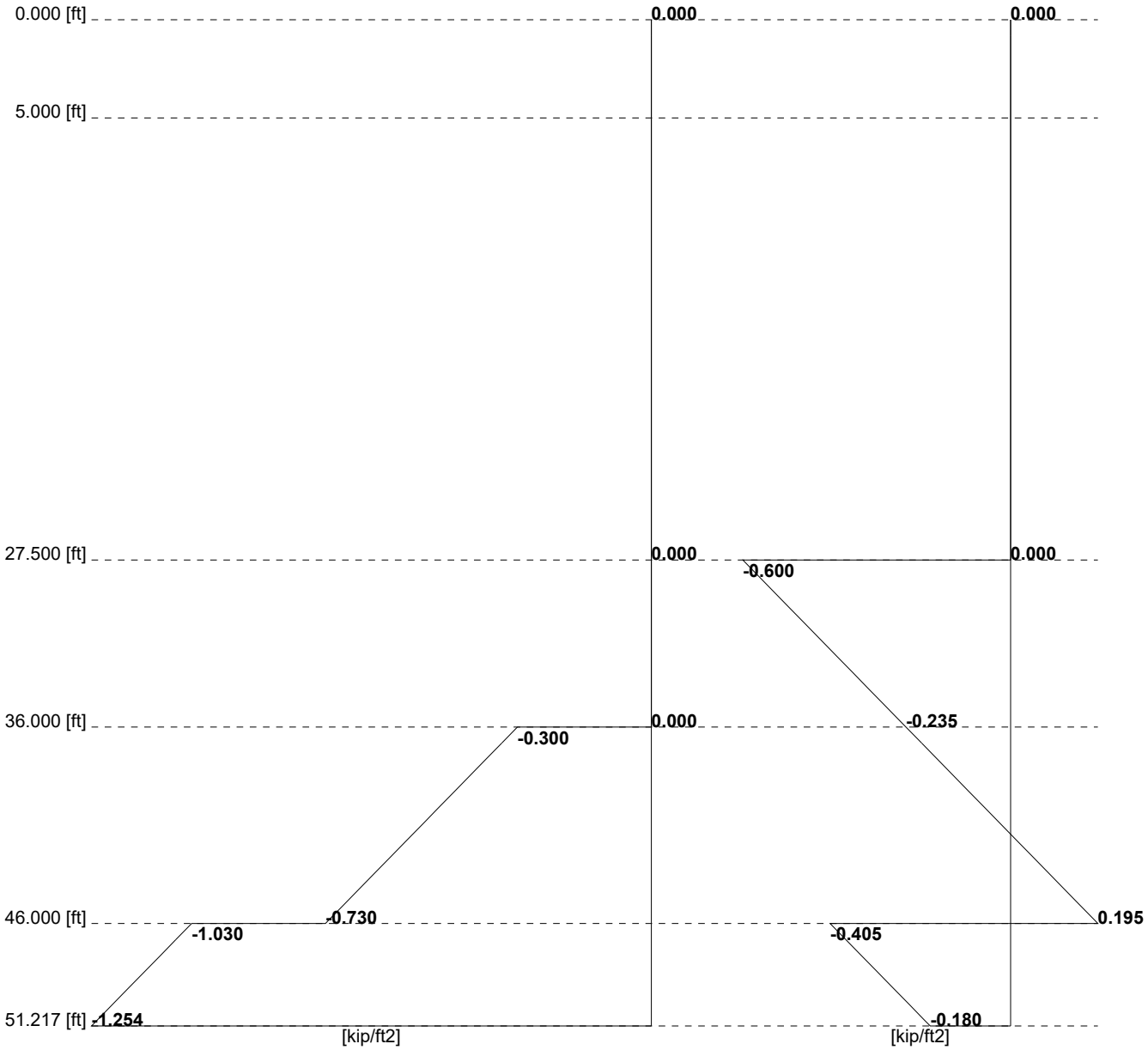
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

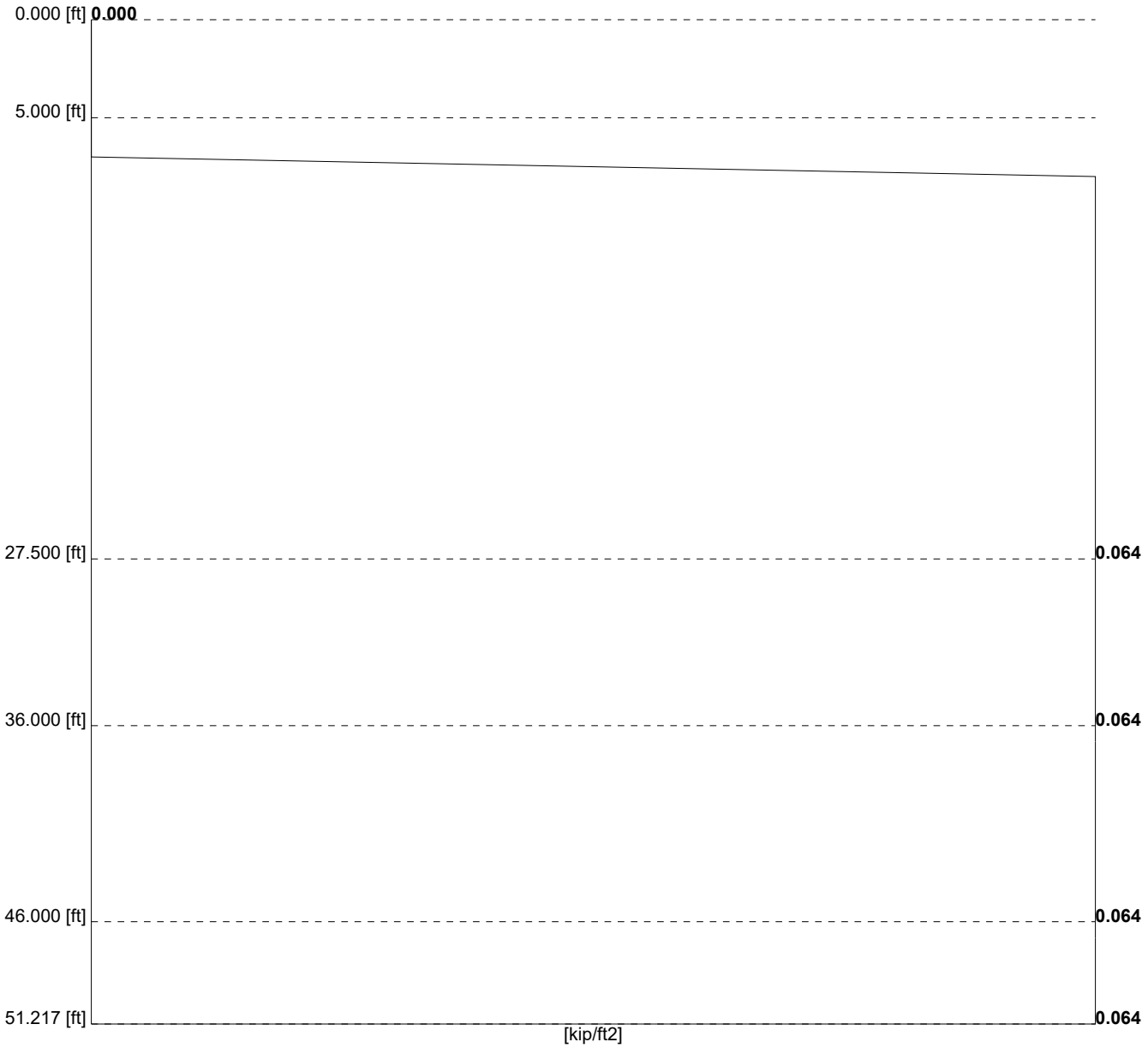
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.487	51.249
Maxmimal Moment [kipft/ft]	31.056	40.921
Normal Forces at Max. Moment [kip/ft]	0.000	51.249
Normal Forces at Min. Moment [kip/ft]	0.000	40.921
Deflection at Min. Moment [ft]	0.000	51.249
Deflection at Max. Moment [ft]	-0.006	40.921
Min. Stress at Min. Moment [lb/in2]	-68.239	51.249
Max. Stress at Min. Moment [lb/in2]	68.239	51.249
Min. Stress at Max. Moment [lb/in2]	-4350.726	40.921
Max. Stress at Max. Moment [lb/in2]	4350.726	40.921
Safety > Req. Safety = 1.500	11.492	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	52.991	
Sheet Pile Length [ft]	52.991	
Included OverLength [ft]	1.775	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

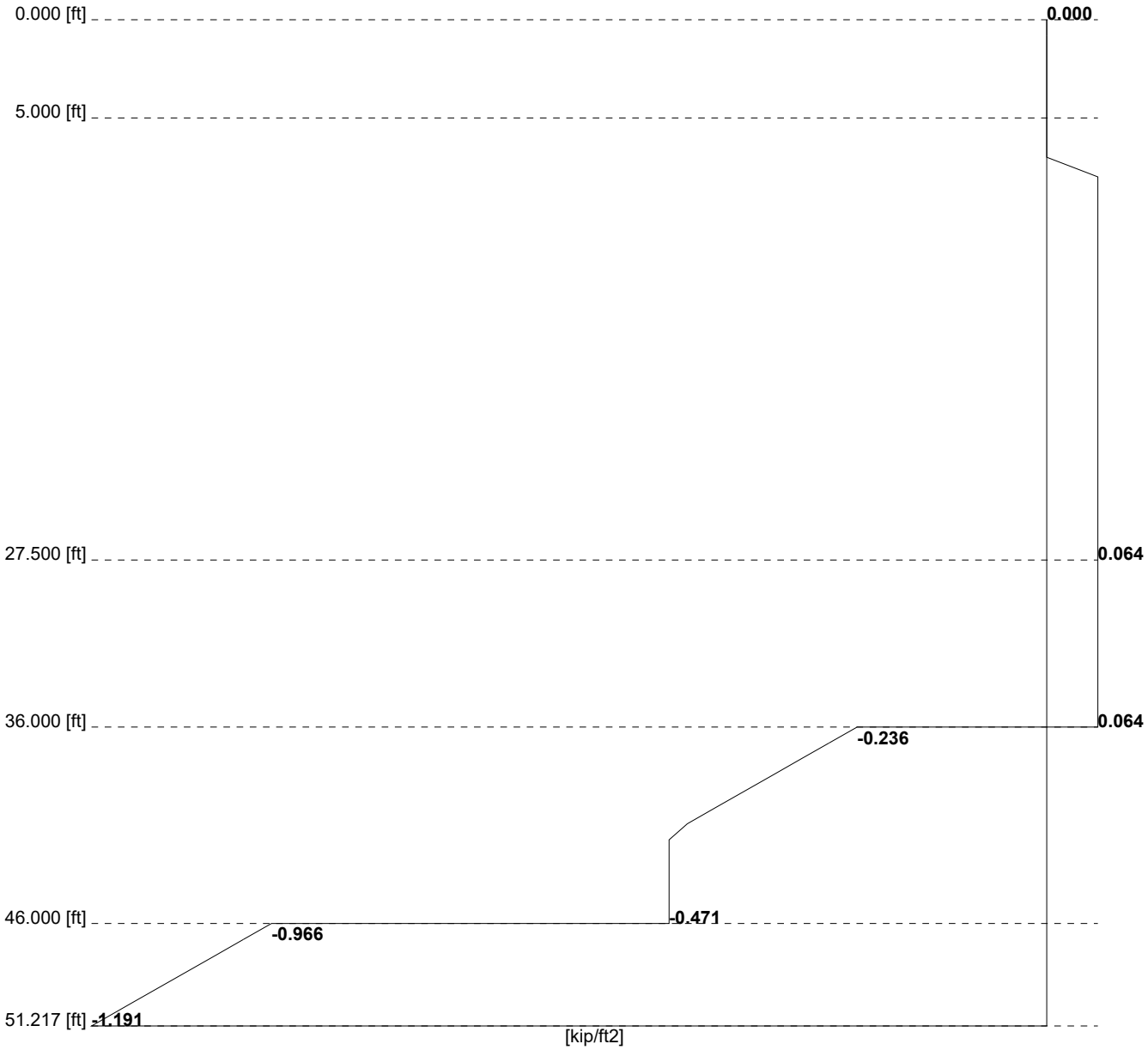
Earth Pressure Diagram



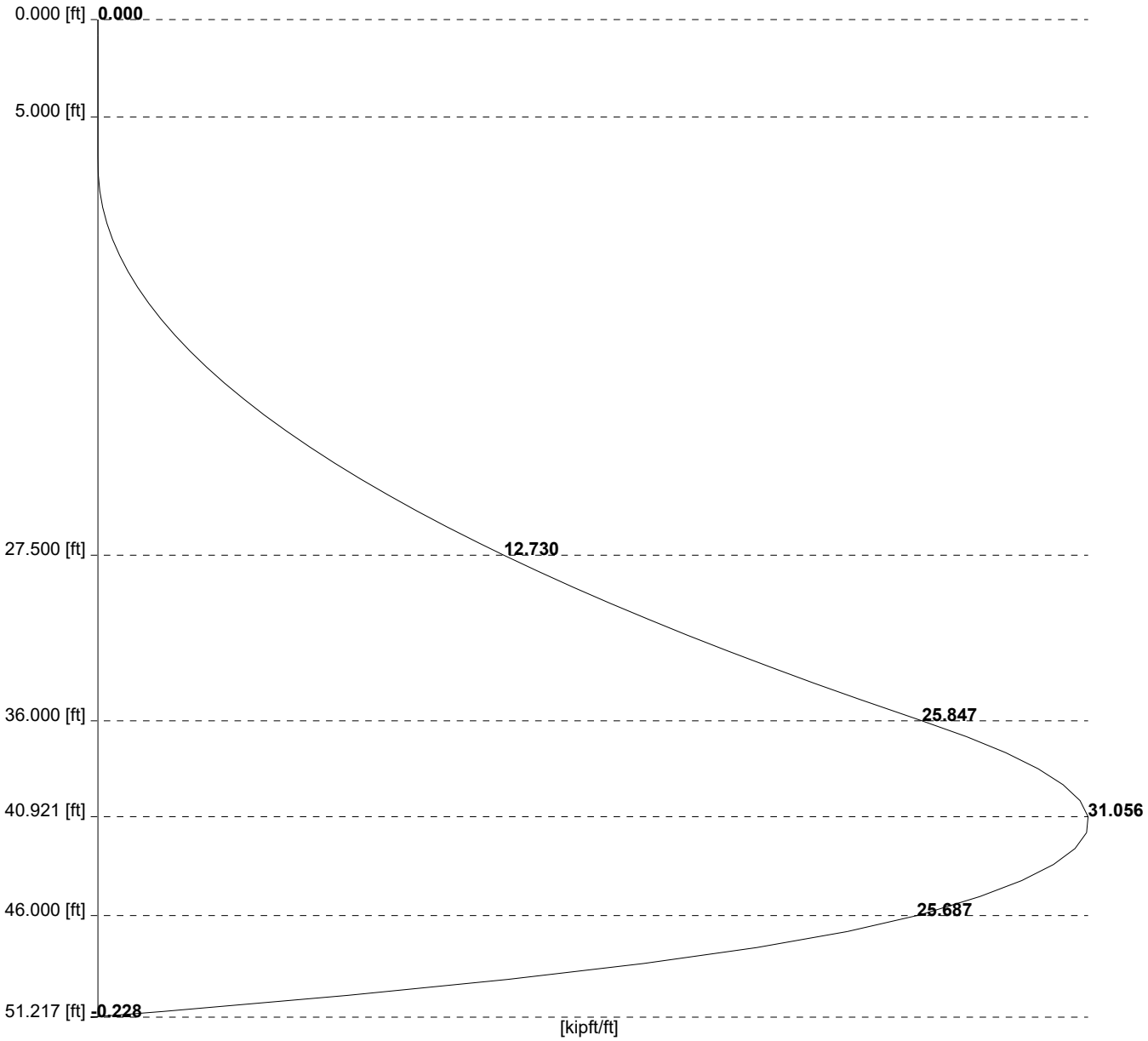
Water Pressure Diagram



Total Pressure Diagram

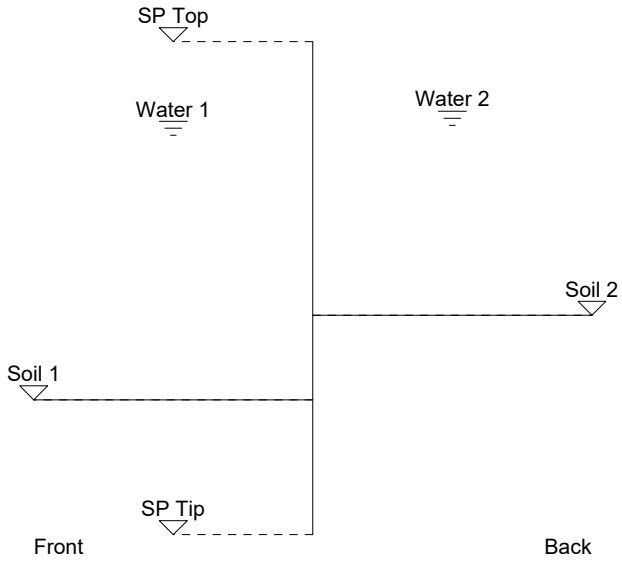


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	49.547
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	27.500
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

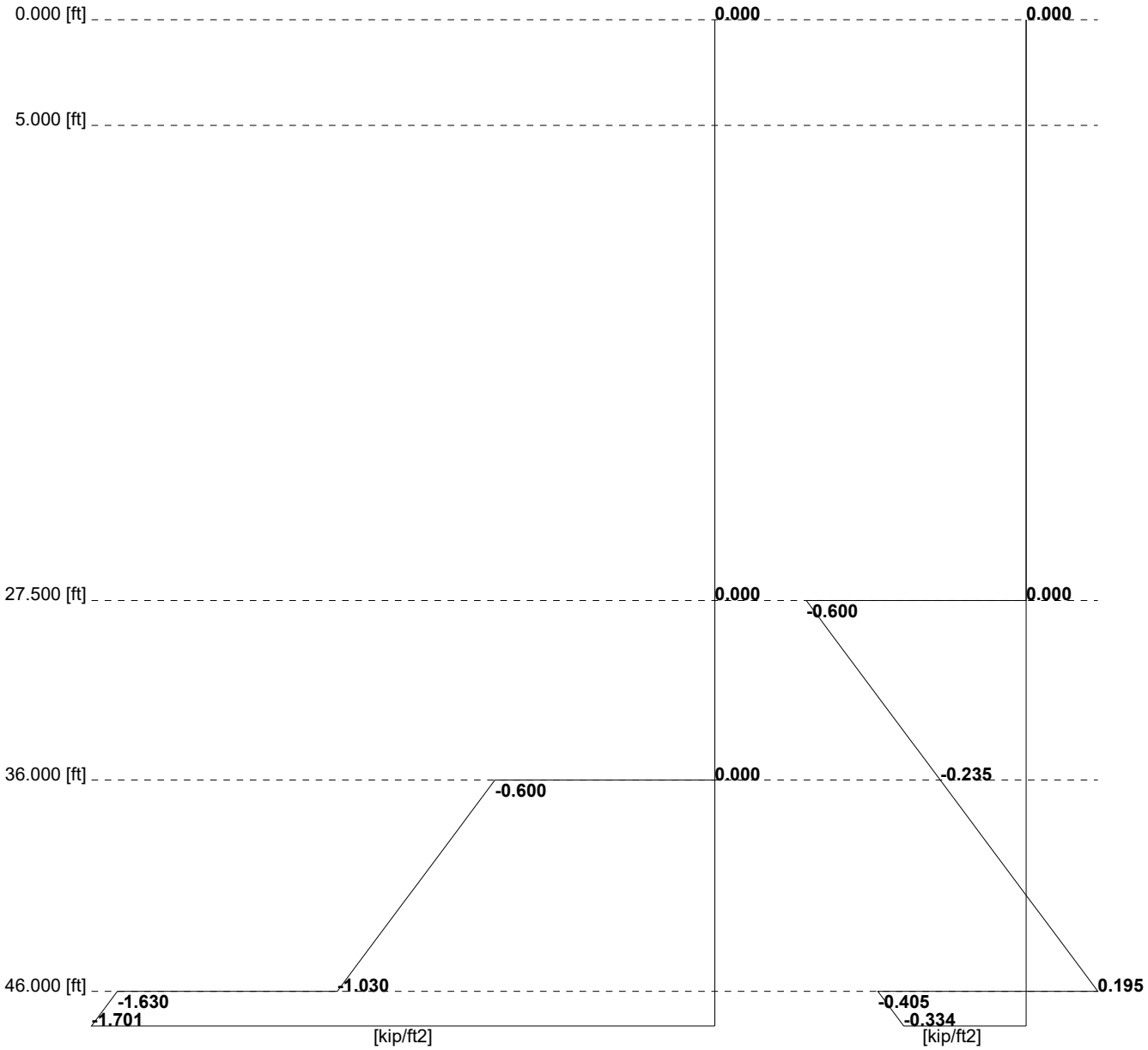
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

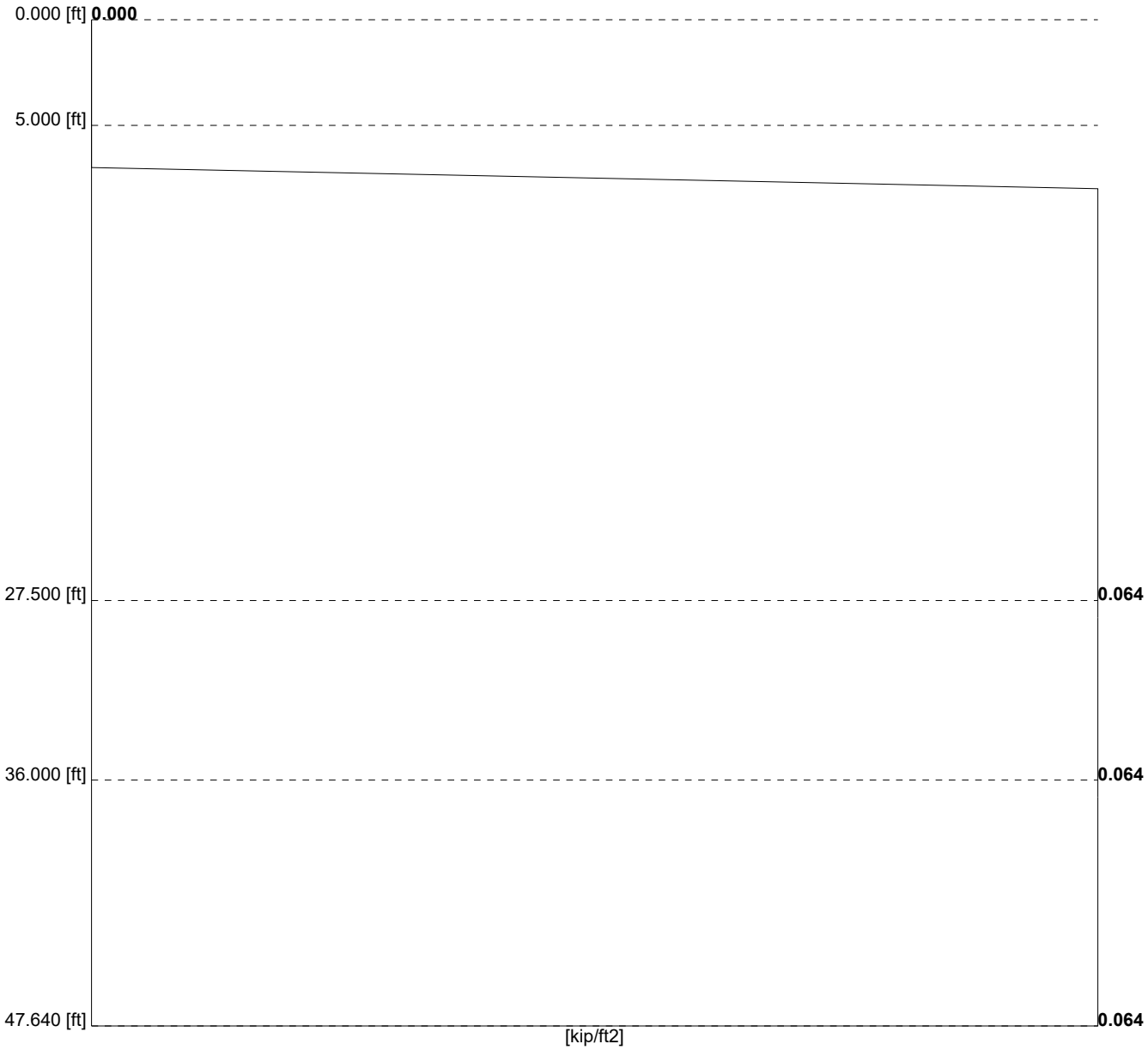
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.327	47.673
Maxmimal Moment [kipft/ft]	28.680	39.018
Normal Forces at Max. Moment [kip/ft]	0.000	47.673
Normal Forces at Min. Moment [kip/ft]	0.000	39.018
Deflection at Min. Moment [ft]	0.000	47.673
Deflection at Max. Moment [ft]	-0.004	39.018
Min. Stress at Min. Moment [lb/in2]	-45.864	47.673
Max. Stress at Min. Moment [lb/in2]	45.864	47.673
Min. Stress at Max. Moment [lb/in2]	-4017.987	39.018
Max. Stress at Max. Moment [lb/in2]	4017.987	39.018
Safety > Req. Safety = 1.500	12.444	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	49.547	
Sheet Pile Length [ft]	49.547	
Included OverLength [ft]	1.907	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

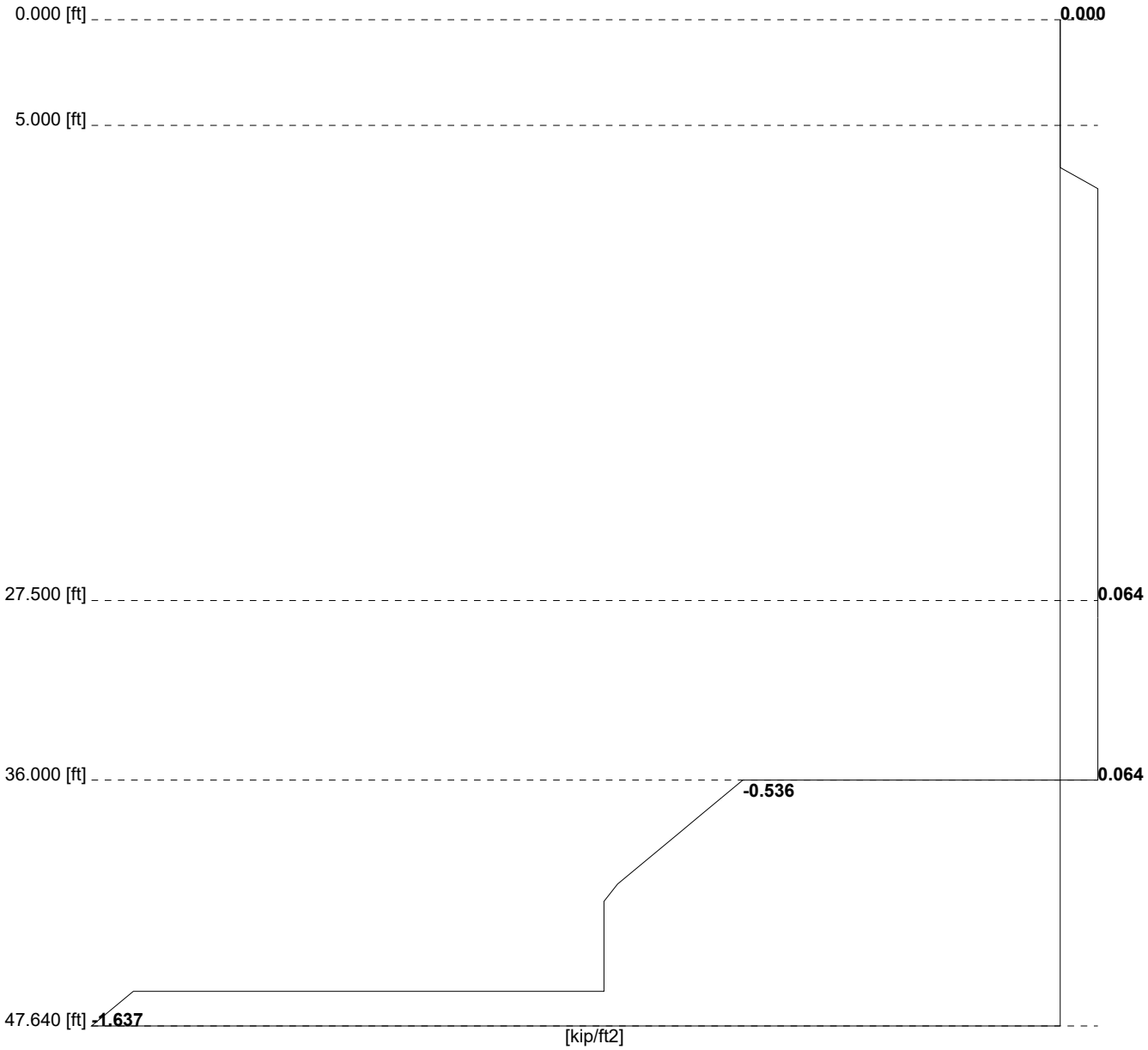
Earth Pressure Diagram



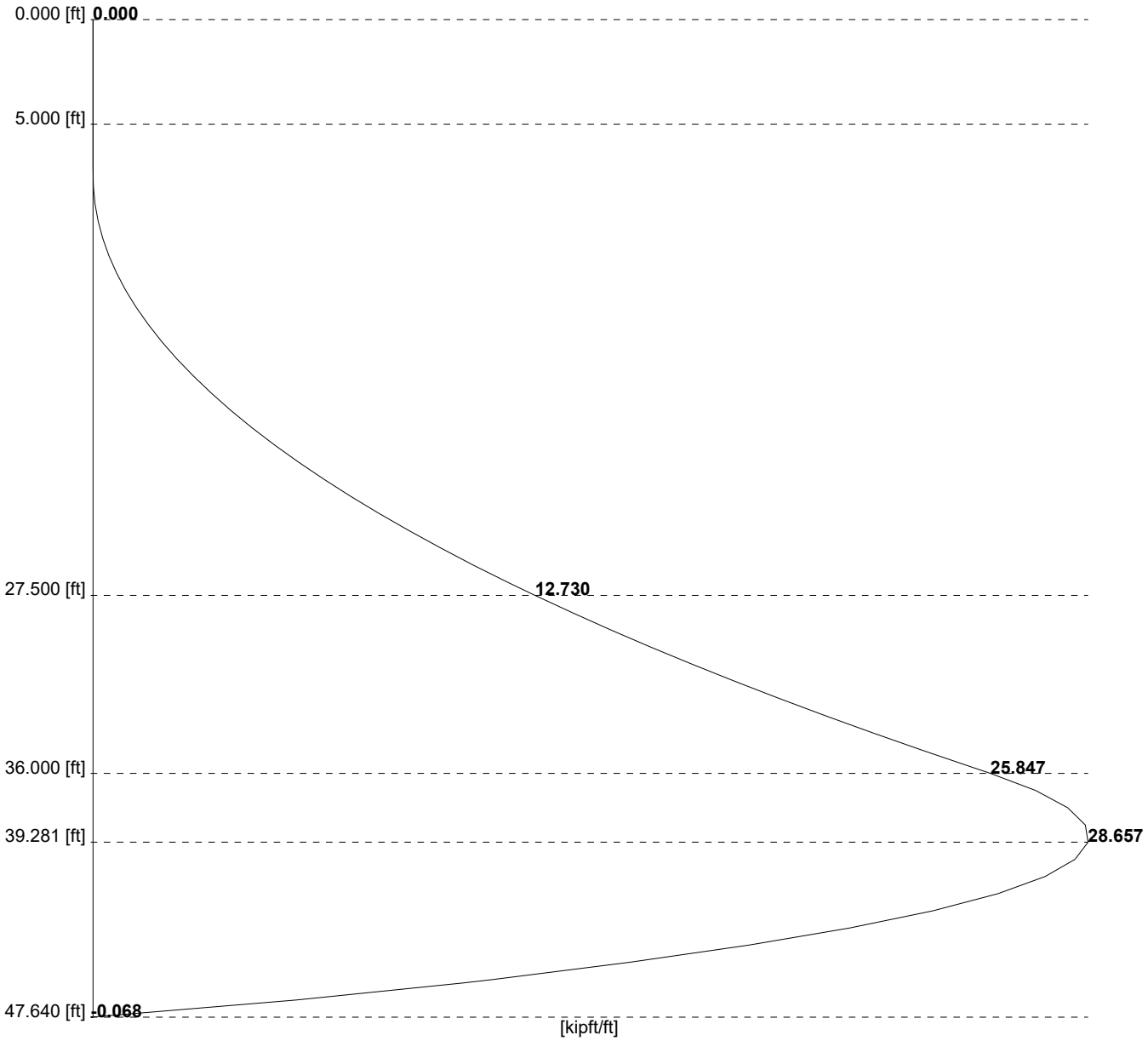
Water Pressure Diagram



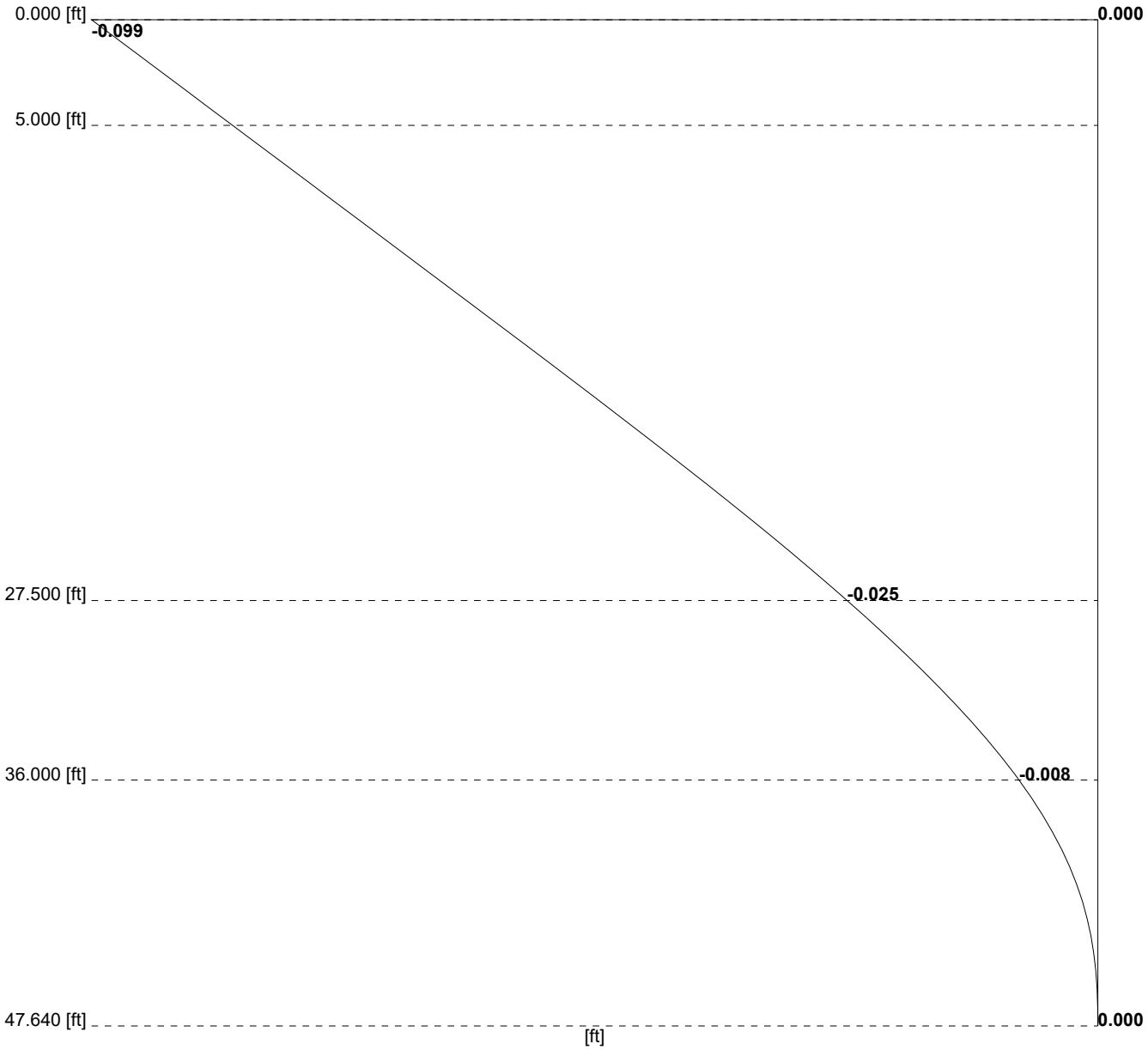
Total Pressure Diagram



Moment Diagram

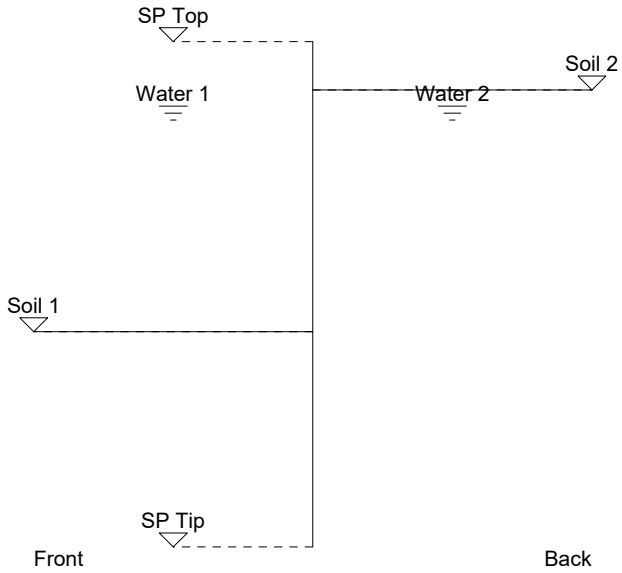


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	62.697
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

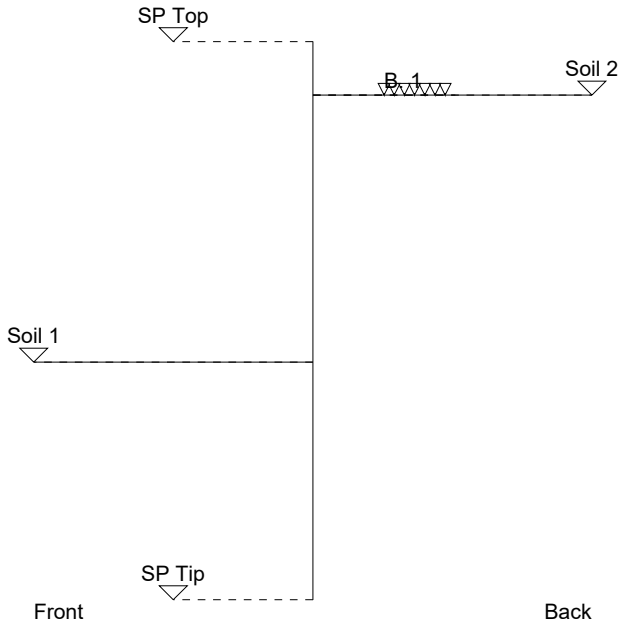
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

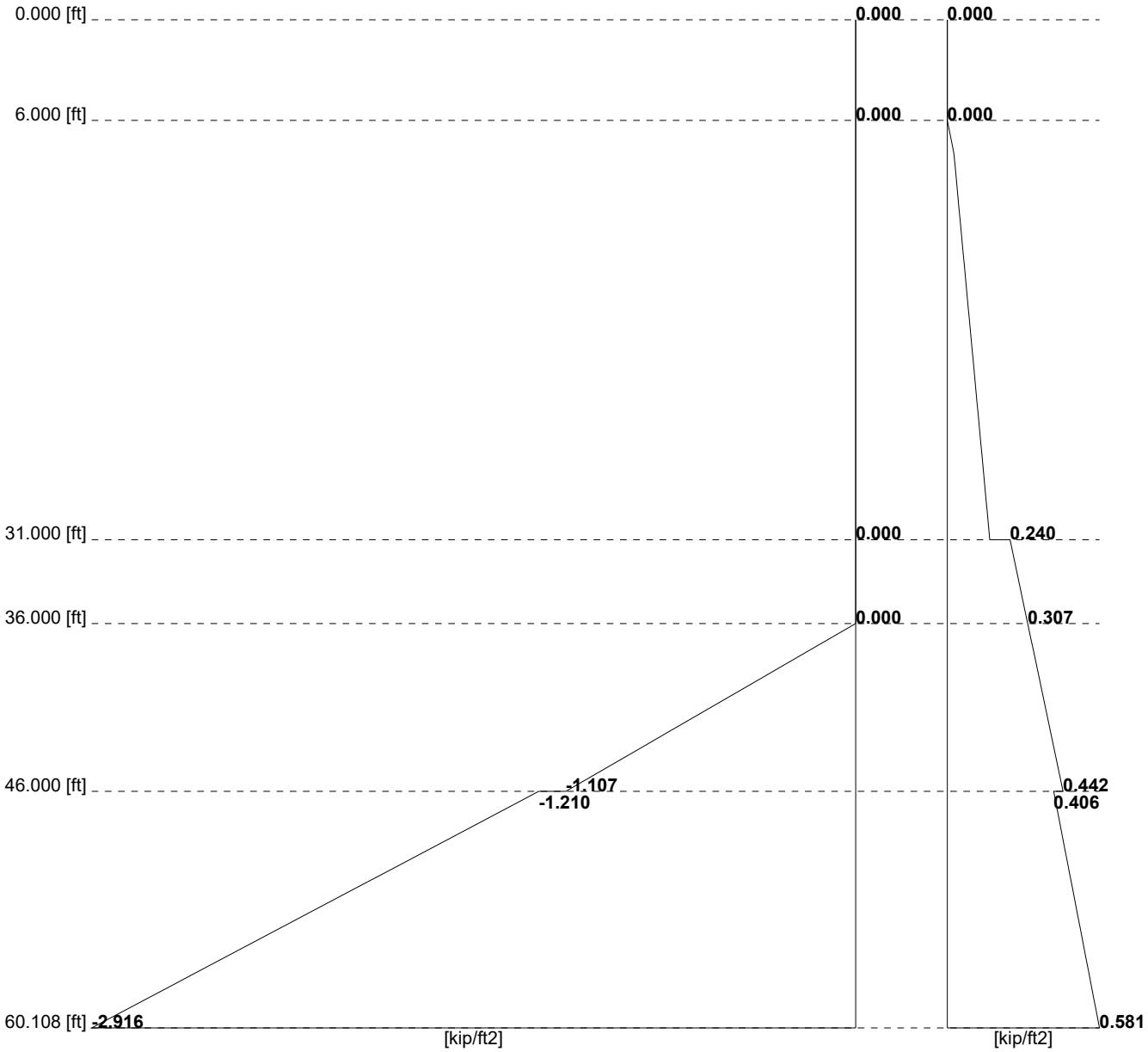
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



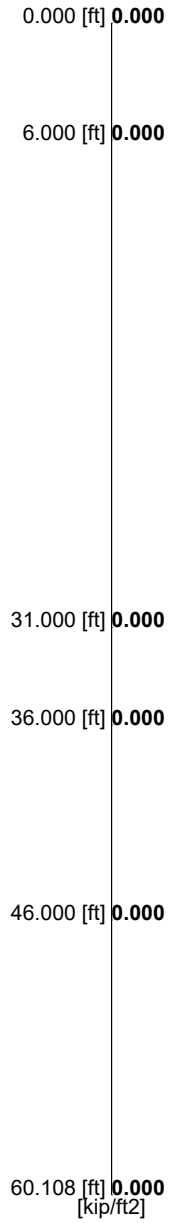
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.757	60.141
Maxmimal Moment [kipft/ft]	90.126	49.182
Normal Forces at Max. Moment [kip/ft]	-2.131	60.141
Normal Forces at Min. Moment [kip/ft]	1.056	49.182
Deflection at Min. Moment [ft]	0.000	60.141
Deflection at Max. Moment [ft]	-0.018	49.182
Min. Stress at Min. Moment [lb/in2]	-263.308	60.141
Max. Stress at Min. Moment [lb/in2]	-51.072	60.141
Min. Stress at Max. Moment [lb/in2]	-12550.940	49.182
Max. Stress at Max. Moment [lb/in2]	12706.742	49.182
Safety > Req. Safety = 1.500	3.935	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	62.697	
Sheet Pile Length [ft]	62.697	
Included OverLength [ft]	2.589	
Vertical Equilibrium [kip/ft]	3.292	
Anchor Force (horiz.) [kip/ft]	0.000	

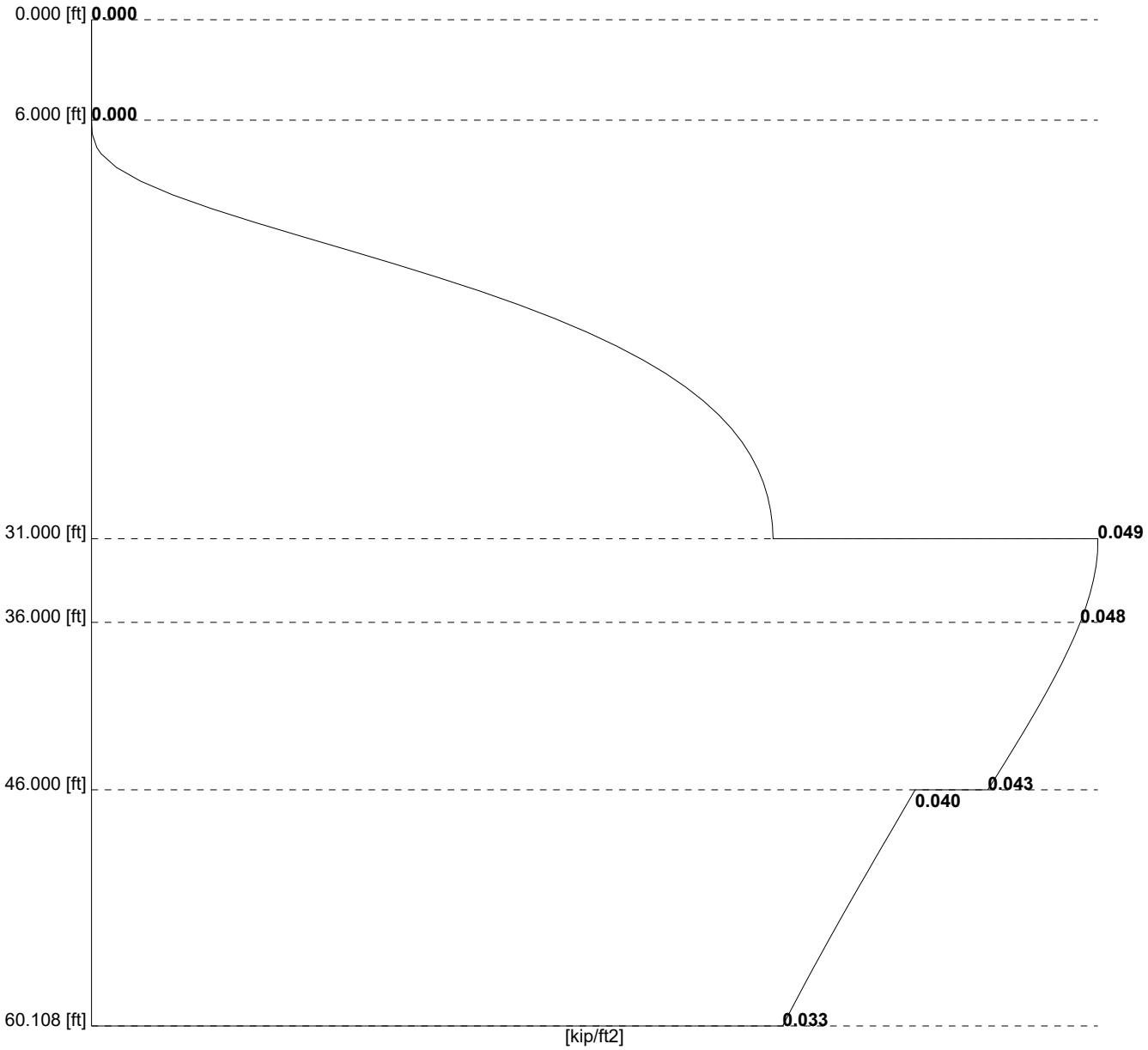
Earth Pressure Diagram



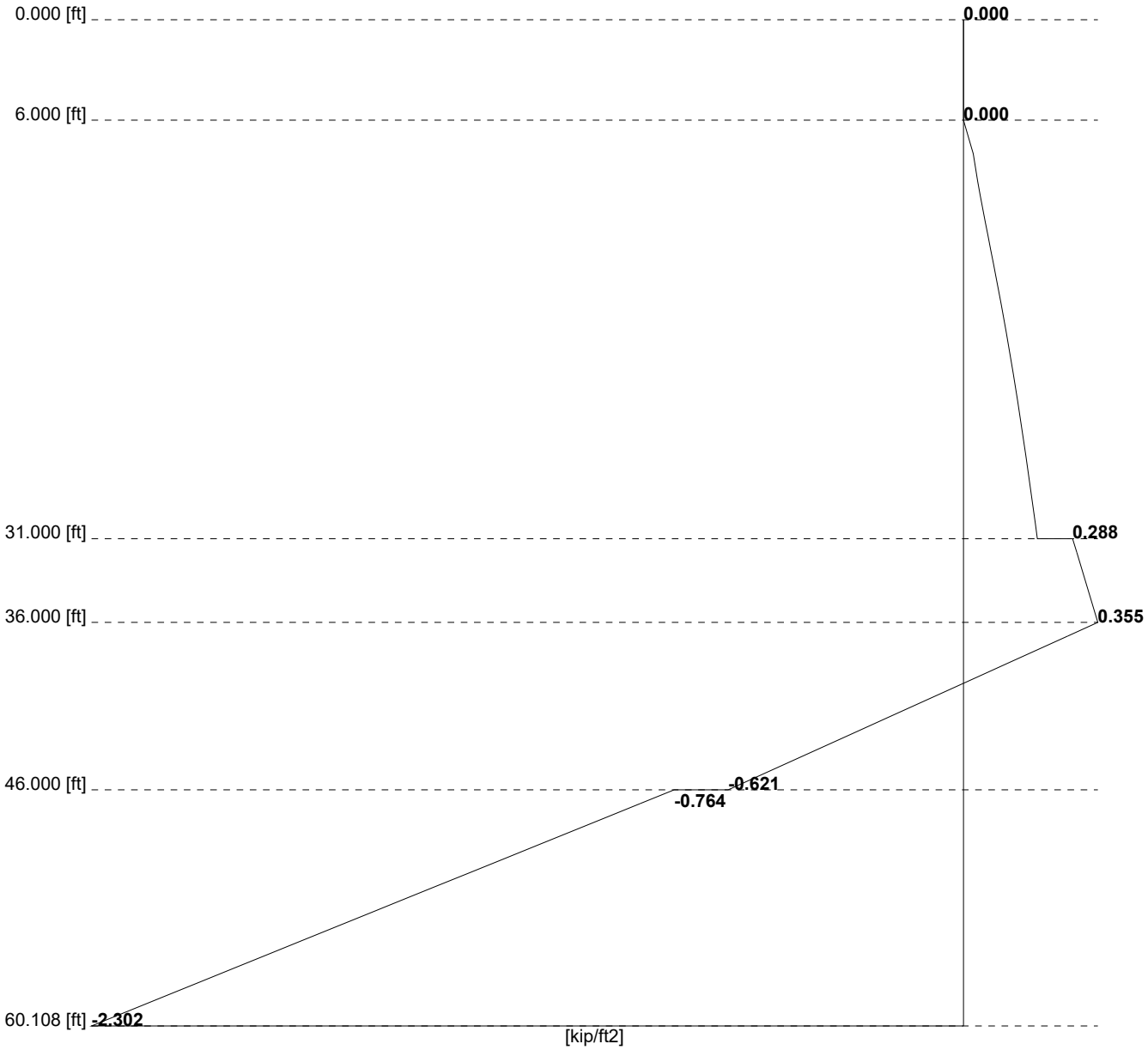
Water Pressure Diagram



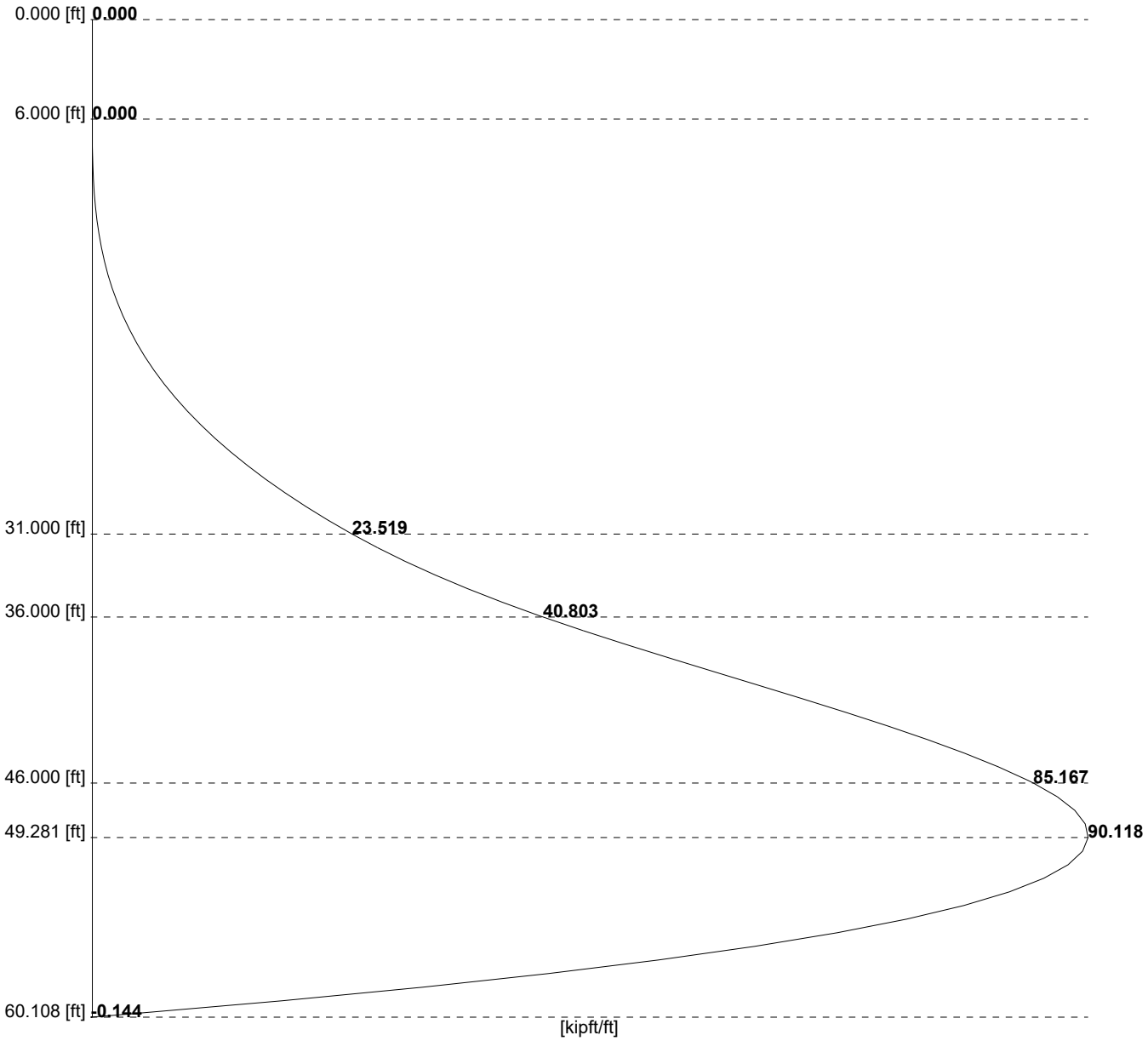
Boussinesq Diagram



Total Pressure Diagram

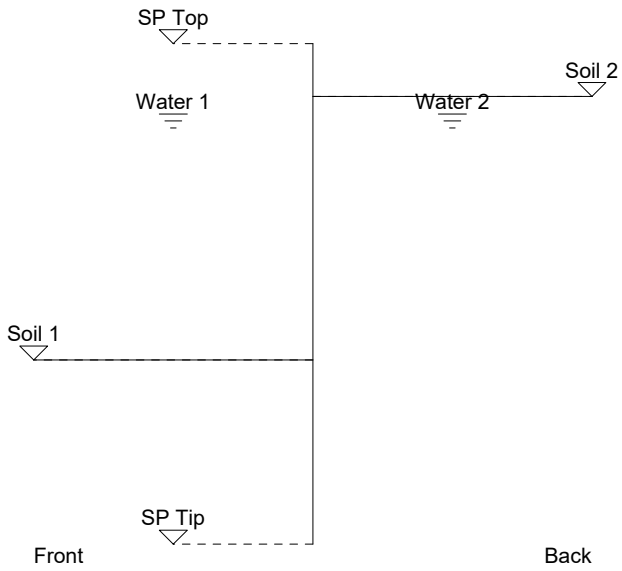


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	56.953
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

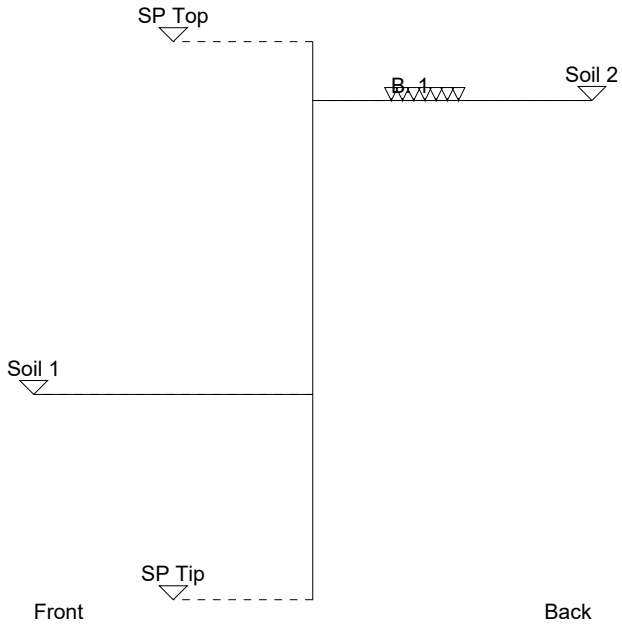
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



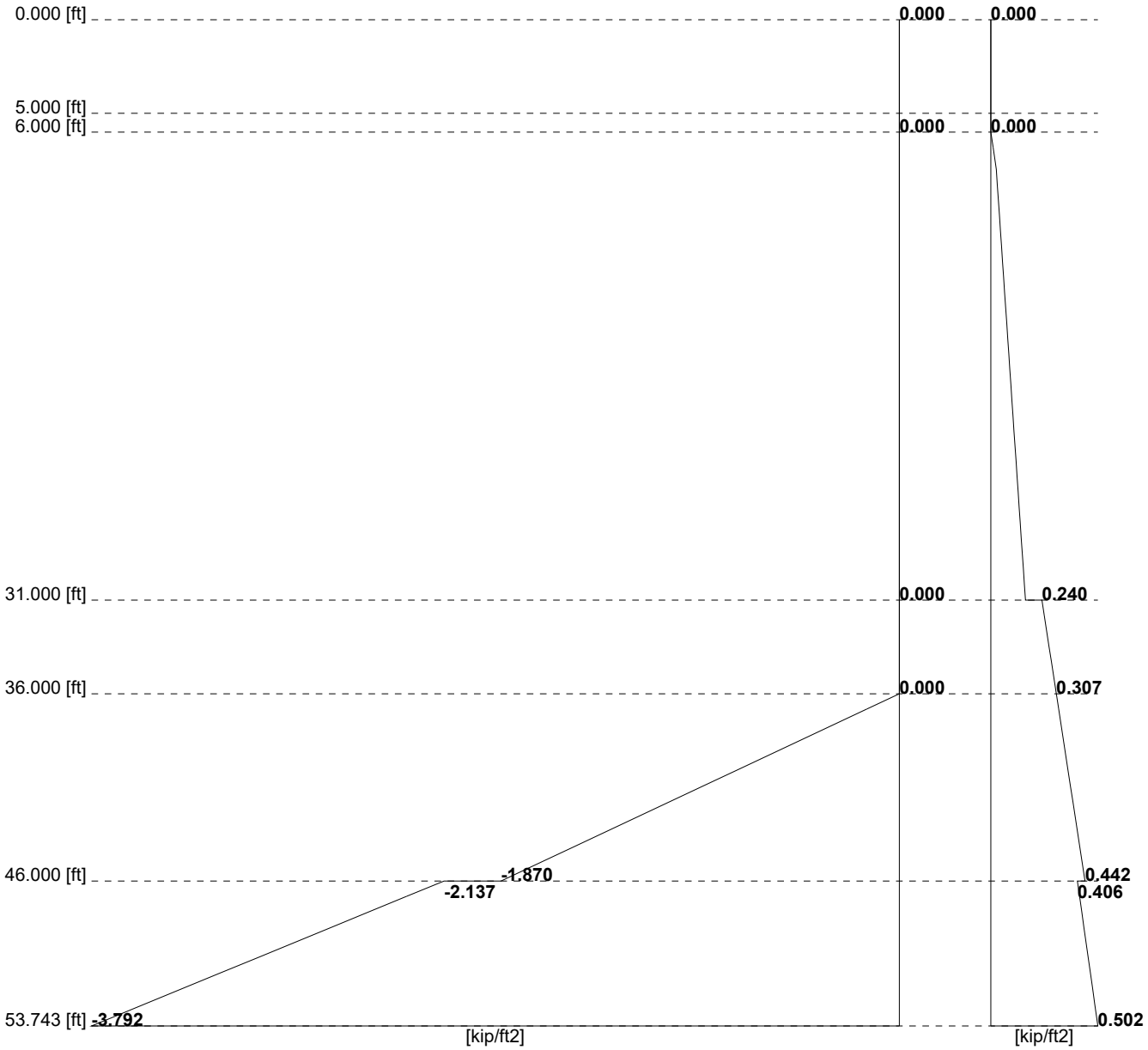
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

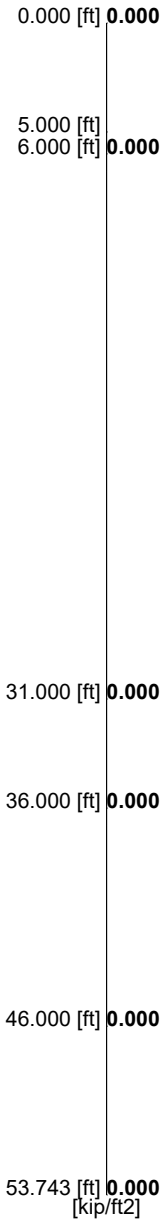
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.165	53.776
Maxmimal Moment [kipft/ft]	72.653	45.022
Normal Forces at Max. Moment [kip/ft]	-5.503	53.776
Normal Forces at Min. Moment [kip/ft]	0.381	45.022
Deflection at Min. Moment [ft]	0.000	53.776
Deflection at Max. Moment [ft]	-0.010	45.022
Min. Stress at Min. Moment [lb/in2]	-569.067	53.776
Max. Stress at Min. Moment [lb/in2]	-242.602	53.776
Min. Stress at Max. Moment [lb/in2]	-10150.771	45.022
Max. Stress at Max. Moment [lb/in2]	10206.923	45.022
Safety > Req. Safety = 1.500	4.899	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	56.953	
Sheet Pile Length [ft]	56.953	
Included OverLength [ft]	3.210	
Vertical Equilibrium [kip/ft]	0.308	
Anchor Force (horiz.) [kip/ft]	0.000	

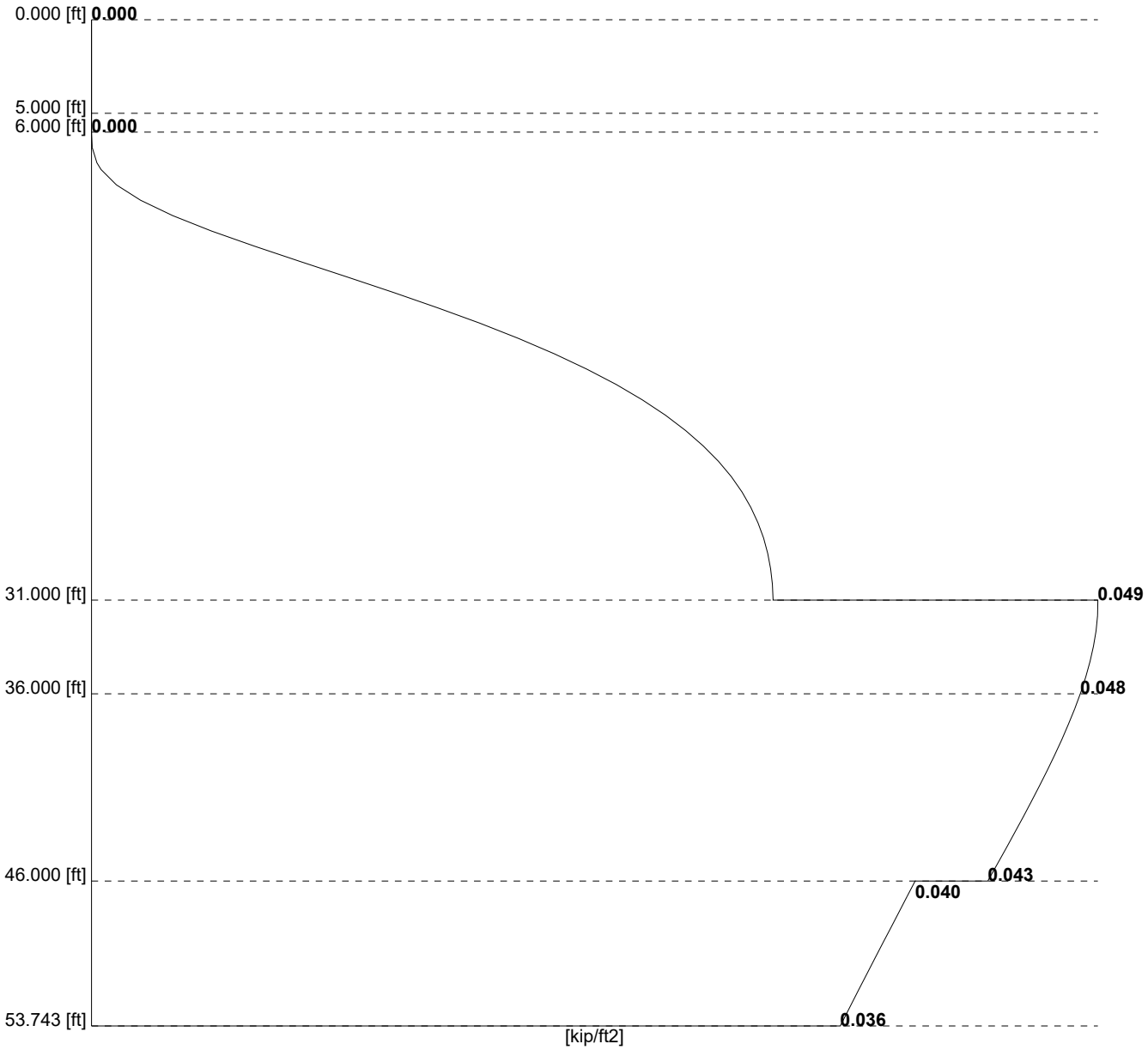
Earth Pressure Diagram



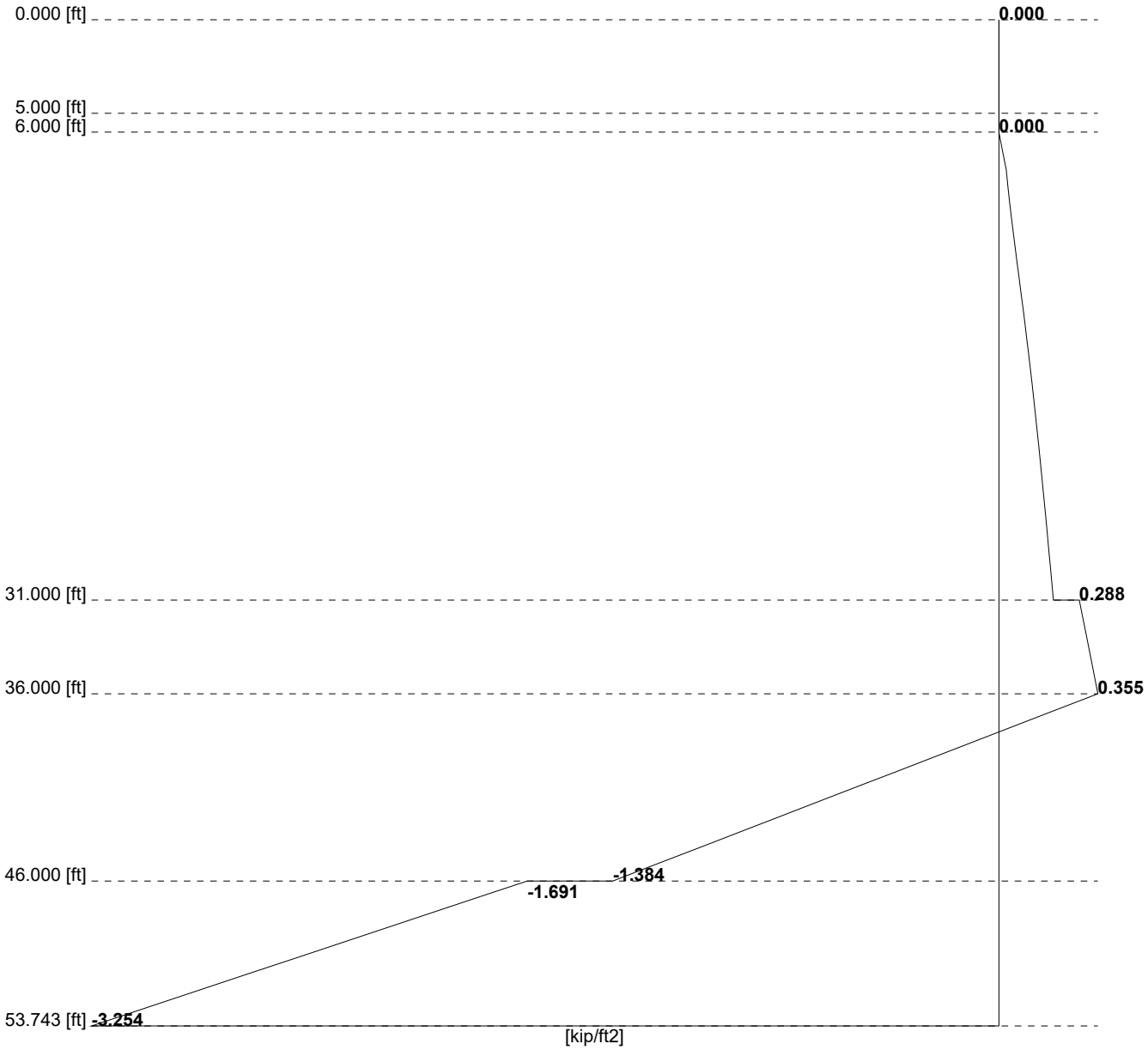
Water Pressure Diagram



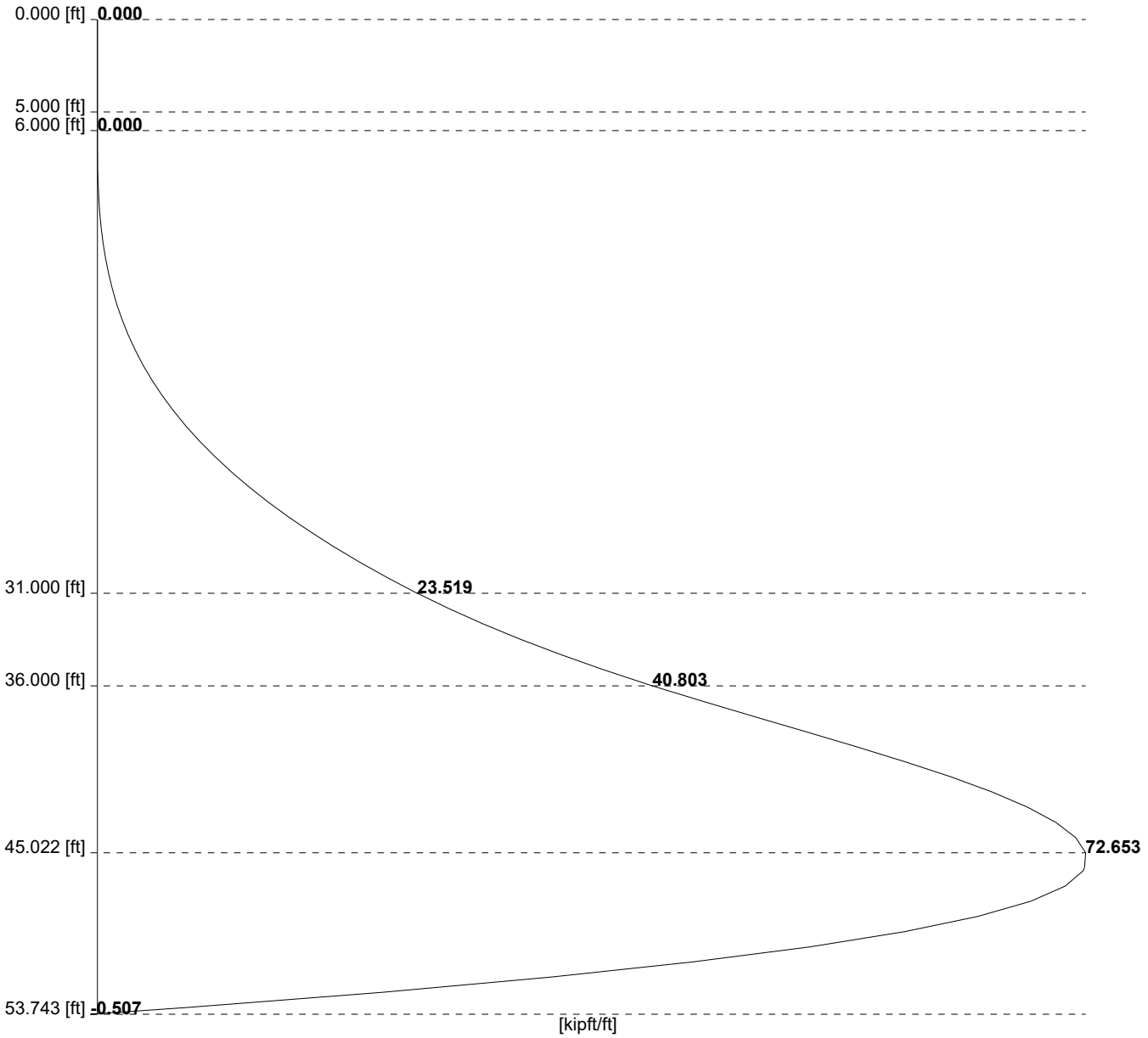
Boussinesq Diagram



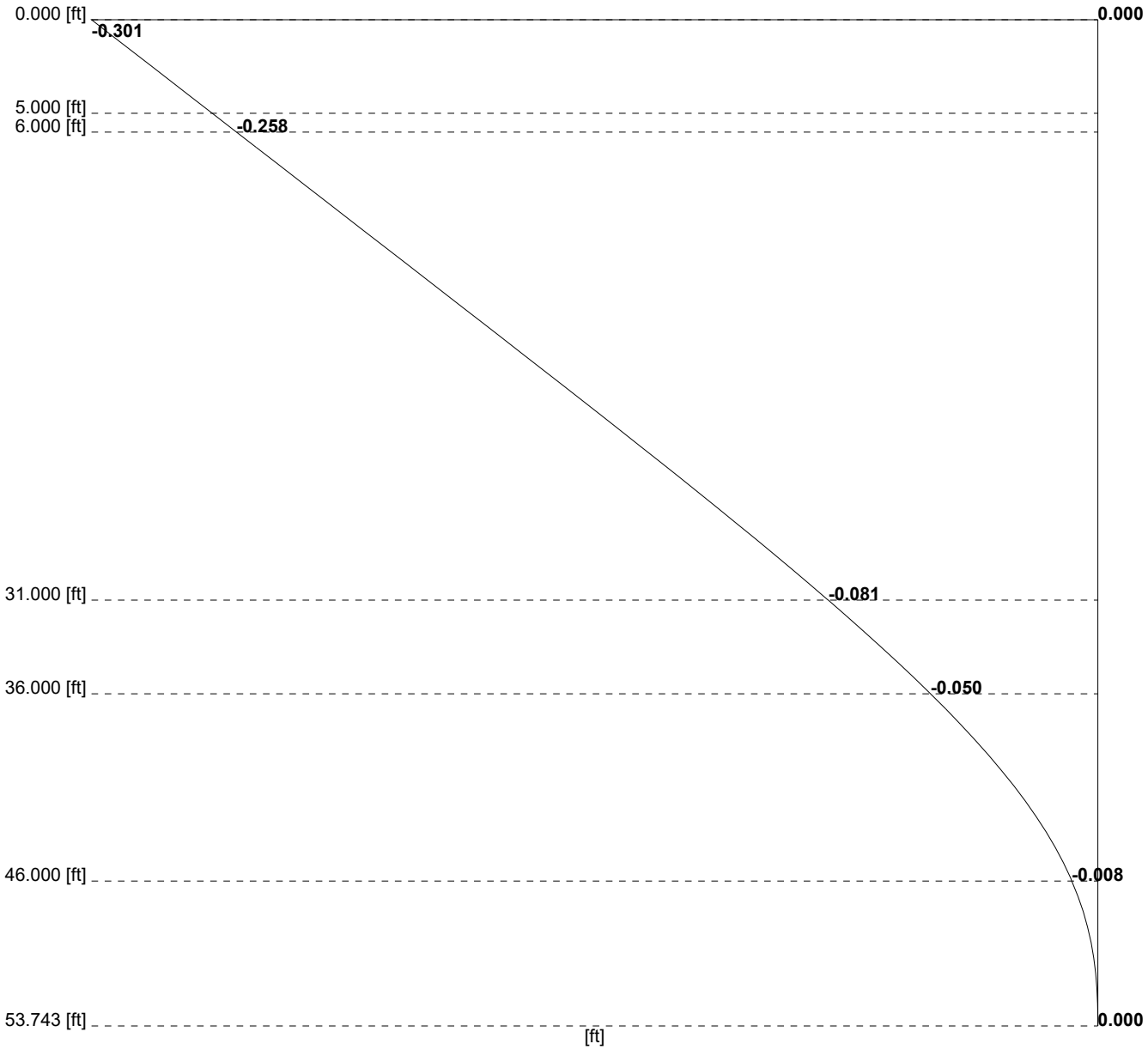
Total Pressure Diagram



Moment Diagram

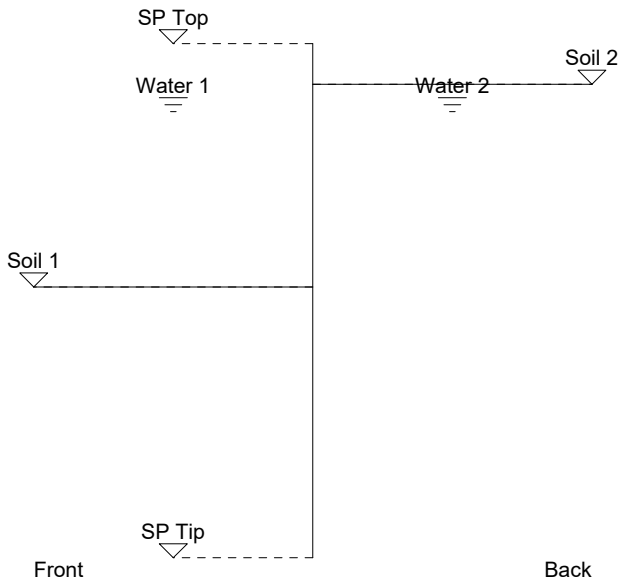


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	76.067
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

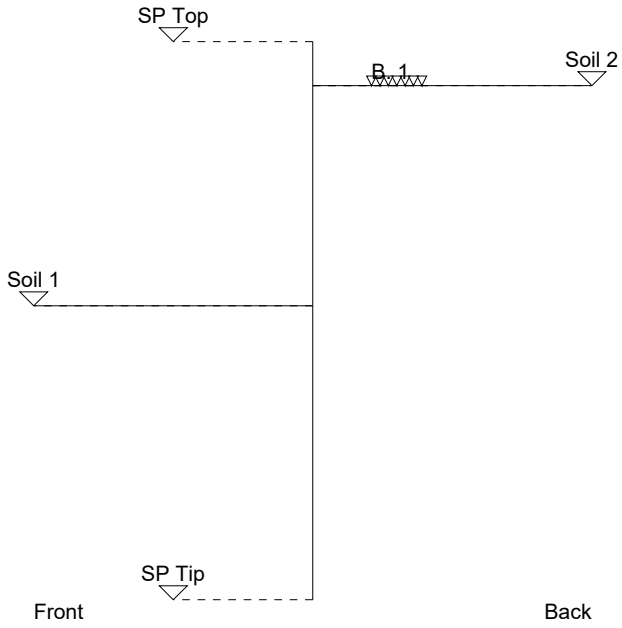
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

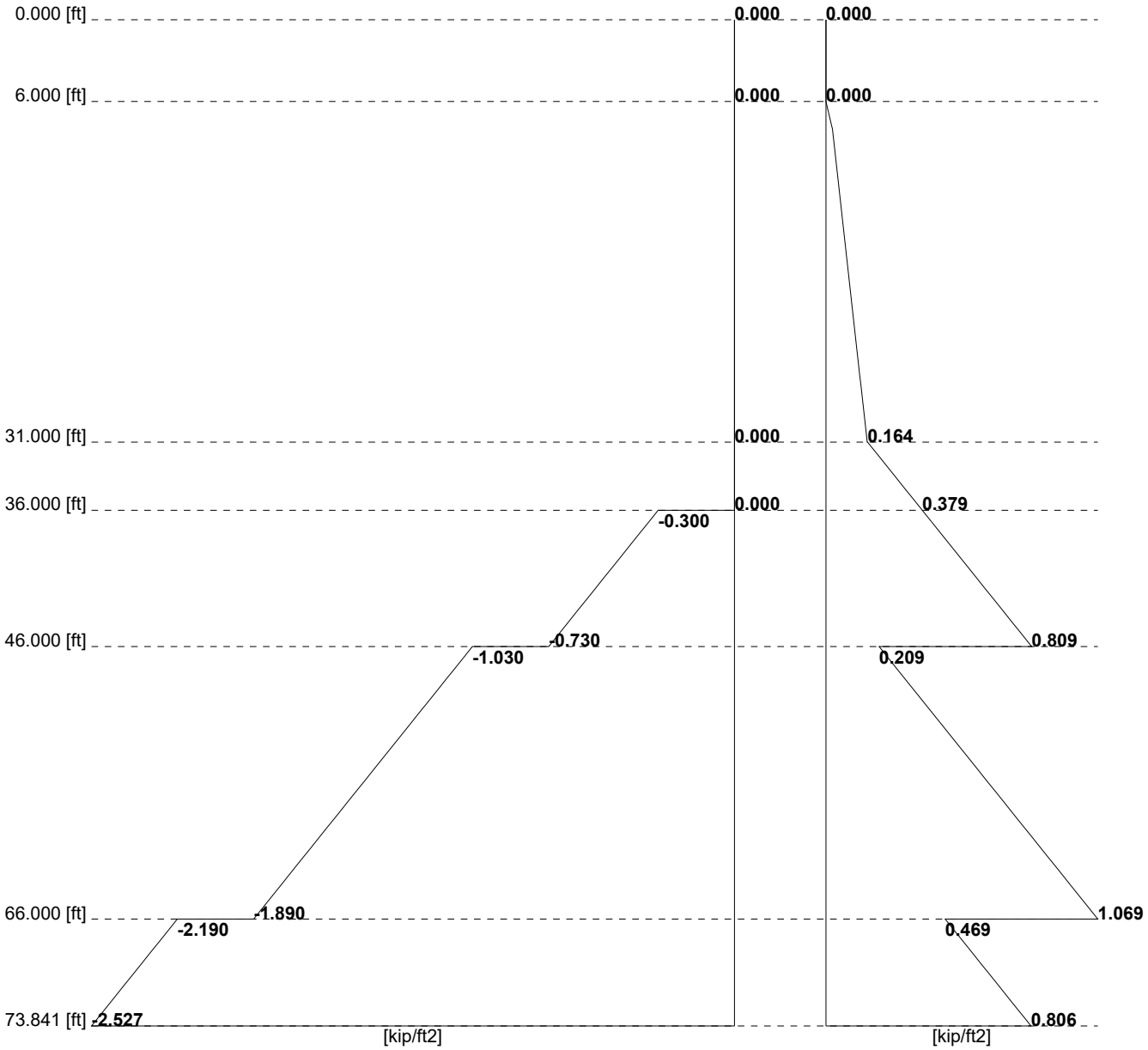
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



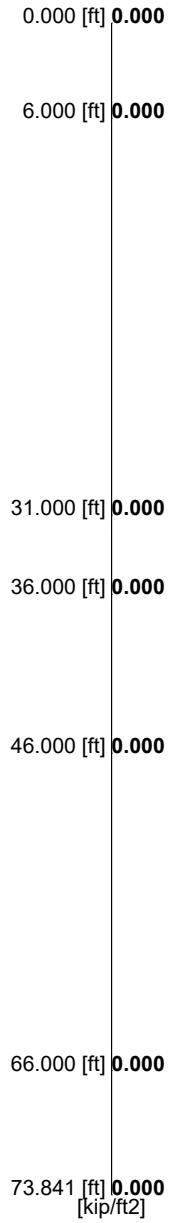
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.121	73.874
Maxmimal Moment [kipft/ft]	137.286	55.843
Normal Forces at Max. Moment [kip/ft]	0.984	73.874
Normal Forces at Min. Moment [kip/ft]	0.984	55.843
Deflection at Min. Moment [ft]	0.000	73.874
Deflection at Max. Moment [ft]	-0.077	55.843
Min. Stress at Min. Moment [lb/in2]	-84.427	73.874
Max. Stress at Min. Moment [lb/in2]	229.562	73.874
Min. Stress at Max. Moment [lb/in2]	-19171.049	55.843
Max. Stress at Max. Moment [lb/in2]	19316.186	55.843
Safety > Req. Safety = 1.500	2.589	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	76.067	
Sheet Pile Length [ft]	76.067	
Included OverLength [ft]	2.226	
Vertical Equilibrium [kip/ft]	0.984	
Anchor Force (horiz.) [kip/ft]	0.000	

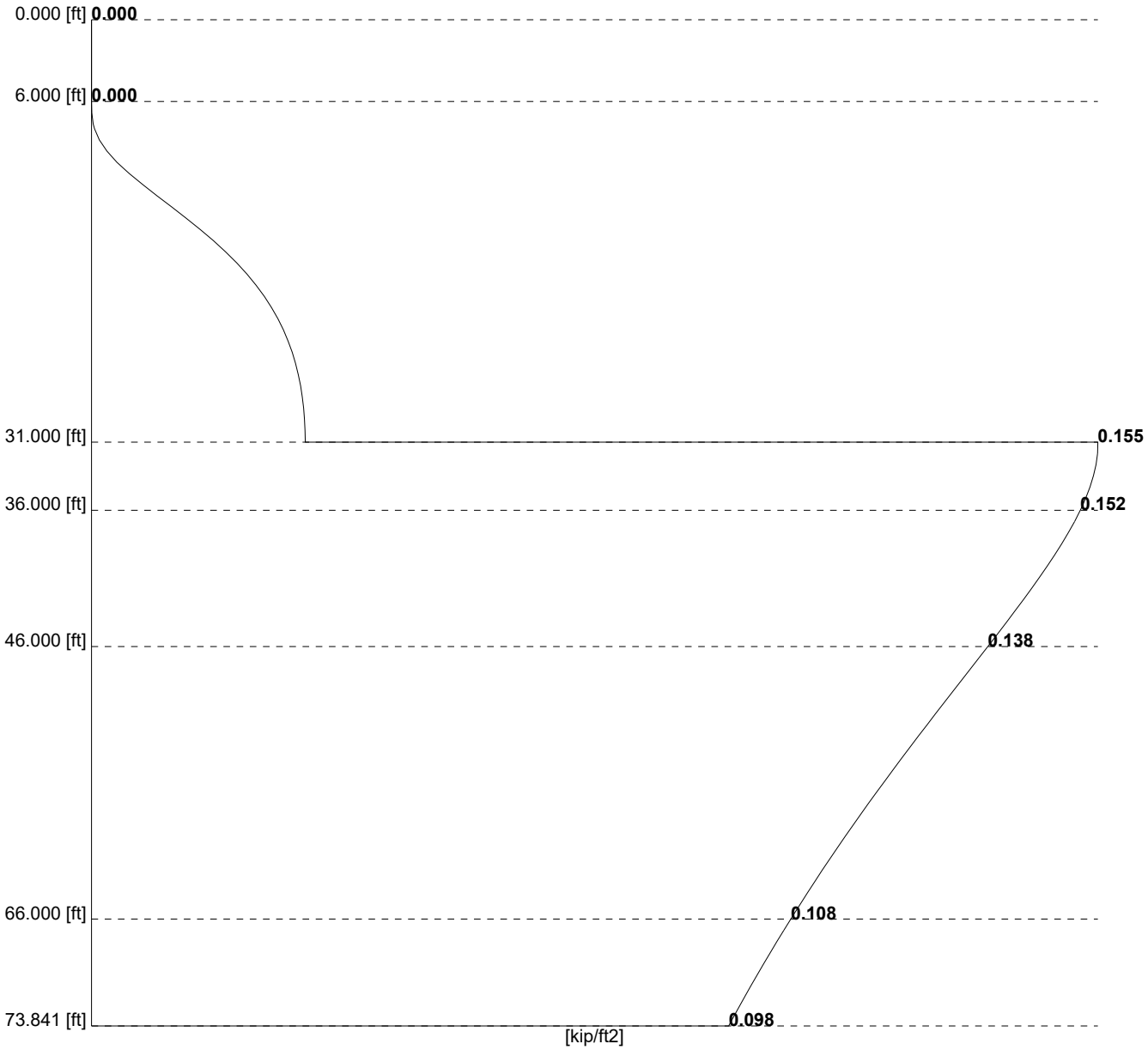
Earth Pressure Diagram



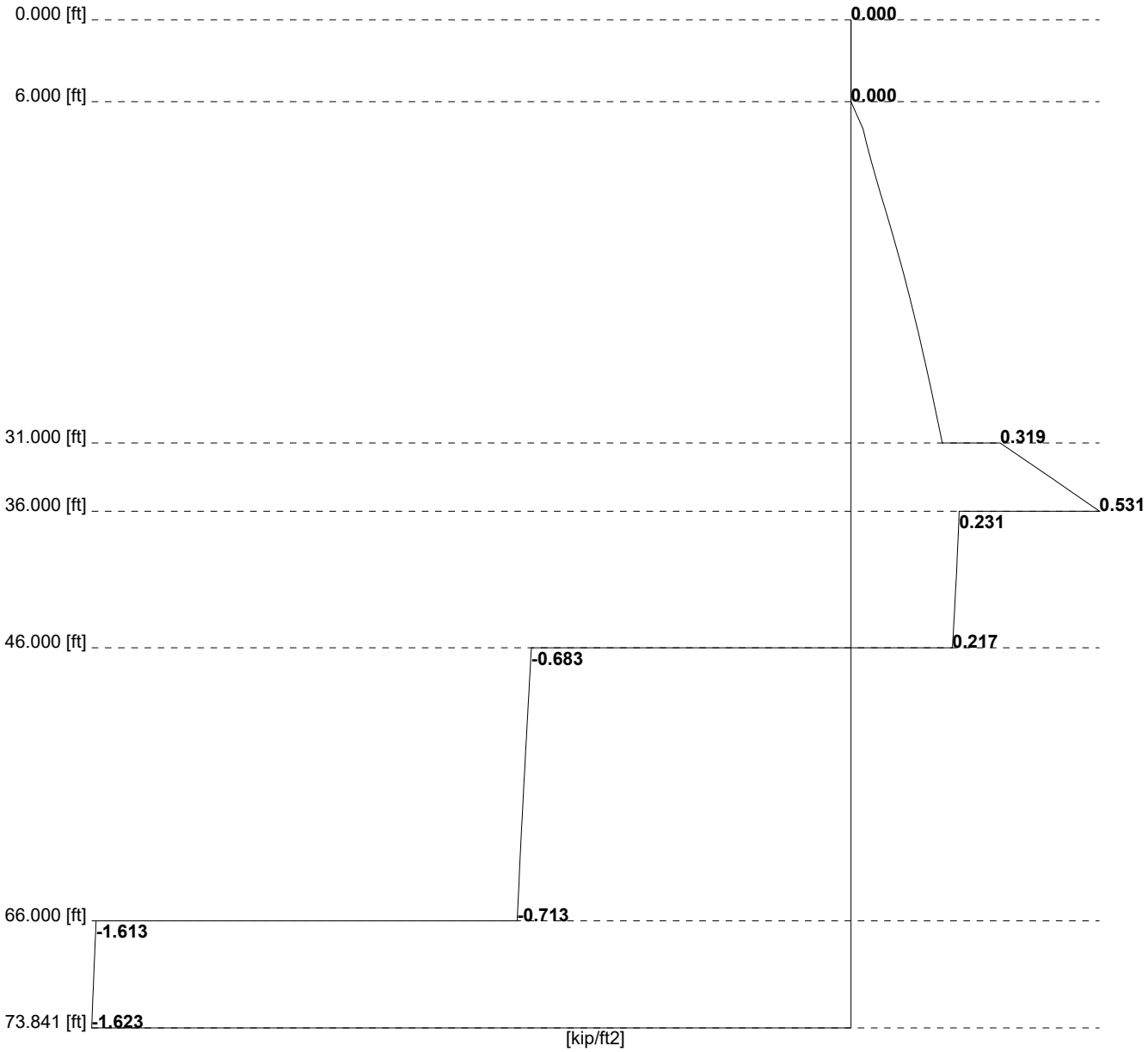
Water Pressure Diagram



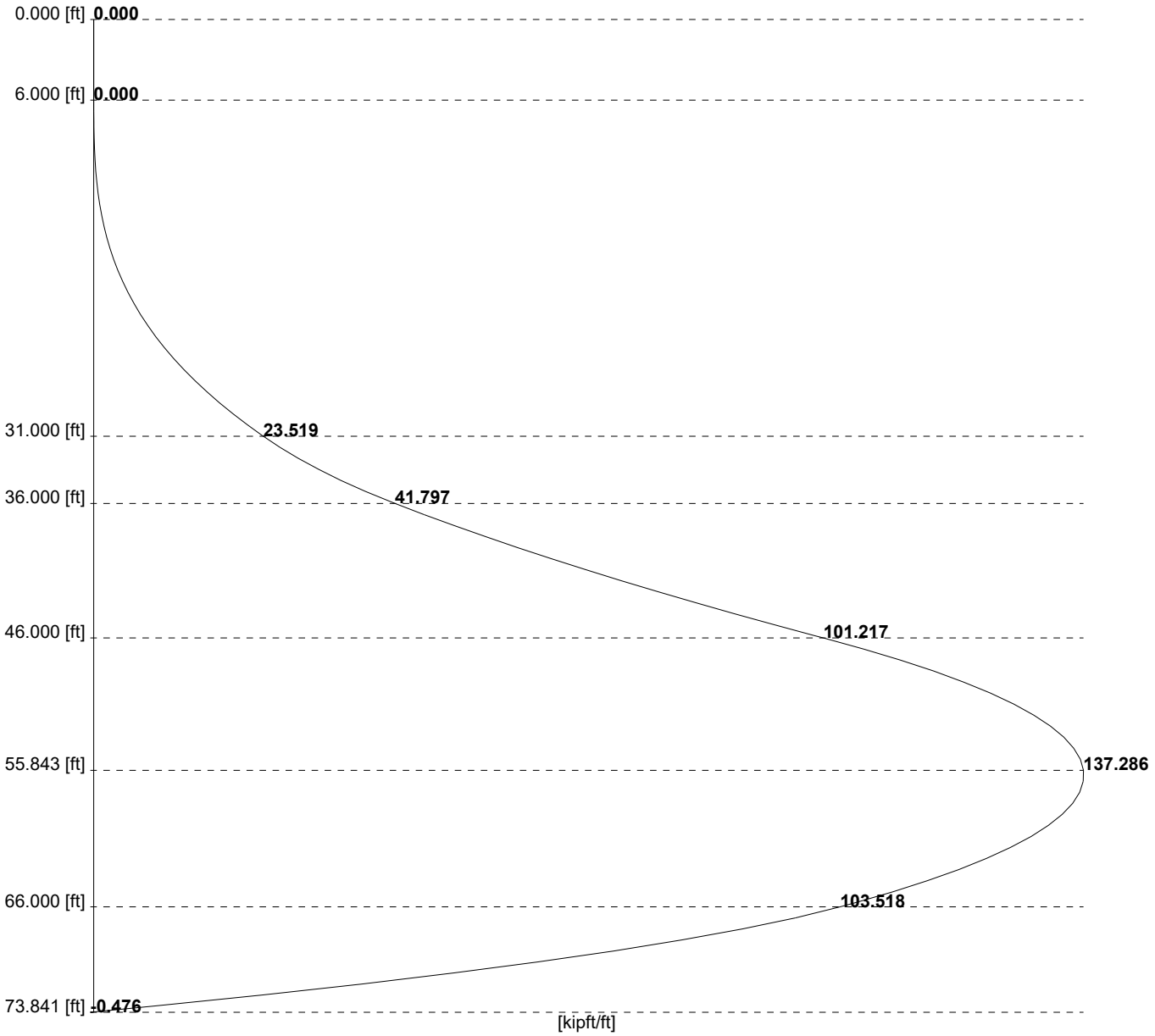
Boussinesq Diagram



Total Pressure Diagram

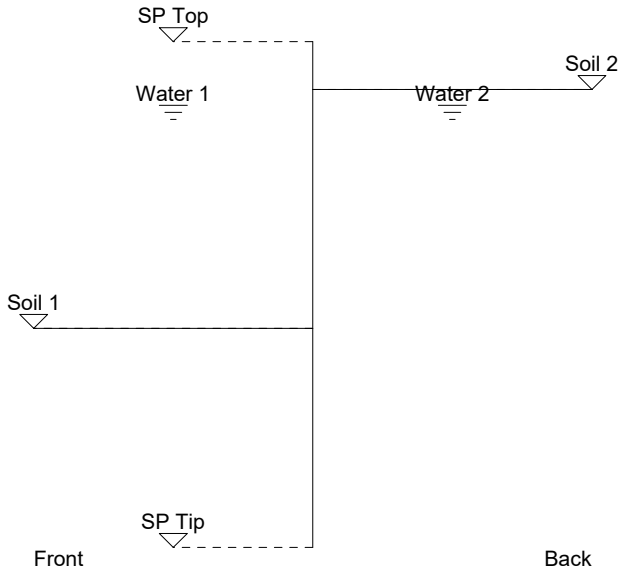


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	63.508
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

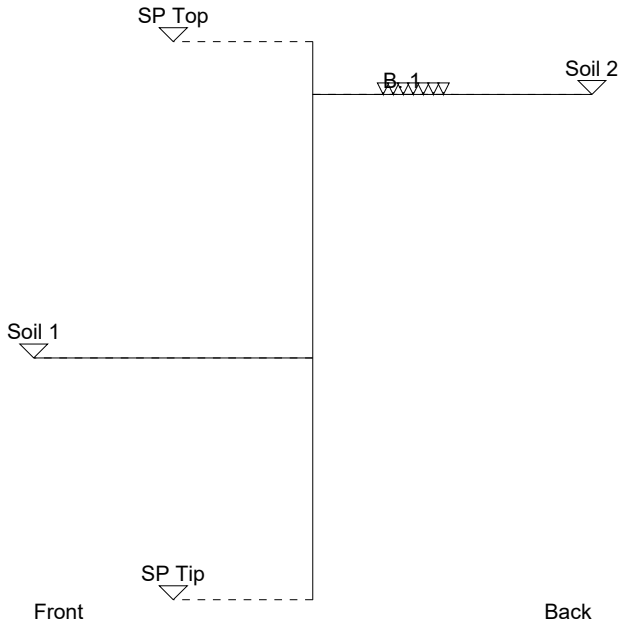
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



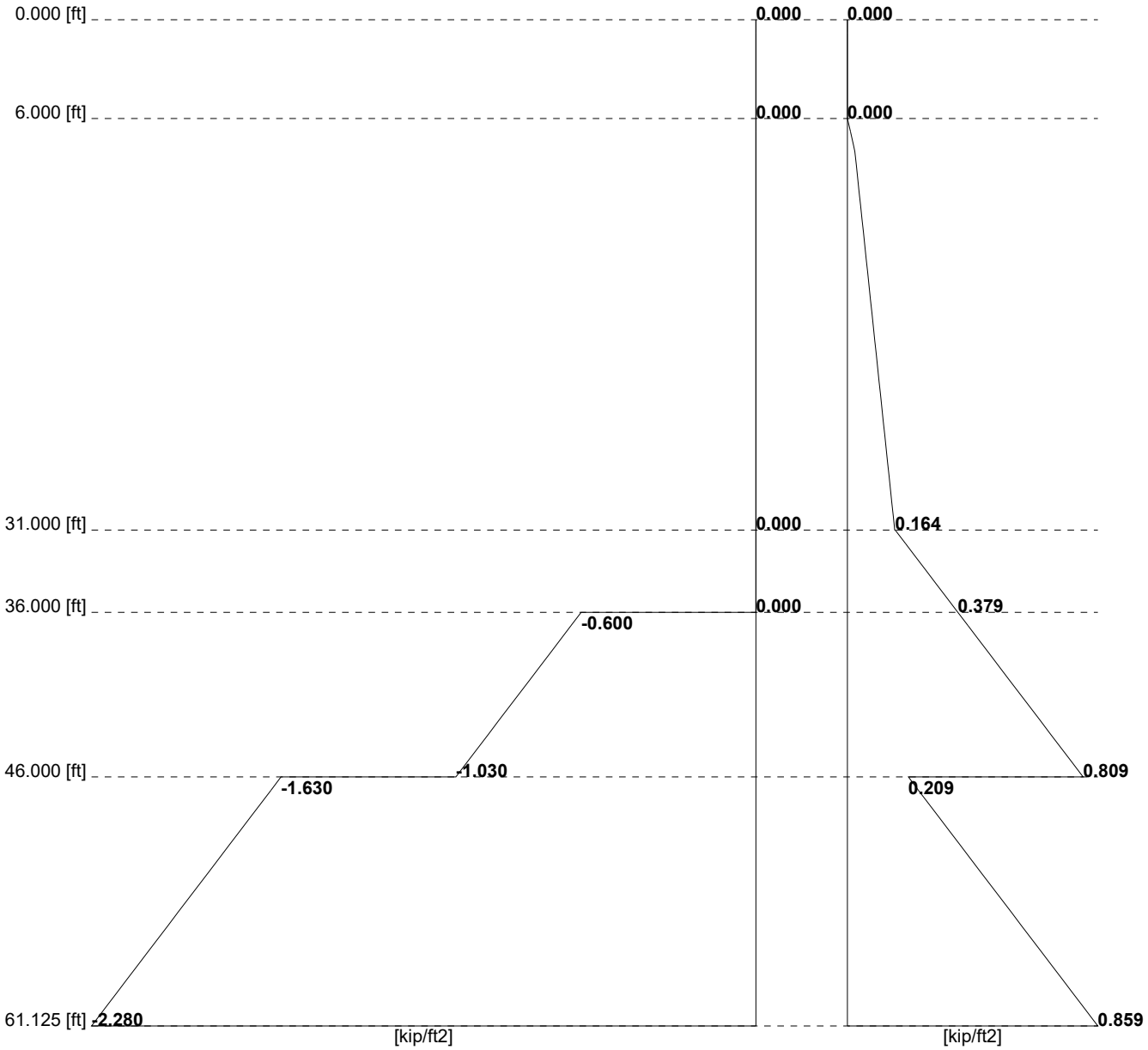
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

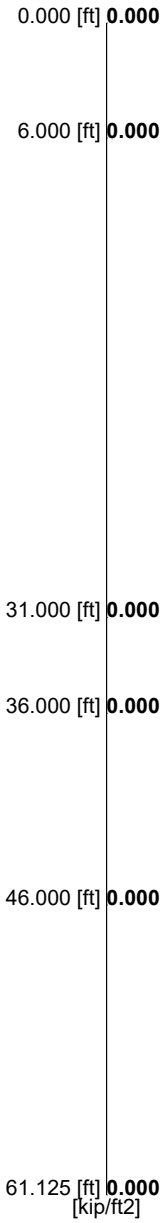
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.689	61.158
Maxmimal Moment [kipft/ft]	92.608	49.182
Normal Forces at Max. Moment [kip/ft]	0.984	61.158
Normal Forces at Min. Moment [kip/ft]	0.984	49.182
Deflection at Min. Moment [ft]	0.000	61.158
Deflection at Max. Moment [ft]	-0.021	49.182
Min. Stress at Min. Moment [lb/in2]	-23.907	61.158
Max. Stress at Min. Moment [lb/in2]	169.042	61.158
Min. Stress at Max. Moment [lb/in2]	-12904.248	49.182
Max. Stress at Max. Moment [lb/in2]	13049.382	49.182
Safety > Req. Safety = 1.500	3.832	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	63.508	
Sheet Pile Length [ft]	63.508	
Included OverLength [ft]	2.383	
Vertical Equilibrium [kip/ft]	0.984	
Anchor Force (horiz.) [kip/ft]	0.000	

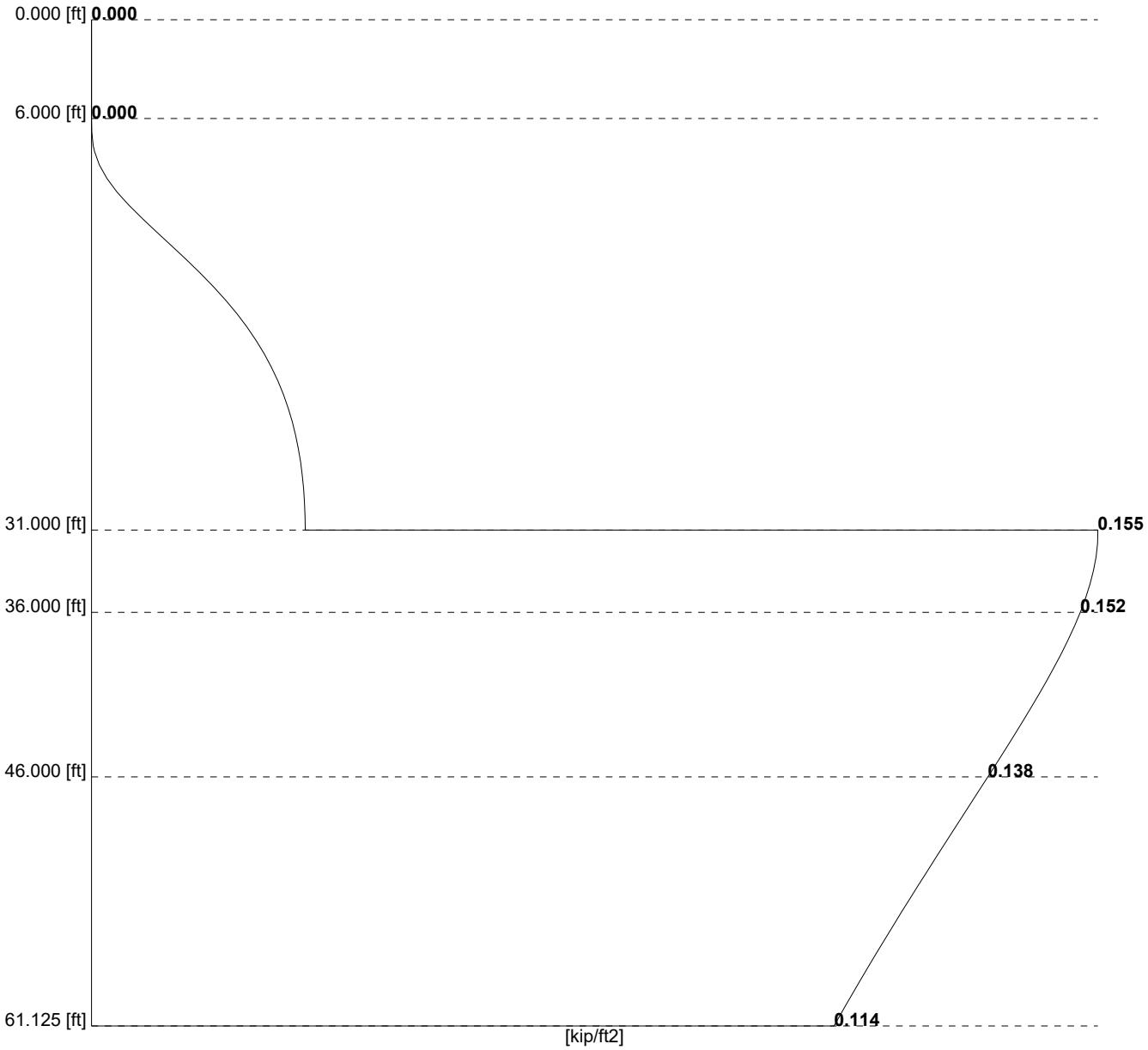
Earth Pressure Diagram



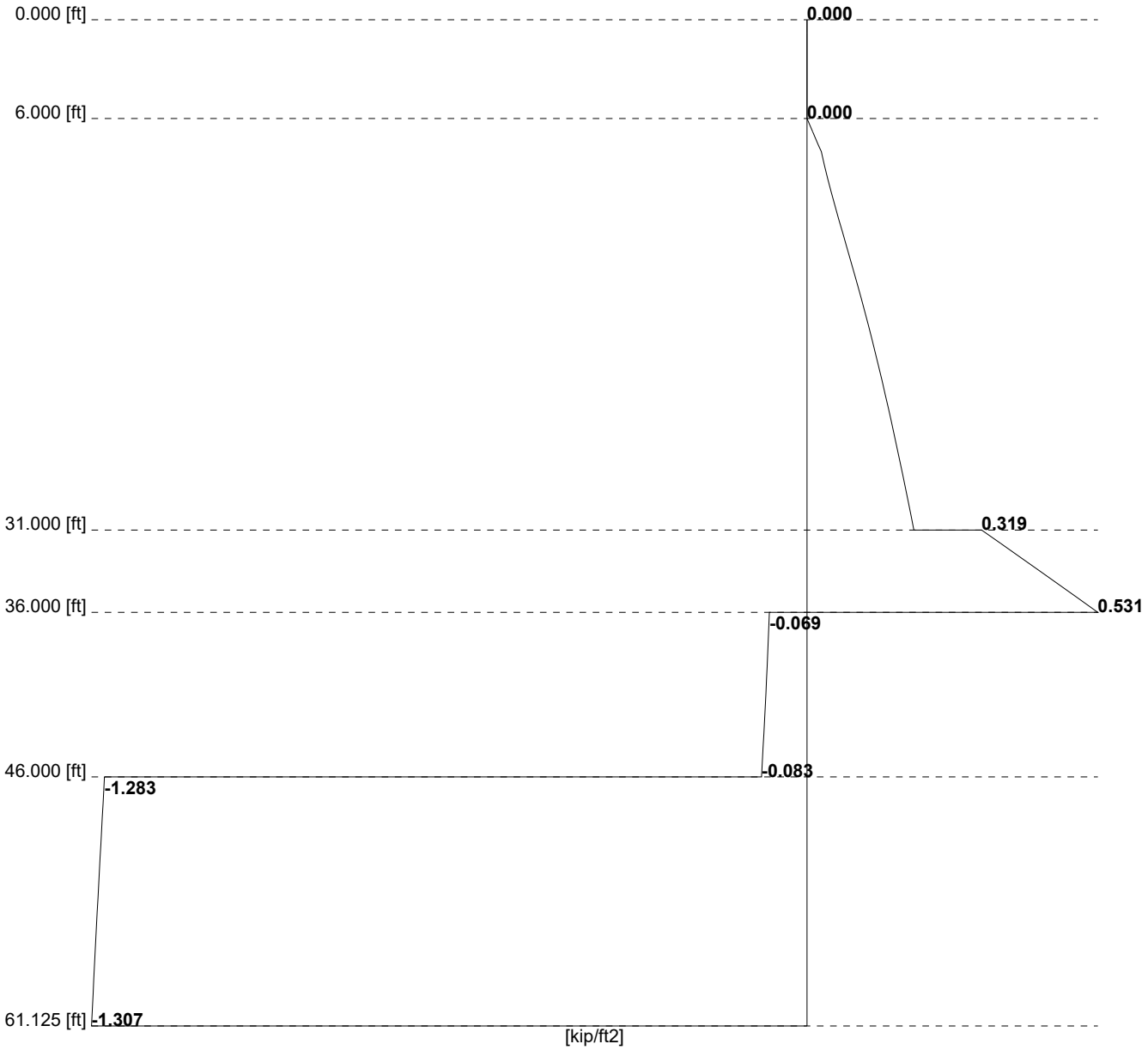
Water Pressure Diagram



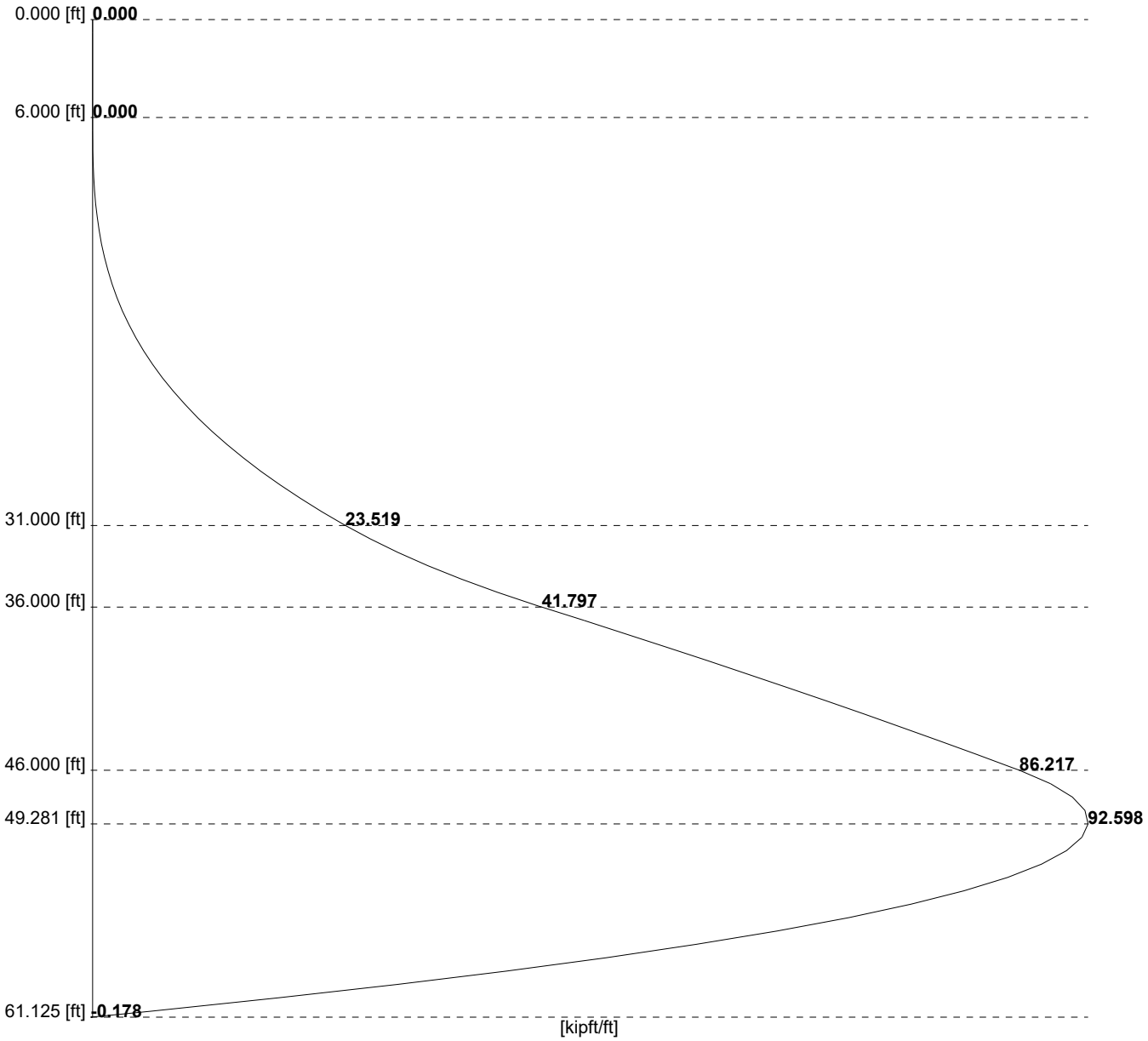
Boussinesq Diagram



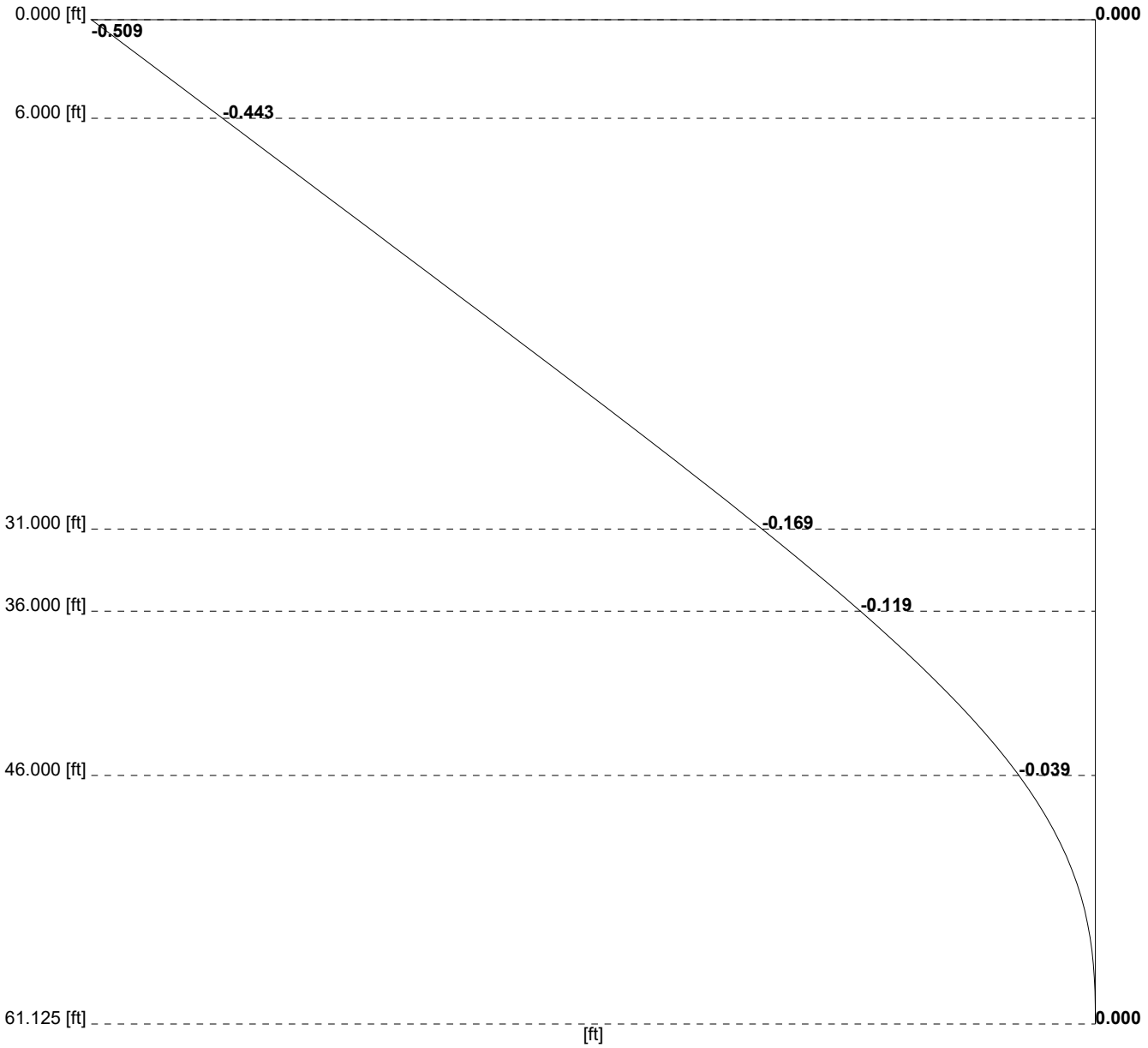
Total Pressure Diagram



Moment Diagram

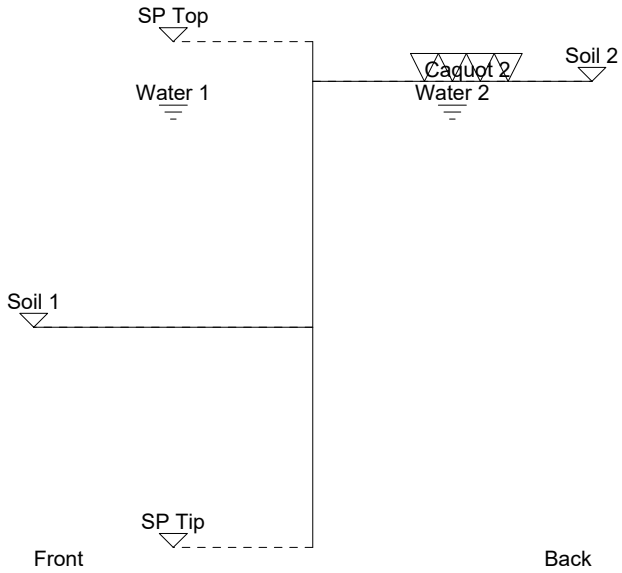


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	63.746
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.100
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

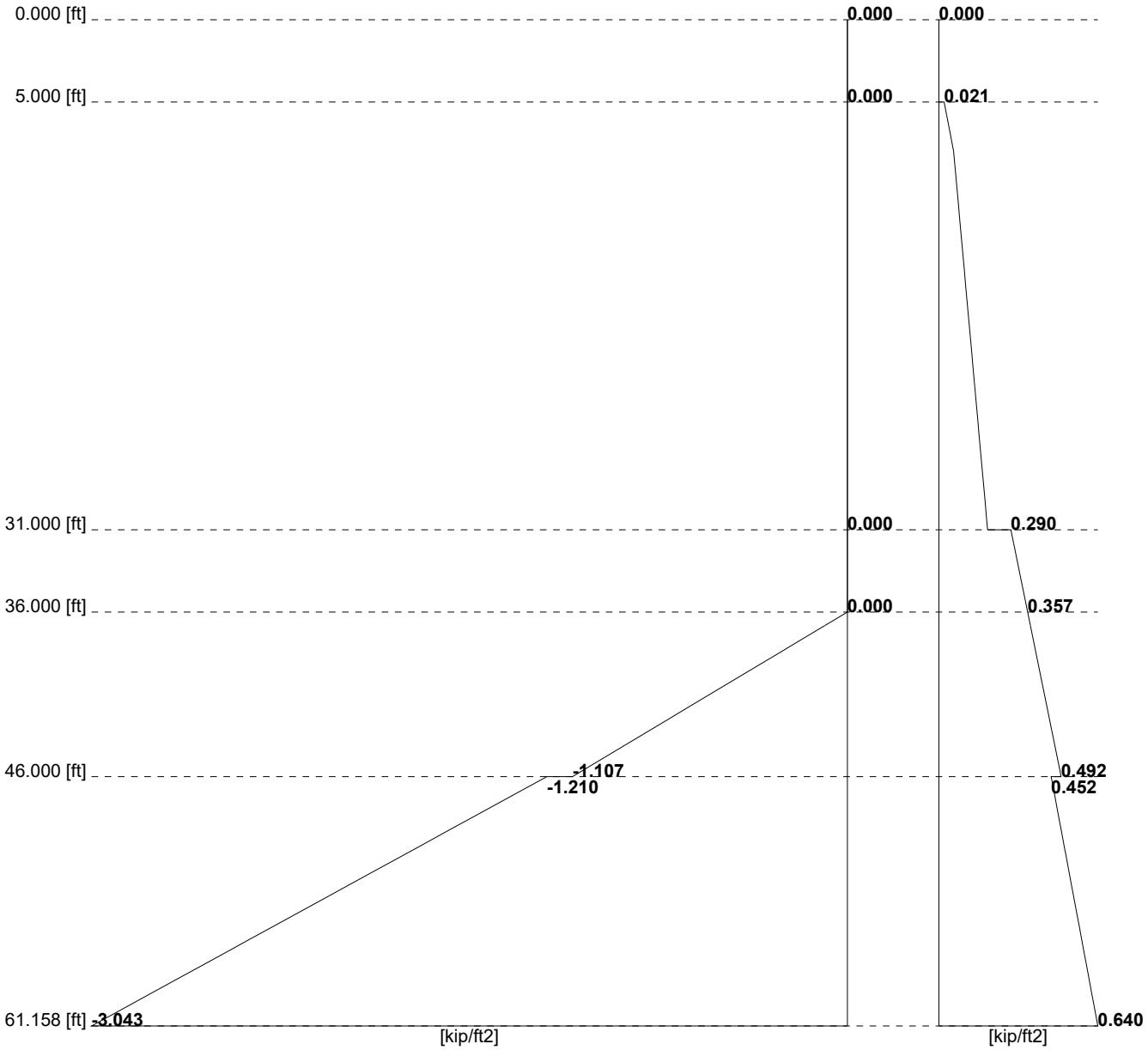
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

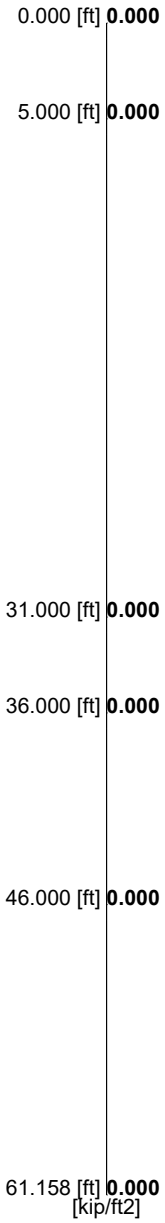
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.833	61.190
Maxmimal Moment [kipft/ft]	104.839	49.281
Normal Forces at Max. Moment [kip/ft]	-2.406	61.190
Normal Forces at Min. Moment [kip/ft]	1.190	49.281
Deflection at Min. Moment [ft]	0.000	61.190
Deflection at Max. Moment [ft]	-0.026	49.281
Min. Stress at Min. Moment [lb/in2]	-294.159	61.190
Max. Stress at Min. Moment [lb/in2]	-60.793	61.190
Min. Stress at Max. Moment [lb/in2]	-14603.918	49.281
Max. Stress at Max. Moment [lb/in2]	14779.451	49.281
Safety > Req. Safety = 1.500	3.383	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	63.746	
Sheet Pile Length [ft]	63.746	
Included OverLength [ft]	2.588	
Vertical Equilibrium [kip/ft]	3.566	
Anchor Force (horiz.) [kip/ft]	0.000	

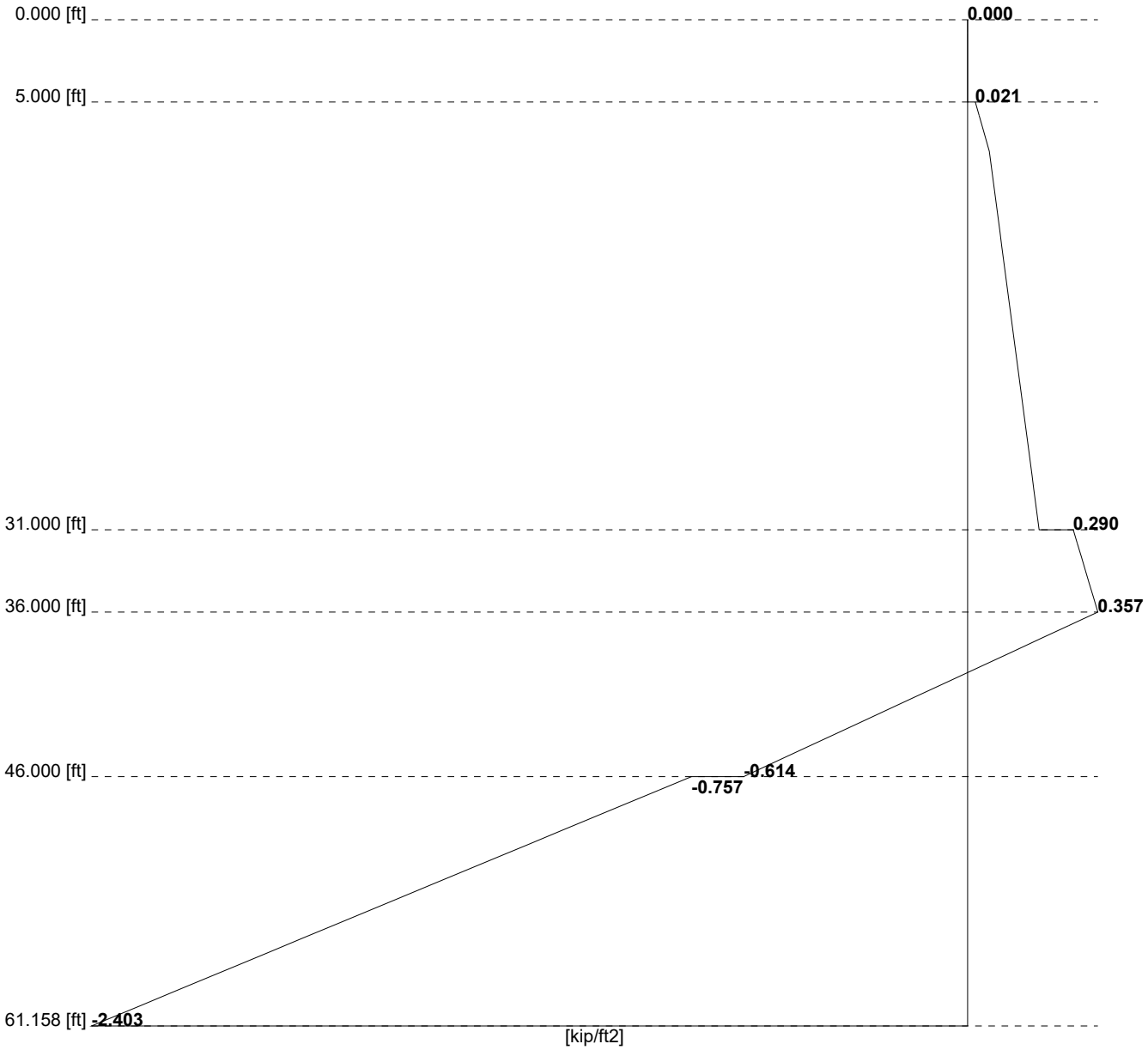
Earth Pressure Diagram



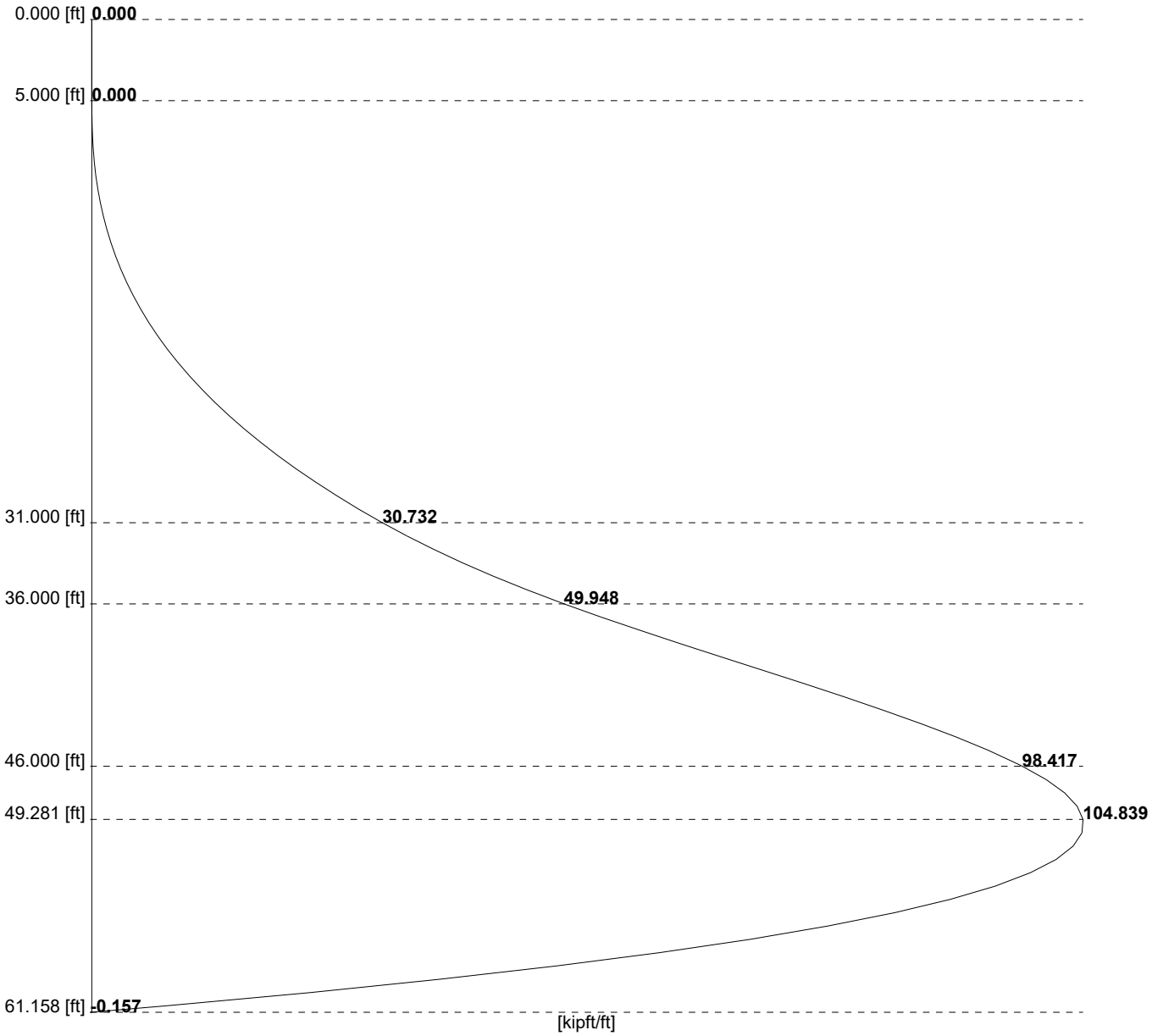
Water Pressure Diagram



Total Pressure Diagram

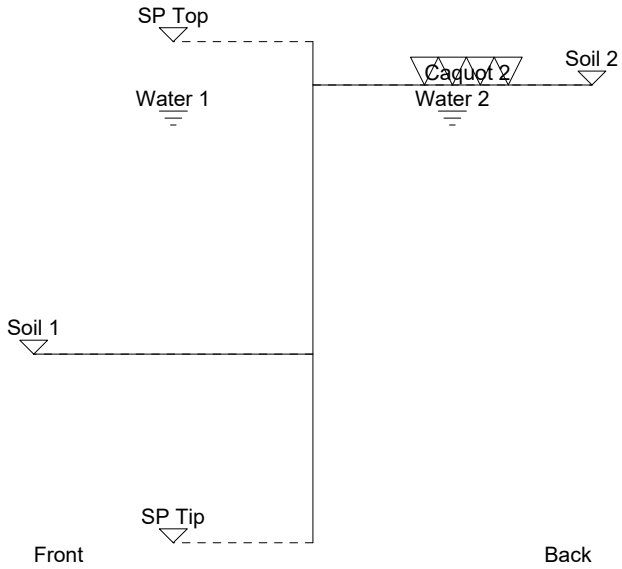


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	57.725
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.100
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

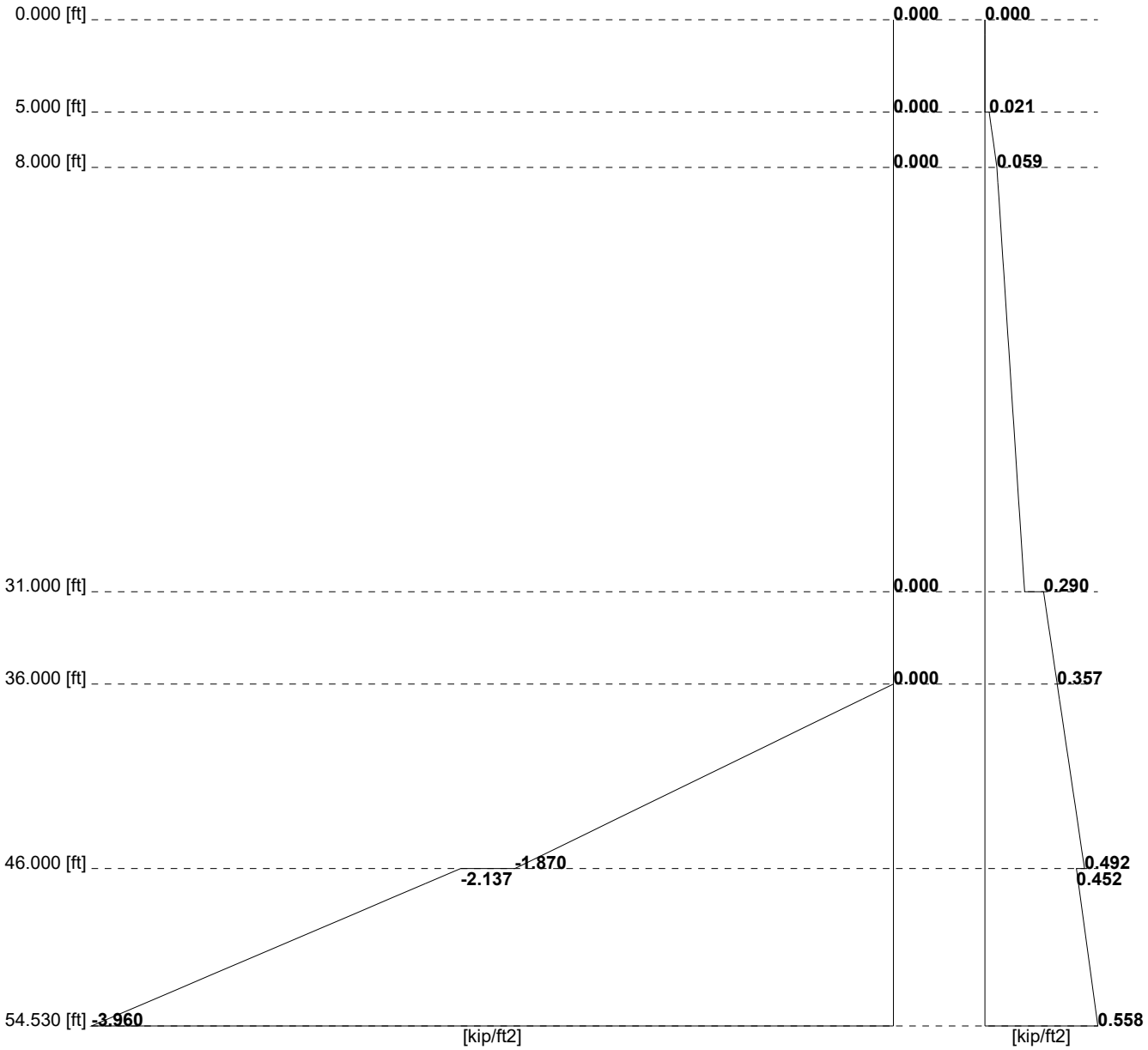
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

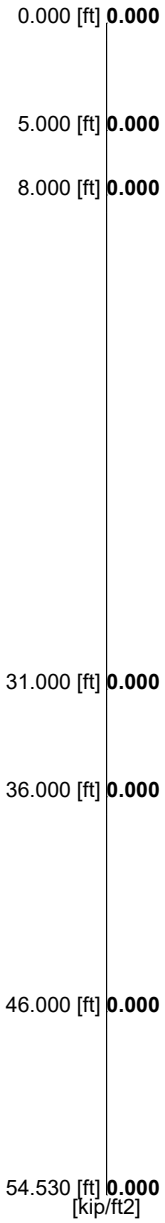
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.752	54.563
Maxmimal Moment [kipft/ft]	85.764	45.711
Normal Forces at Max. Moment [kip/ft]	-6.123	54.563
Normal Forces at Min. Moment [kip/ft]	0.230	45.711
Deflection at Min. Moment [ft]	0.000	54.563
Deflection at Max. Moment [ft]	-0.012	45.711
Min. Stress at Min. Moment [lb/in2]	-556.927	54.563
Max. Stress at Min. Moment [lb/in2]	-346.220	54.563
Min. Stress at Max. Moment [lb/in2]	-11998.442	45.711
Max. Stress at Max. Moment [lb/in2]	12032.396	45.711
Safety > Req. Safety = 1.500	4.155	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	57.725	
Sheet Pile Length [ft]	57.725	
Included OverLength [ft]	3.195	
Vertical Equilibrium [kip/ft]	0.303	
Anchor Force (horiz.) [kip/ft]	0.000	

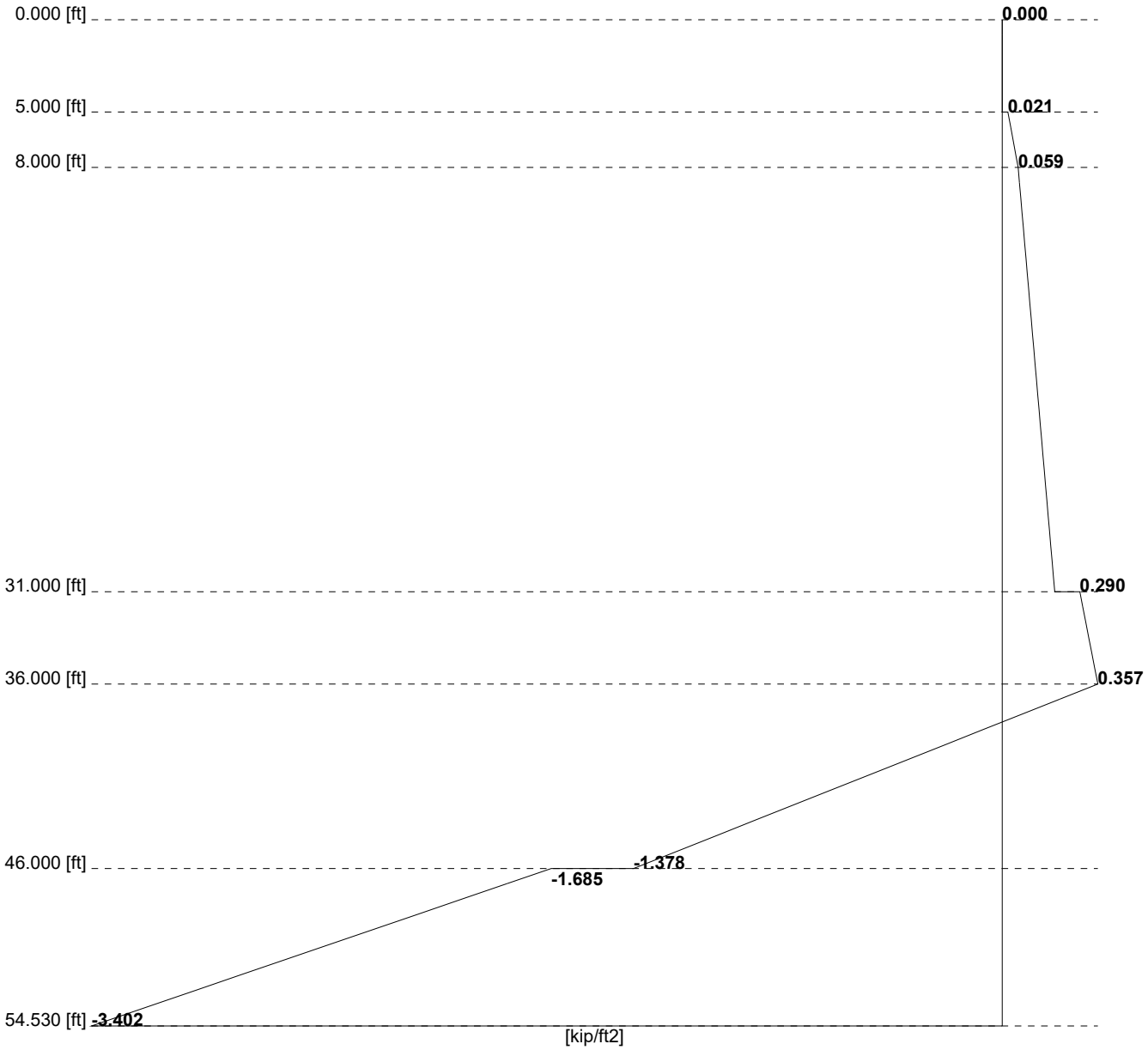
Earth Pressure Diagram



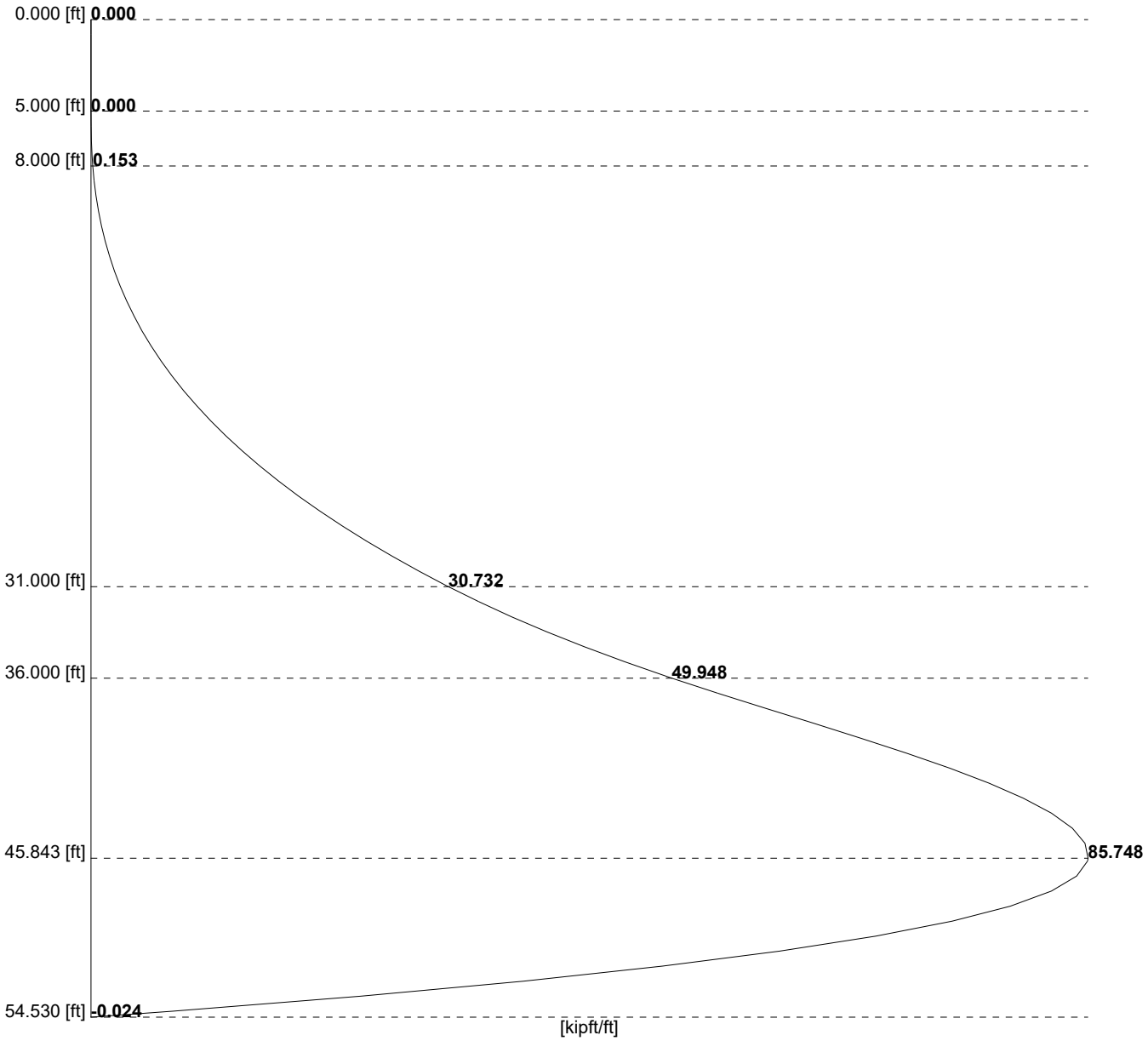
Water Pressure Diagram



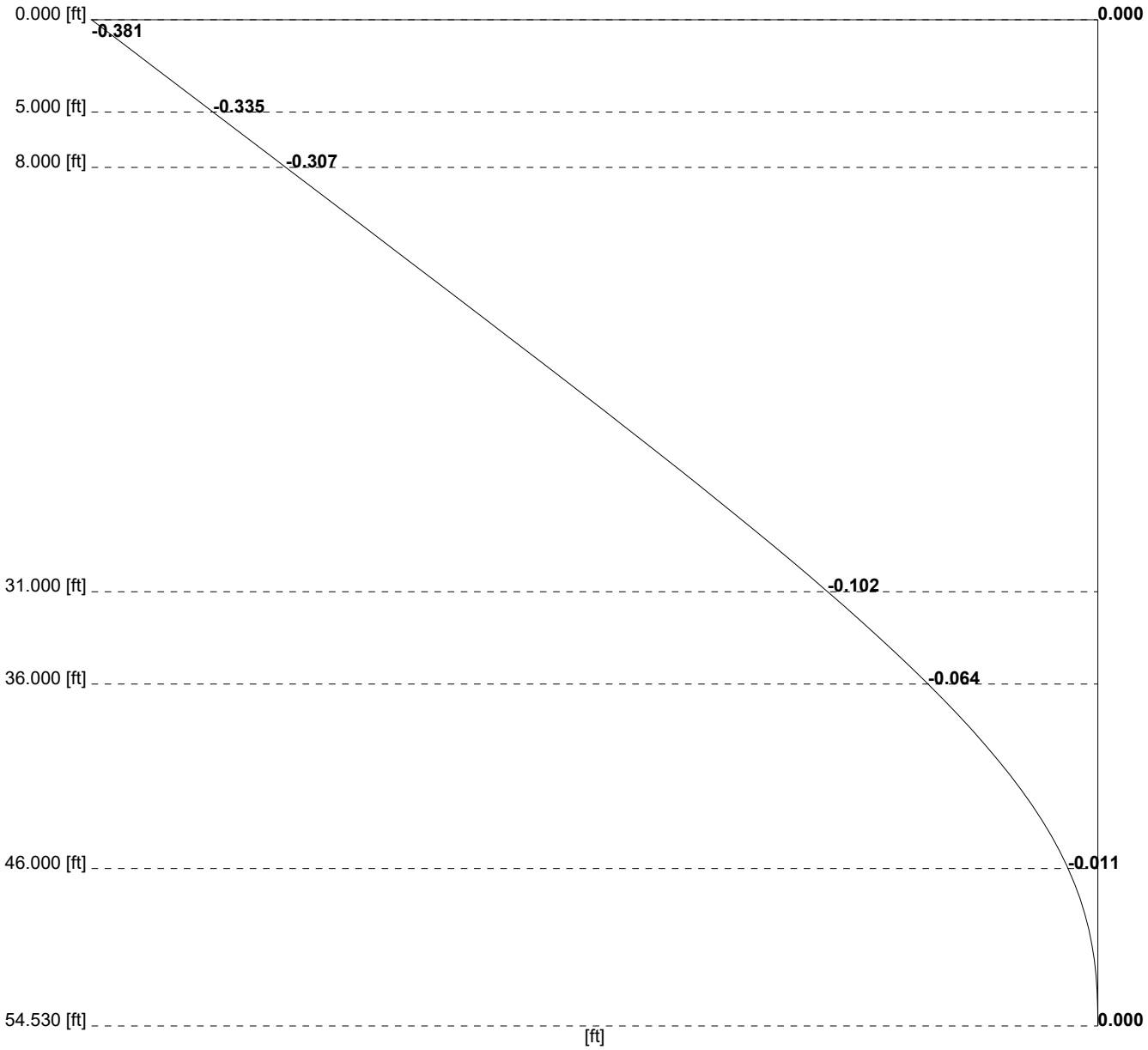
Total Pressure Diagram



Moment Diagram

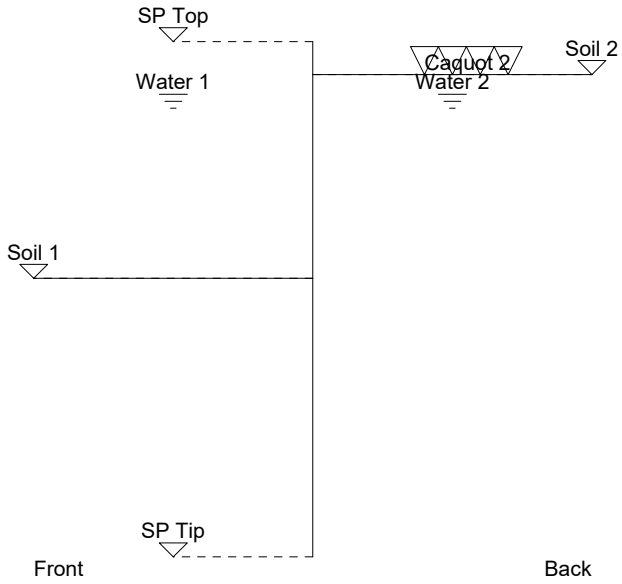


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	78.360
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.100
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

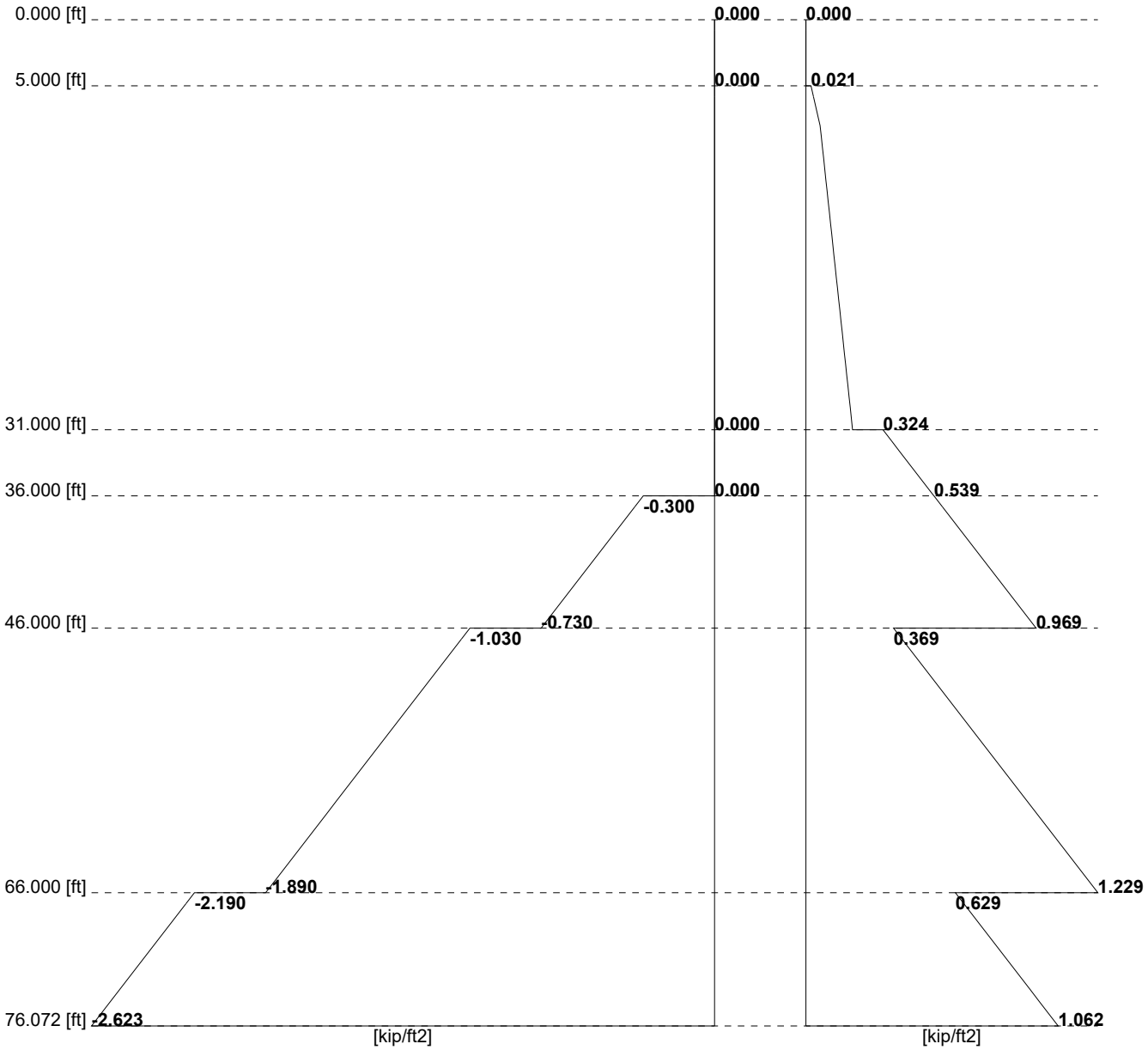
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

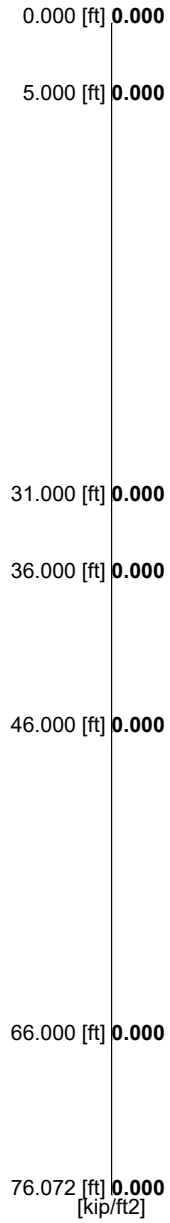
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.256	76.105
Maxmimal Moment [kipft/ft]	158.941	57.483
Normal Forces at Max. Moment [kip/ft]	1.113	76.105
Normal Forces at Min. Moment [kip/ft]	1.113	57.483
Deflection at Min. Moment [ft]	0.000	76.105
Deflection at Max. Moment [ft]	-0.094	57.483
Min. Stress at Min. Moment [lb/in2]	-93.842	76.105
Max. Stress at Min. Moment [lb/in2]	258.068	76.105
Min. Stress at Max. Moment [lb/in2]	-22199.475	57.483
Max. Stress at Max. Moment [lb/in2]	22363.699	57.483
Safety > Req. Safety = 1.500	2.236	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	78.360	
Sheet Pile Length [ft]	78.360	
Included OverLength [ft]	2.288	
Vertical Equilibrium [kip/ft]	1.113	
Anchor Force (horiz.) [kip/ft]	0.000	

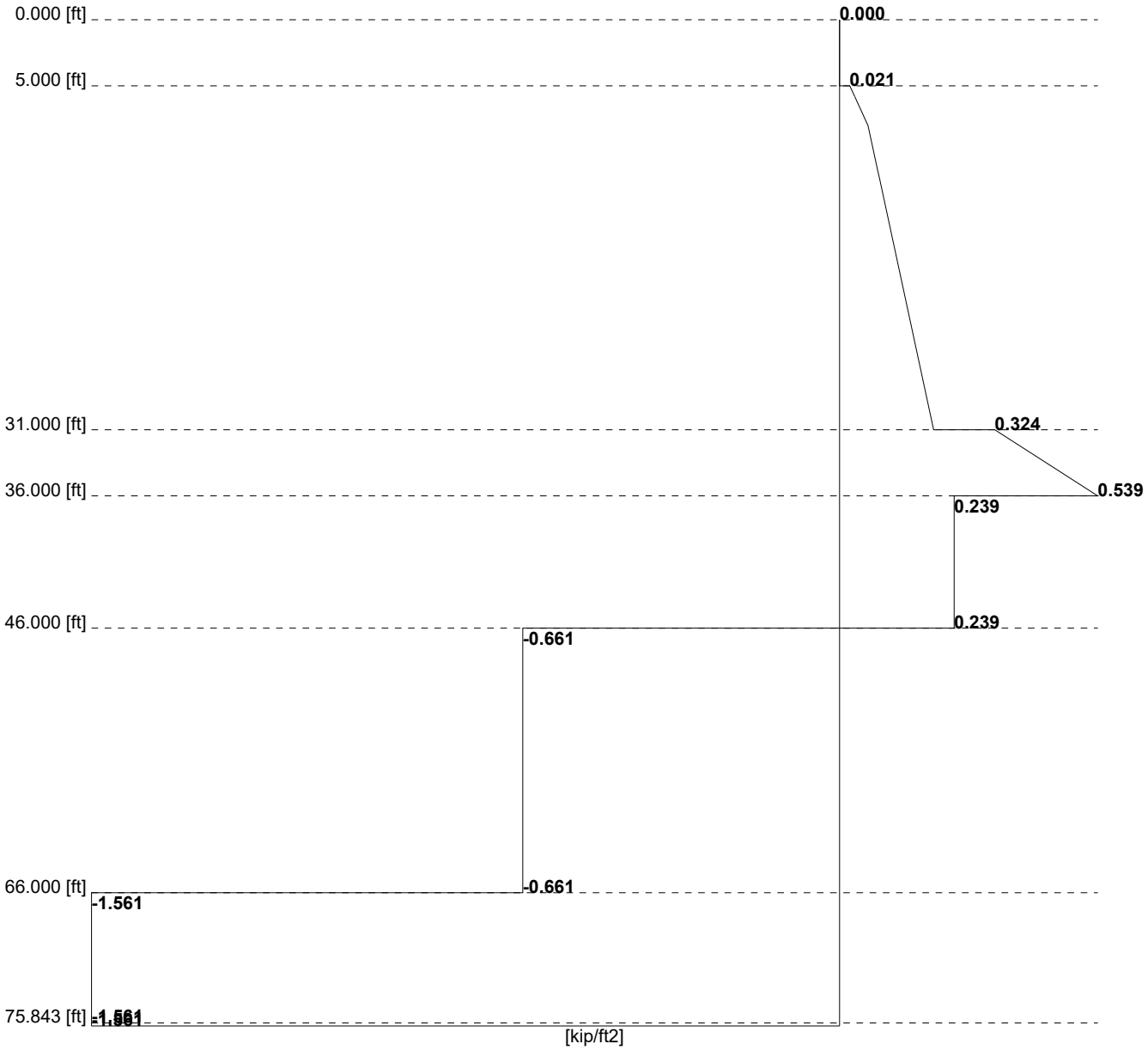
Earth Pressure Diagram



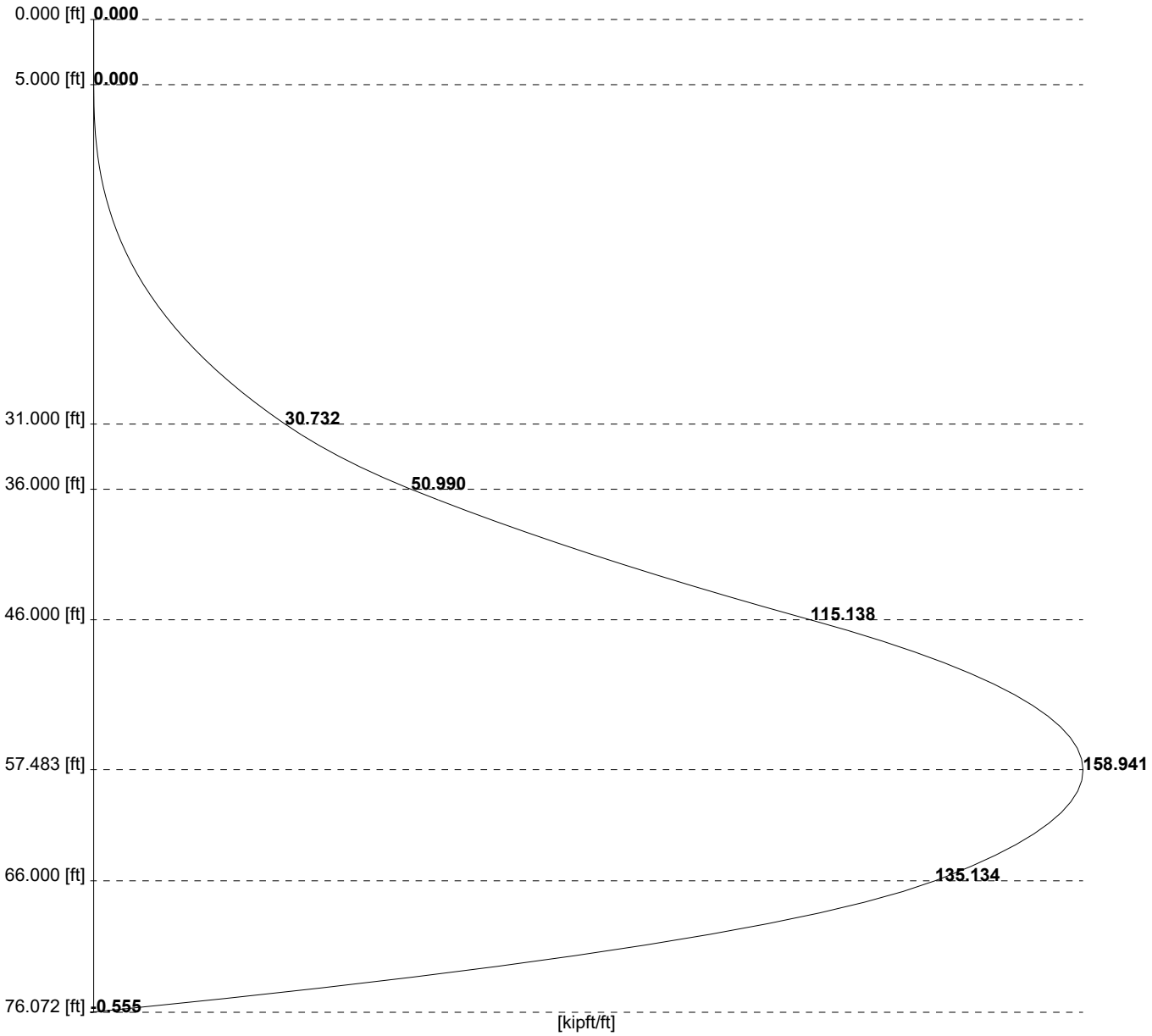
Water Pressure Diagram



Total Pressure Diagram

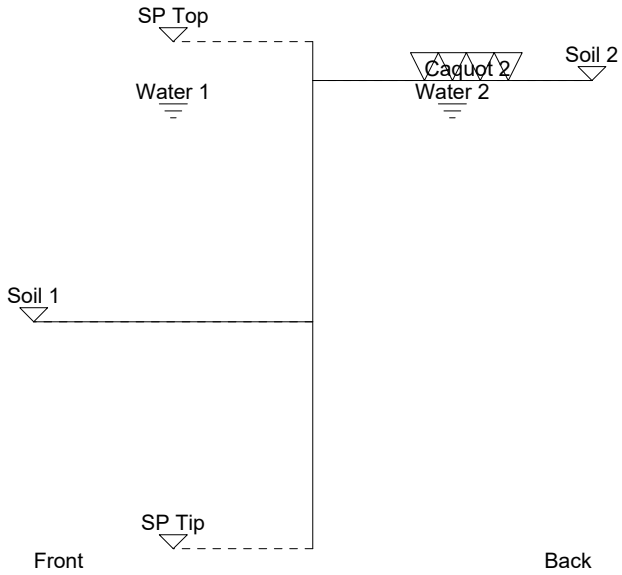


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	65.171
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.100
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

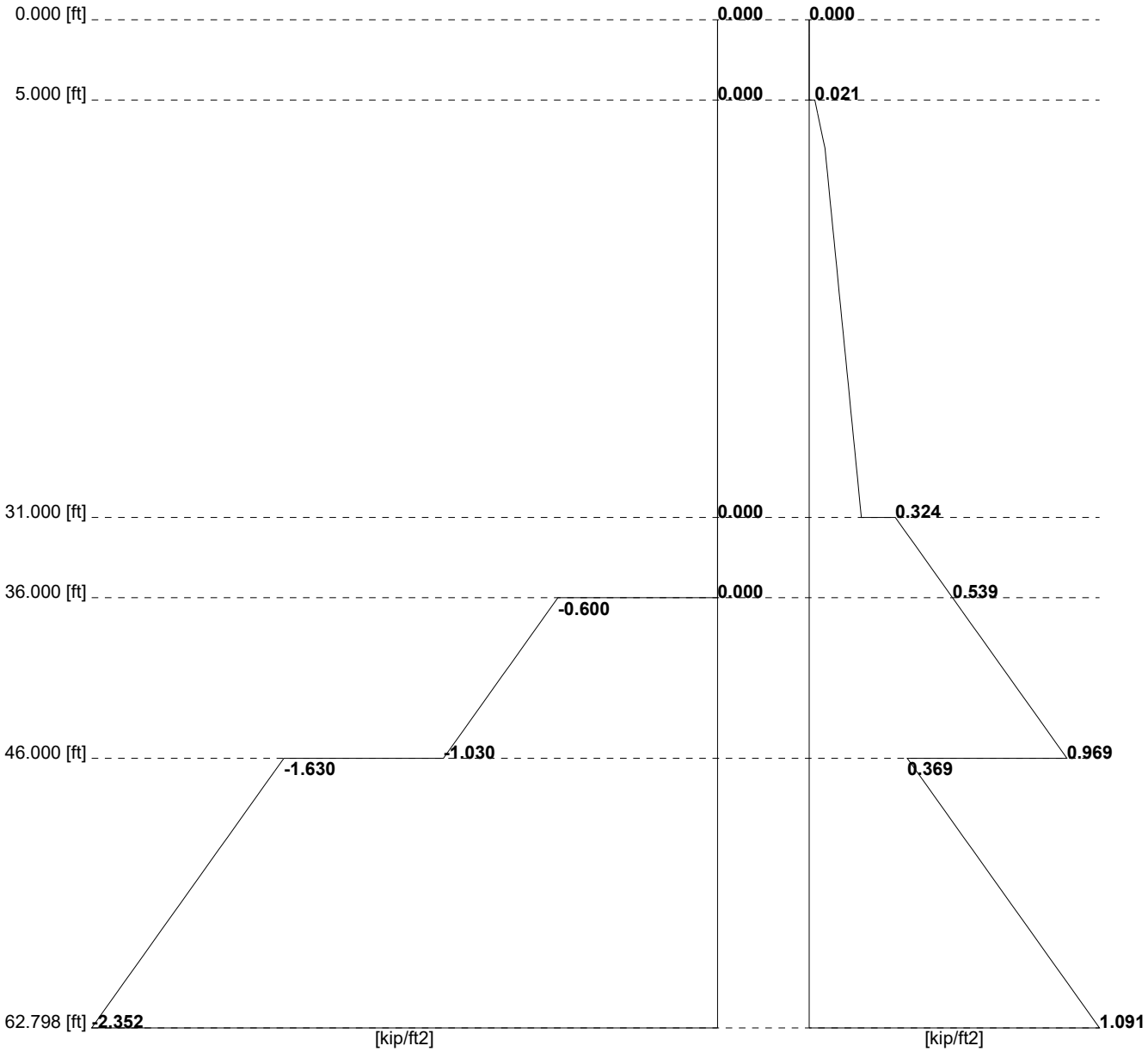
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

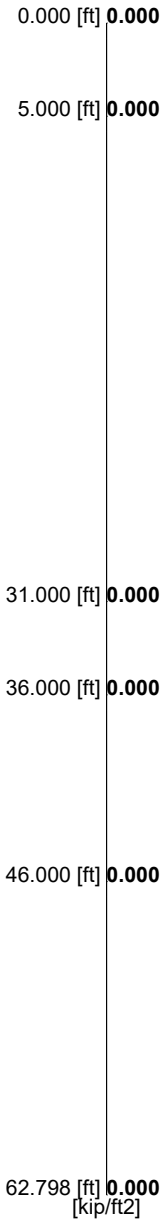
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.880	62.831
Maxmimal Moment [kipft/ft]	108.476	49.281
Normal Forces at Max. Moment [kip/ft]	1.113	62.831
Normal Forces at Min. Moment [kip/ft]	1.113	49.281
Deflection at Min. Moment [ft]	0.000	62.831
Deflection at Max. Moment [ft]	-0.033	49.281
Min. Stress at Min. Moment [lb/in2]	-41.184	62.831
Max. Stress at Min. Moment [lb/in2]	205.411	62.831
Min. Stress at Max. Moment [lb/in2]	-15119.845	49.281
Max. Stress at Max. Moment [lb/in2]	15284.070	49.281
Safety > Req. Safety = 1.500	3.271	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	65.171	
Sheet Pile Length [ft]	65.171	
Included OverLength [ft]	2.373	
Vertical Equilibrium [kip/ft]	1.113	
Anchor Force (horiz.) [kip/ft]	0.000	

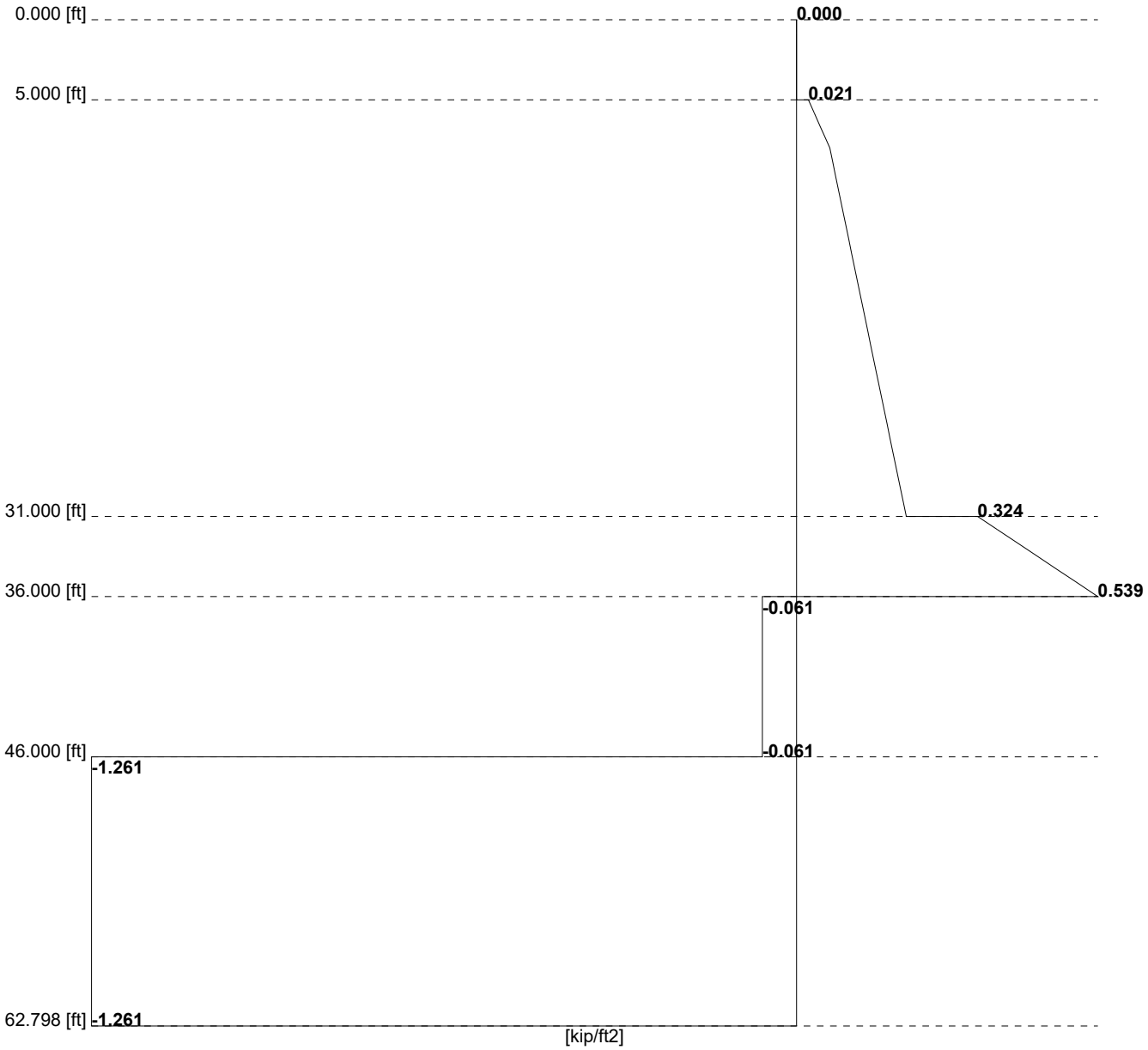
Earth Pressure Diagram



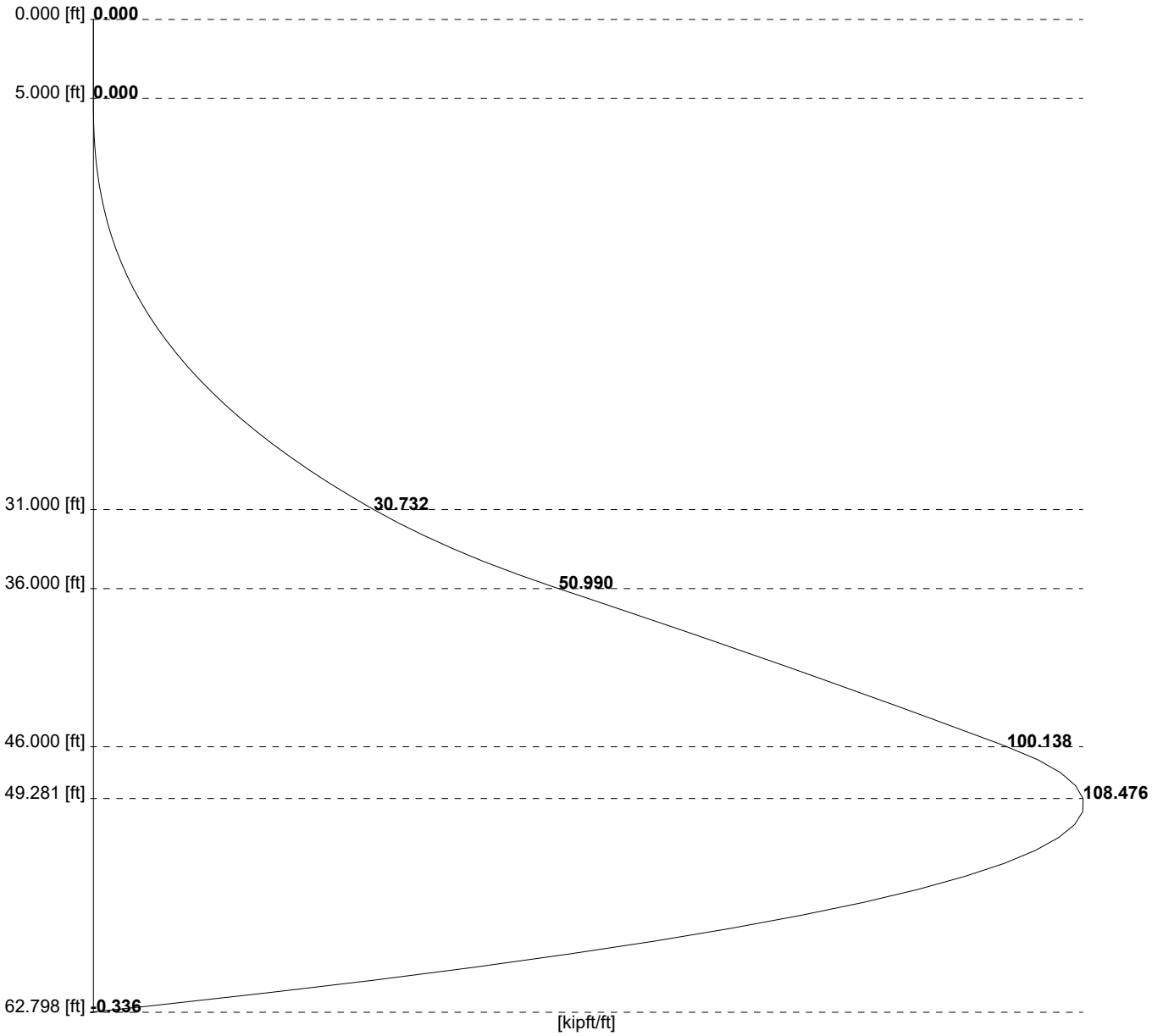
Water Pressure Diagram



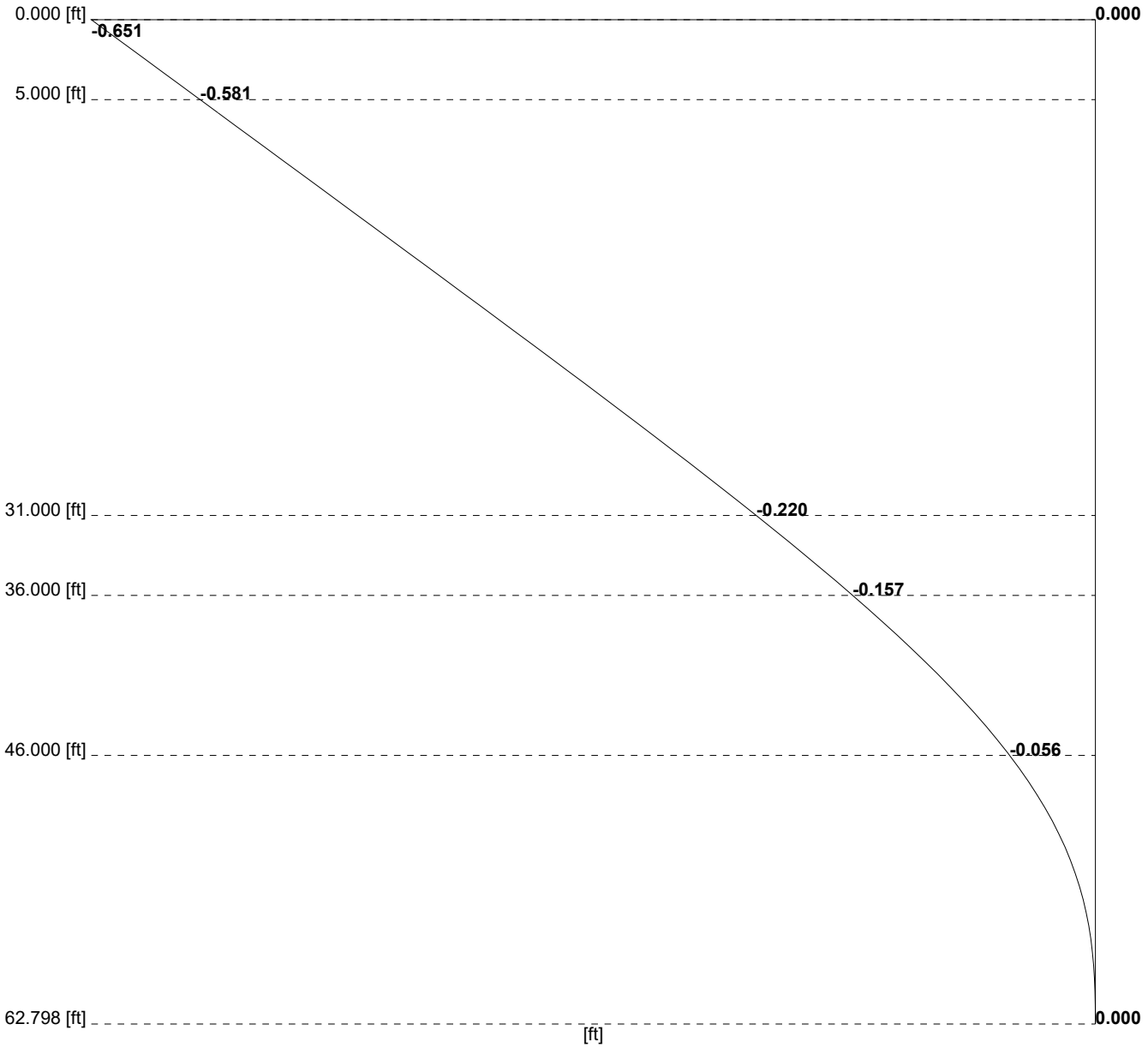
Total Pressure Diagram



Moment Diagram

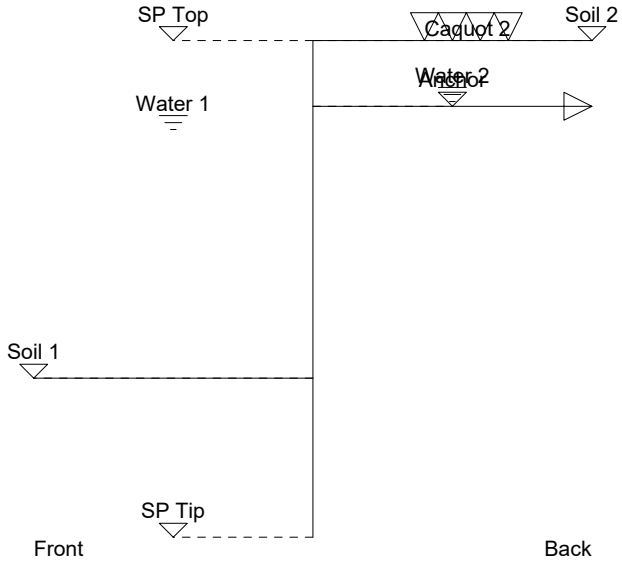


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	52.955
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

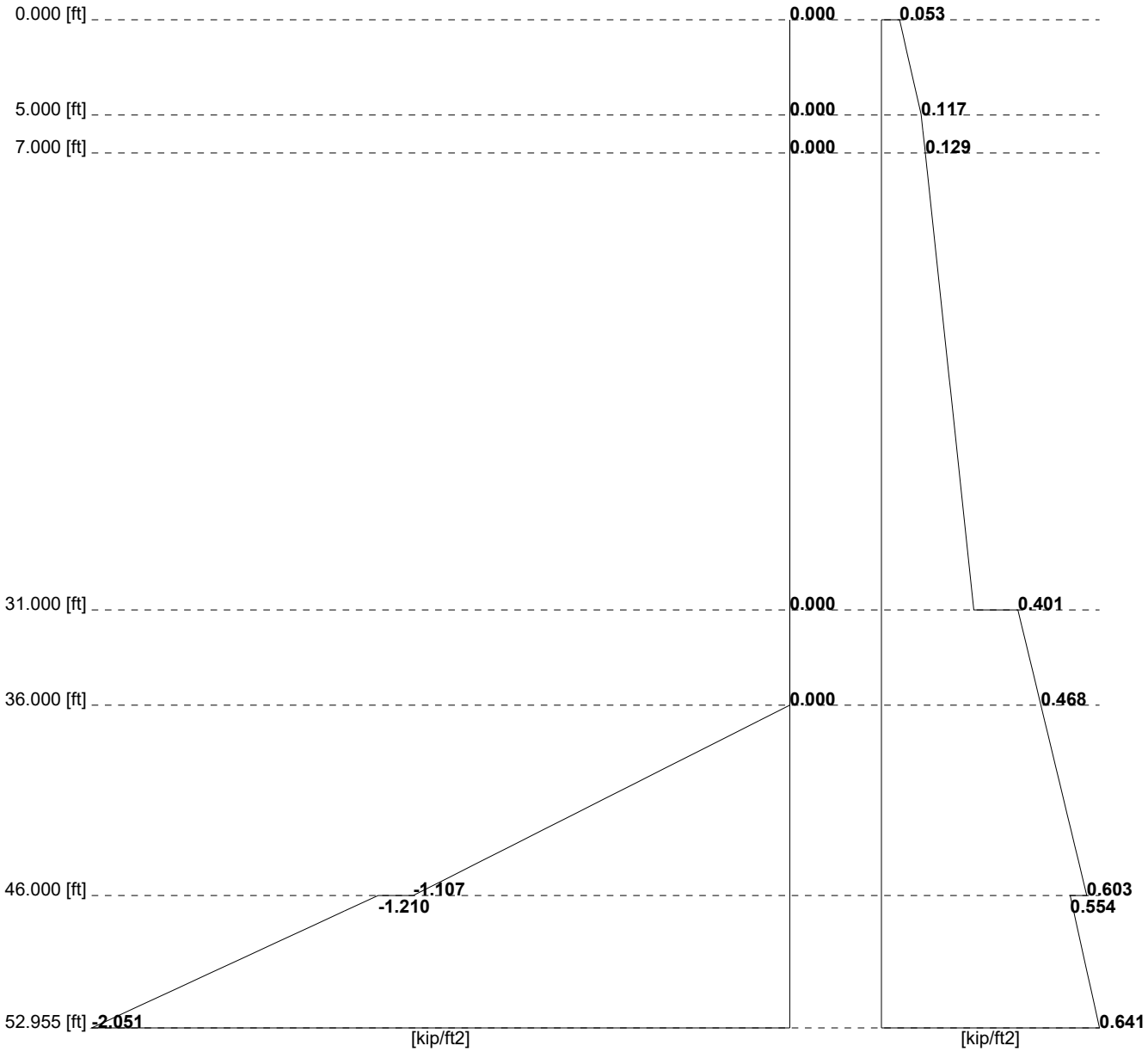
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

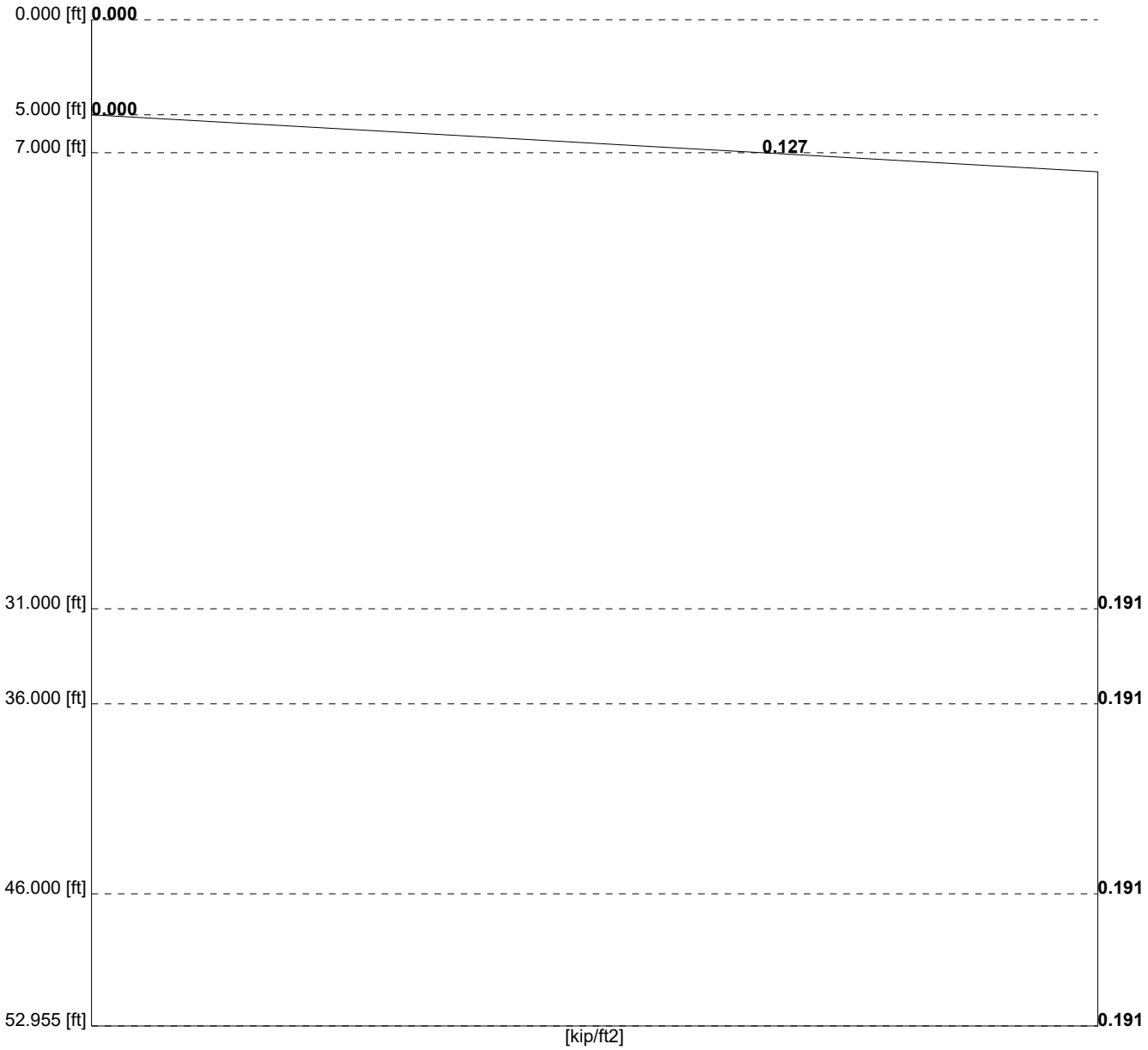
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-94.800	28.505
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.750	28.505
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.109	28.505
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-13178.525	28.505
Max. Stress at Min. Moment [lb/in2]	13436.702	28.505
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	3.721	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	52.955	
Sheet Pile Length [ft]	52.955	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.922	
Anchor Force (horiz.) [kip/ft]	-9.168	

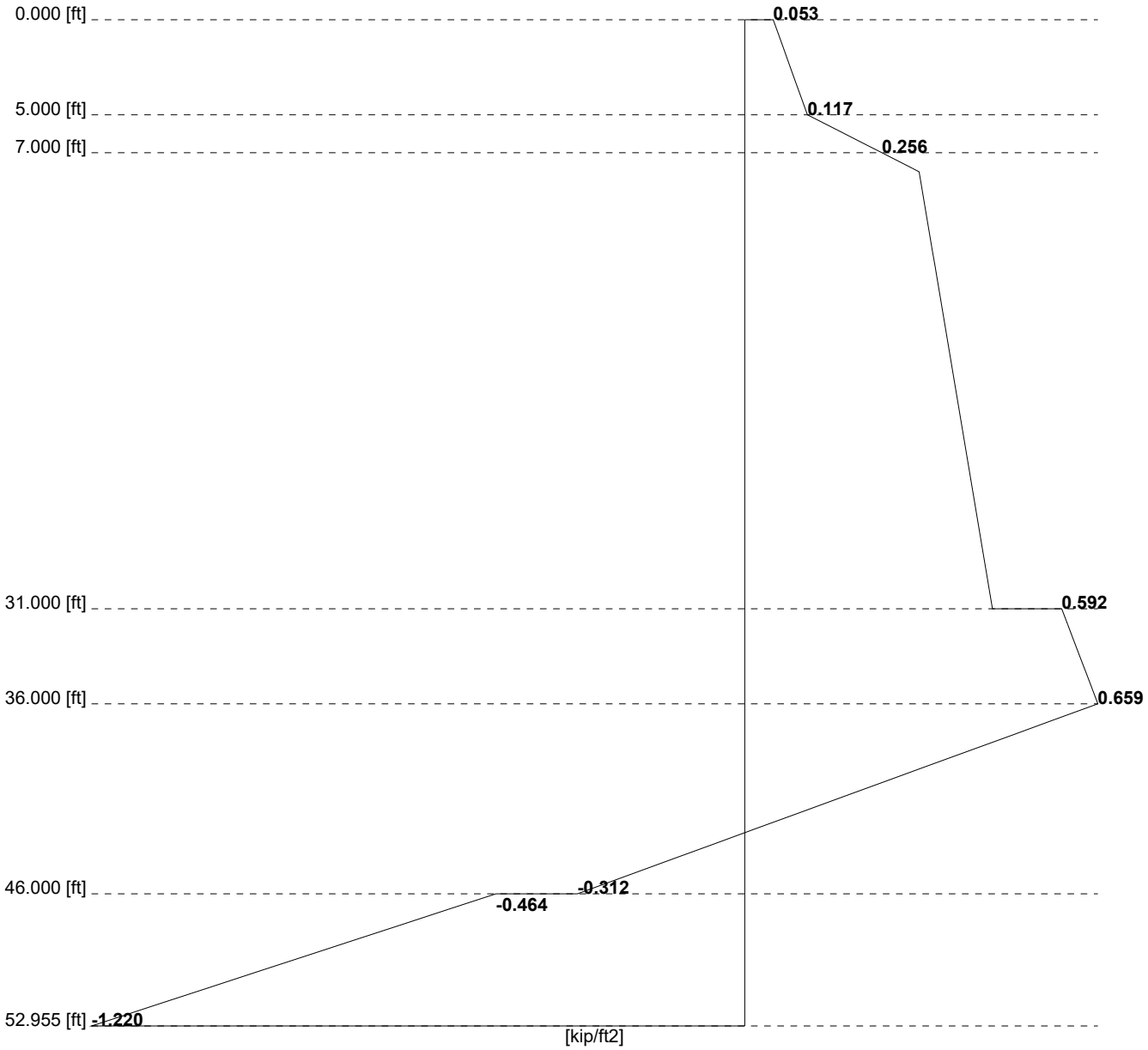
Earth Pressure Diagram



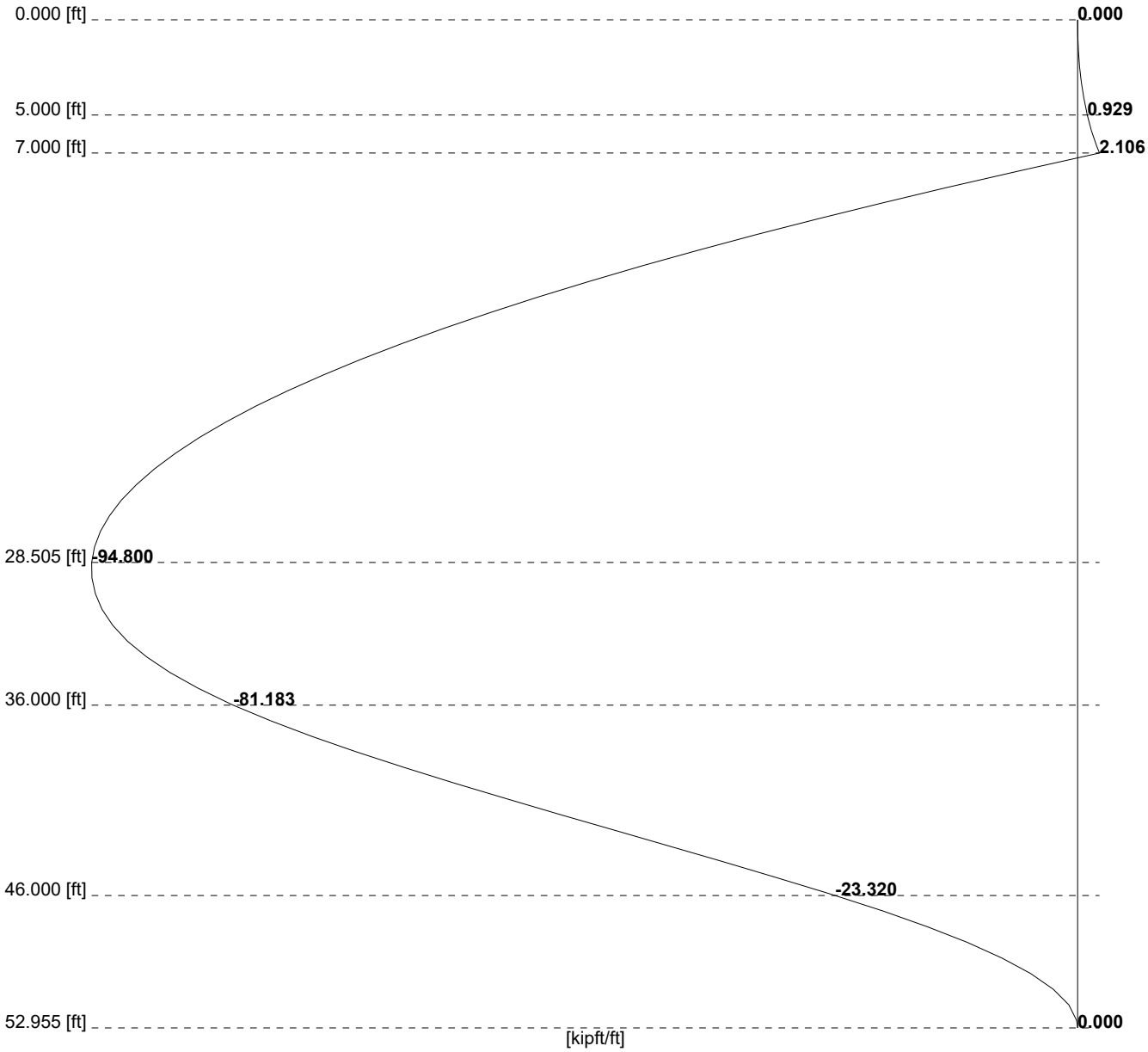
Water Pressure Diagram



Total Pressure Diagram

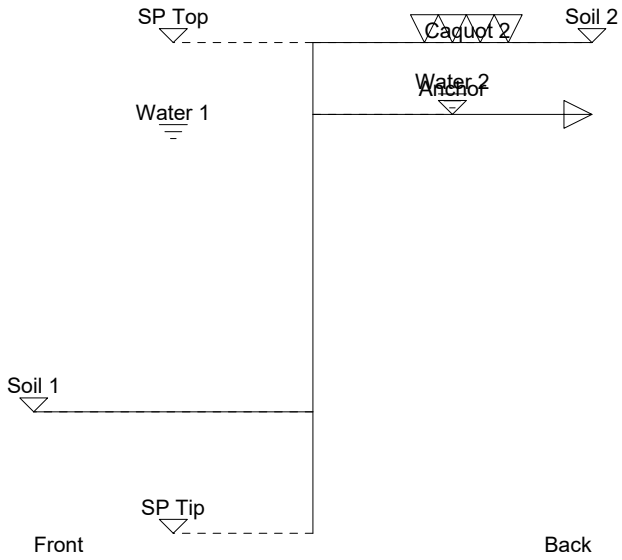


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	47.837
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

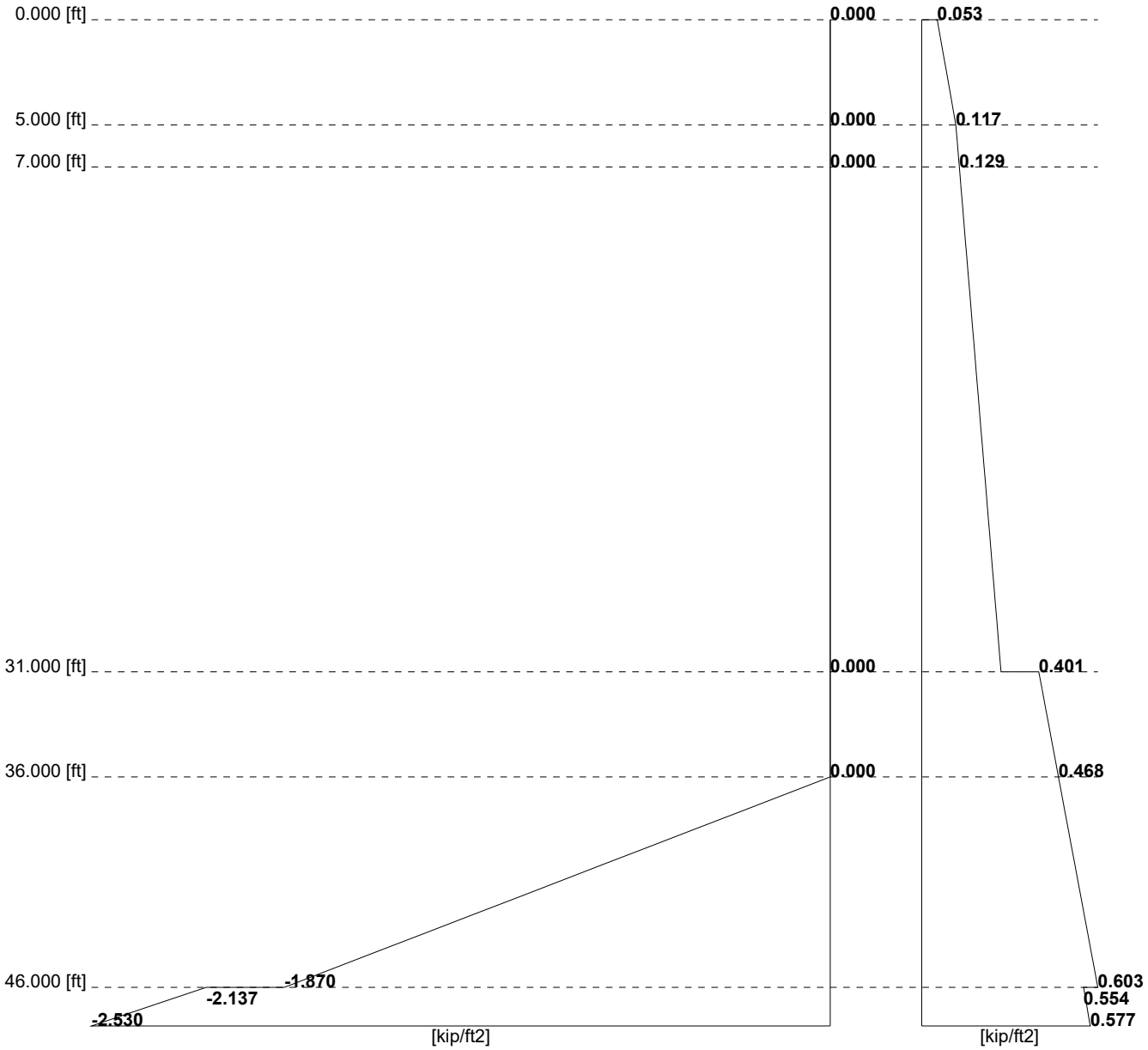
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

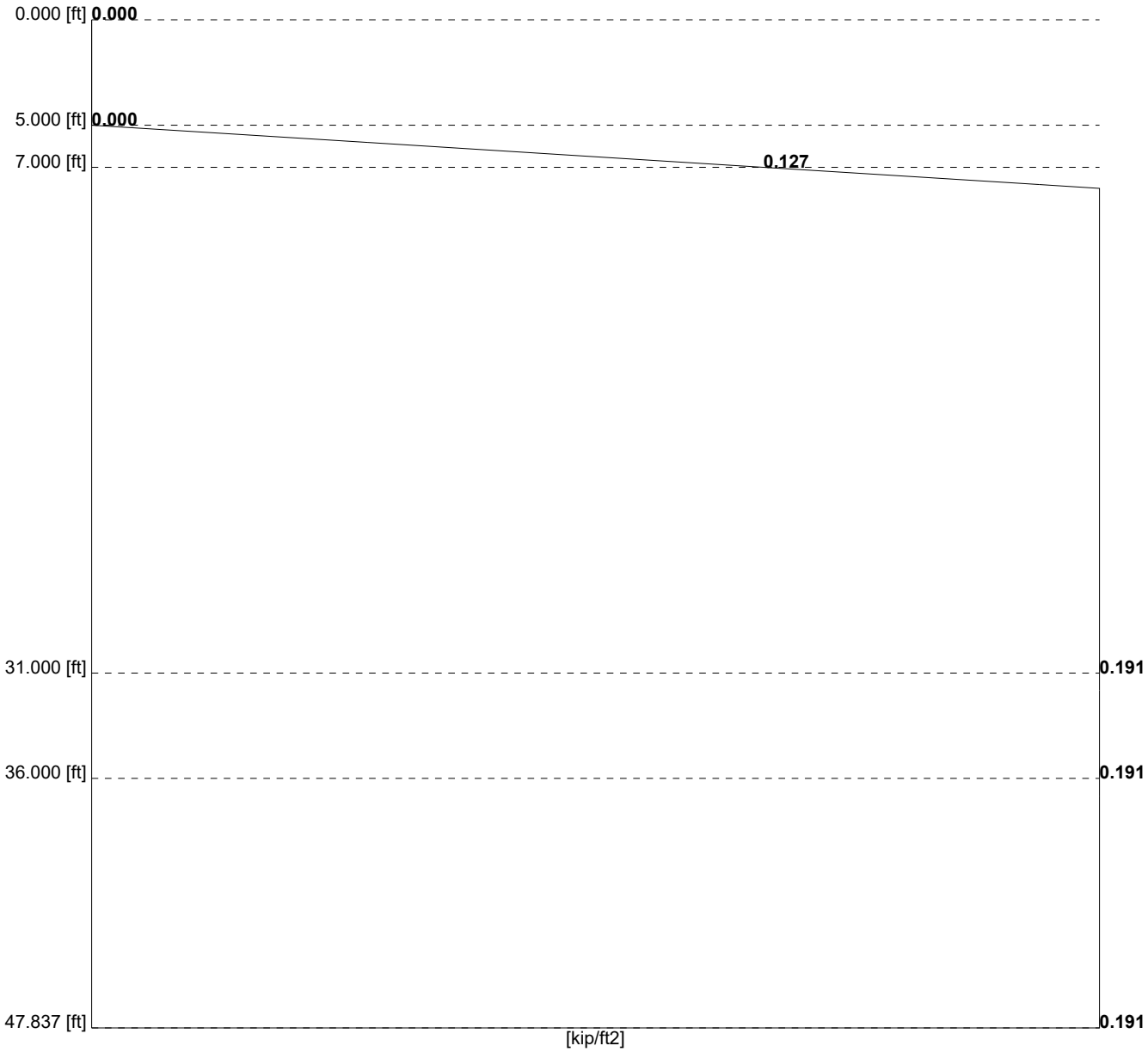
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-76.989	26.865
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.600	26.865
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.071	26.865
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-10683.676	26.865
Max. Stress at Min. Moment [lb/in2]	10919.704	26.865
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	4.579	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	47.837	
Sheet Pile Length [ft]	47.837	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.558	
Anchor Force (horiz.) [kip/ft]	-8.314	

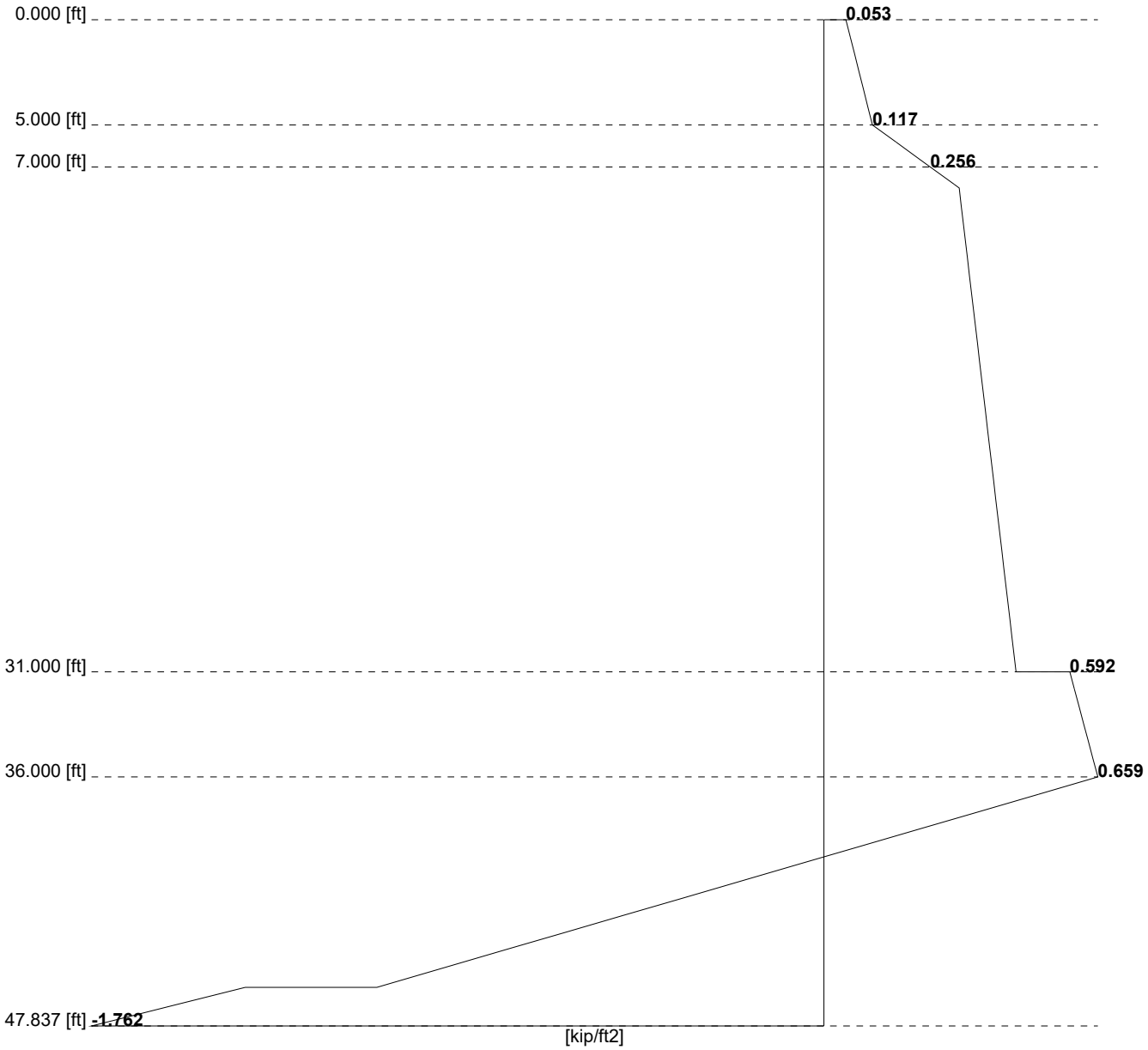
Earth Pressure Diagram



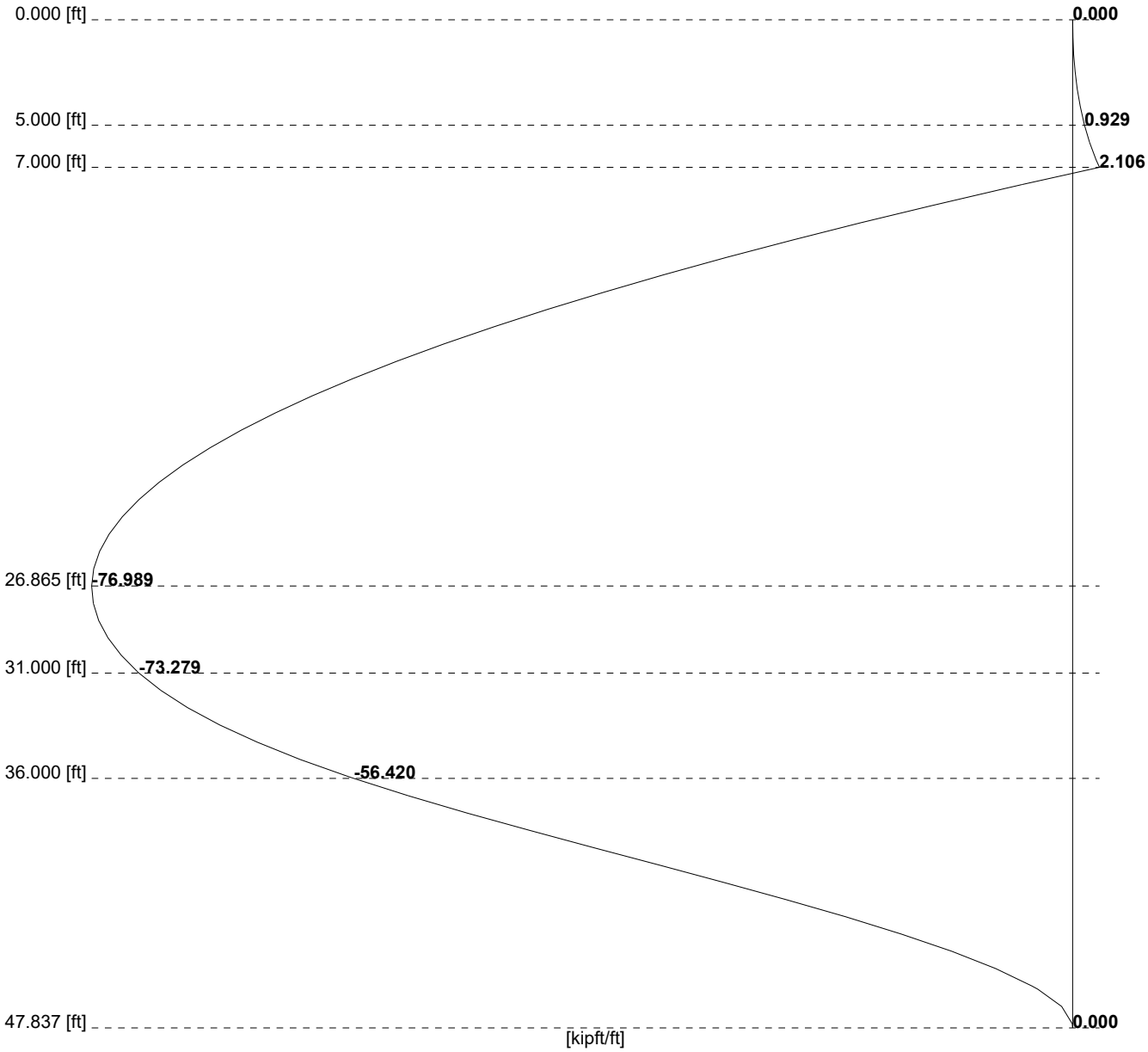
Water Pressure Diagram



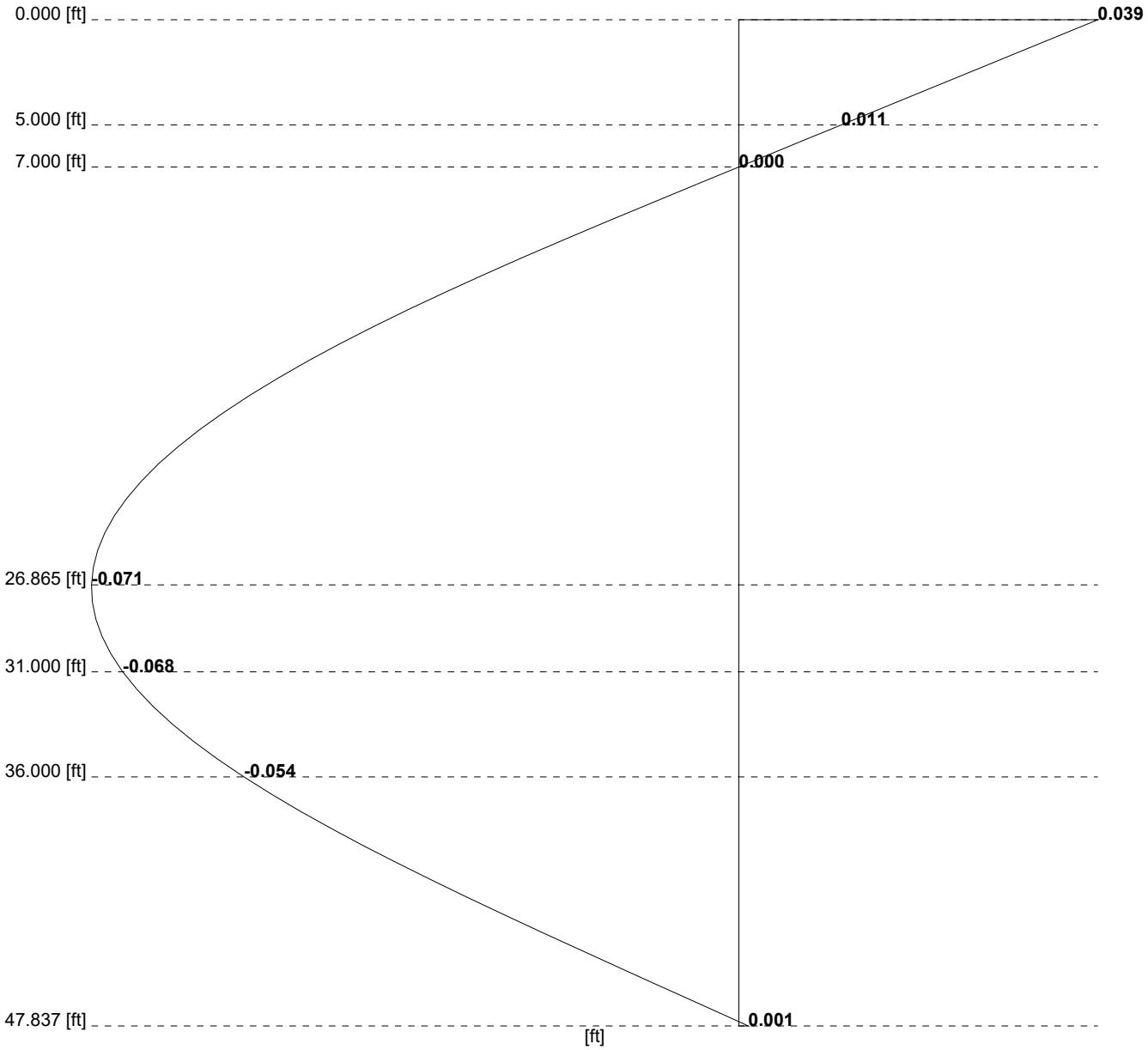
Total Pressure Diagram



Moment Diagram

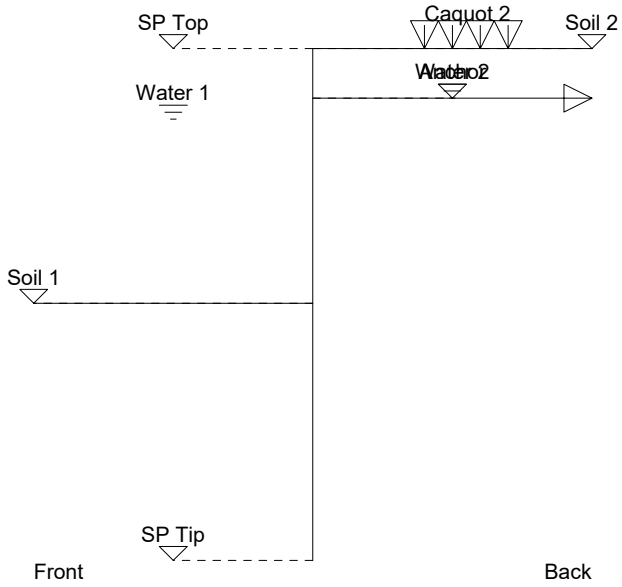


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	72.332
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

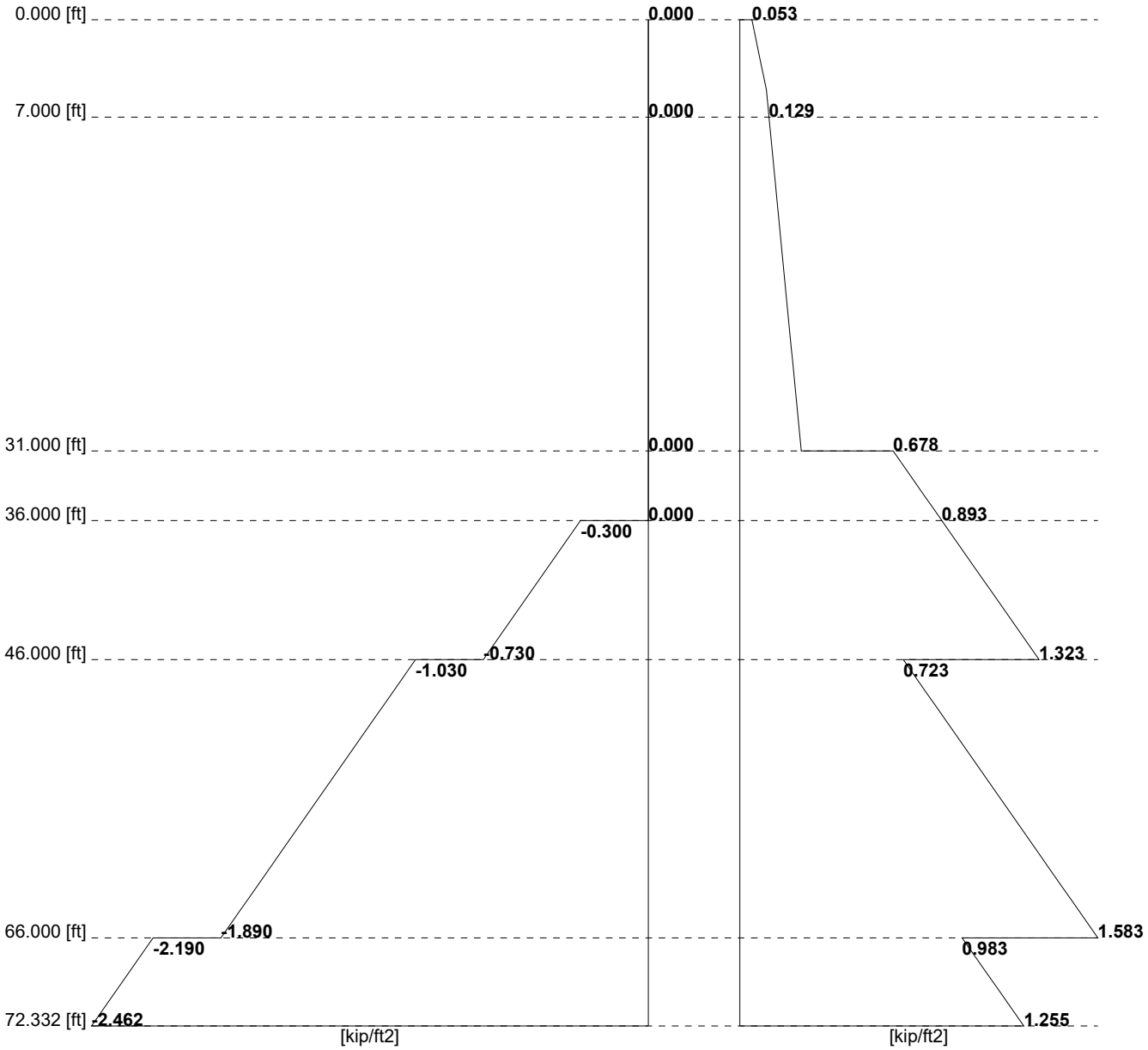
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

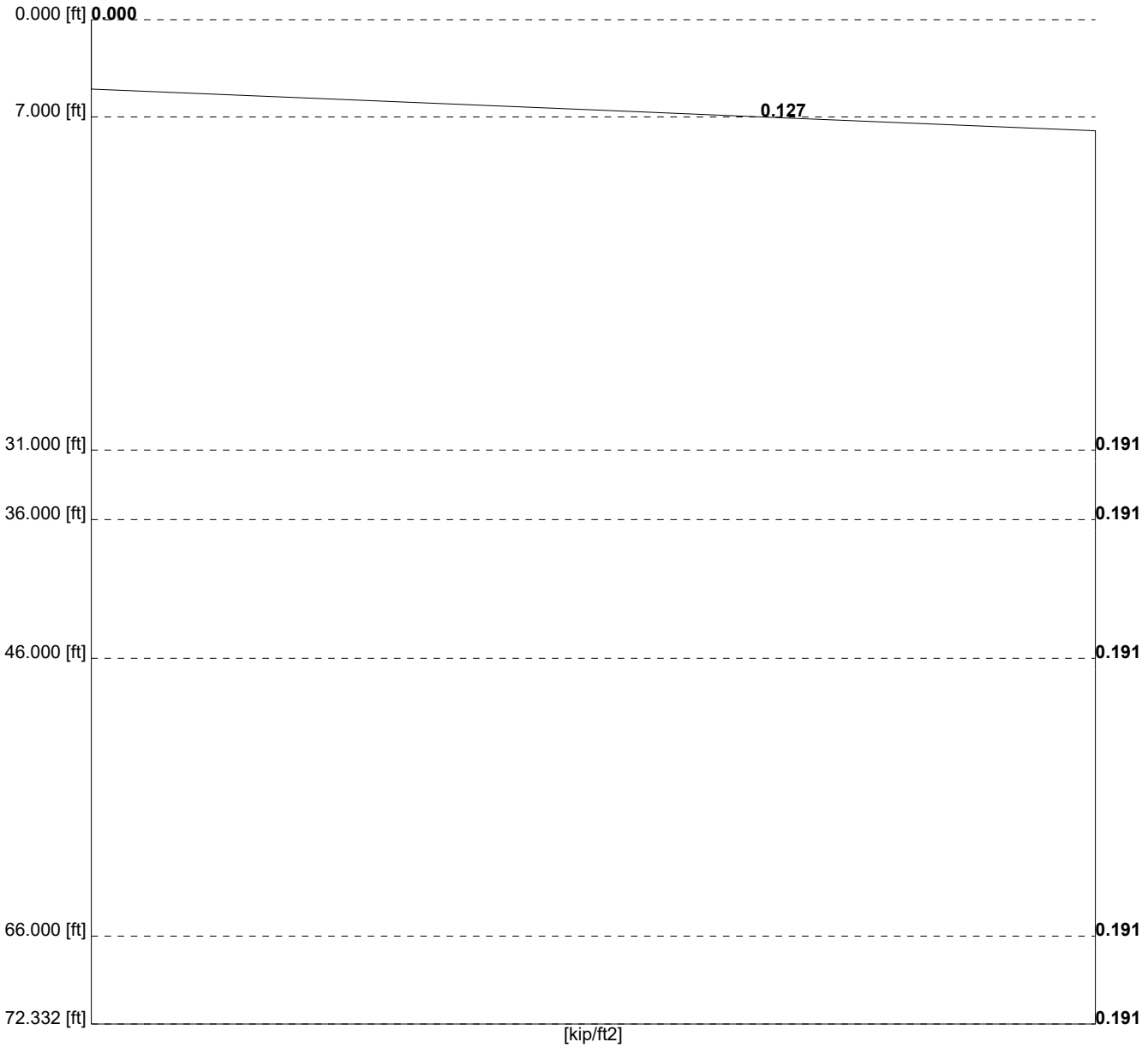
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-220.992	35.101
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.990	35.101
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.478	35.101
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-30946.264	35.101
Max. Stress at Min. Moment [lb/in2]	31239.766	35.101
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	1.601	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	72.332	
Sheet Pile Length [ft]	72.332	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-14.116	

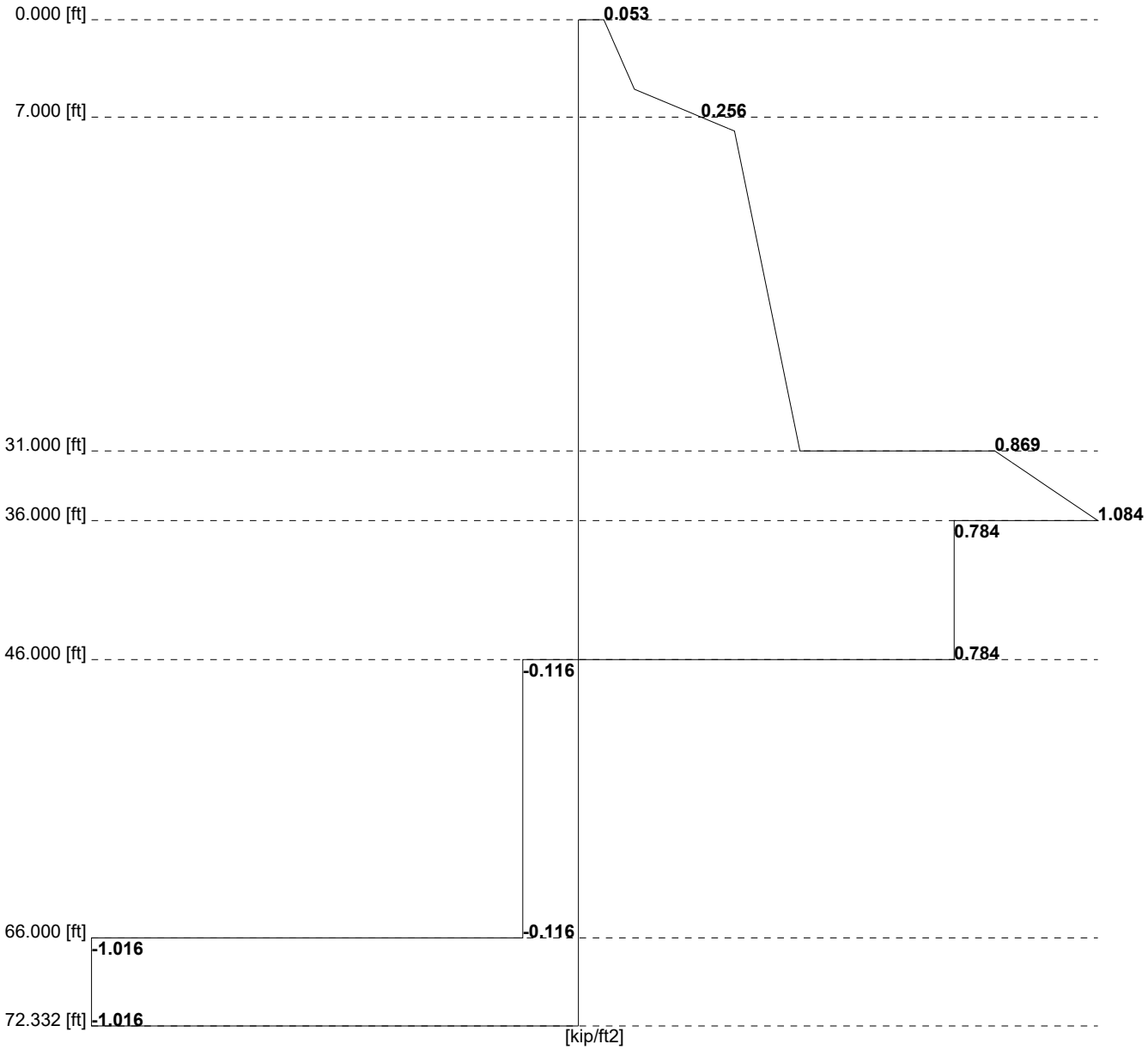
Earth Pressure Diagram



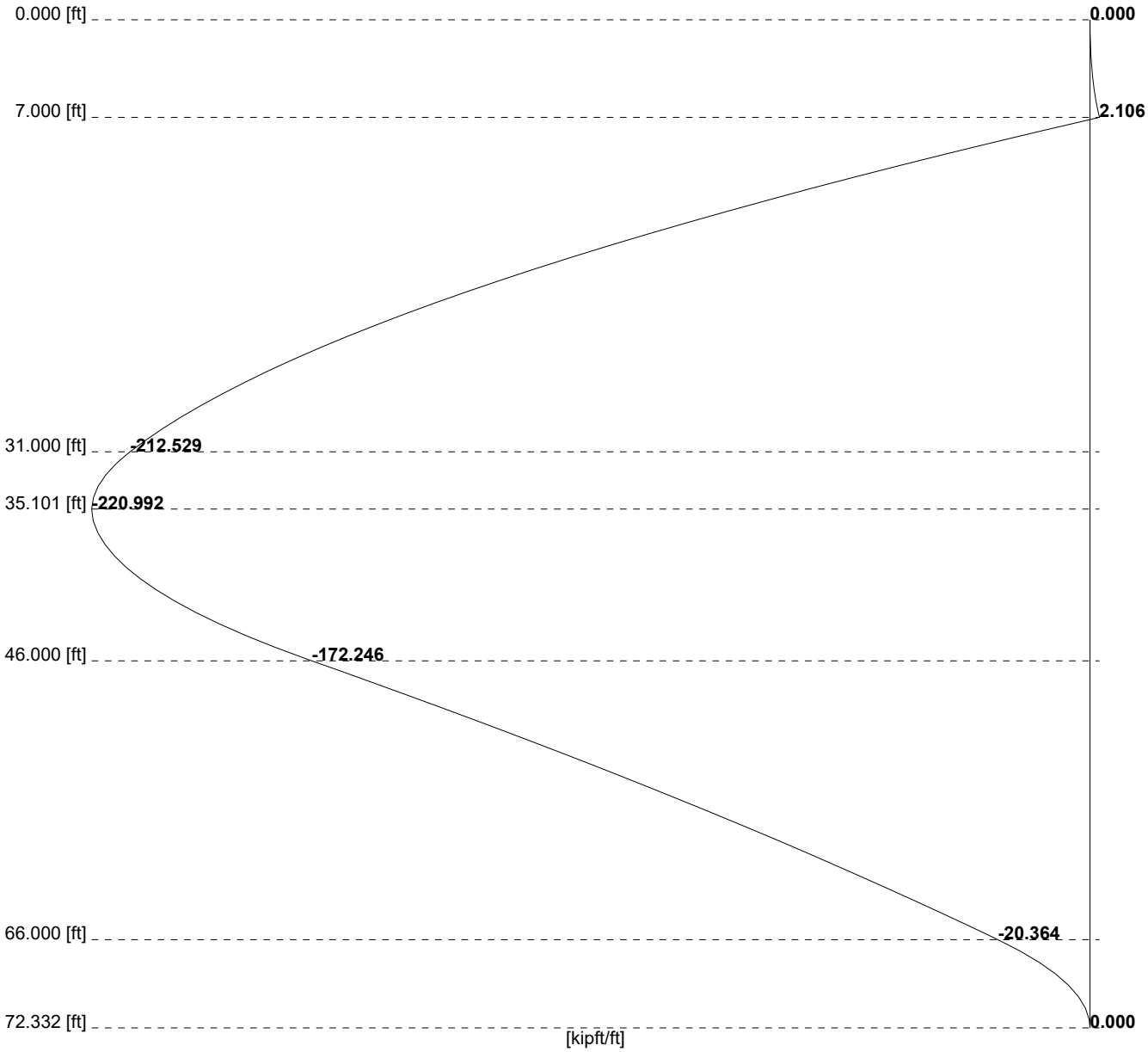
Water Pressure Diagram



Total Pressure Diagram

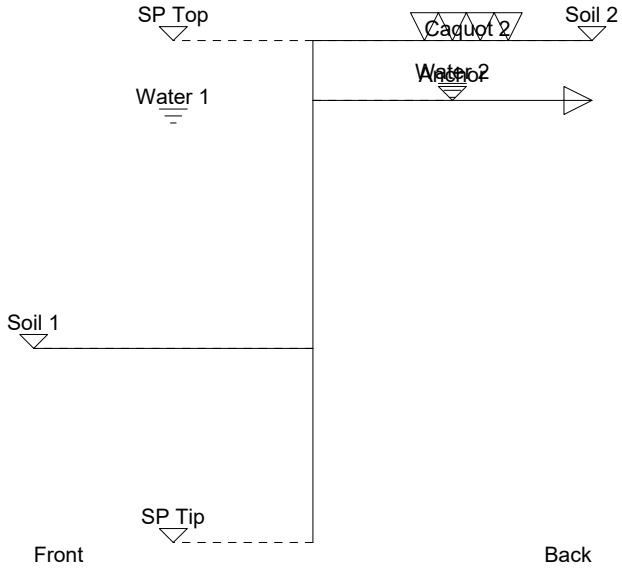


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	58.697
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

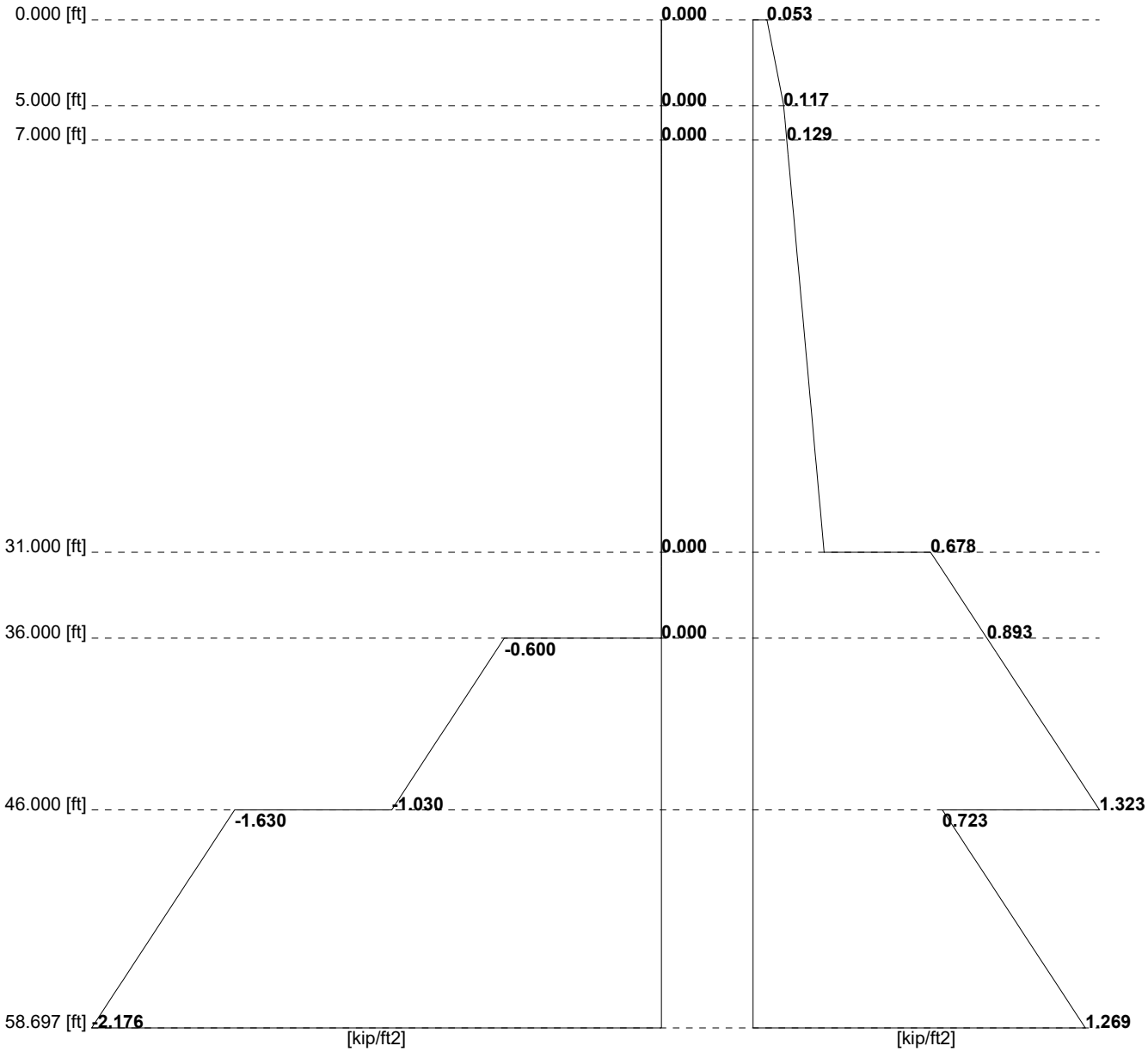
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

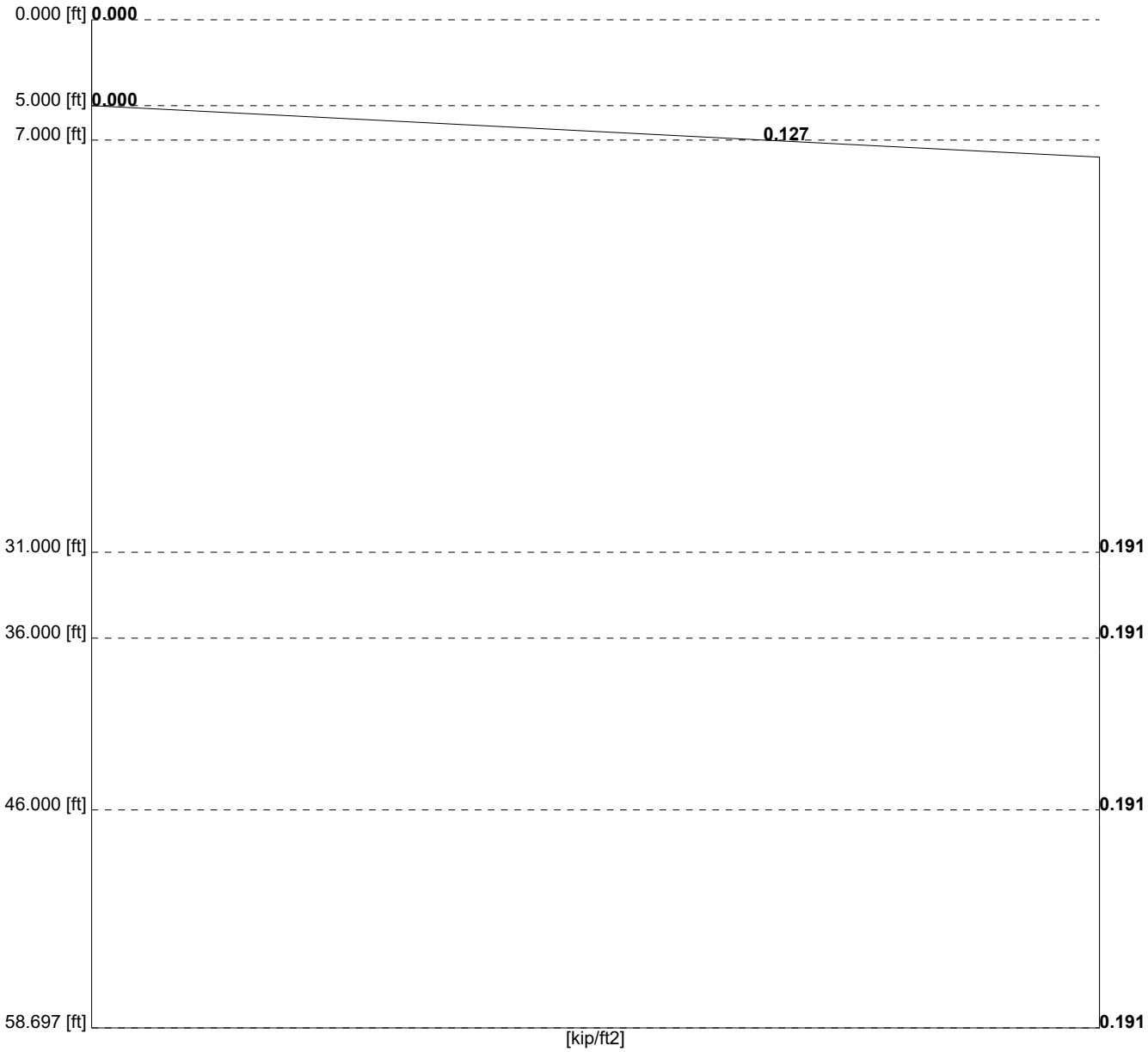
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-132.961	31.755
Maxmimal Moment [kipft/ft]	2.106	7.000
Normal Forces at Max. Moment [kip/ft]	1.990	31.755
Normal Forces at Min. Moment [kip/ft]	0.244	7.000
Deflection at Min. Moment [ft]	-0.186	31.755
Deflection at Max. Moment [ft]	0.000	7.000
Min. Stress at Min. Moment [lb/in2]	-18532.156	31.755
Max. Stress at Min. Moment [lb/in2]	18825.660	31.755
Min. Stress at Max. Moment [lb/in2]	-277.002	7.000
Max. Stress at Max. Moment [lb/in2]	312.955	7.000
Safety > Req. Safety = 1.500	2.656	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	58.697	
Sheet Pile Length [ft]	58.697	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-10.791	

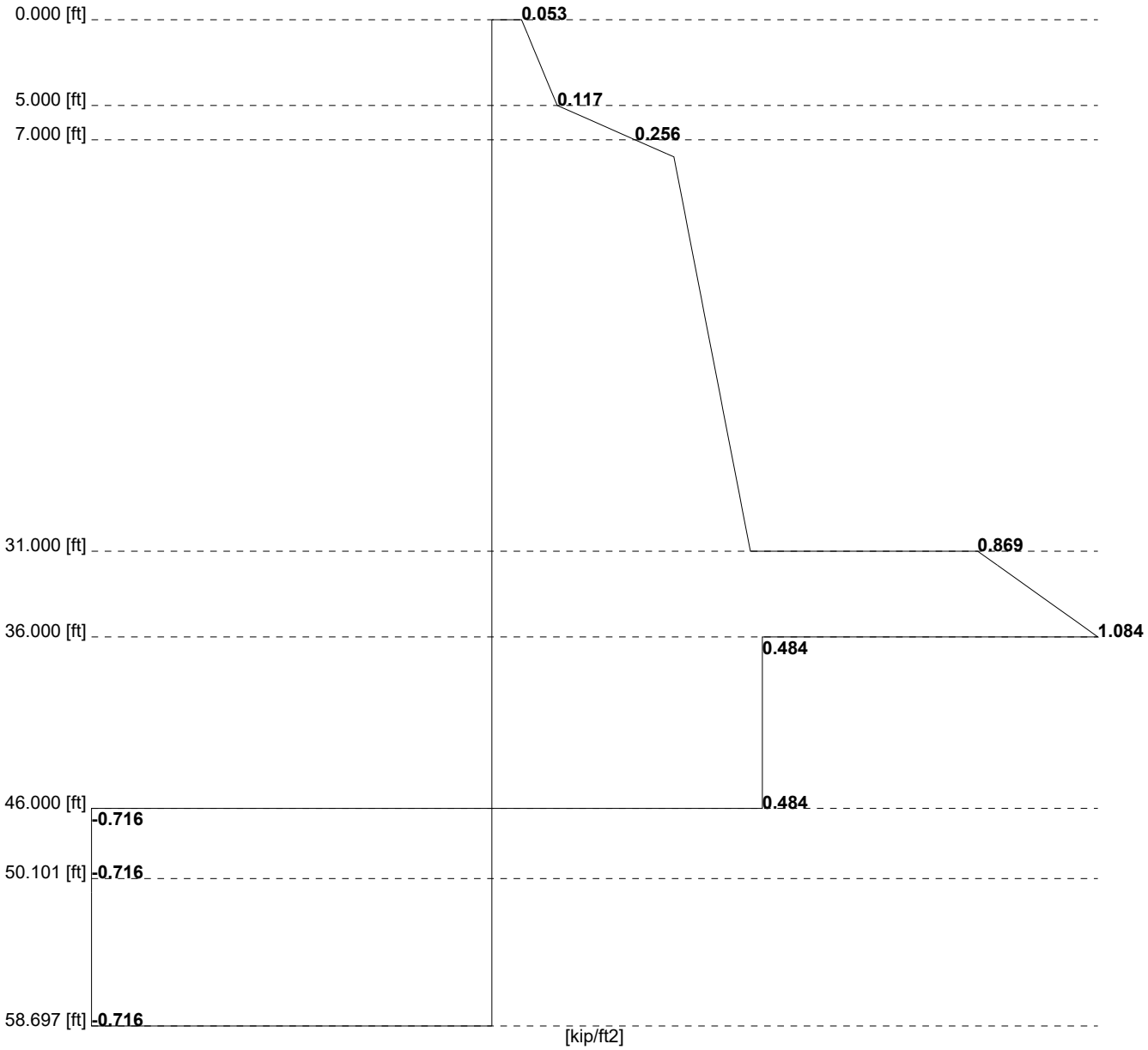
Earth Pressure Diagram



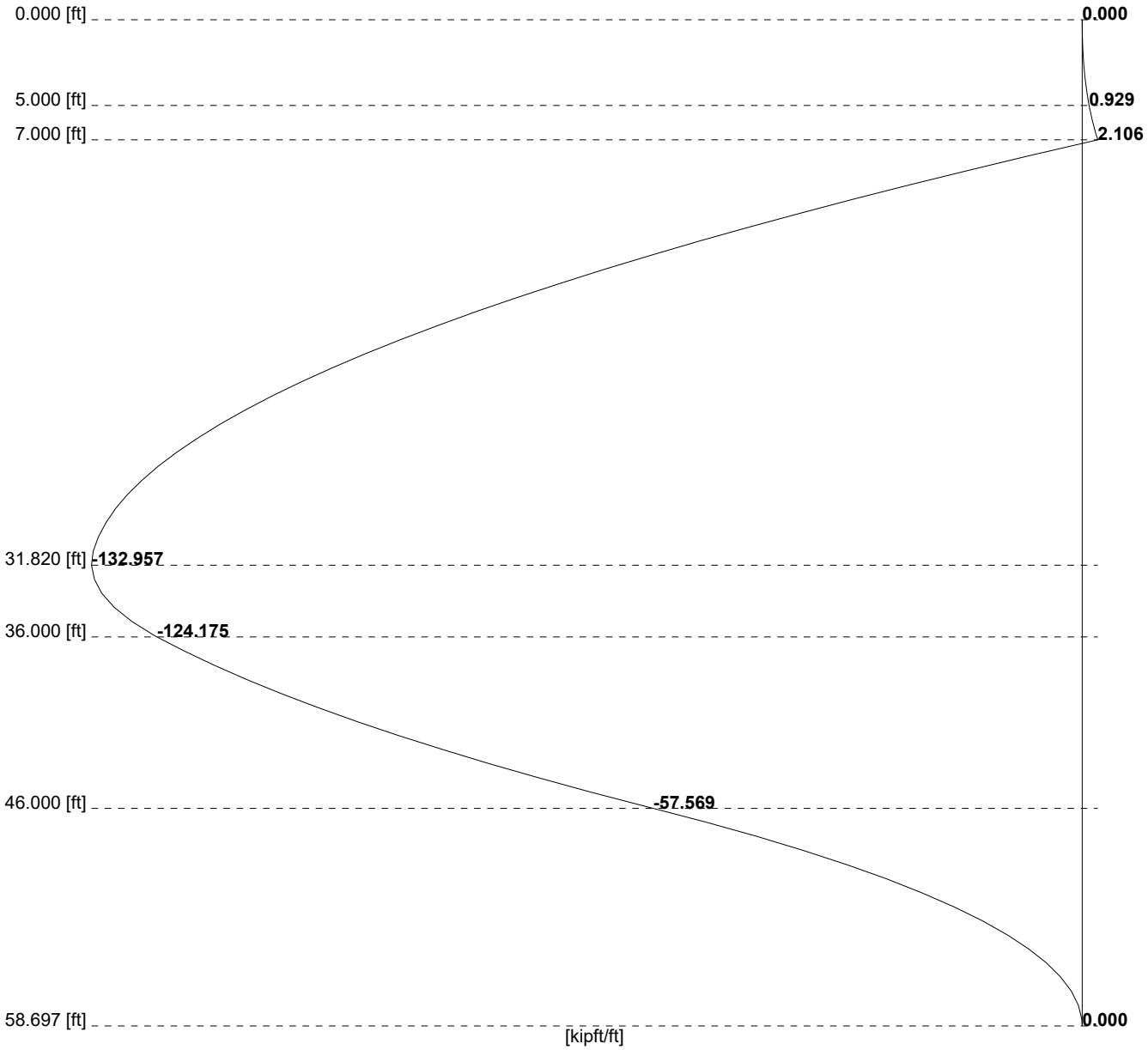
Water Pressure Diagram



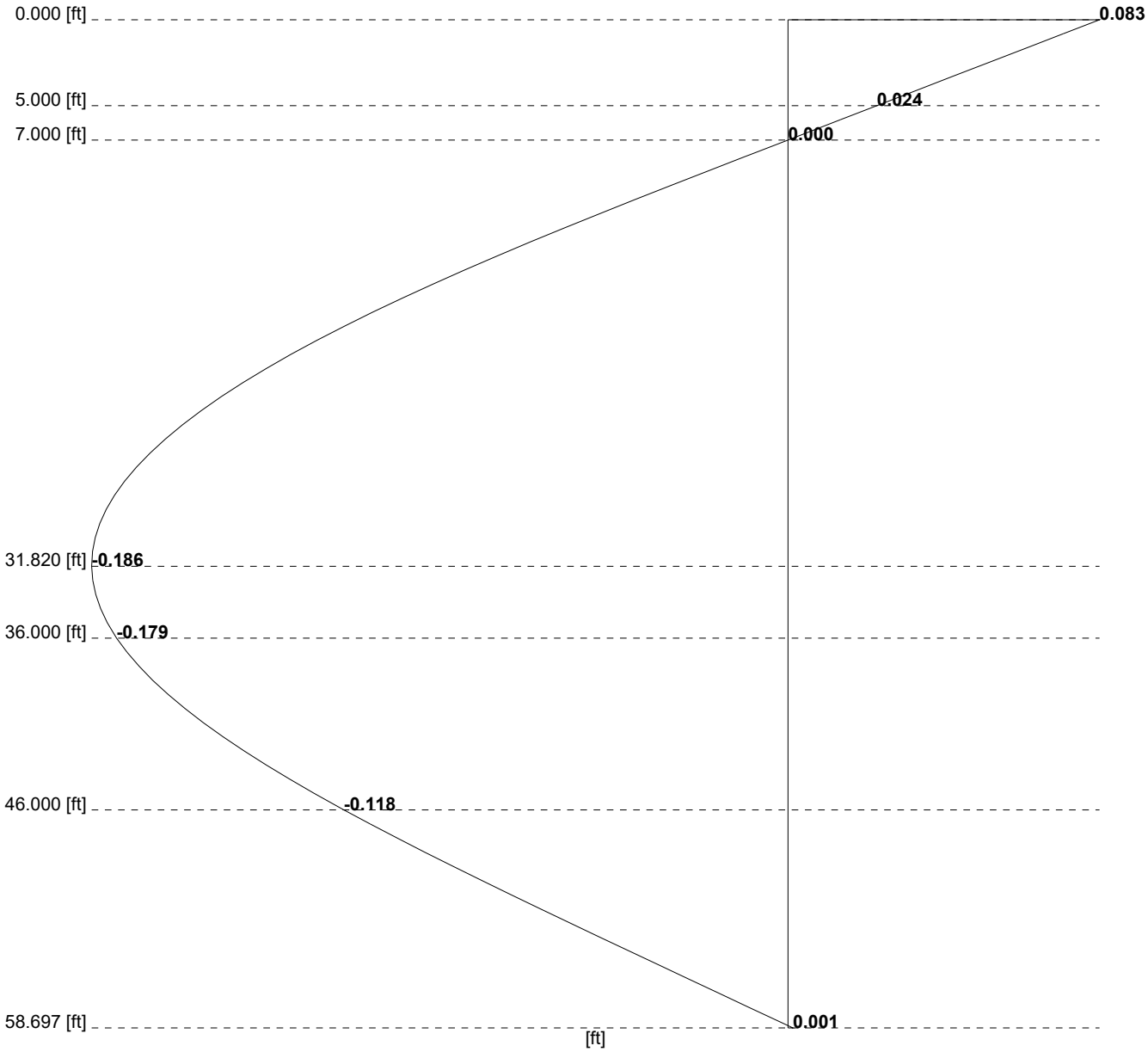
Total Pressure Diagram



Moment Diagram

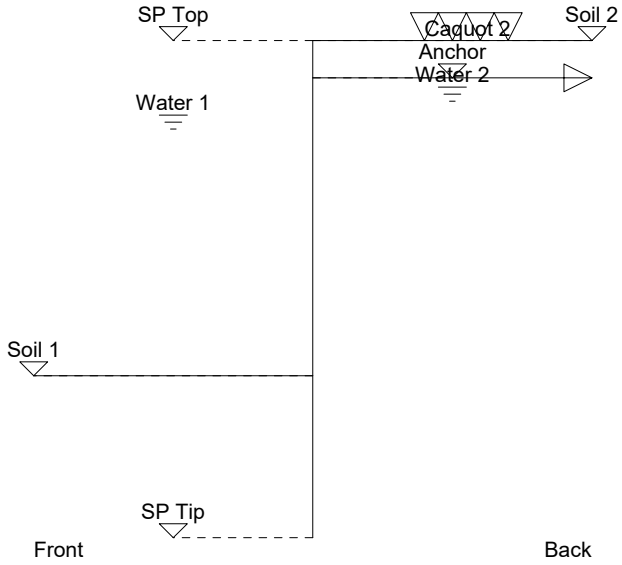


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	53.382
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

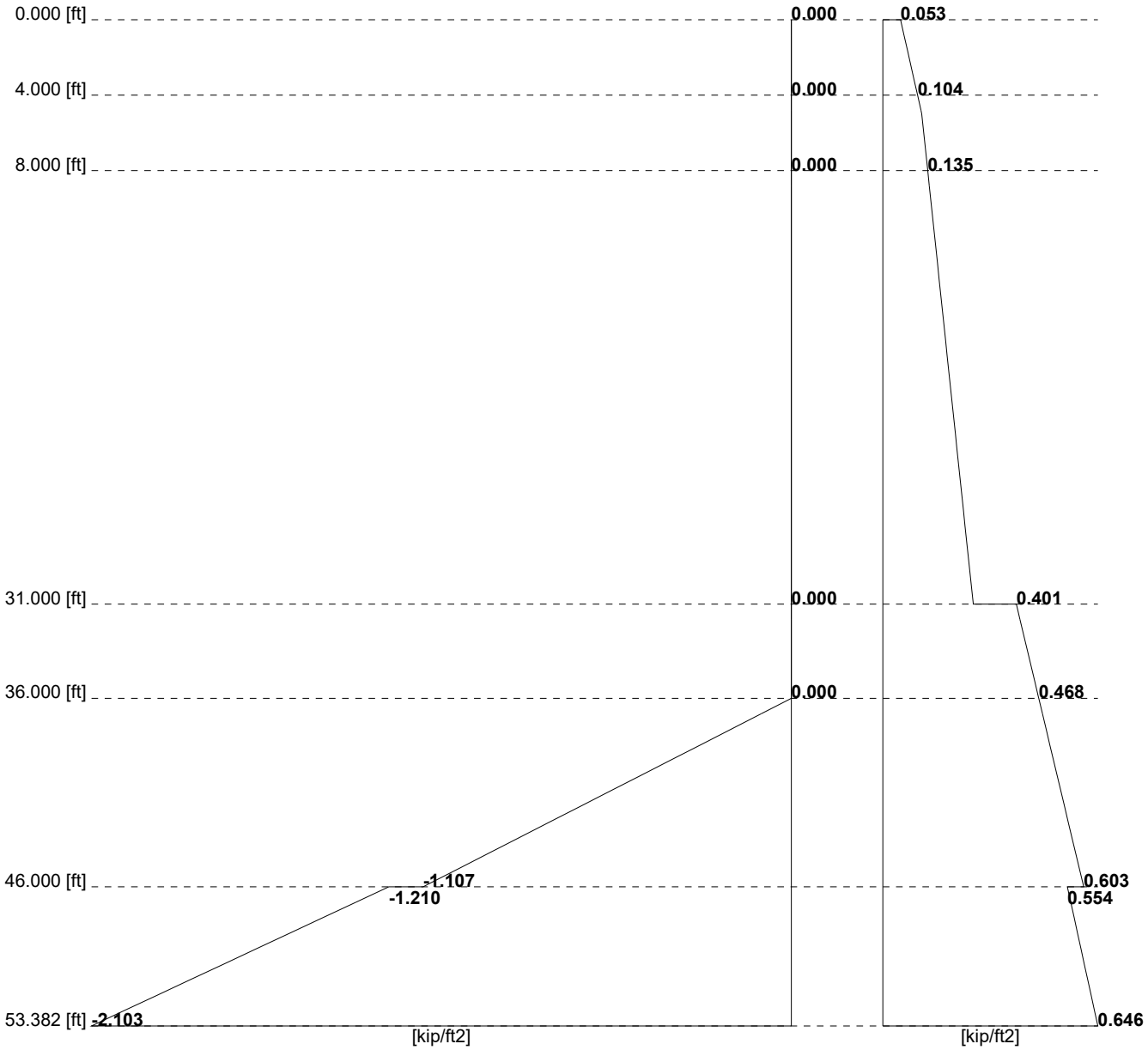
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

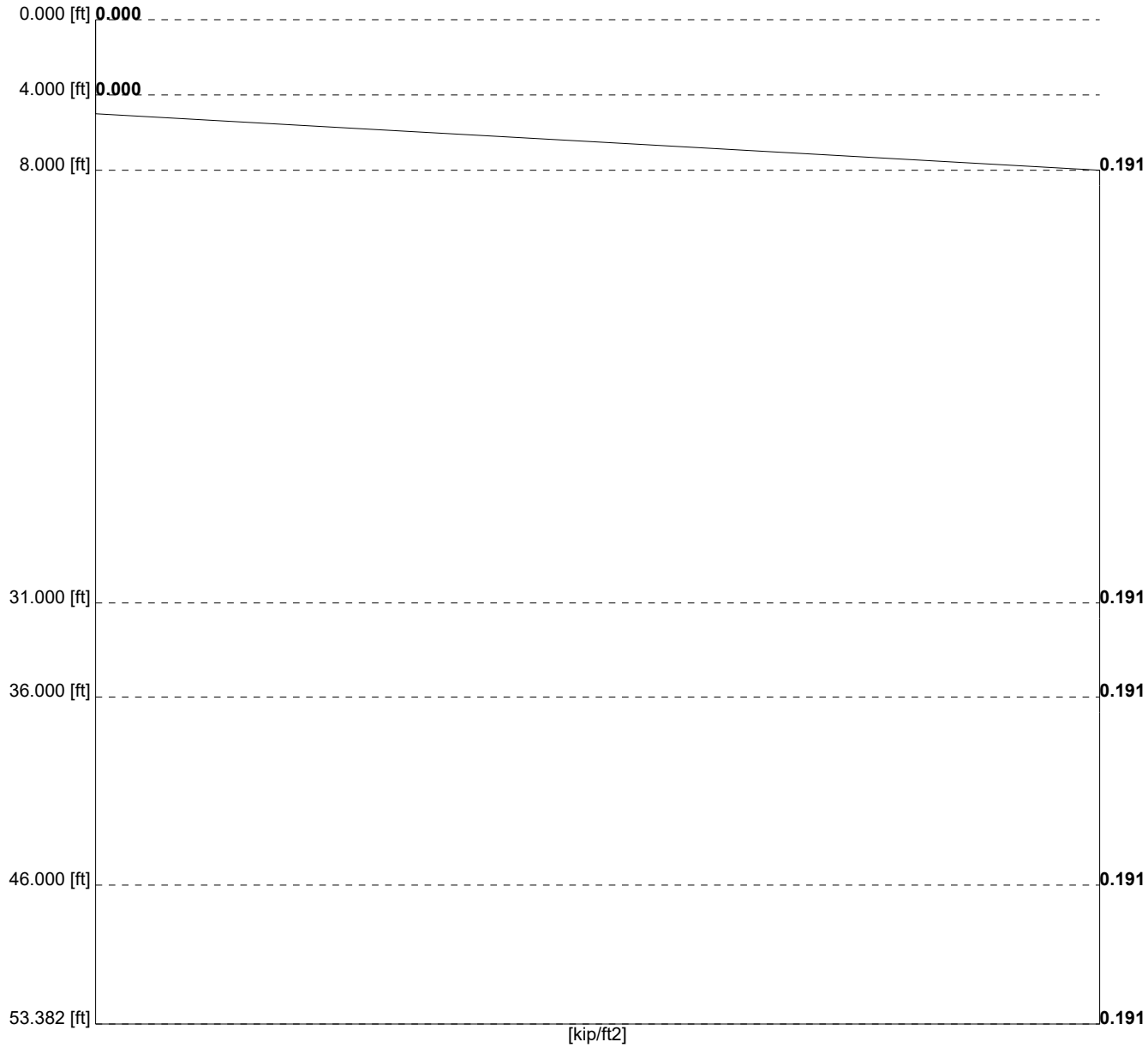
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-108.782	27.620
Maxmimal Moment [kipft/ft]	0.561	4.000
Normal Forces at Max. Moment [kip/ft]	1.675	27.620
Normal Forces at Min. Moment [kip/ft]	0.114	4.000
Deflection at Min. Moment [ft]	-0.146	27.620
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-15150.444	27.620
Max. Stress at Min. Moment [lb/in2]	15397.438	27.620
Min. Stress at Max. Moment [lb/in2]	-70.138	4.000
Max. Stress at Max. Moment [lb/in2]	86.998	4.000
Safety > Req. Safety = 1.500	3.247	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	53.382	
Sheet Pile Length [ft]	53.382	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.824	
Anchor Force (horiz.) [kip/ft]	-8.609	

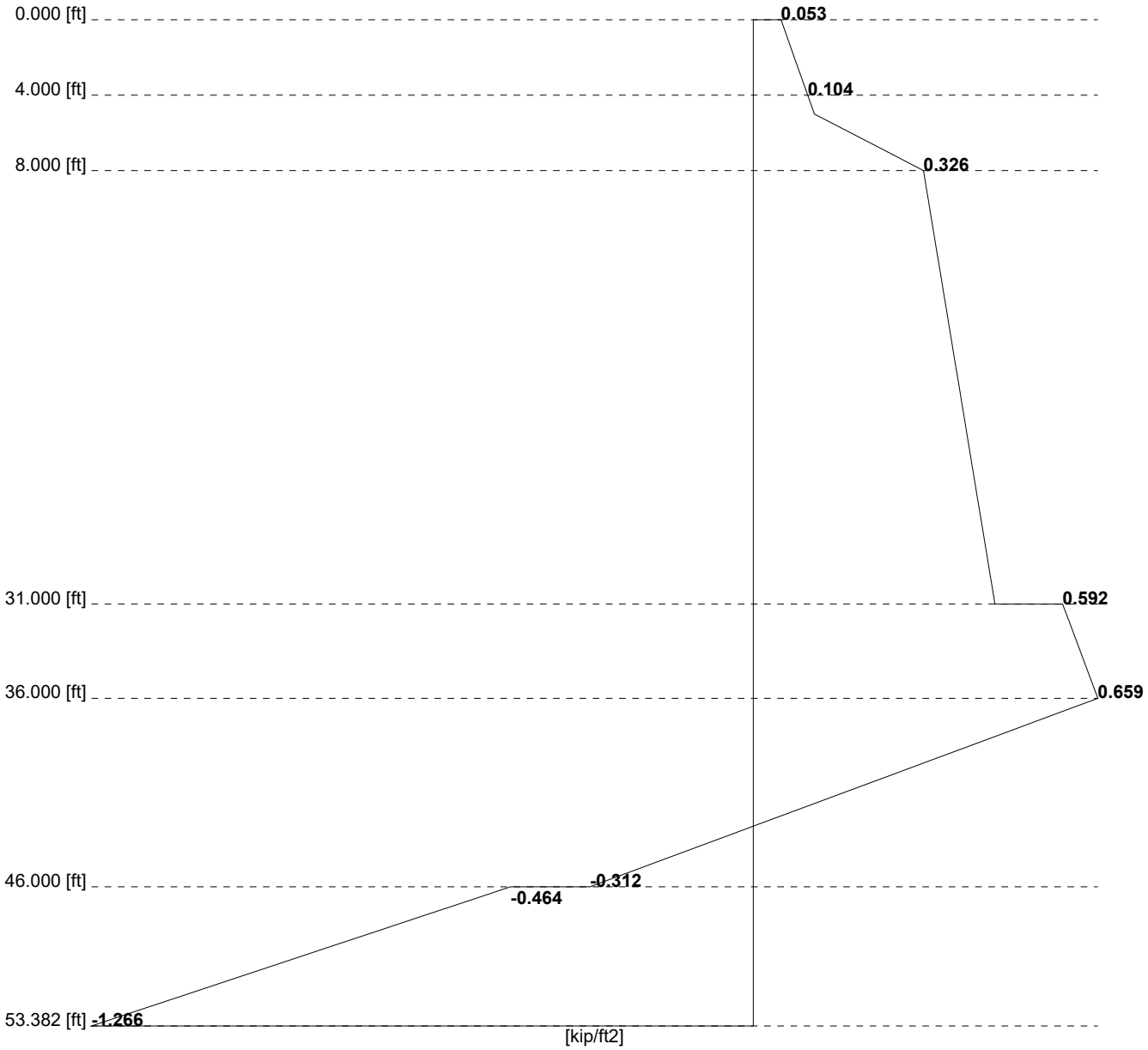
Earth Pressure Diagram



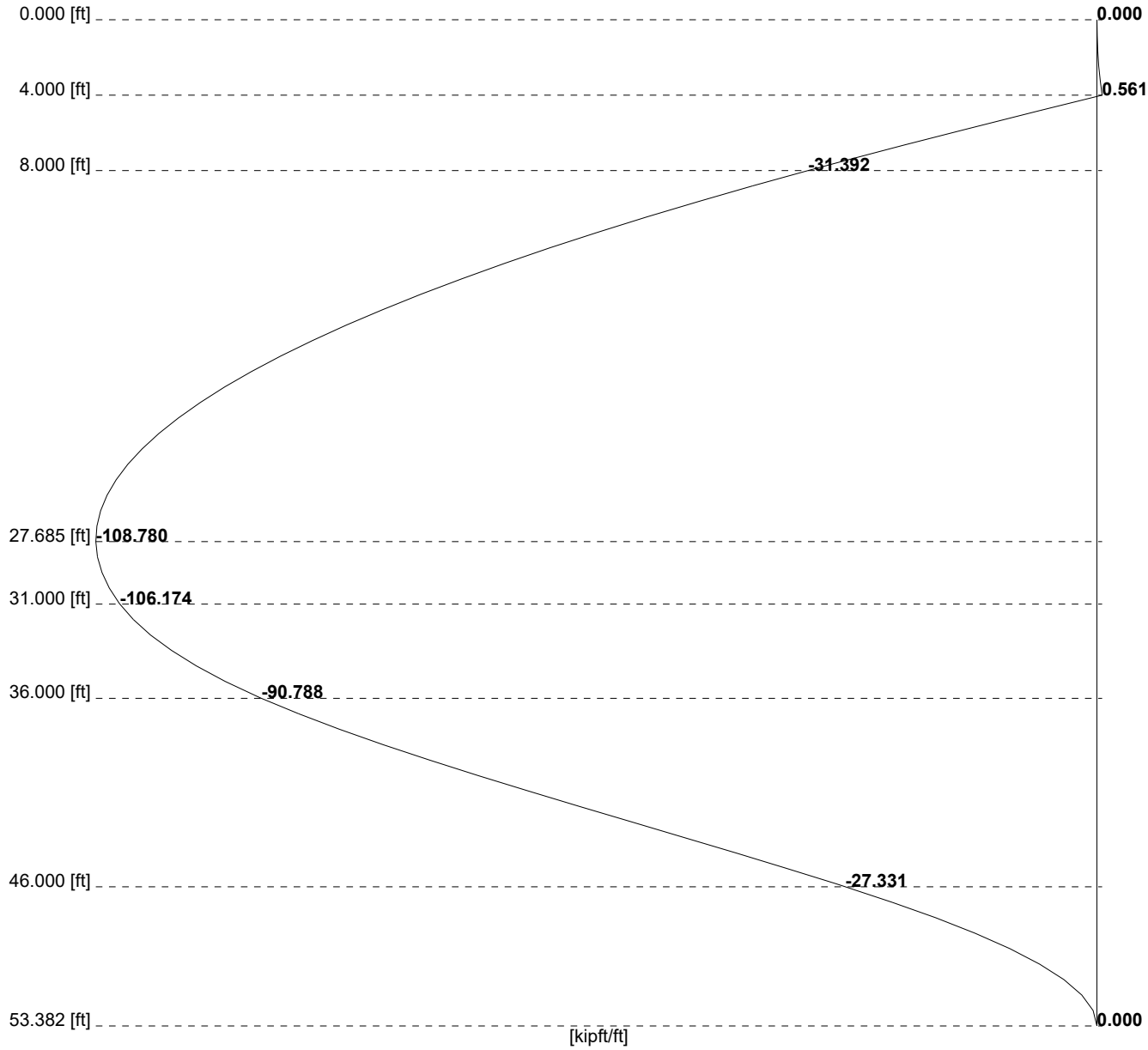
Water Pressure Diagram



Total Pressure Diagram

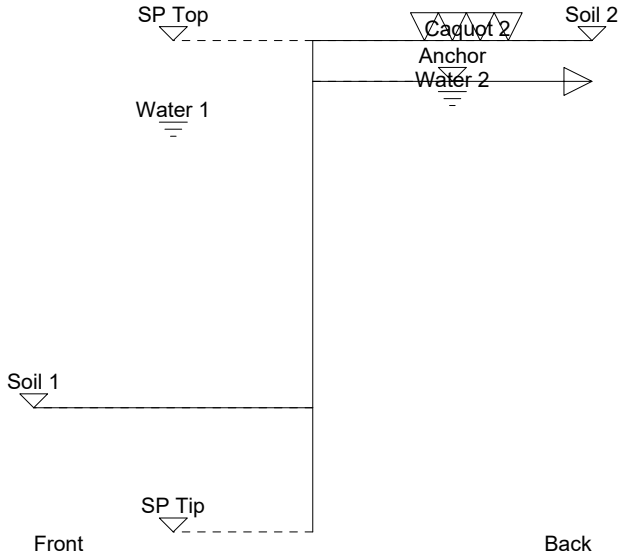


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	48.165
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

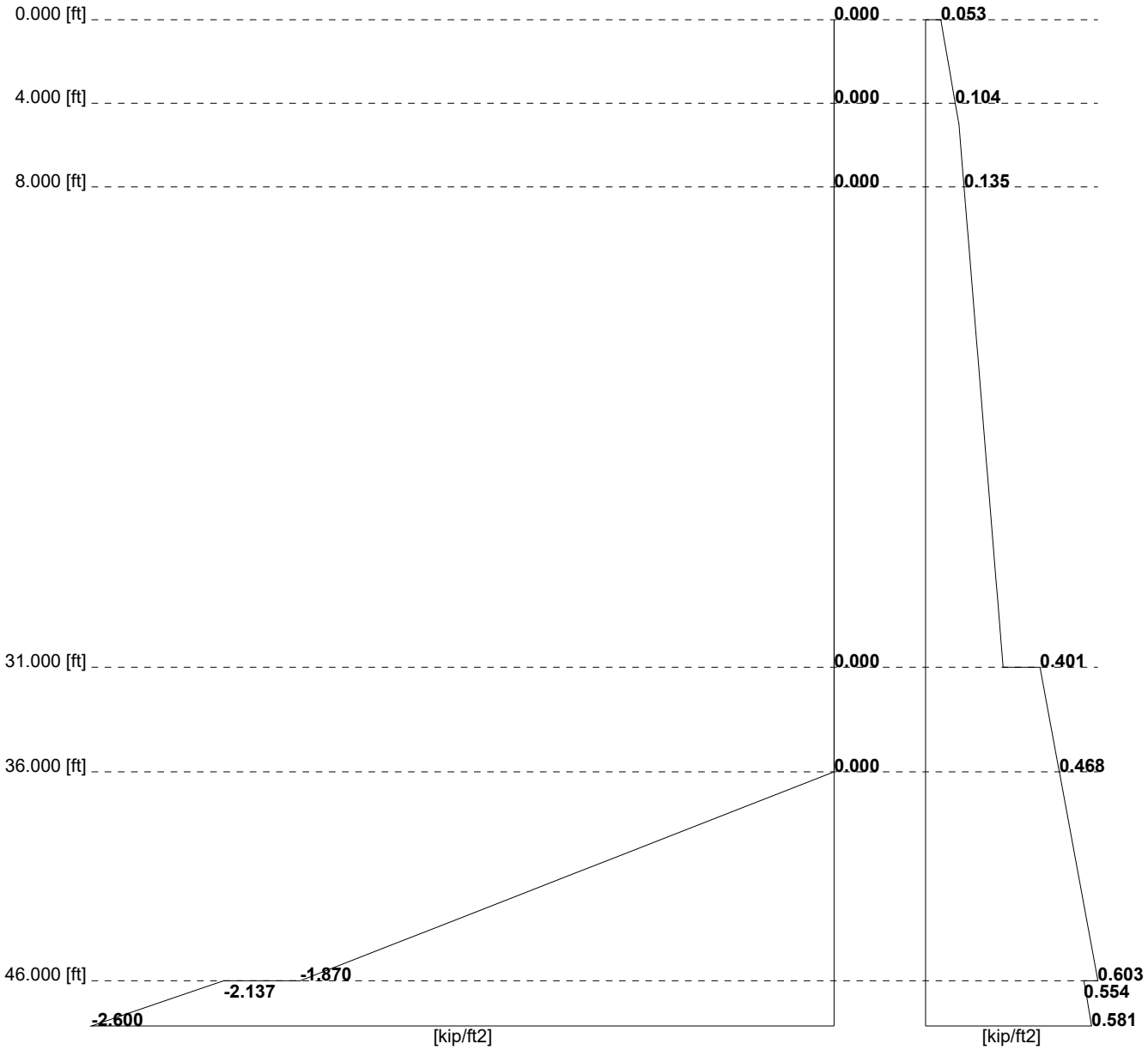
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

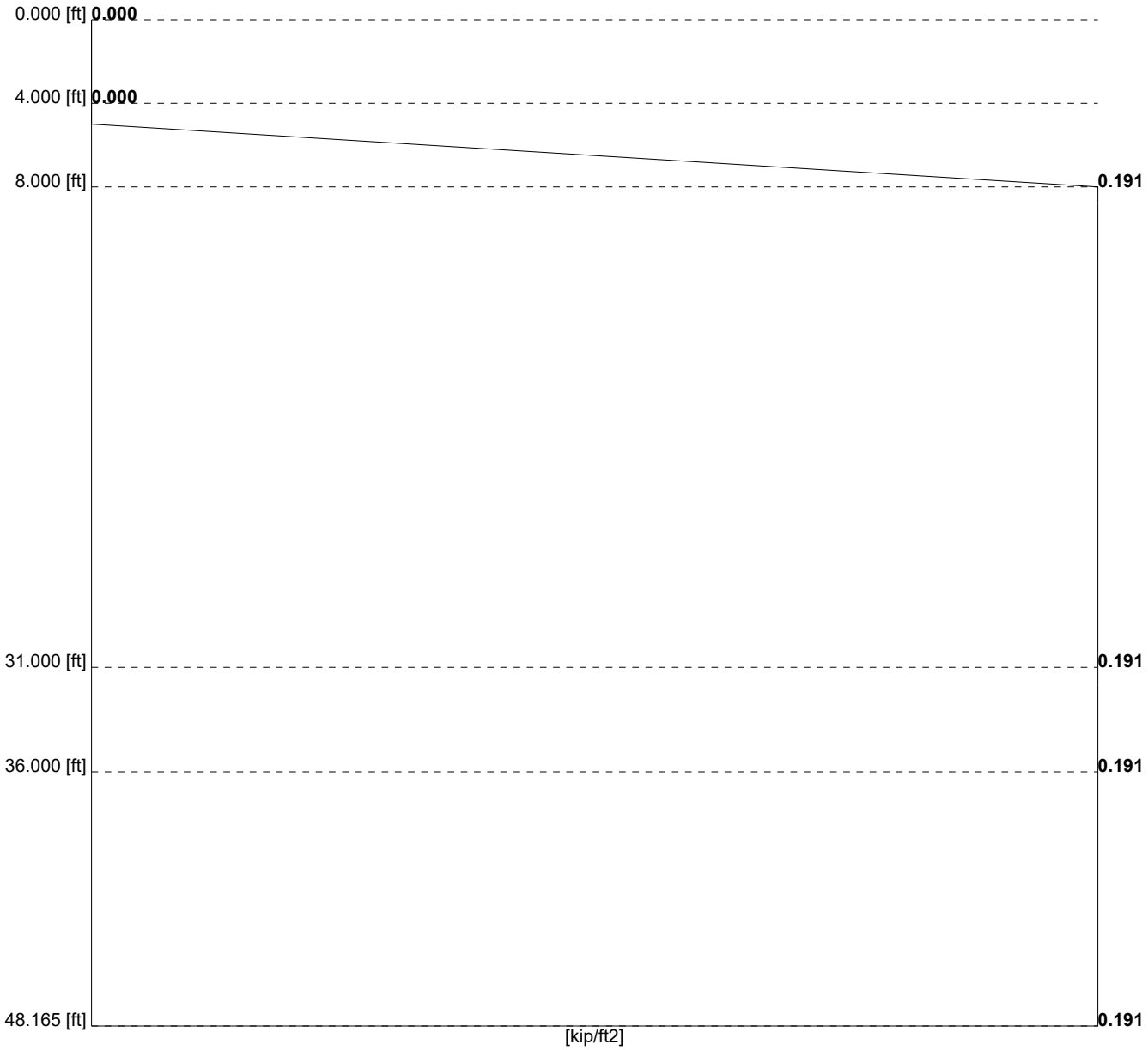
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-89.271	25.225
Maxmimal Moment [kipft/ft]	0.561	4.000
Normal Forces at Max. Moment [kip/ft]	1.456	25.225
Normal Forces at Min. Moment [kip/ft]	0.114	4.000
Deflection at Min. Moment [ft]	-0.097	25.225
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-12418.830	25.225
Max. Stress at Min. Moment [lb/in2]	12633.567	25.225
Min. Stress at Max. Moment [lb/in2]	-70.138	4.000
Max. Stress at Max. Moment [lb/in2]	86.998	4.000
Safety > Req. Safety = 1.500	3.958	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	48.165	
Sheet Pile Length [ft]	48.165	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.374	
Anchor Force (horiz.) [kip/ft]	-7.747	

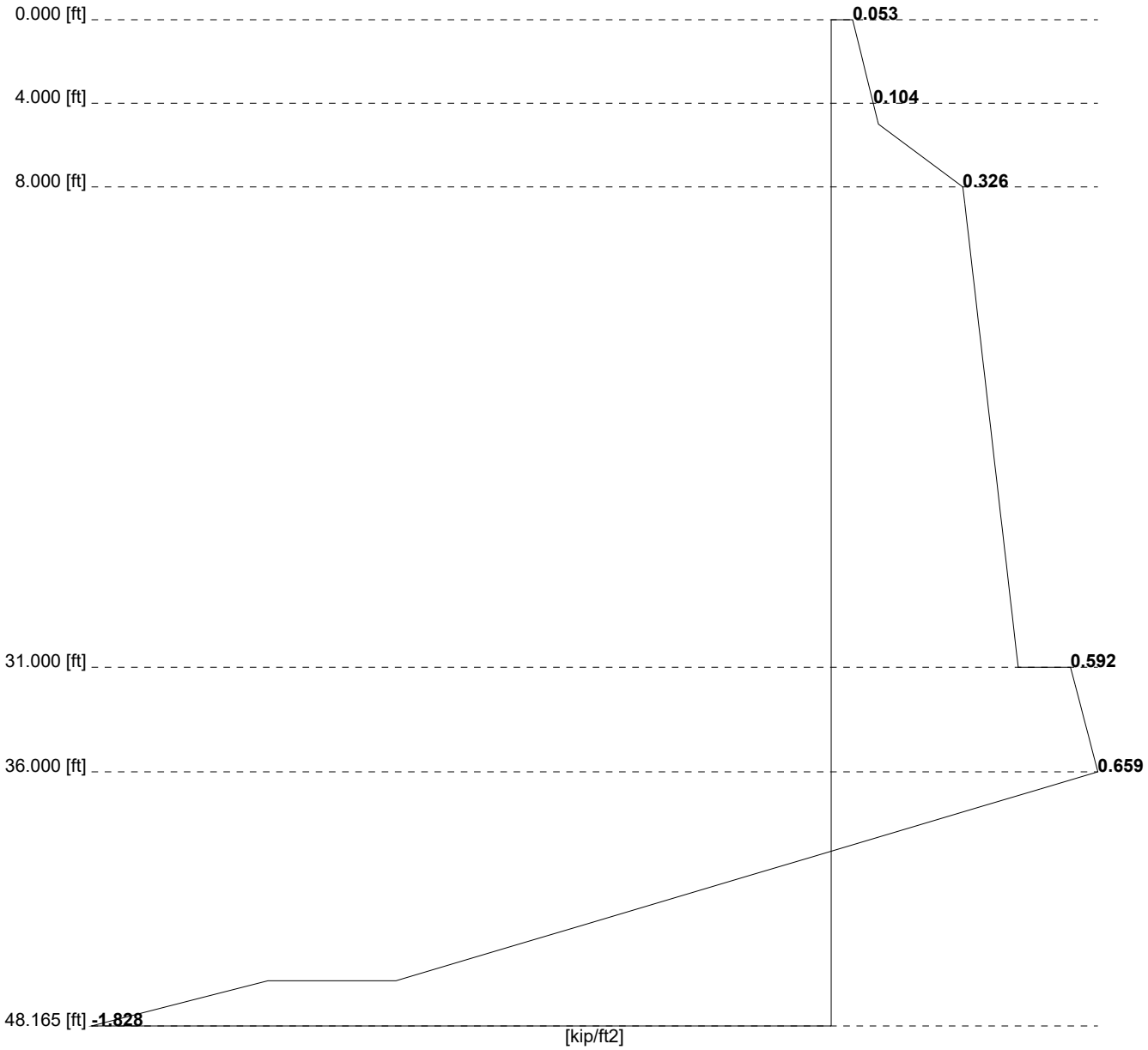
Earth Pressure Diagram



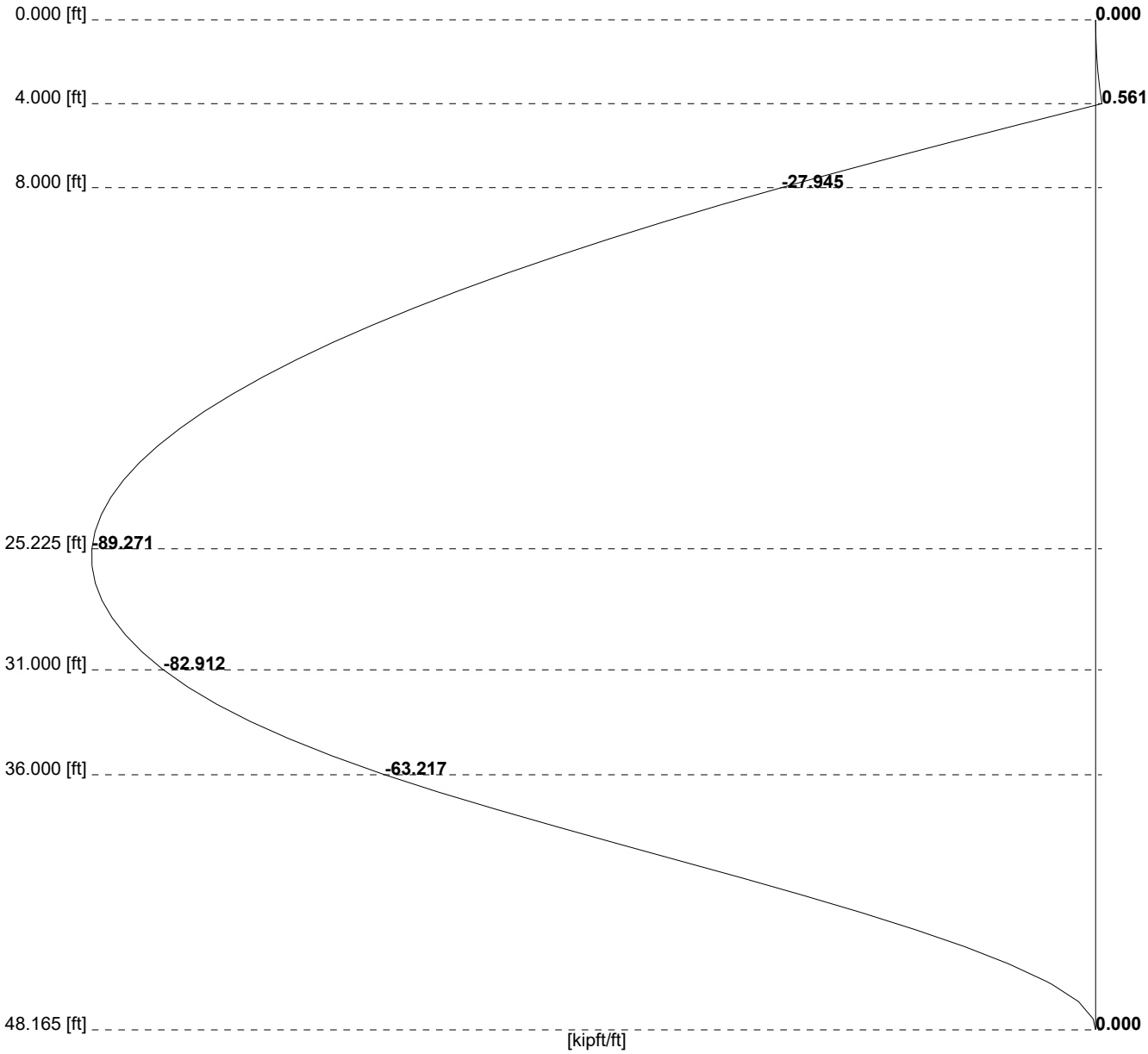
Water Pressure Diagram



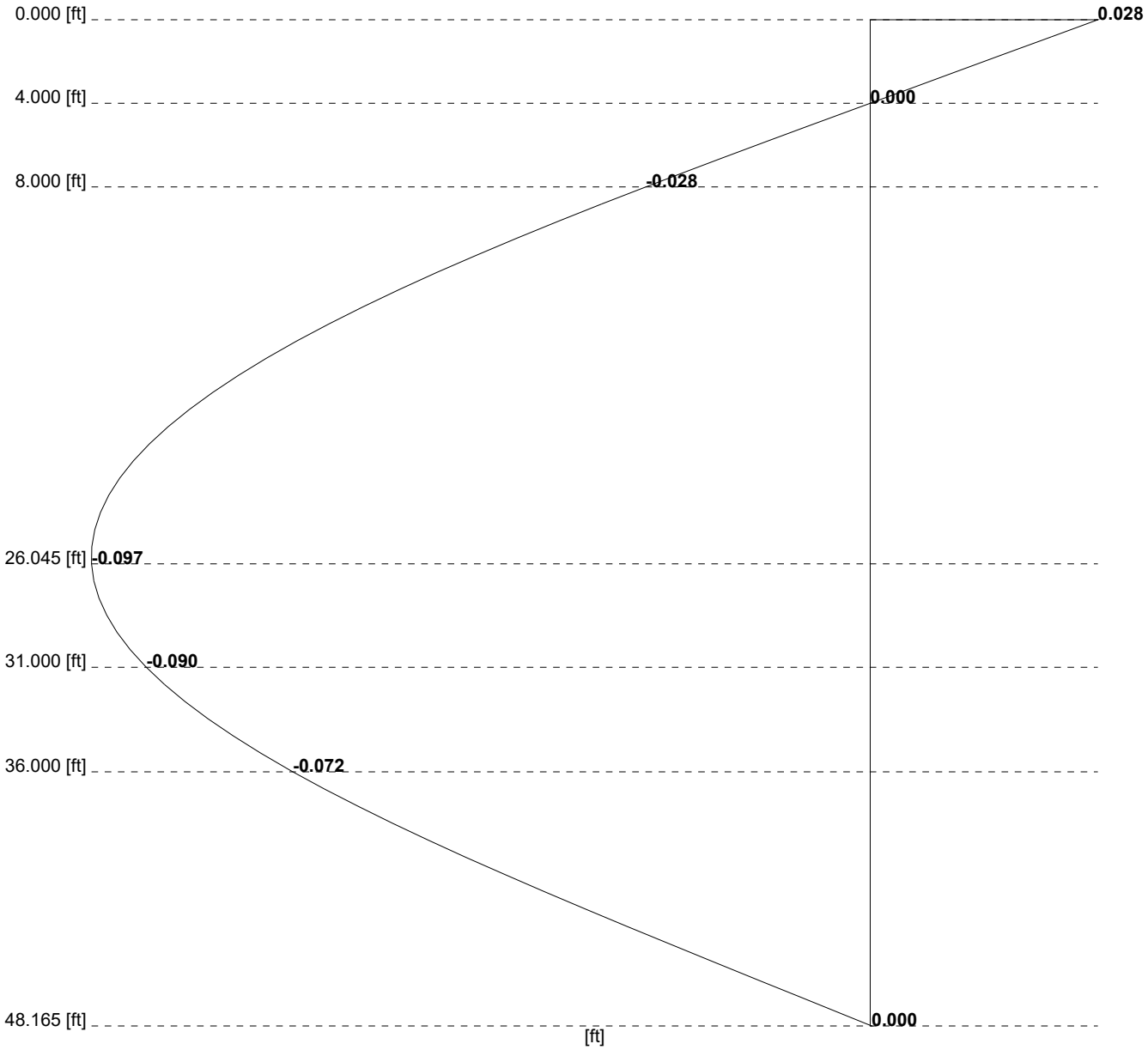
Total Pressure Diagram



Moment Diagram

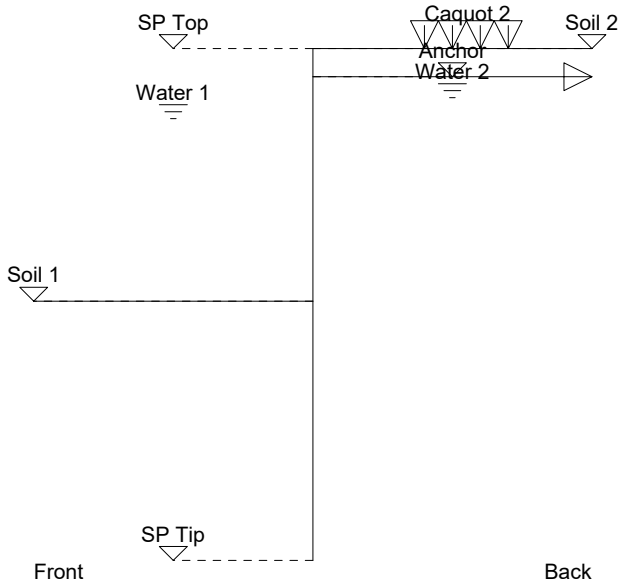


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	72.955
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

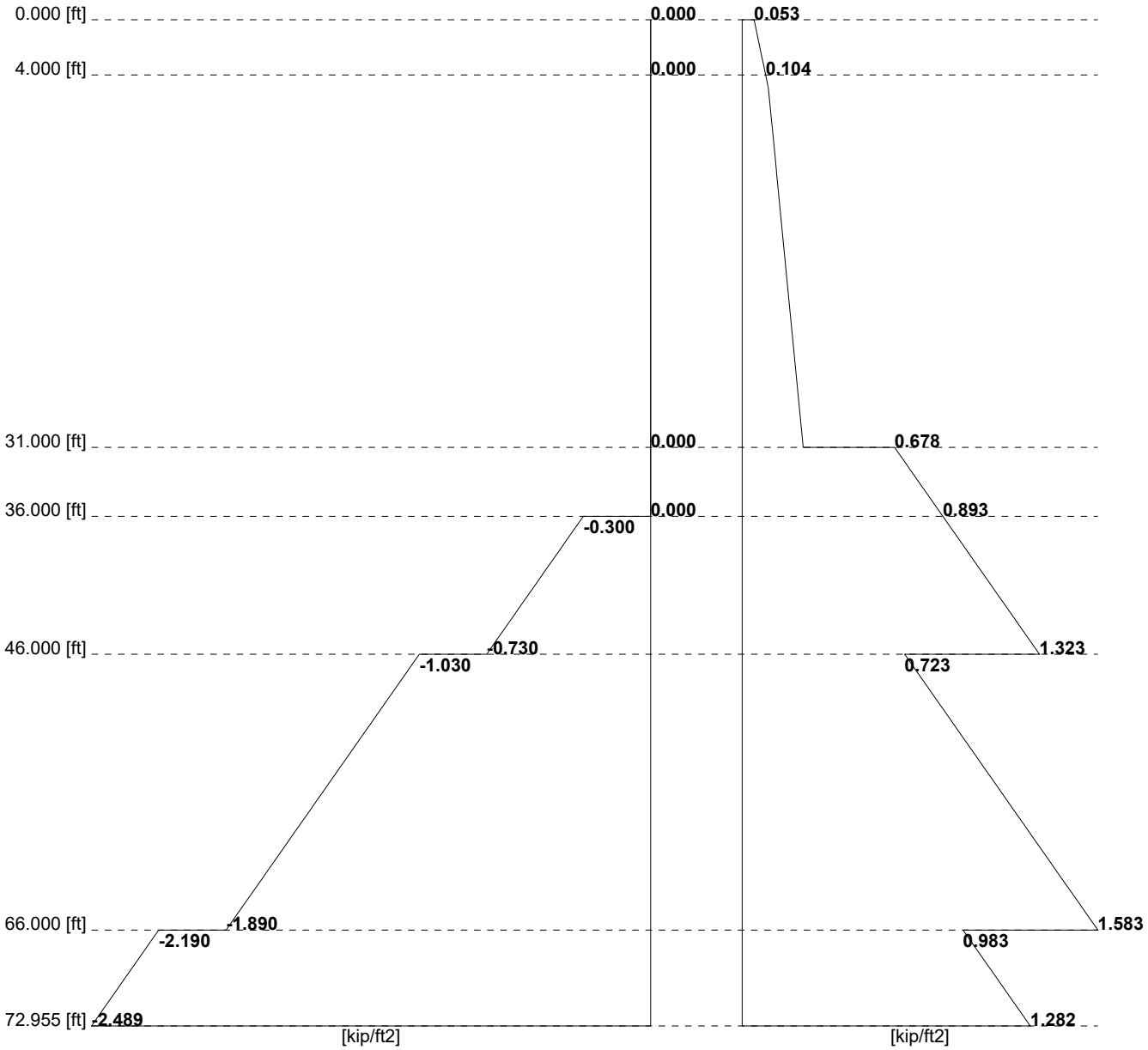
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

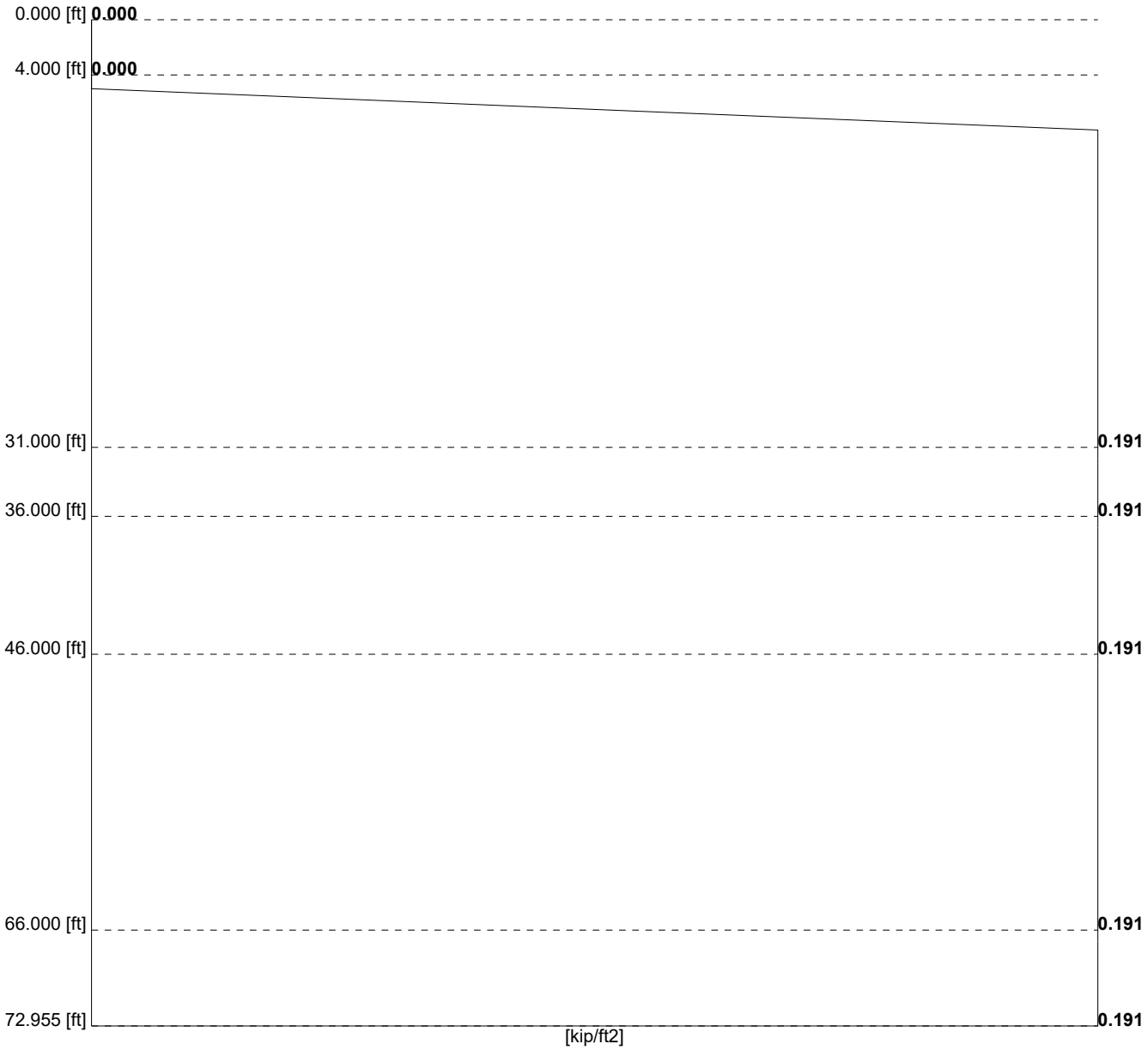
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-244.276	34.281
Maxmimal Moment [kipft/ft]	0.561	4.000
Normal Forces at Max. Moment [kip/ft]	1.990	34.281
Normal Forces at Min. Moment [kip/ft]	0.114	4.000
Deflection at Min. Moment [ft]	-0.594	34.281
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-34240.660	34.281
Max. Stress at Min. Moment [lb/in2]	34534.164	34.281
Min. Stress at Max. Moment [lb/in2]	-70.138	4.000
Max. Stress at Max. Moment [lb/in2]	86.998	4.000
Safety < Req. Safety = 1.500	1.448	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	72.955	
Sheet Pile Length [ft]	72.955	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-13.499	

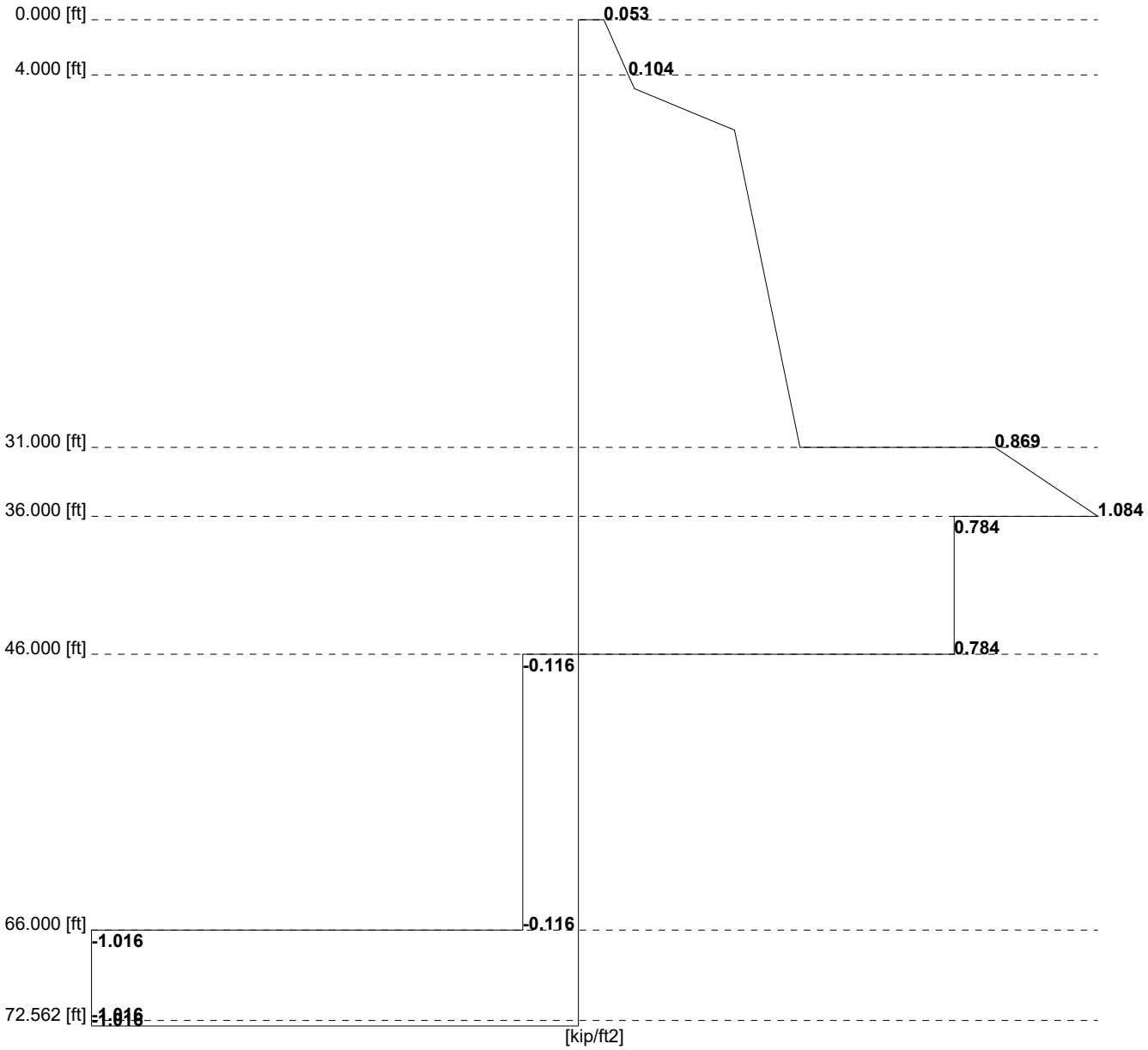
Earth Pressure Diagram



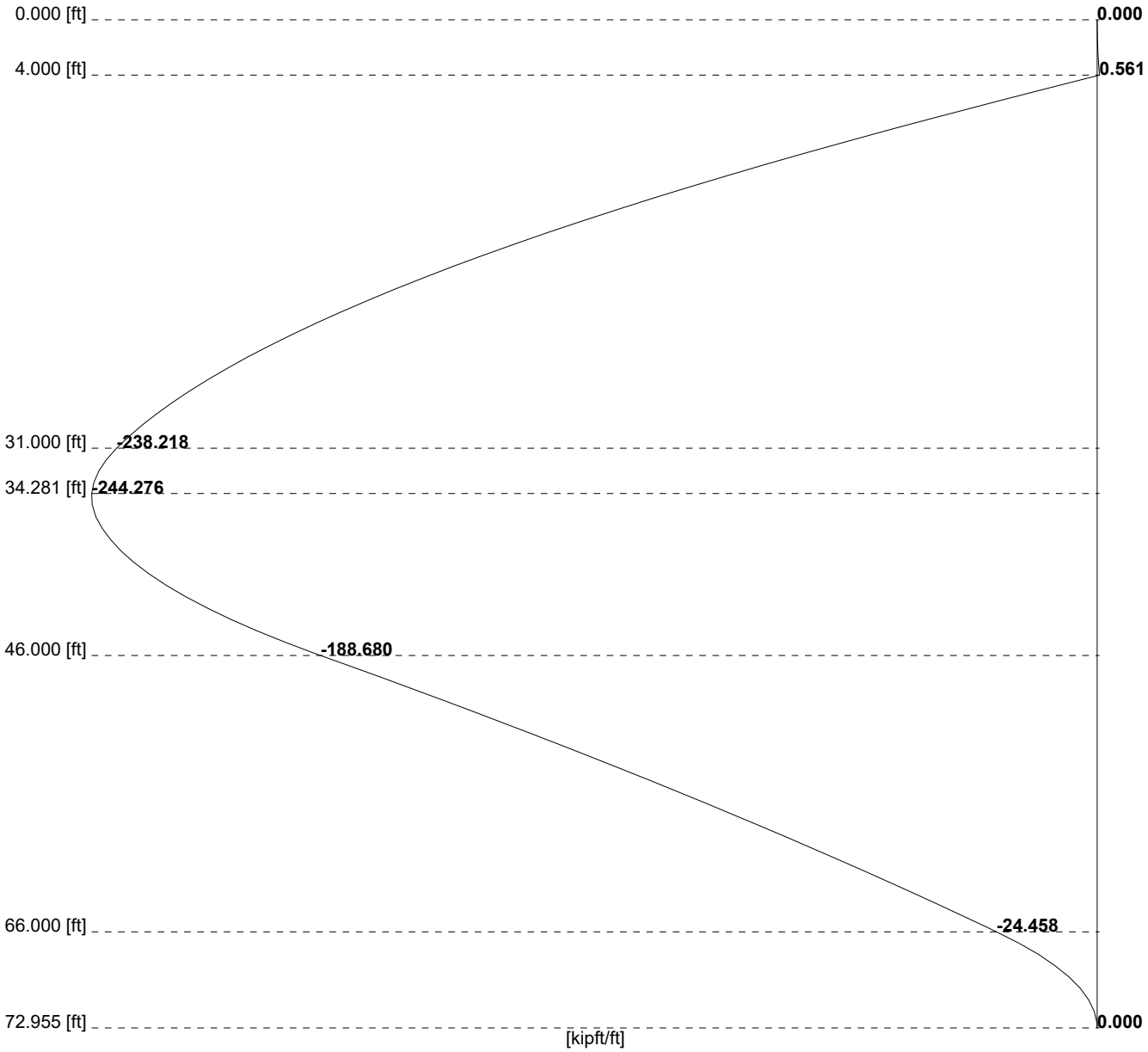
Water Pressure Diagram



Total Pressure Diagram

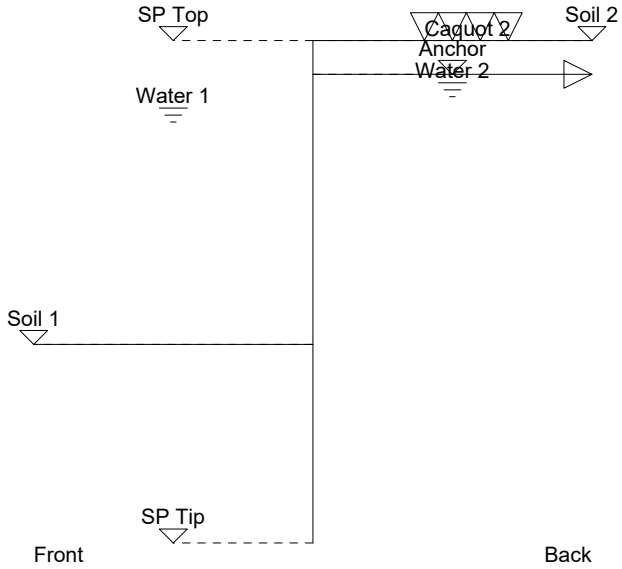


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	59.517
Soil Level in Front [ft]	36.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

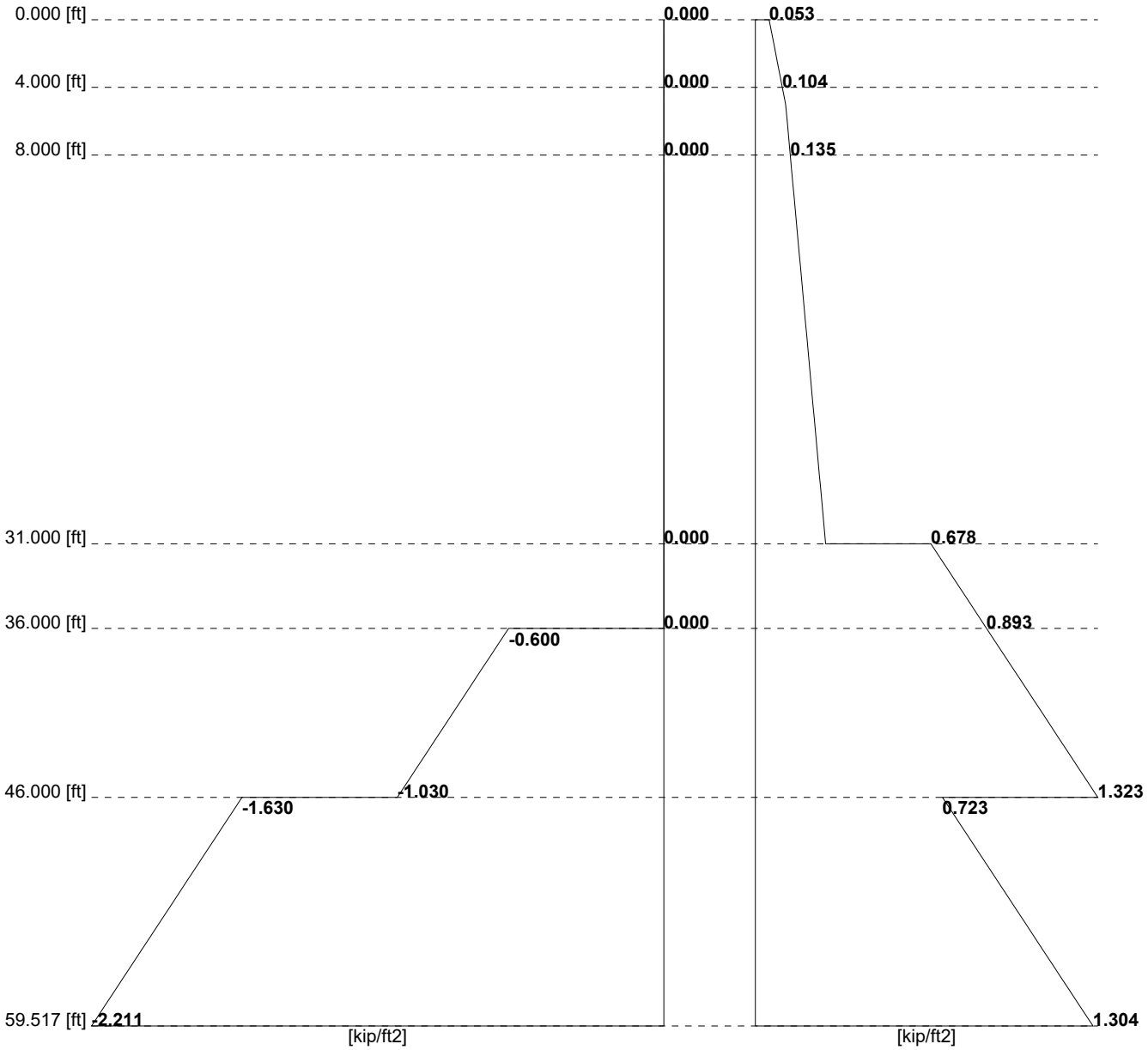
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

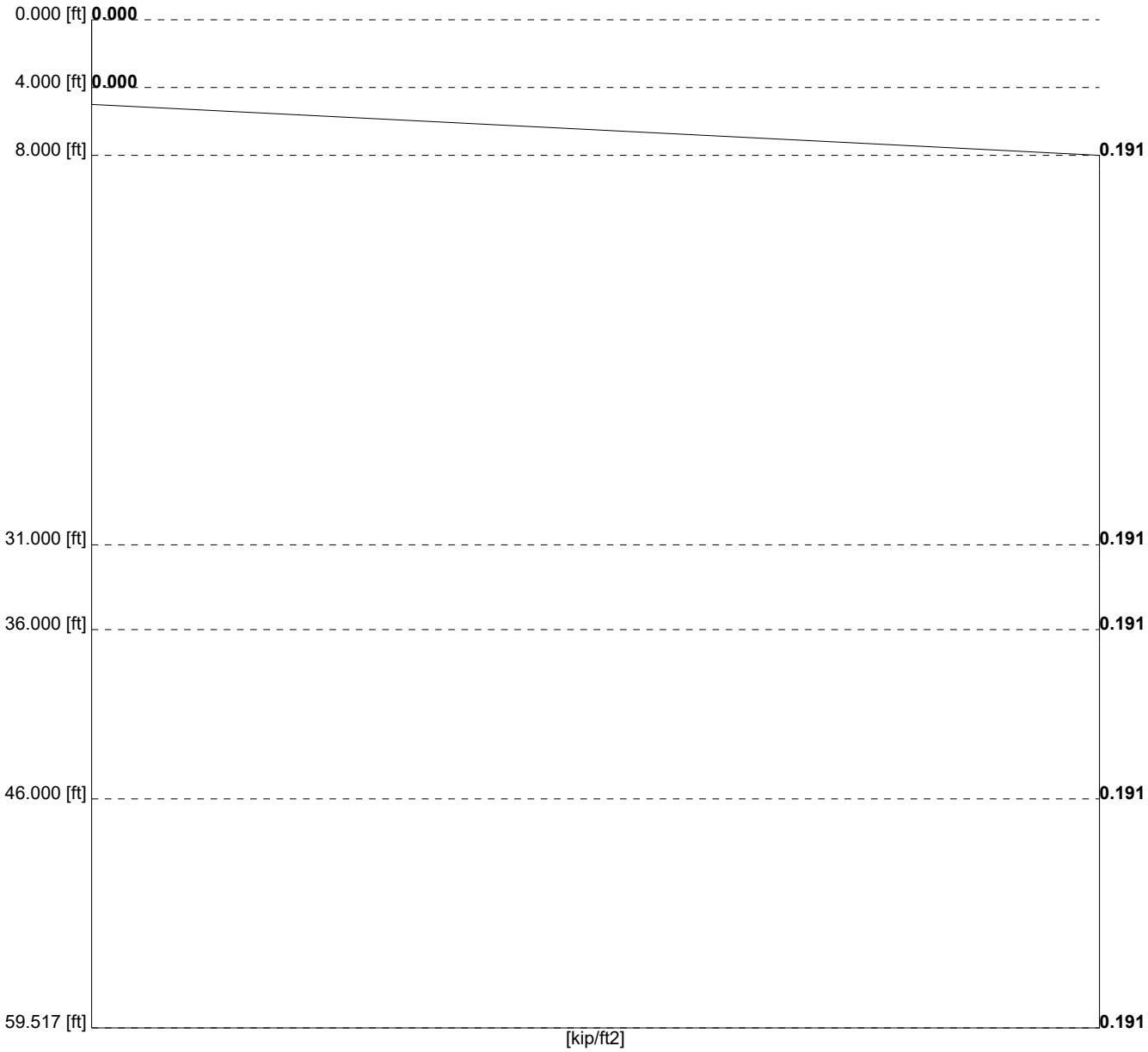
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-149.236	31.032
Maxmimal Moment [kipft/ft]	0.561	4.000
Normal Forces at Max. Moment [kip/ft]	1.990	31.032
Normal Forces at Min. Moment [kip/ft]	0.114	4.000
Deflection at Min. Moment [ft]	-0.242	31.032
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-20828.080	31.032
Max. Stress at Min. Moment [lb/in2]	21121.582	31.032
Min. Stress at Max. Moment [lb/in2]	-70.138	4.000
Max. Stress at Max. Moment [lb/in2]	86.998	4.000
Safety > Req. Safety = 1.500	2.367	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	59.517	
Sheet Pile Length [ft]	59.517	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	-10.203	

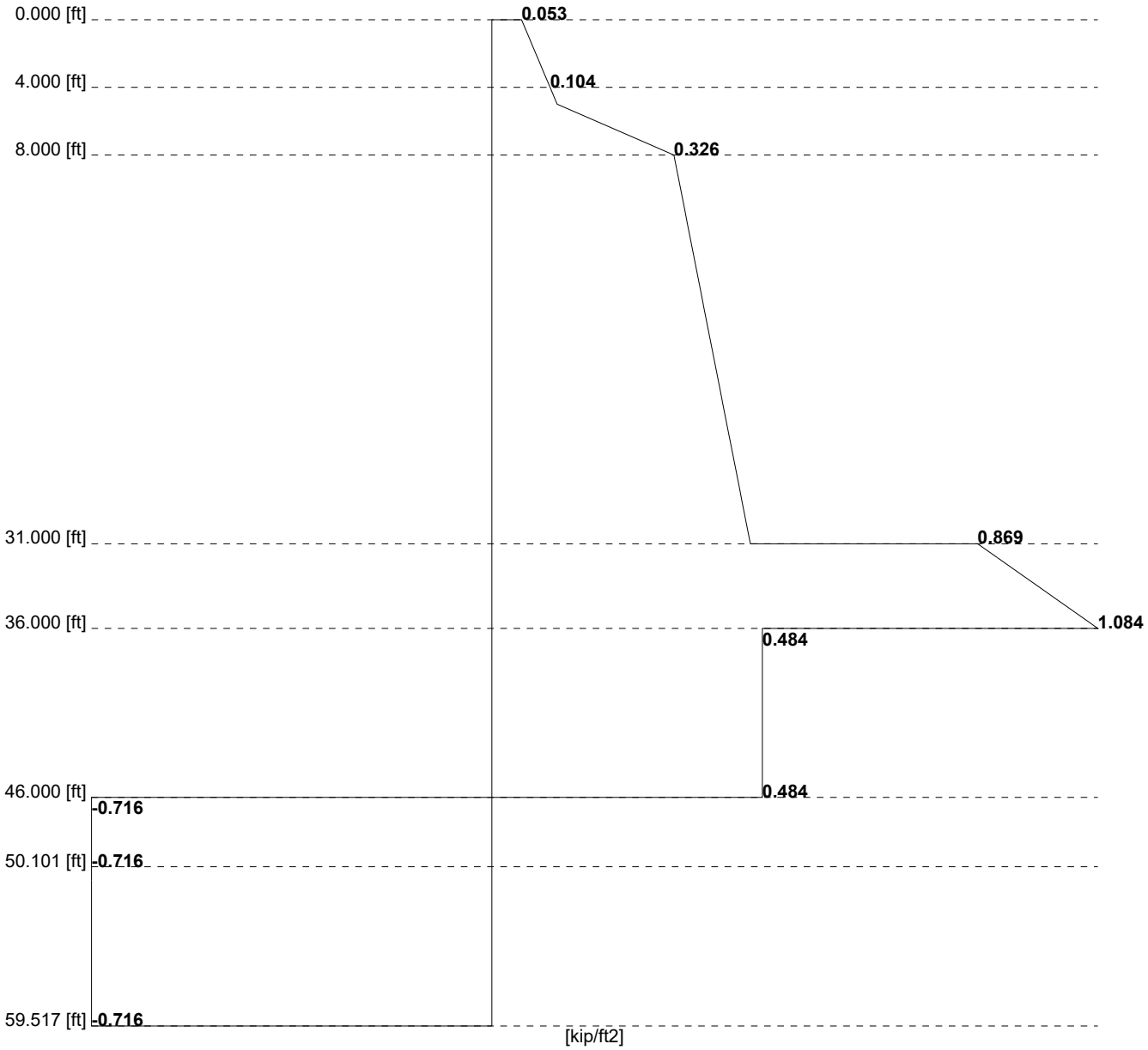
Earth Pressure Diagram



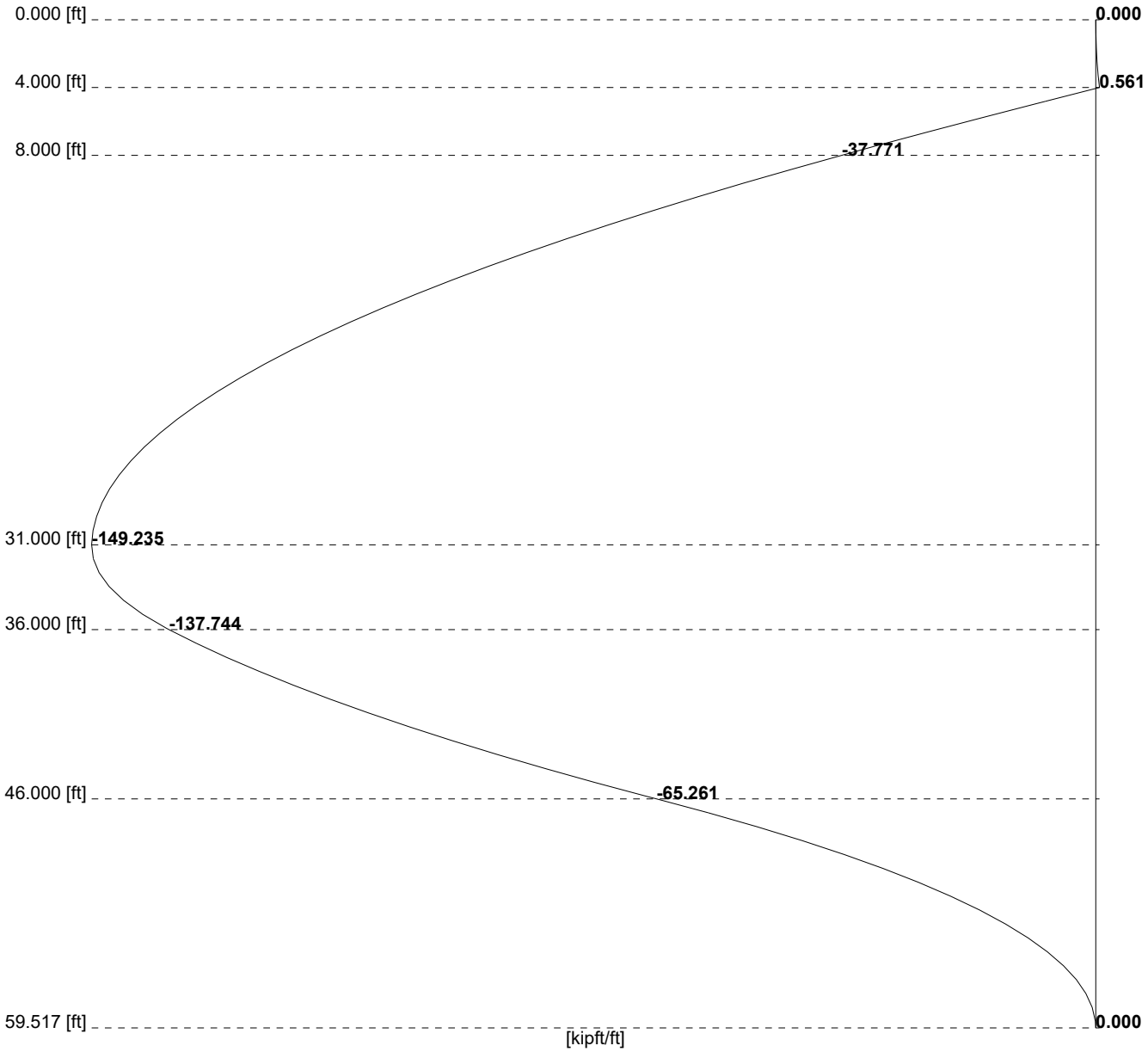
Water Pressure Diagram



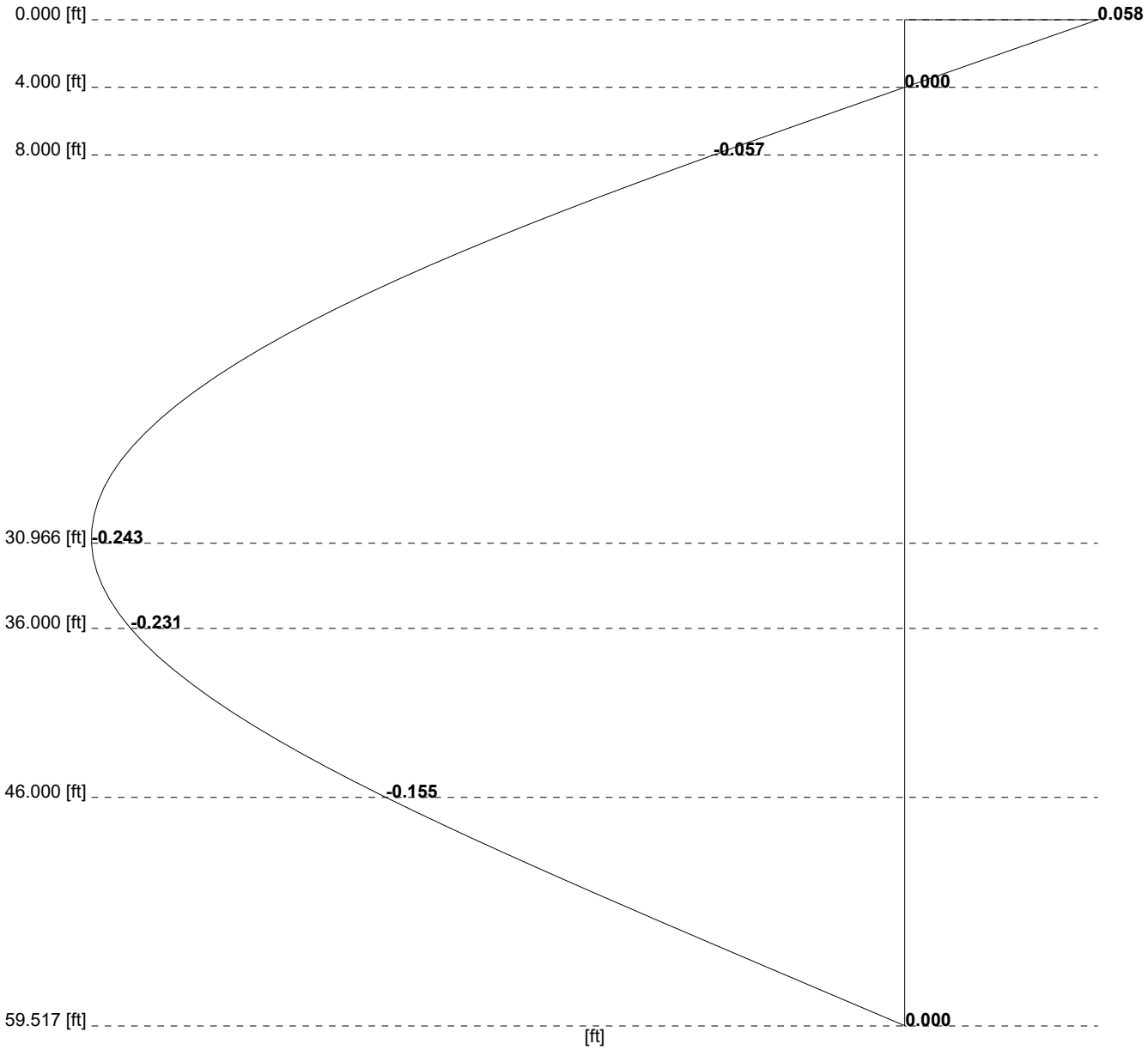
Total Pressure Diagram



Moment Diagram

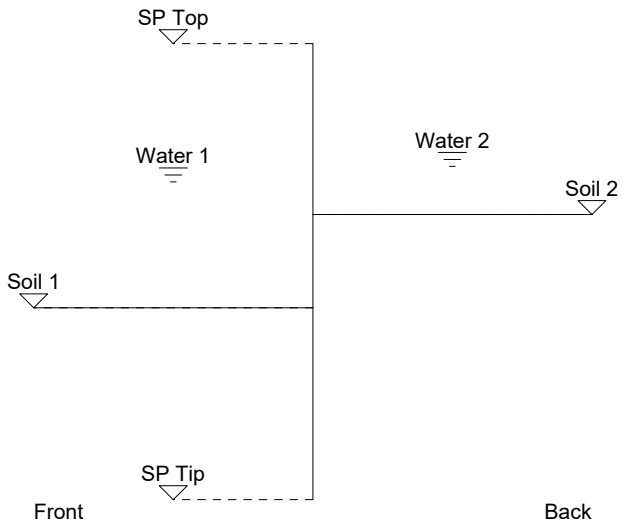


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	29.347
Soil Level in Front [ft]	17.000
Soil Level behind [ft]	11.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	63.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	83.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

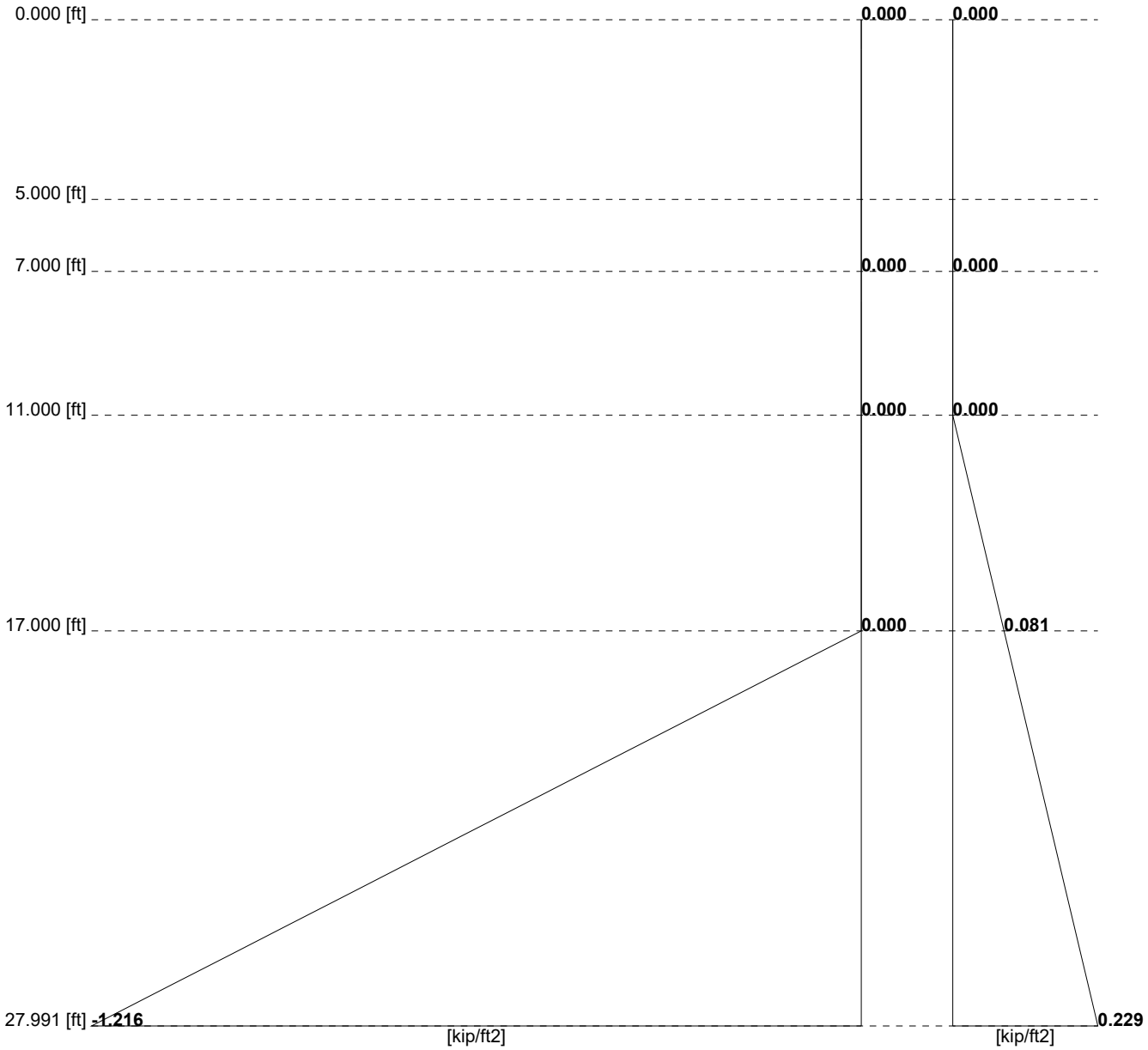
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 2	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 3	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

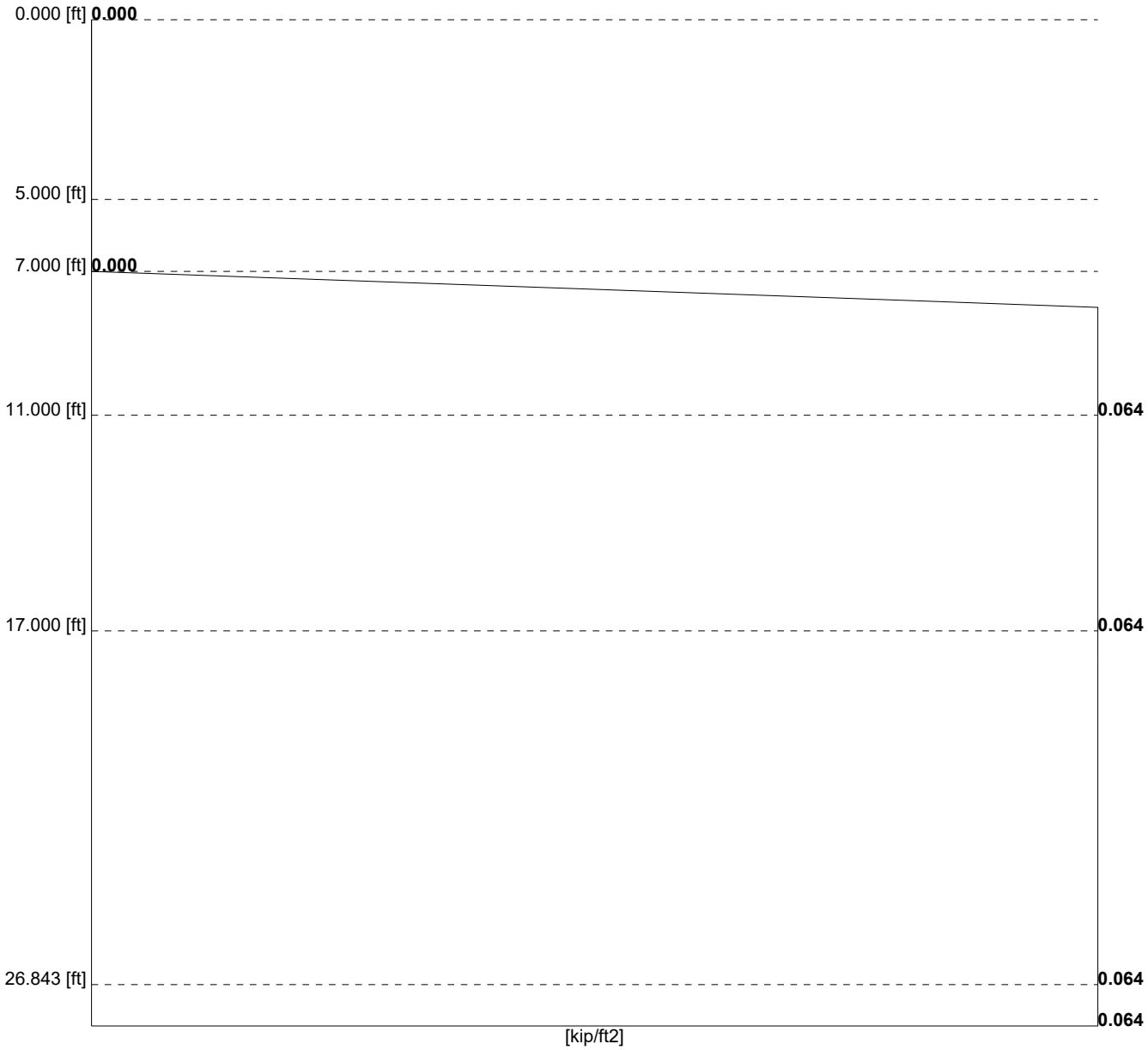
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.210	28.024
Maxmimal Moment [kipft/ft]	7.542	22.742
Normal Forces at Max. Moment [kip/ft]	-0.717	28.024
Normal Forces at Min. Moment [kip/ft]	-0.088	22.742
Deflection at Min. Moment [ft]	0.000	28.024
Deflection at Max. Moment [ft]	0.000	22.742
Min. Stress at Min. Moment [lb/in2]	-82.281	28.024
Max. Stress at Min. Moment [lb/in2]	-23.493	28.024
Min. Stress at Max. Moment [lb/in2]	-1063.127	22.742
Max. Stress at Max. Moment [lb/in2]	1050.127	22.742
Safety > Req. Safety = 1.500	47.031	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	29.347	
Sheet Pile Length [ft]	29.347	
Included OverLength [ft]	1.356	
Vertical Equilibrium [kip/ft]	0.210	
Anchor Force (horiz.) [kip/ft]	0.000	

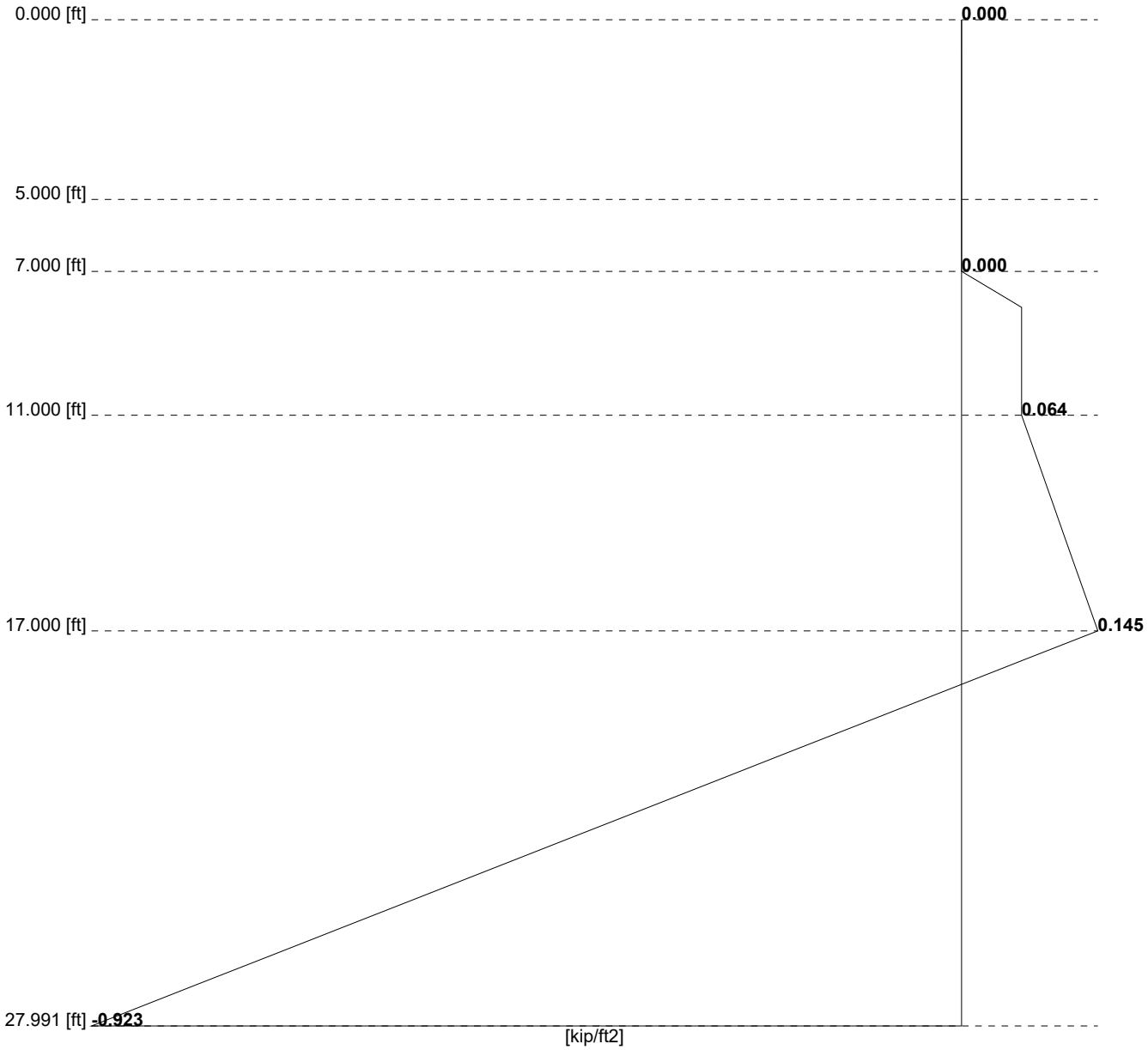
Earth Pressure Diagram



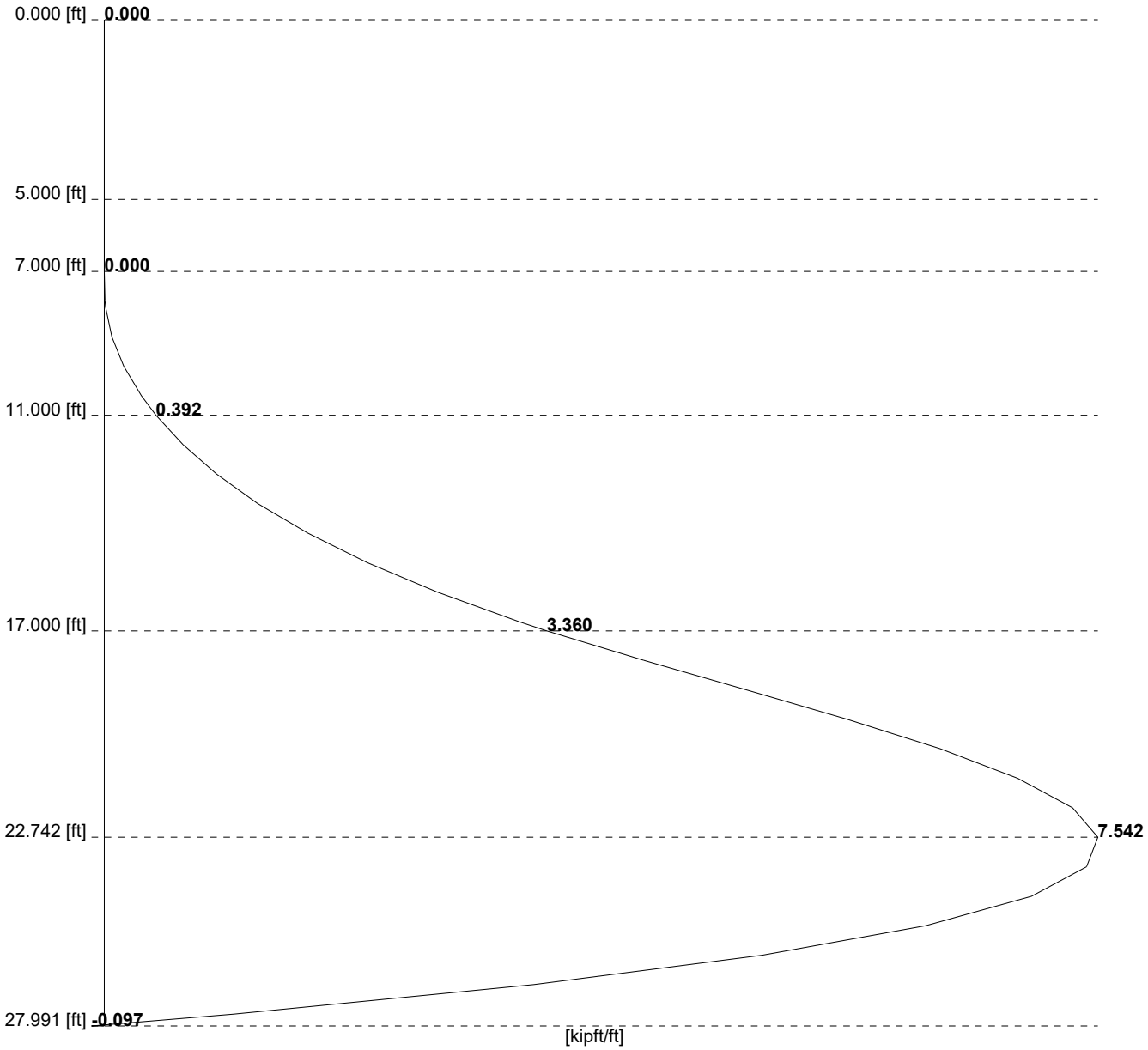
Water Pressure Diagram



Total Pressure Diagram

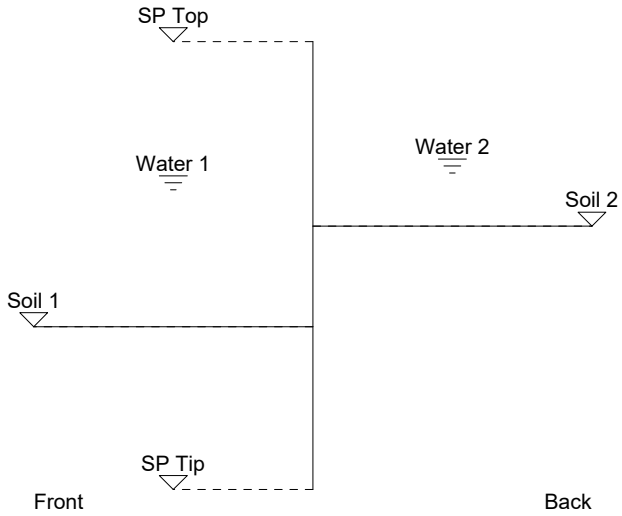


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	26.708
Soil Level in Front [ft]	17.000
Soil Level behind [ft]	11.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	63.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	83.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 2	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 3	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

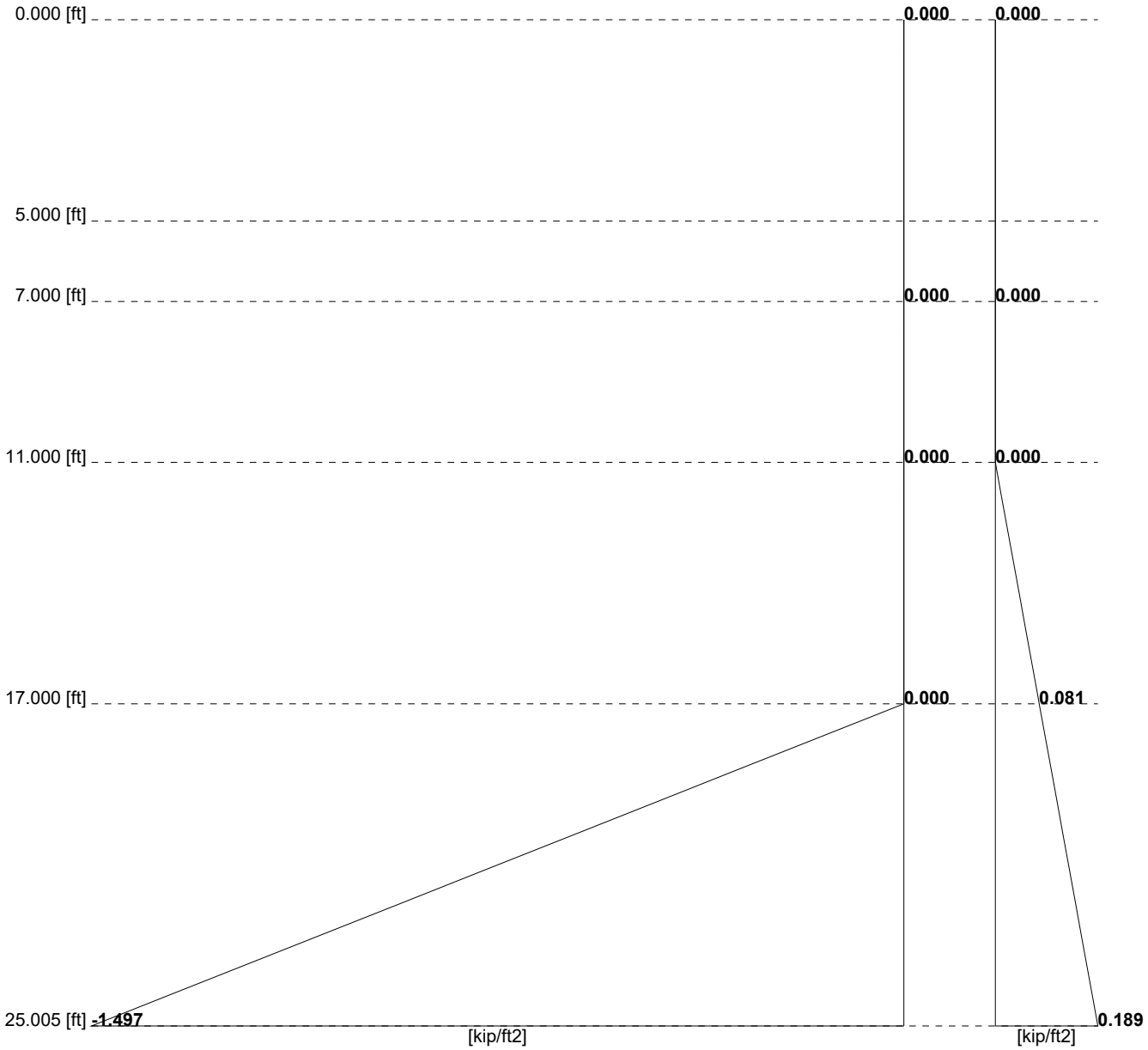
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

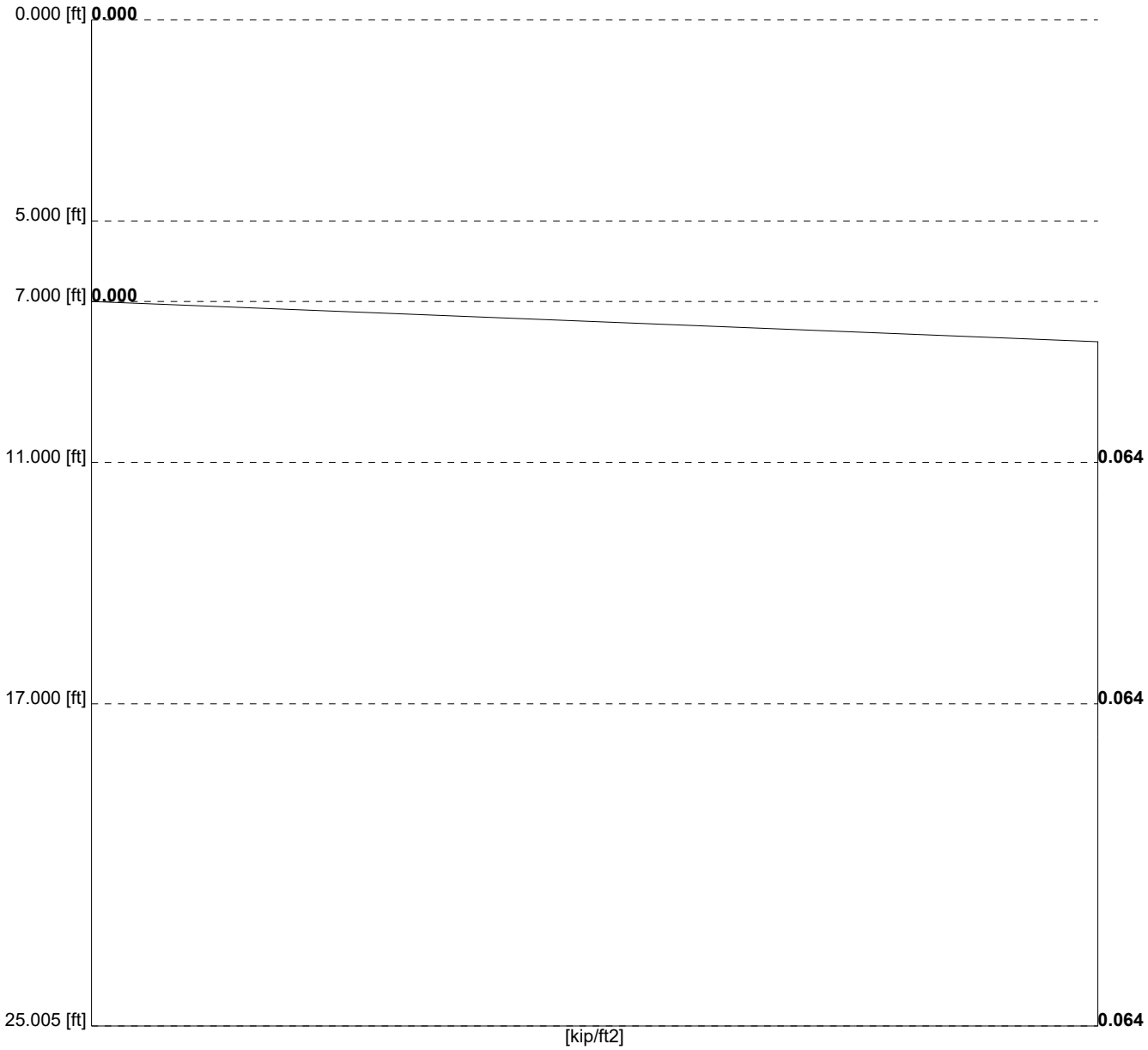
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.175	25.038
Maxmimal Moment [kipft/ft]	6.056	21.068
Normal Forces at Max. Moment [kip/ft]	-1.256	25.038
Normal Forces at Min. Moment [kip/ft]	-0.239	21.068
Deflection at Min. Moment [ft]	0.000	25.038
Deflection at Max. Moment [ft]	0.000	21.068
Min. Stress at Min. Moment [lb/in2]	-117.193	25.038
Max. Stress at Min. Moment [lb/in2]	-68.115	25.038
Min. Stress at Max. Moment [lb/in2]	-866.073	21.068
Max. Stress at Max. Moment [lb/in2]	830.835	21.068
Safety > Req. Safety = 1.500	57.732	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	26.708	
Sheet Pile Length [ft]	26.708	
Included OverLength [ft]	1.703	
Vertical Equilibrium [kip/ft]	-0.296	
Anchor Force (horiz.) [kip/ft]	0.000	

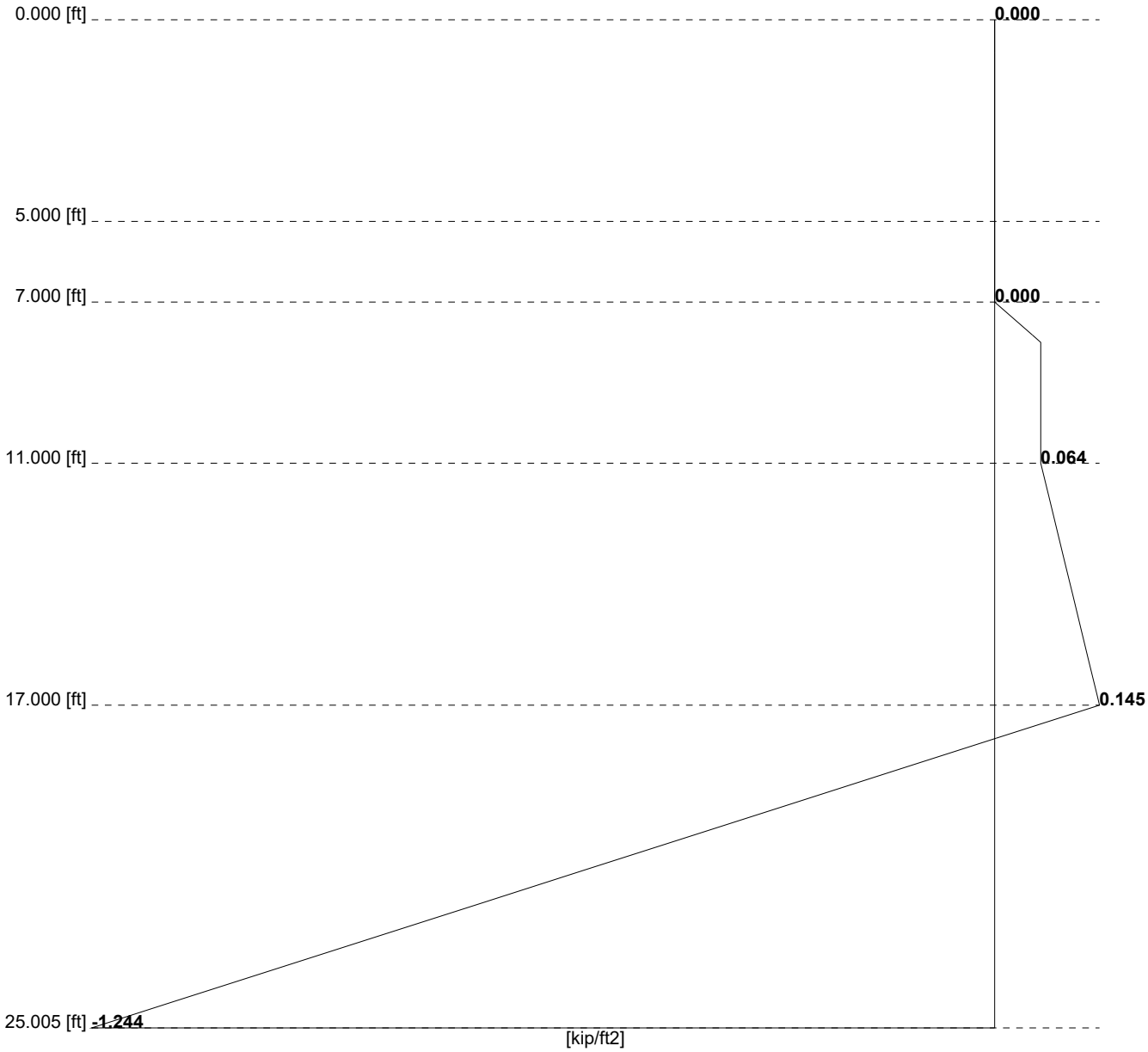
Earth Pressure Diagram



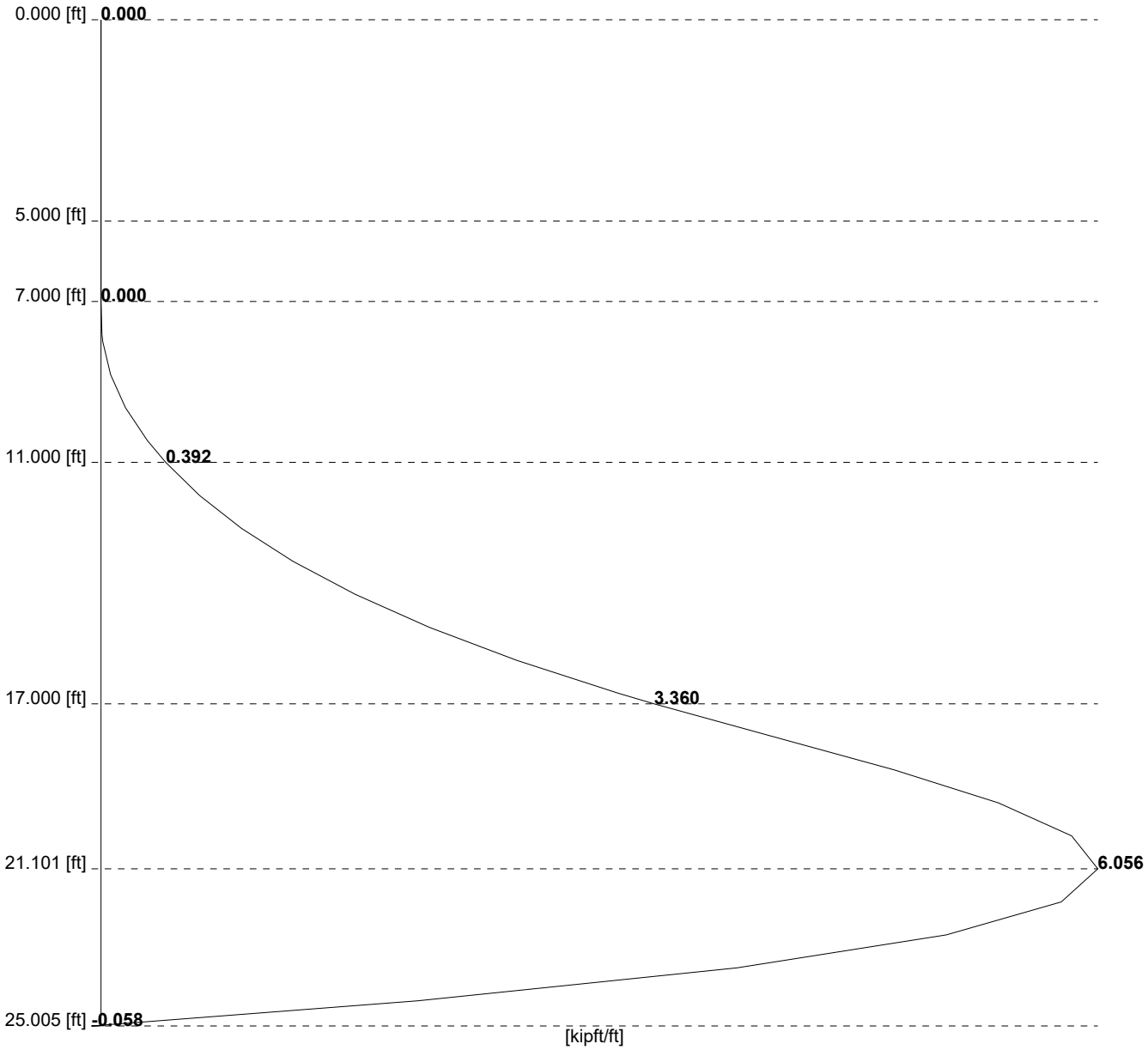
Water Pressure Diagram



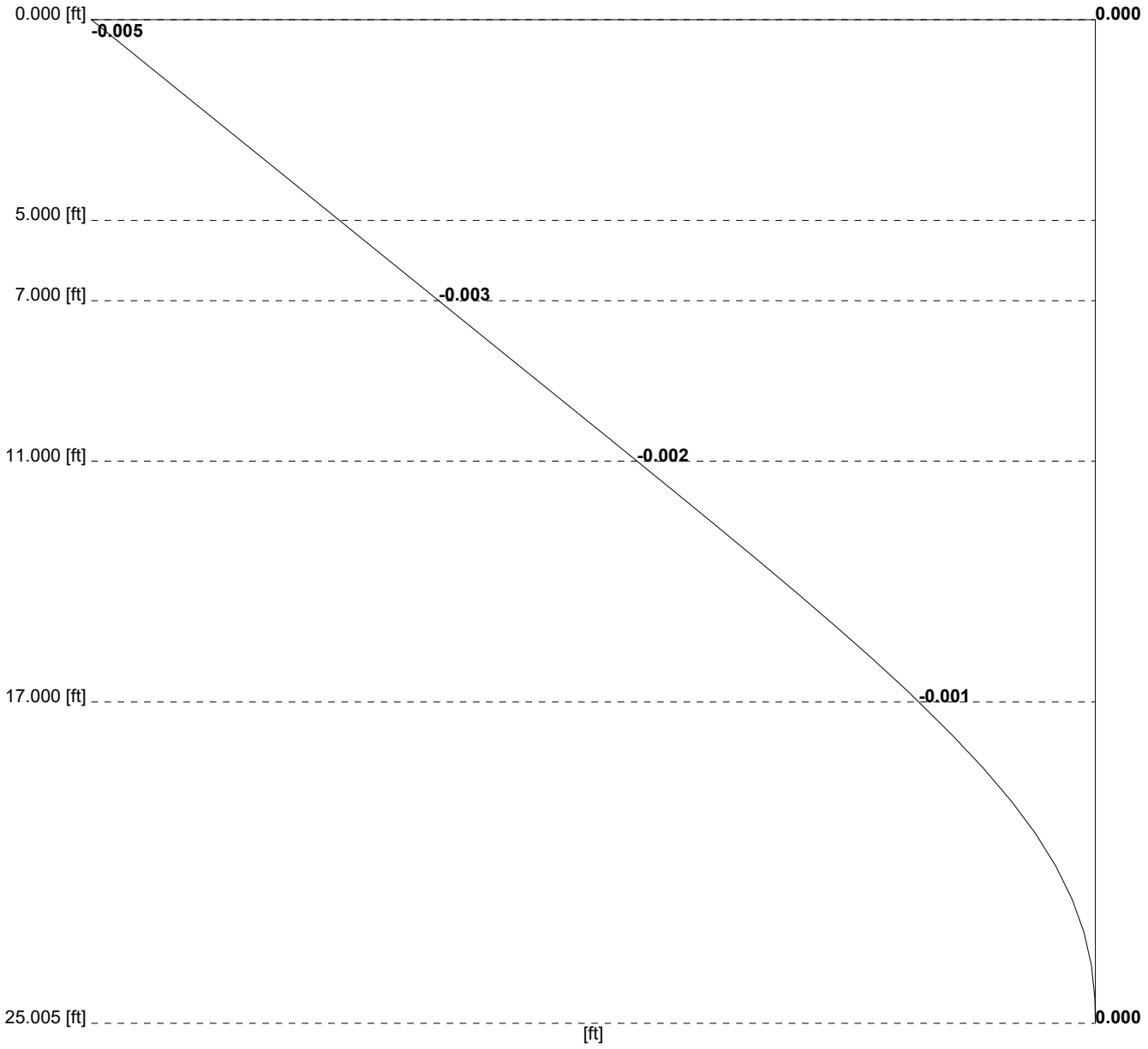
Total Pressure Diagram



Moment Diagram

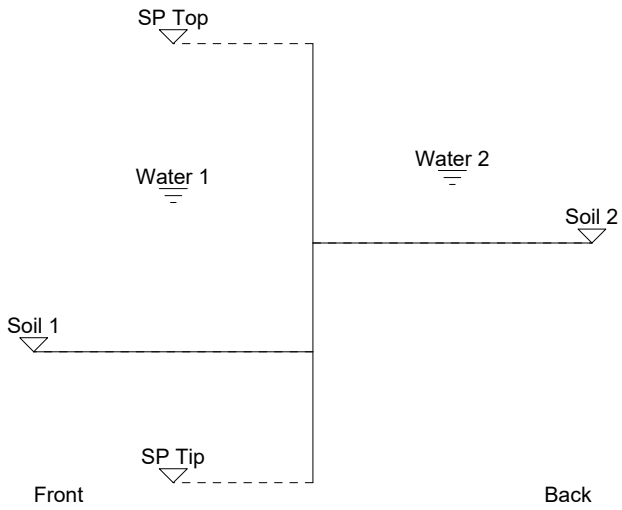


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	24.226
Soil Level in Front [ft]	17.000
Soil Level behind [ft]	11.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

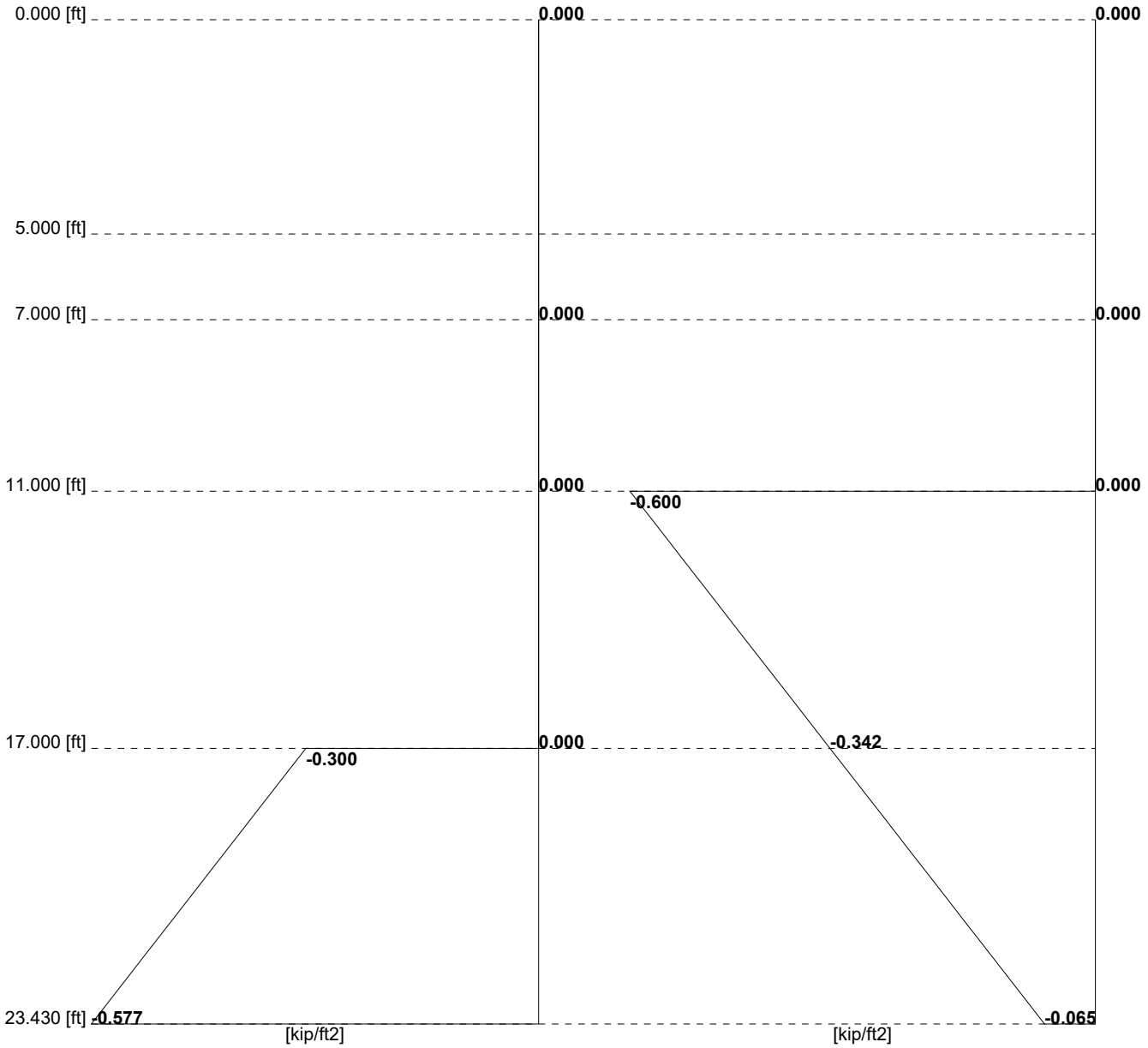
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

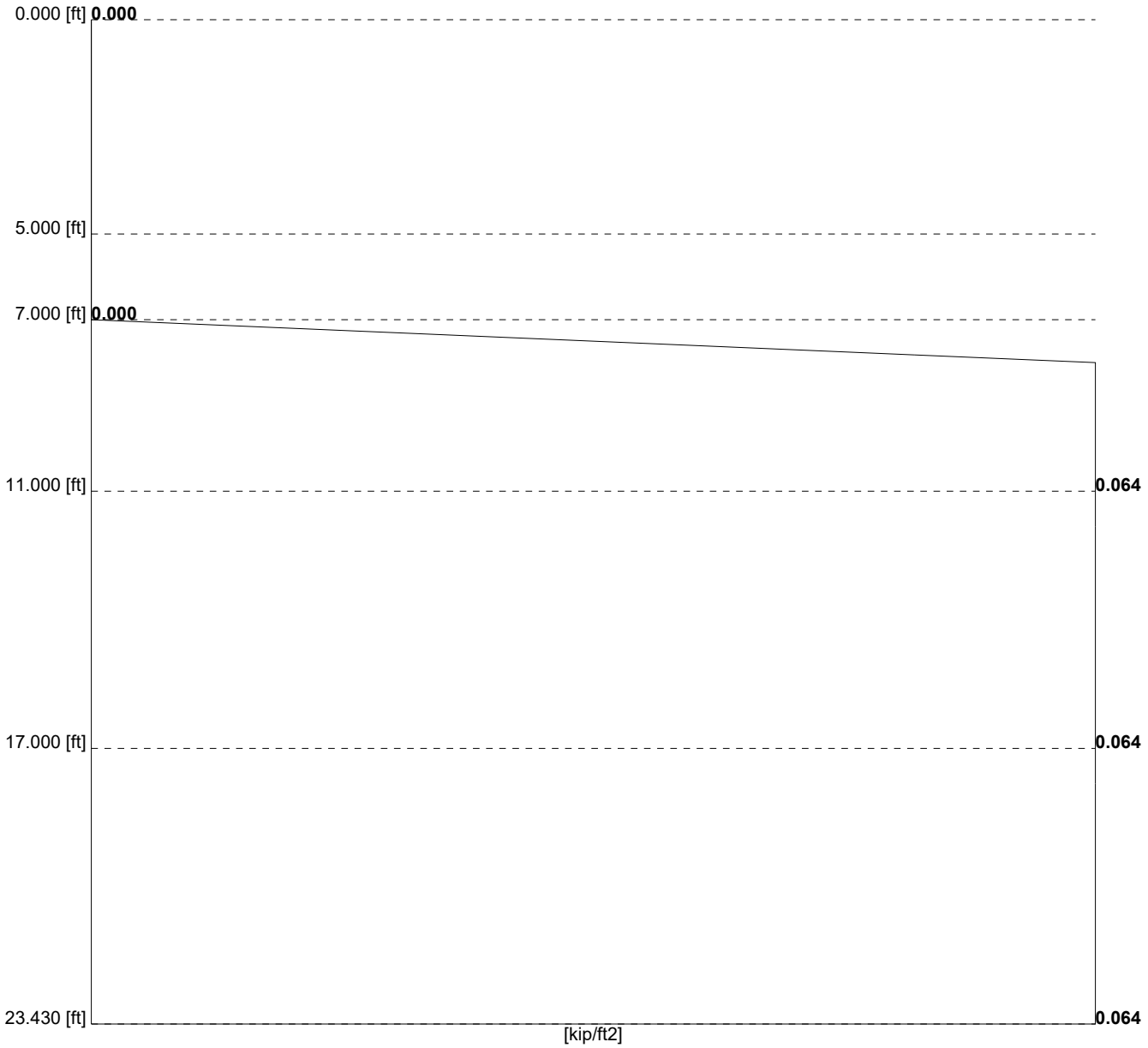
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.090	23.463
Maxmimal Moment [kipft/ft]	3.556	19.165
Normal Forces at Max. Moment [kip/ft]	0.000	23.463
Normal Forces at Min. Moment [kip/ft]	0.000	19.165
Deflection at Min. Moment [ft]	0.000	23.463
Deflection at Max. Moment [ft]	0.000	19.165
Min. Stress at Min. Moment [lb/in2]	-12.657	23.463
Max. Stress at Min. Moment [lb/in2]	12.657	23.463
Min. Stress at Max. Moment [lb/in2]	-498.229	19.165
Max. Stress at Max. Moment [lb/in2]	498.229	19.165
Safety > Req. Safety = 1.500	100.356	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	24.226	
Sheet Pile Length [ft]	24.226	
Included OverLength [ft]	0.795	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

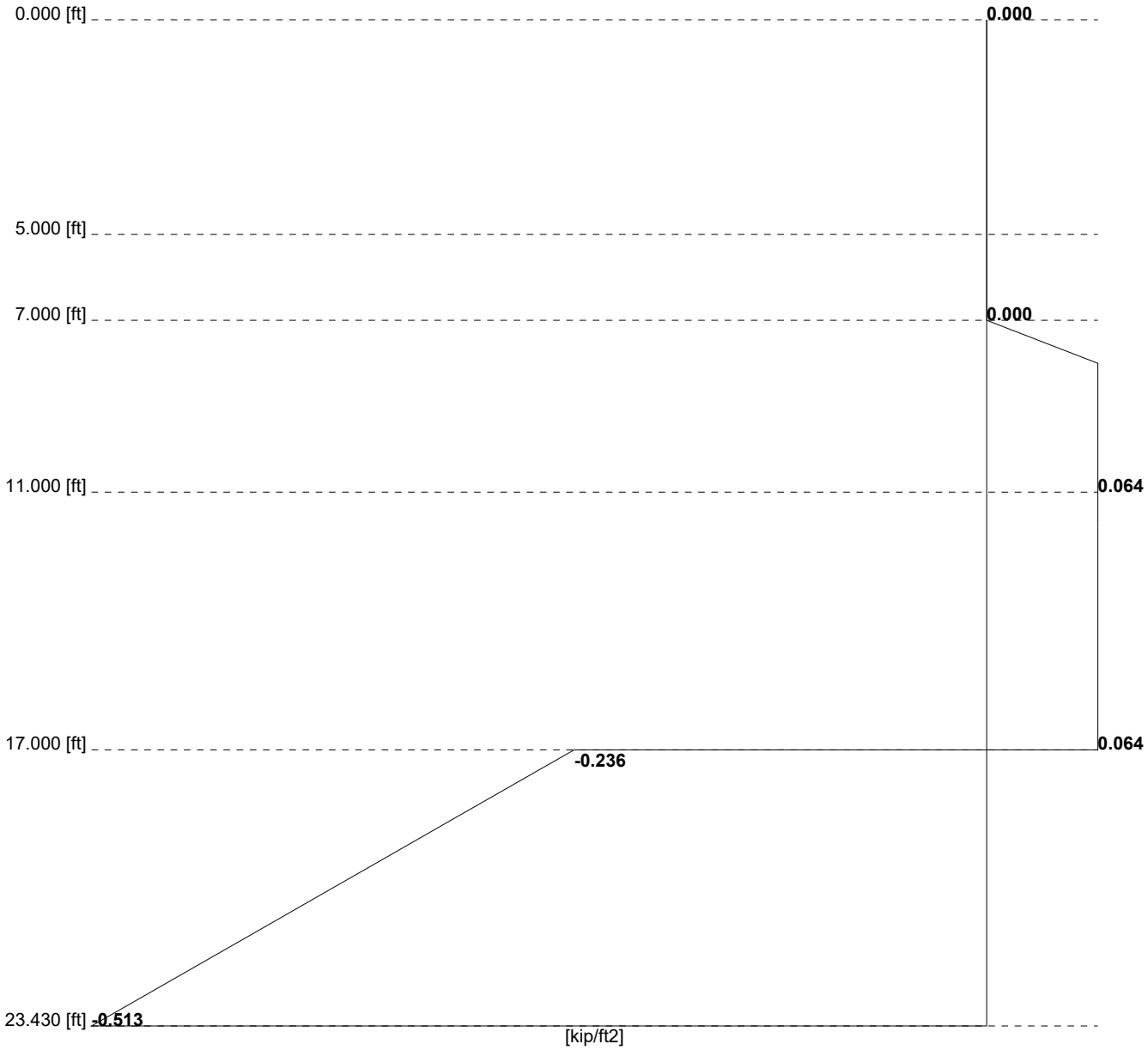
Earth Pressure Diagram



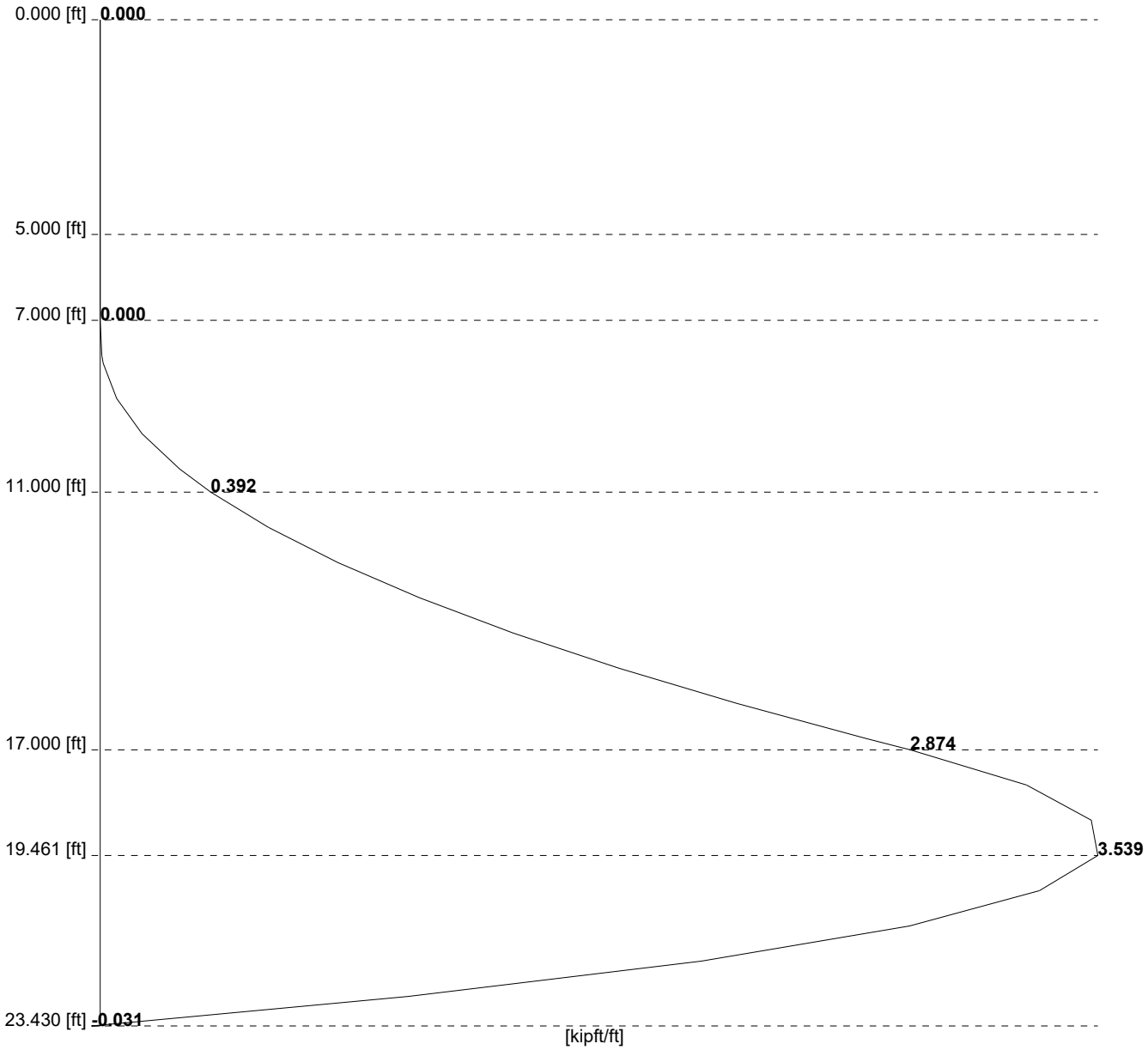
Water Pressure Diagram



Total Pressure Diagram

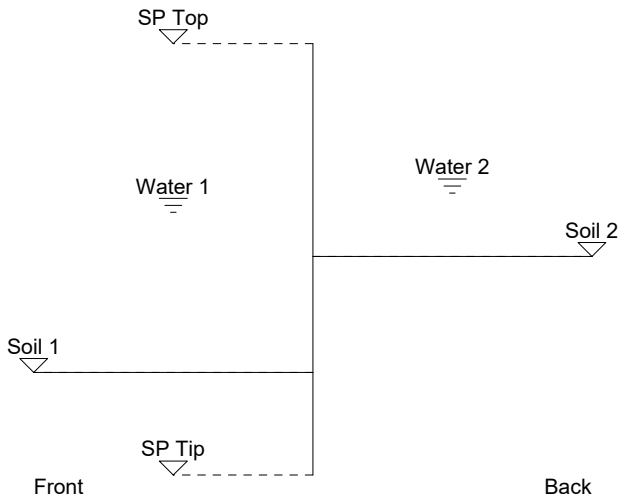


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	22.304
Soil Level in Front [ft]	17.000
Soil Level behind [ft]	11.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	7.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	0.243	34.000	18.360	0.000

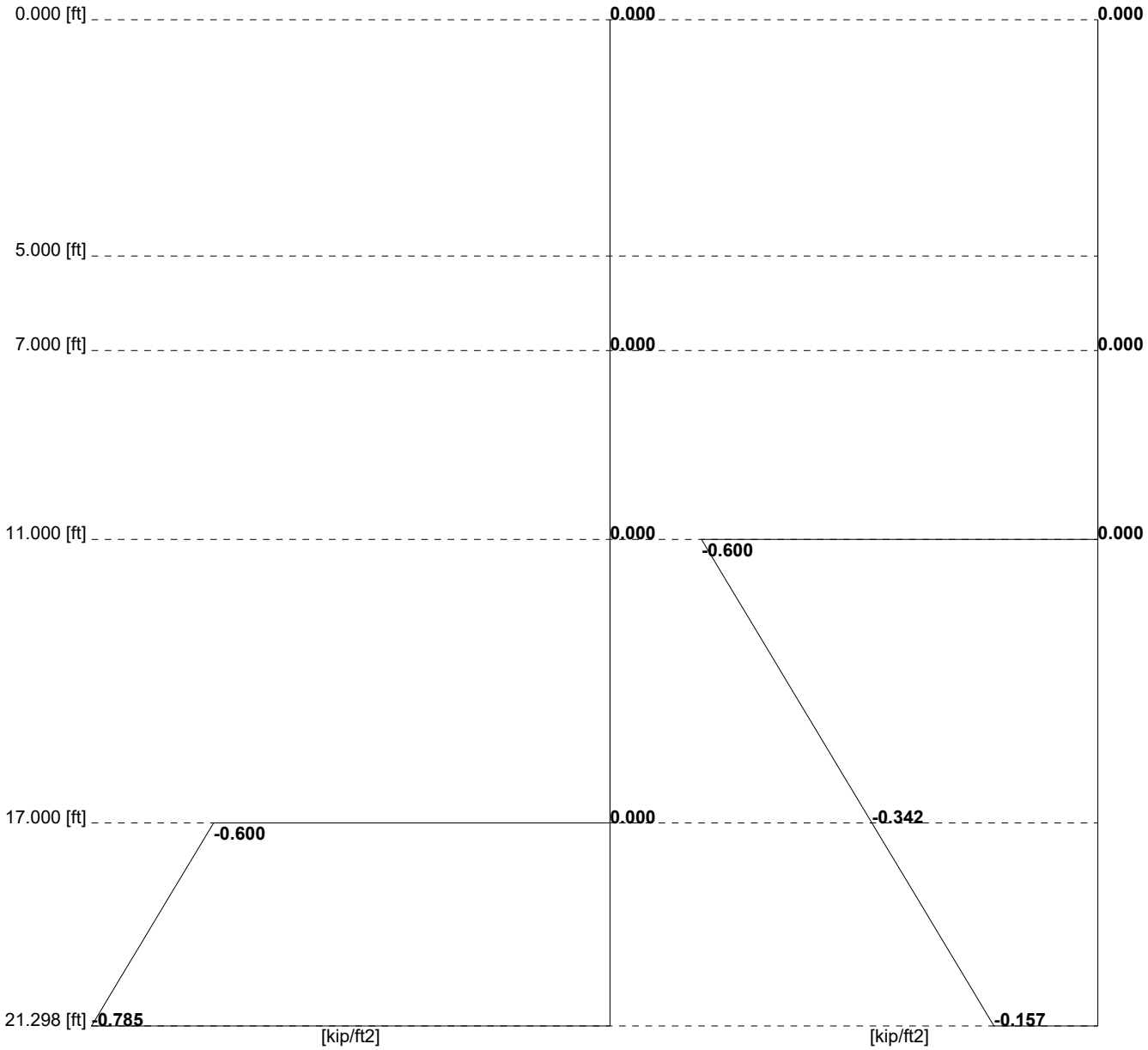
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

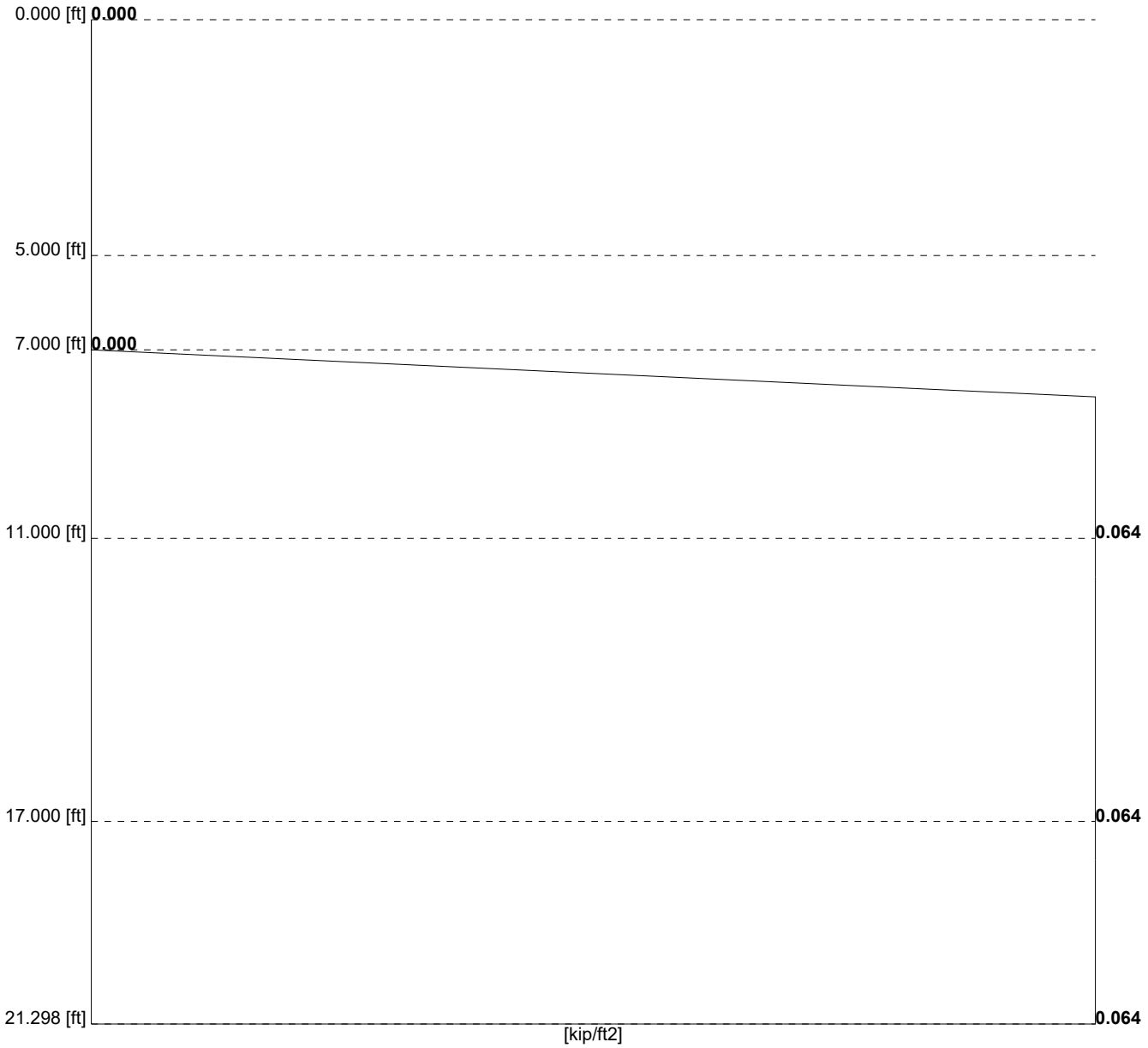
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.120	21.331
Maxmimal Moment [kipft/ft]	3.186	17.820
Normal Forces at Max. Moment [kip/ft]	0.000	21.331
Normal Forces at Min. Moment [kip/ft]	0.000	17.820
Deflection at Min. Moment [ft]	0.000	21.331
Deflection at Max. Moment [ft]	0.000	17.820
Min. Stress at Min. Moment [lb/in2]	-16.751	21.331
Max. Stress at Min. Moment [lb/in2]	16.751	21.331
Min. Stress at Max. Moment [lb/in2]	-446.298	17.820
Max. Stress at Max. Moment [lb/in2]	446.298	17.820
Safety > Req. Safety = 1.500	112.033	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	22.304	
Sheet Pile Length [ft]	22.304	
Included OverLength [ft]	1.006	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

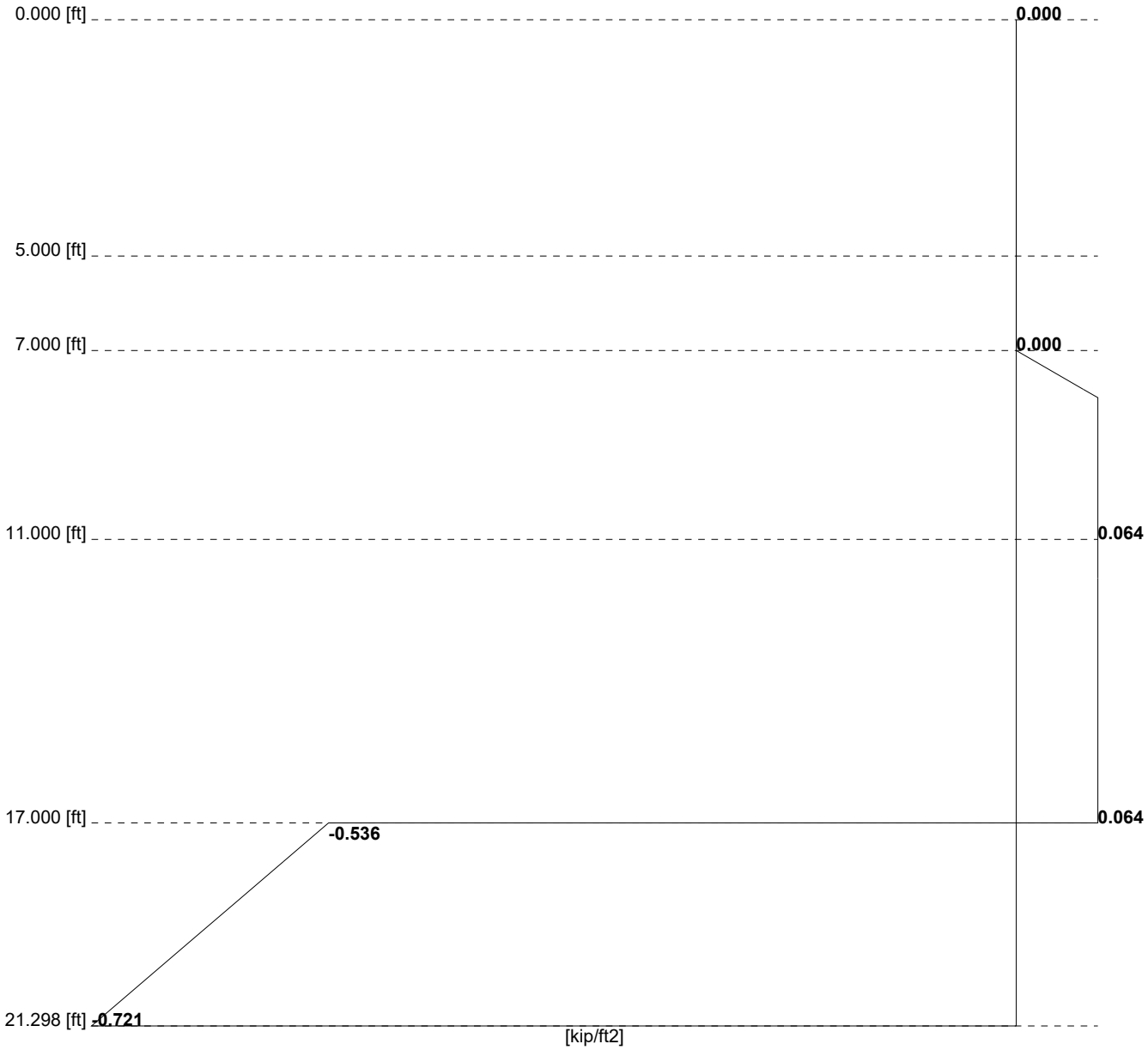
Earth Pressure Diagram



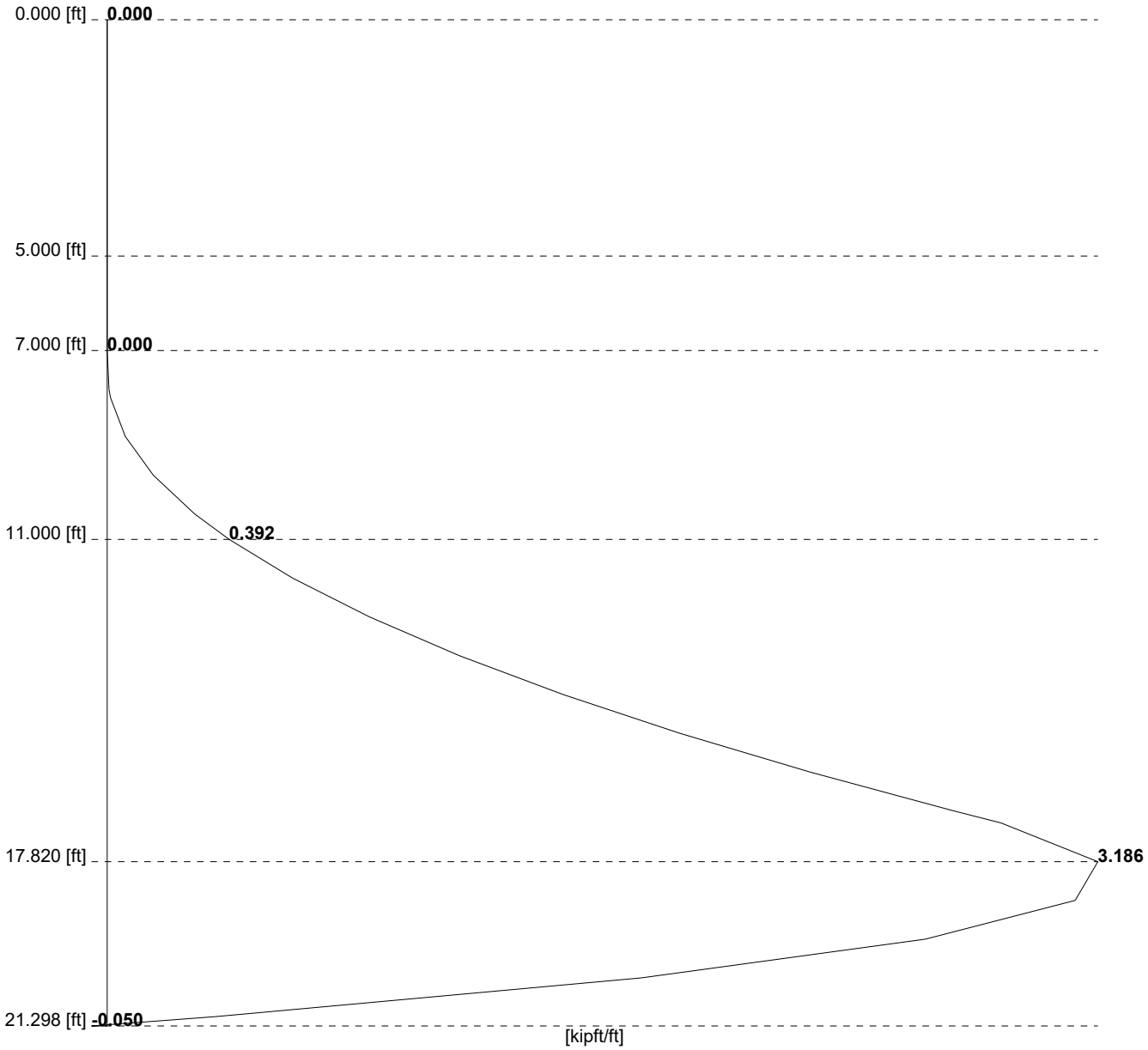
Water Pressure Diagram



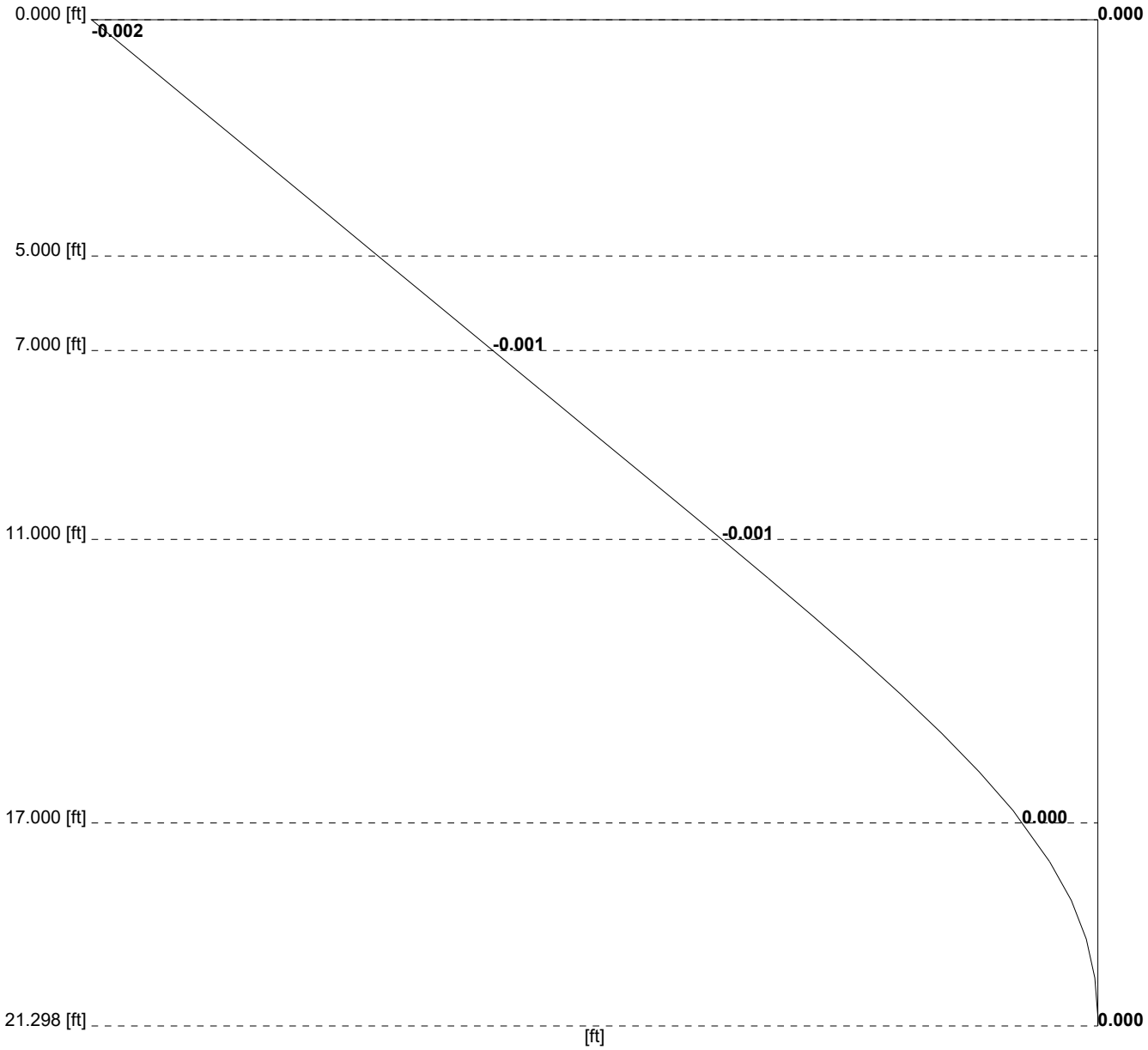
Total Pressure Diagram



Moment Diagram

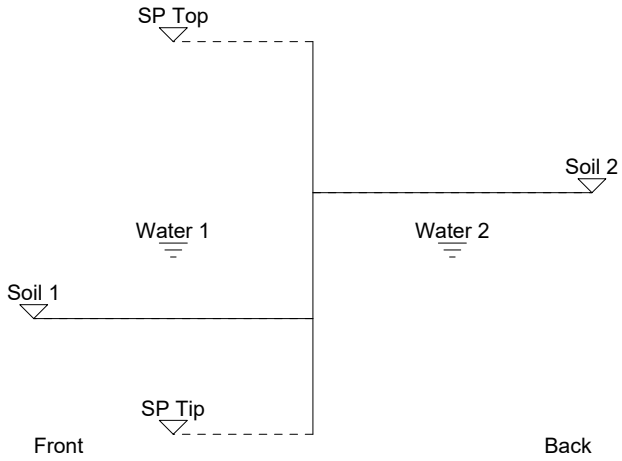


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	15.598
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

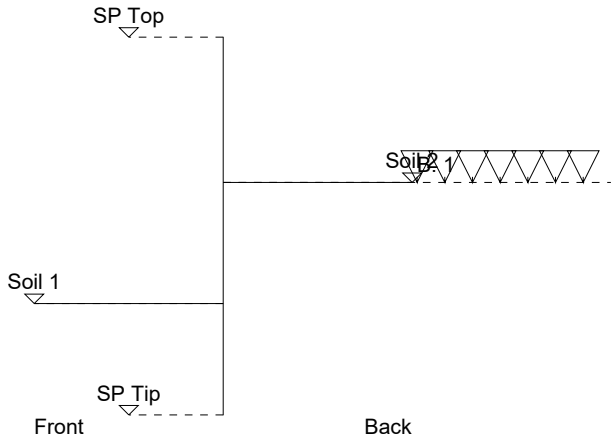
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	63.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	83.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

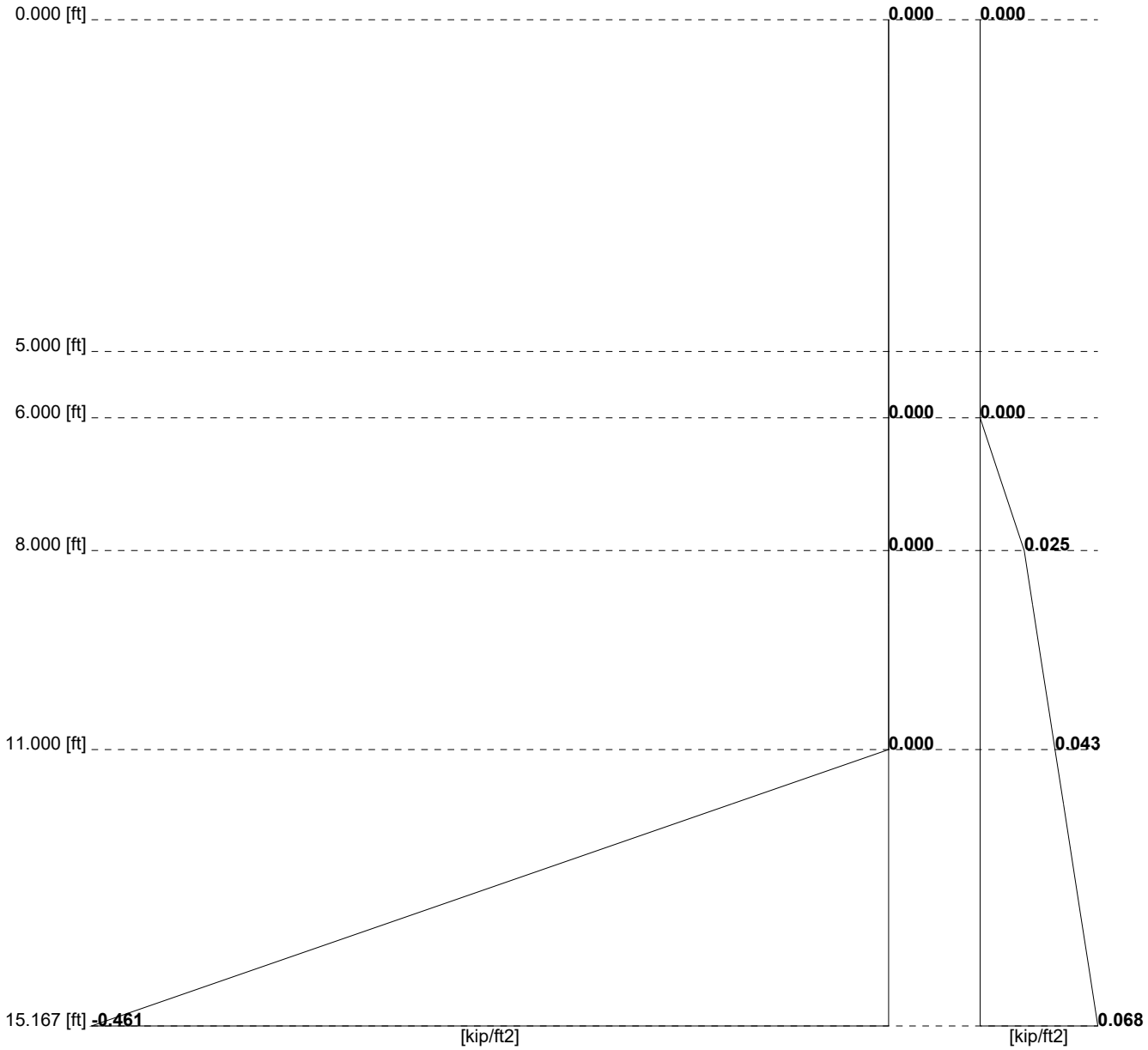
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



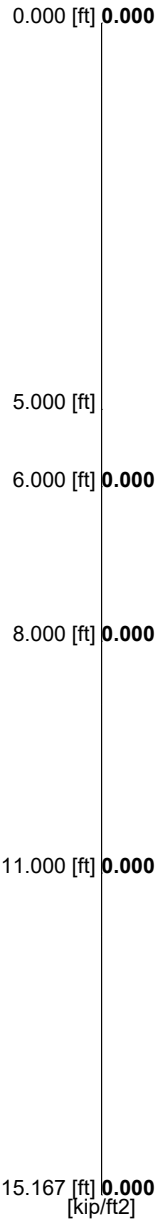
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.018	15.200
Maxmimal Moment [kipft/ft]	0.479	13.198
Normal Forces at Max. Moment [kip/ft]	-0.024	15.200
Normal Forces at Min. Moment [kip/ft]	0.040	13.198
Deflection at Min. Moment [ft]	0.000	15.200
Deflection at Max. Moment [ft]	0.000	13.198
Min. Stress at Min. Moment [lb/in2]	-4.325	15.200
Max. Stress at Min. Moment [lb/in2]	0.807	15.200
Min. Stress at Max. Moment [lb/in2]	-64.065	13.198
Max. Stress at Max. Moment [lb/in2]	70.027	13.198
Safety > Req. Safety = 1.500	714.014	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	15.598	
Sheet Pile Length [ft]	15.598	
Included OverLength [ft]	0.431	
Vertical Equilibrium [kip/ft]	0.175	
Anchor Force (horiz.) [kip/ft]	0.000	

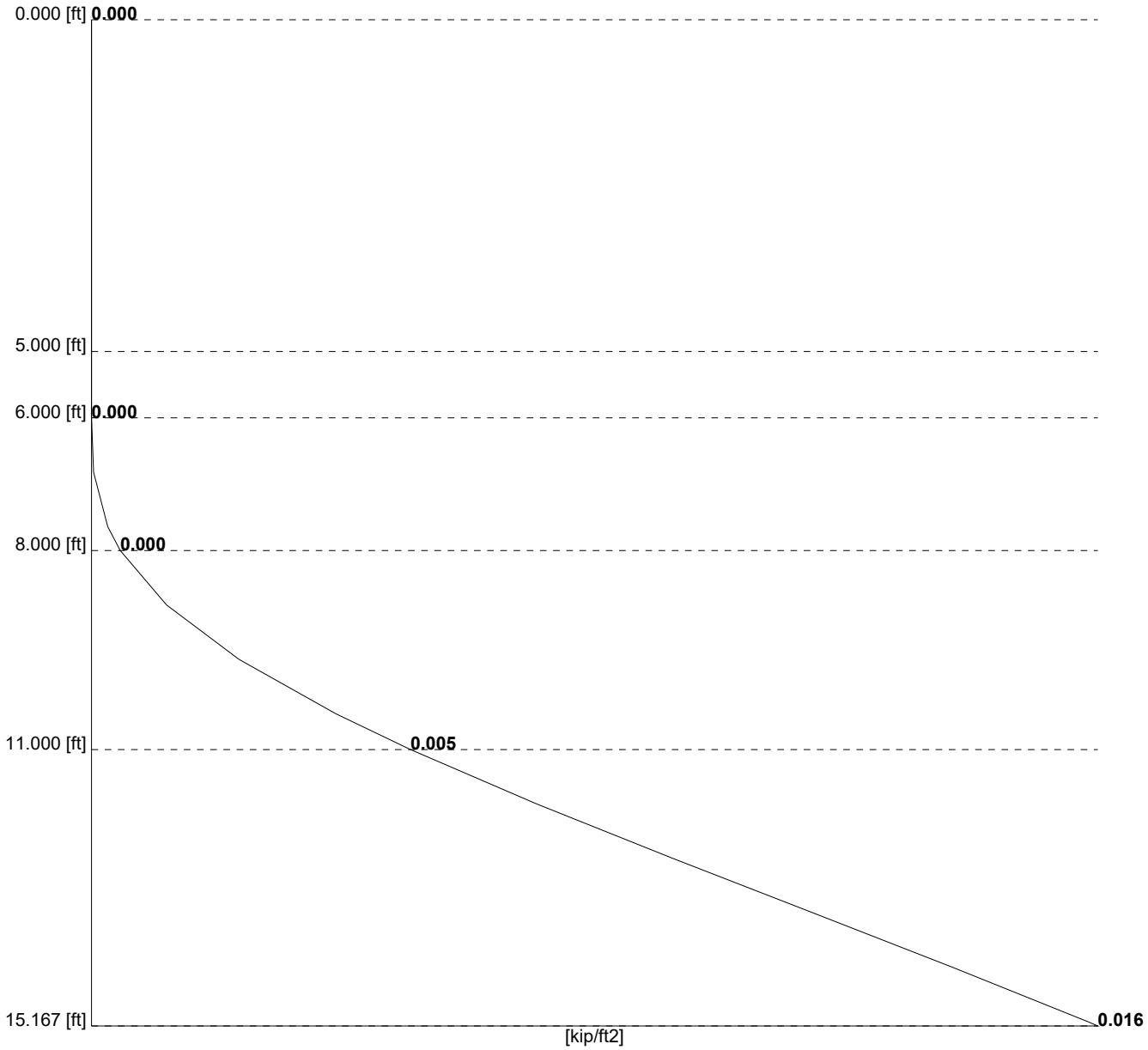
Earth Pressure Diagram



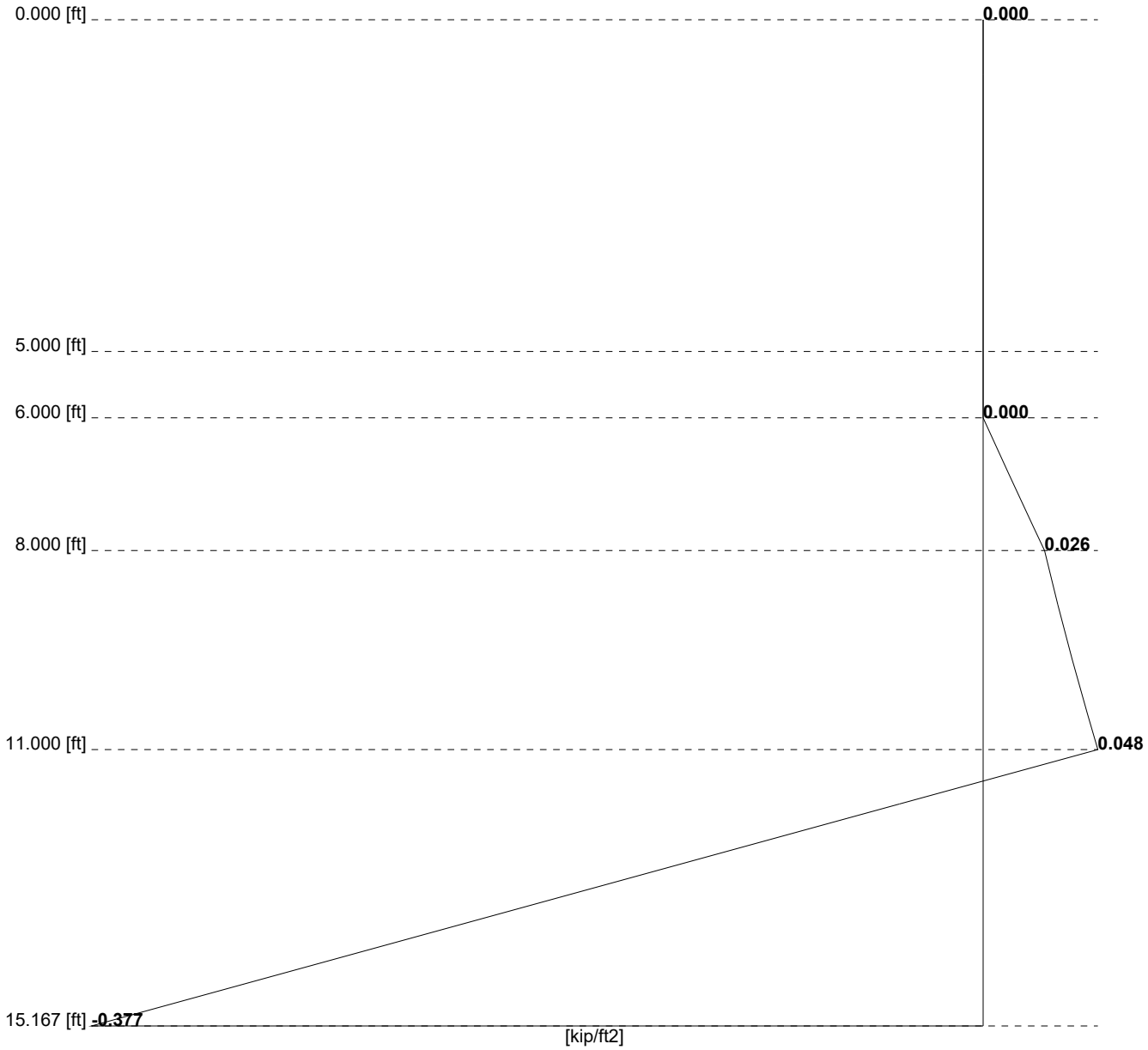
Water Pressure Diagram



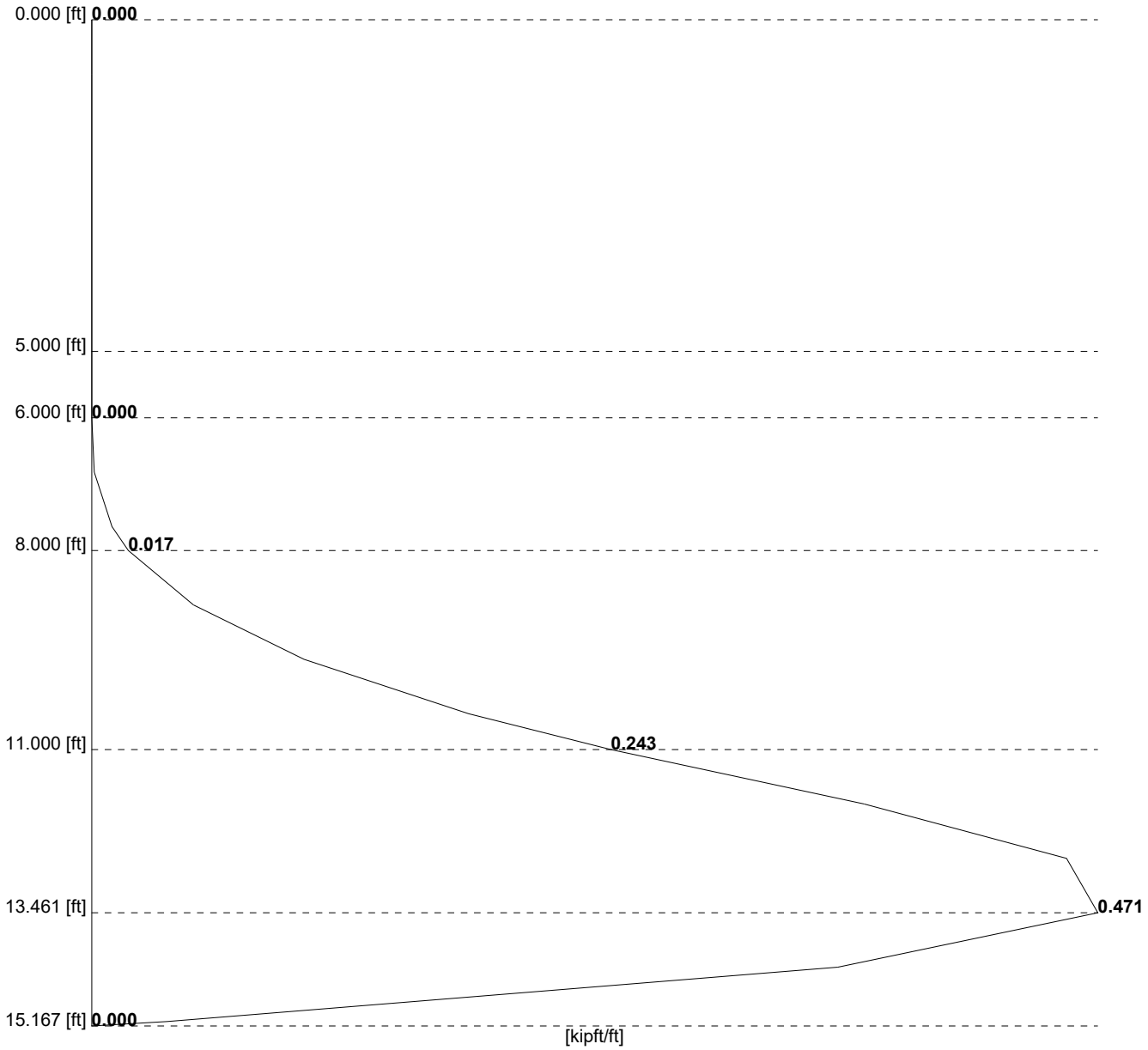
Boussinesq Diagram



Total Pressure Diagram

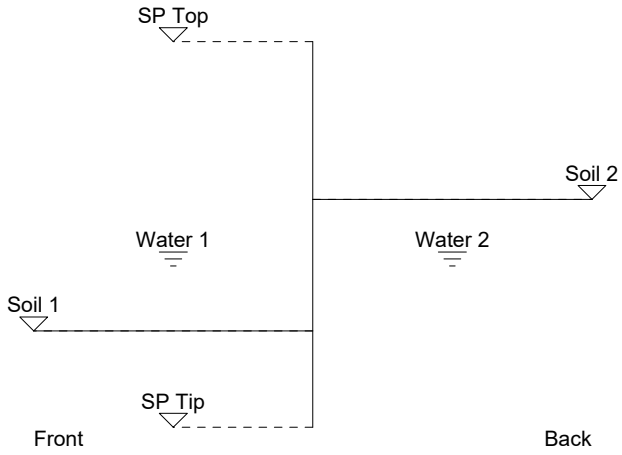


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	14.664
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

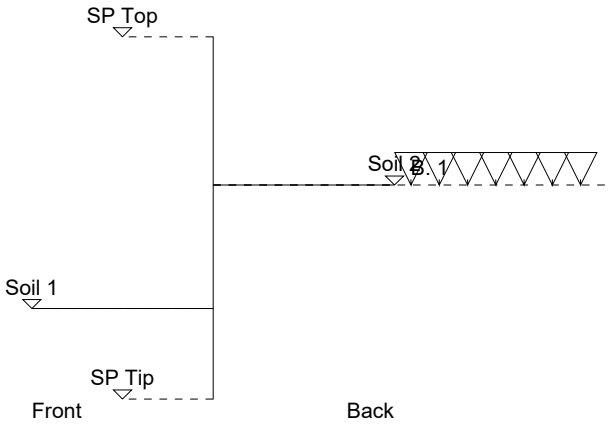
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	63.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	83.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



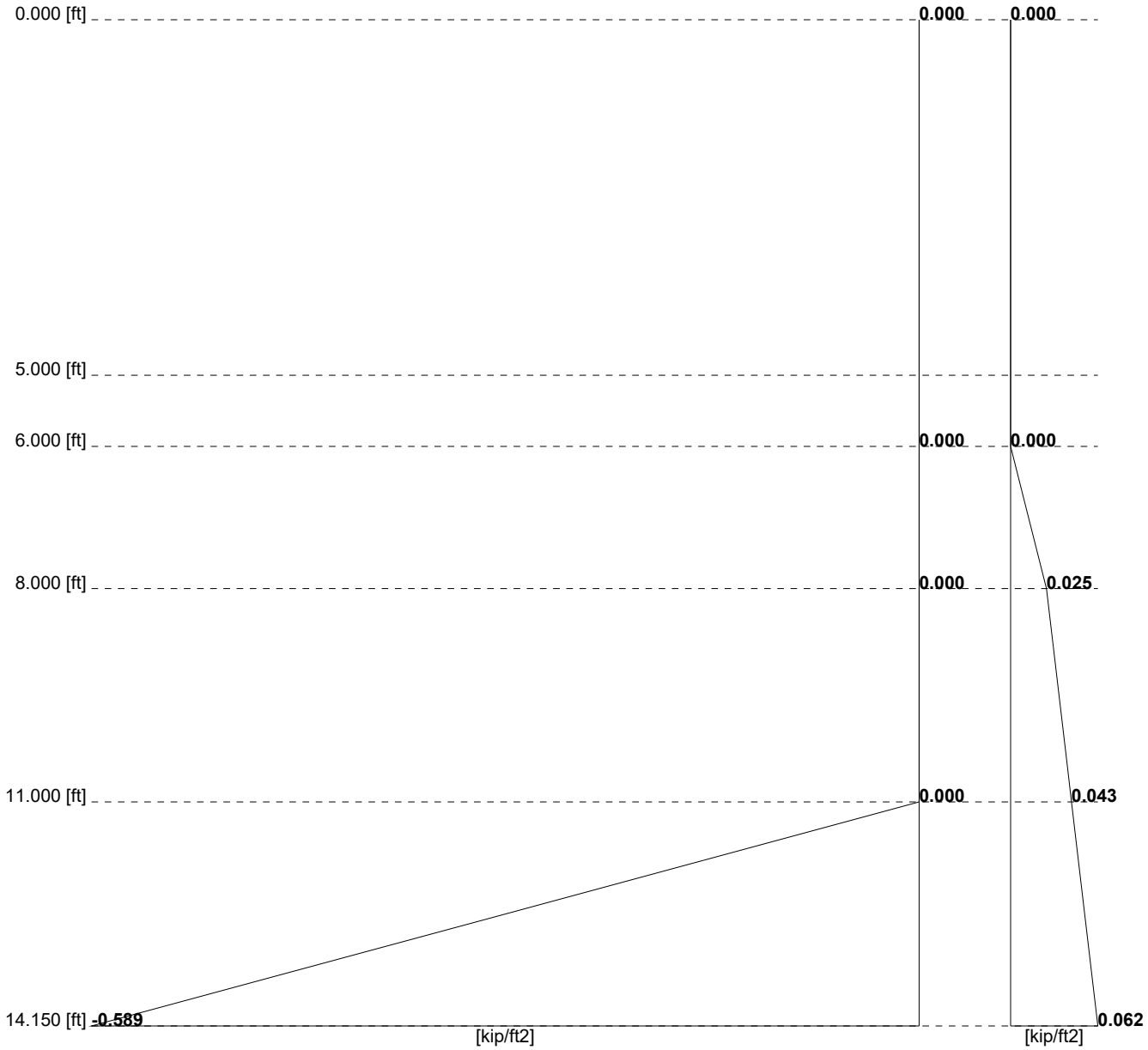
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

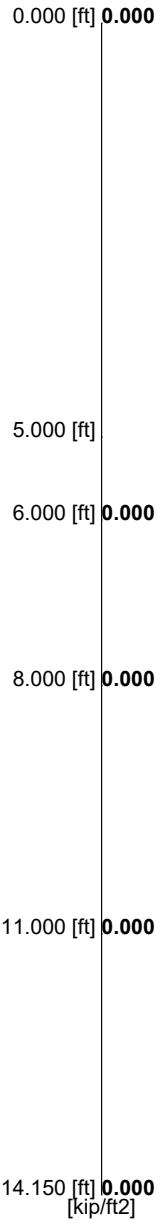
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.037	14.182
Maxmimal Moment [kipft/ft]	0.402	12.542
Normal Forces at Max. Moment [kip/ft]	-0.127	14.182
Normal Forces at Min. Moment [kip/ft]	0.015	12.542
Deflection at Min. Moment [ft]	0.000	14.182
Deflection at Max. Moment [ft]	0.000	12.542
Min. Stress at Min. Moment [lb/in2]	-14.559	14.182
Max. Stress at Min. Moment [lb/in2]	-4.231	14.182
Min. Stress at Max. Moment [lb/in2]	-55.144	12.542
Max. Stress at Max. Moment [lb/in2]	57.371	12.542
Safety > Req. Safety = 1.500	871.517	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	14.664	
Sheet Pile Length [ft]	14.664	
Included OverLength [ft]	0.514	
Vertical Equilibrium [kip/ft]	0.089	
Anchor Force (horiz.) [kip/ft]	0.000	

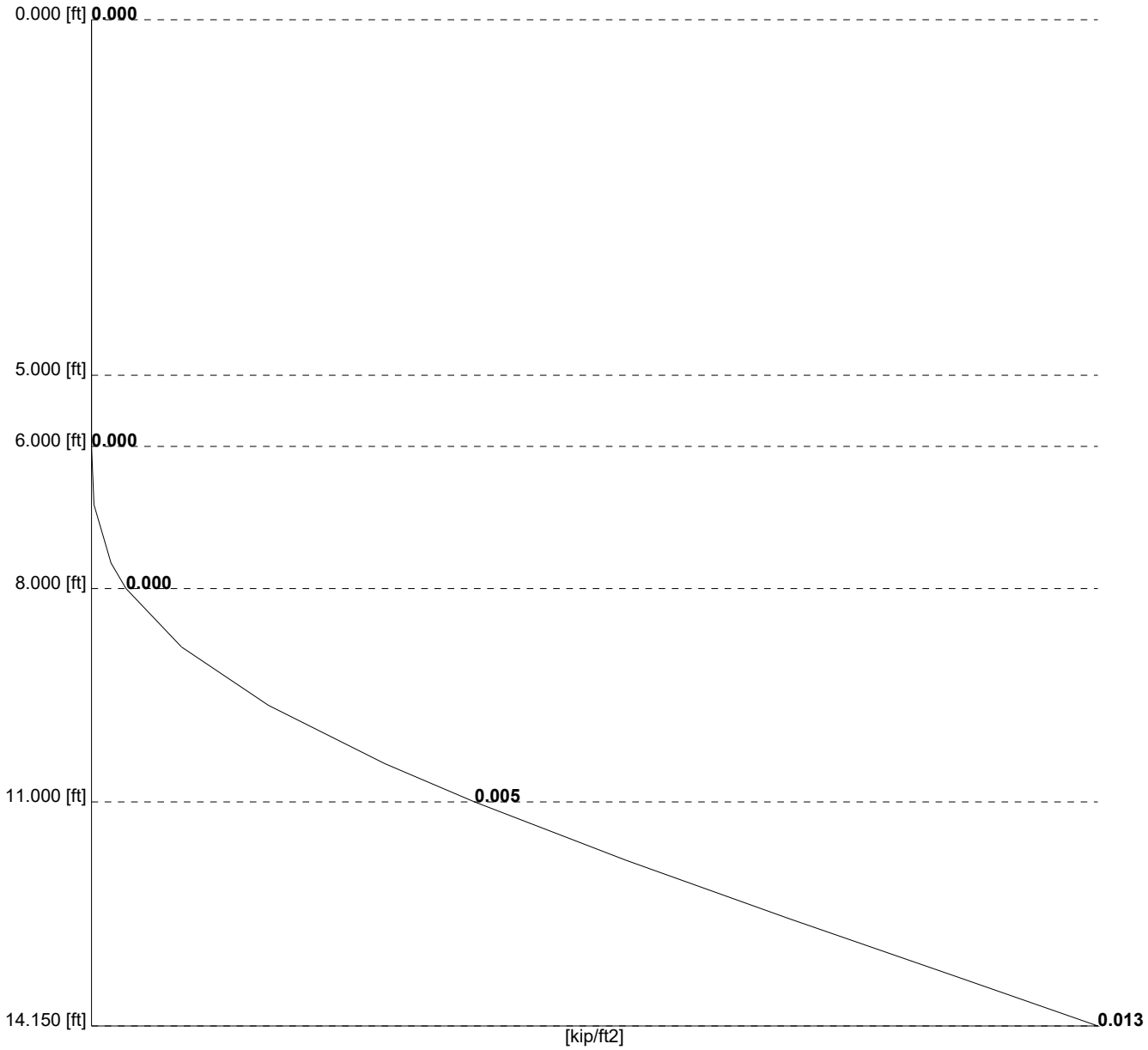
Earth Pressure Diagram



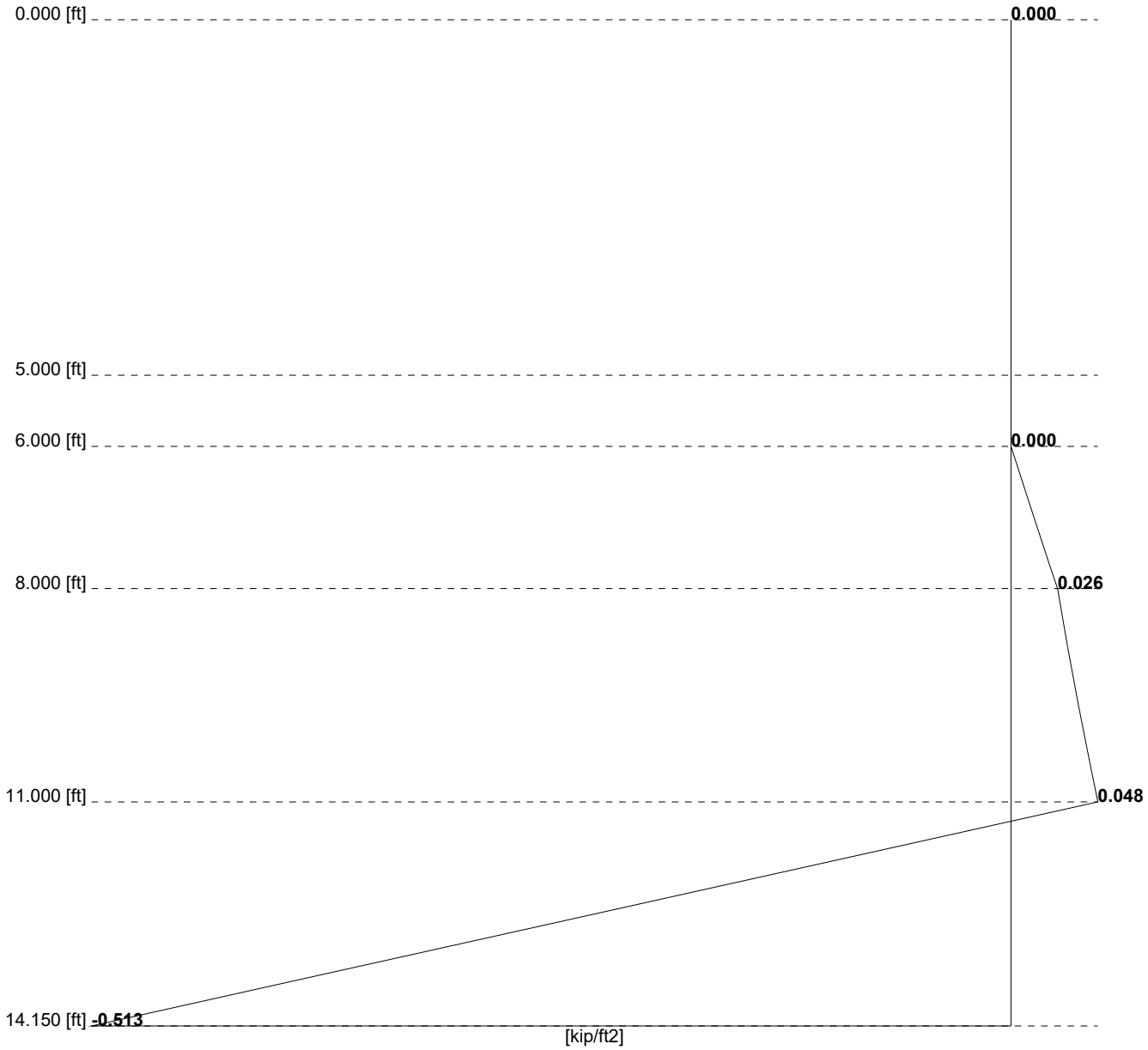
Water Pressure Diagram



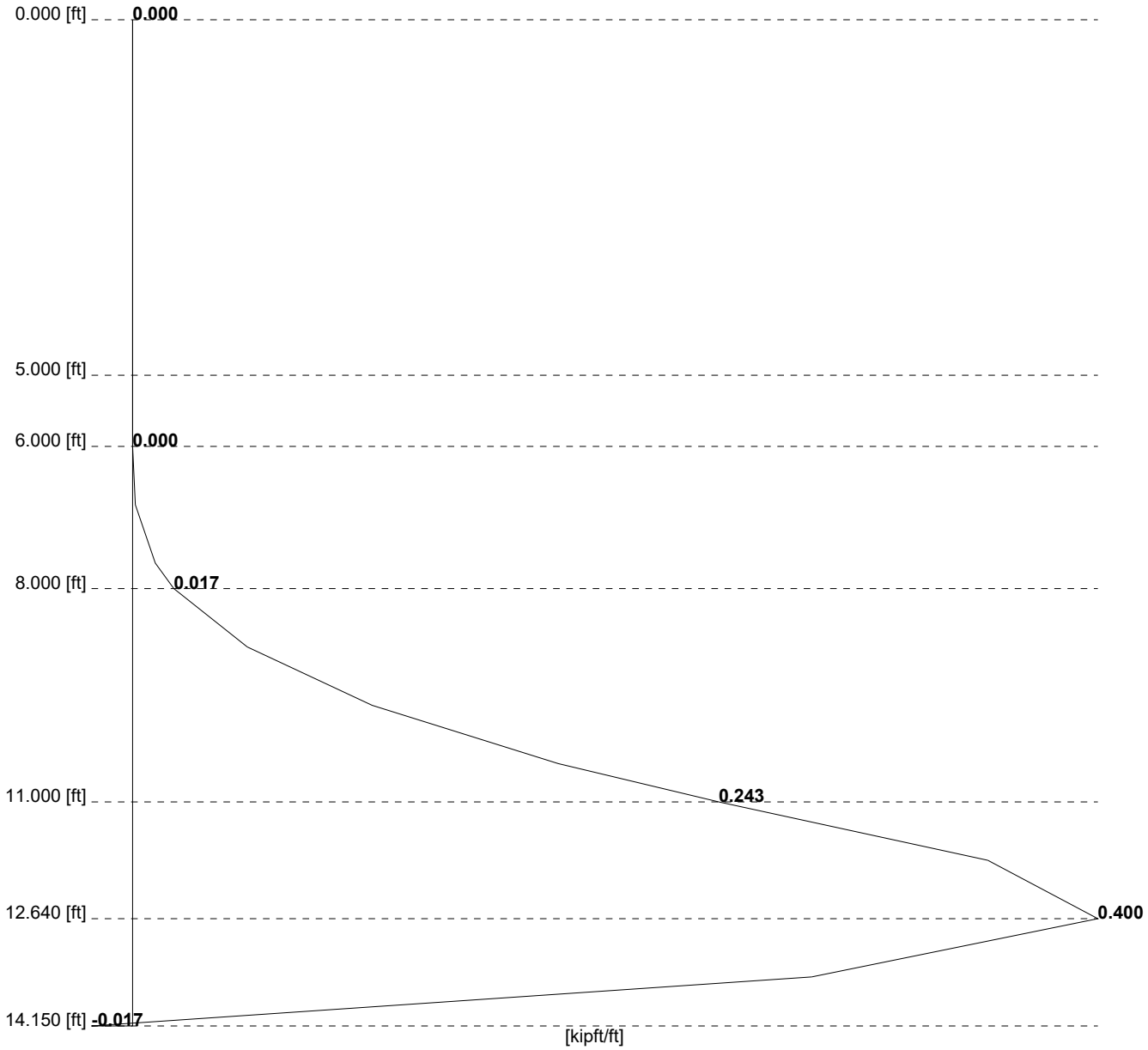
Boussinesq Diagram



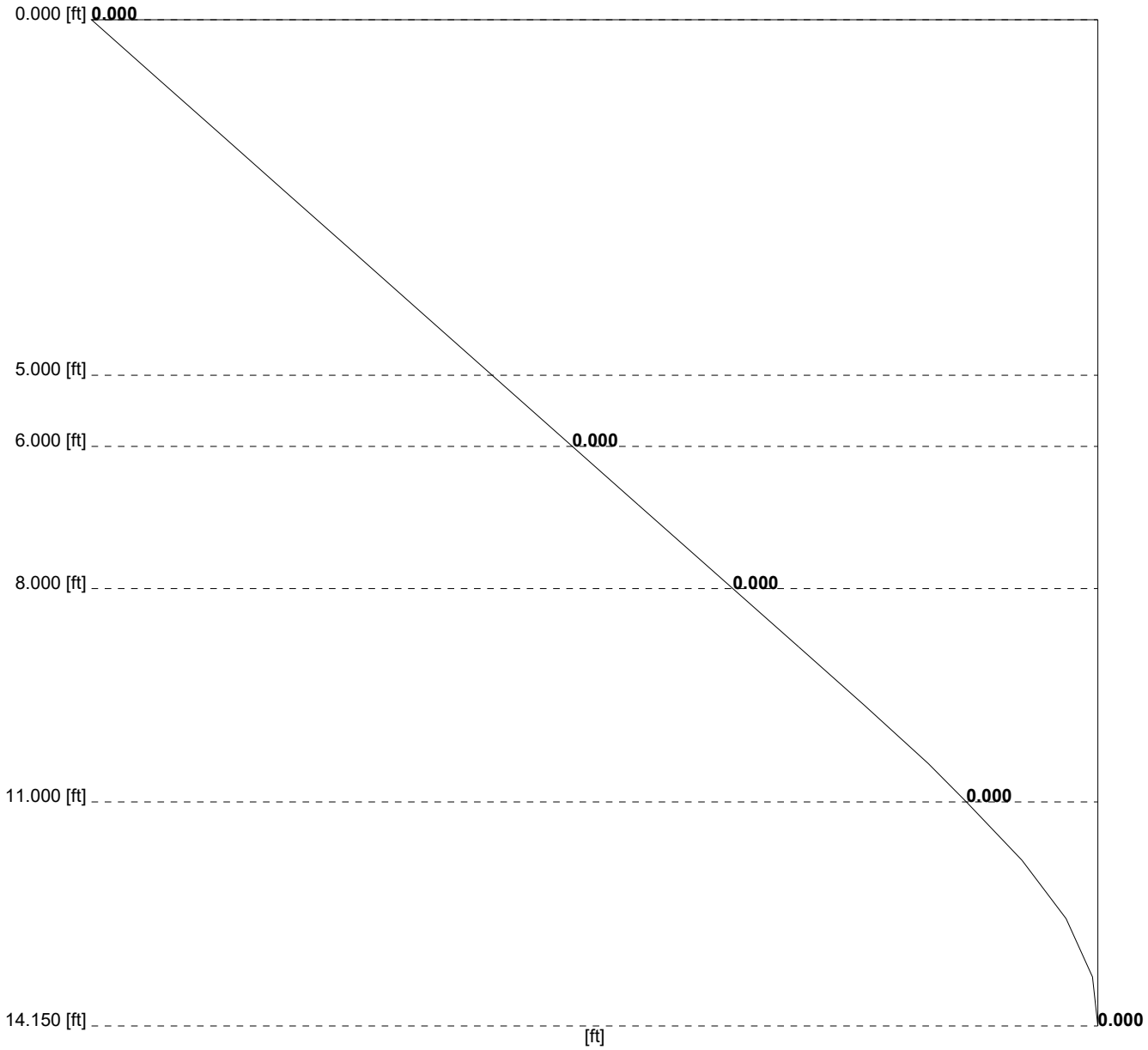
Total Pressure Diagram



Moment Diagram

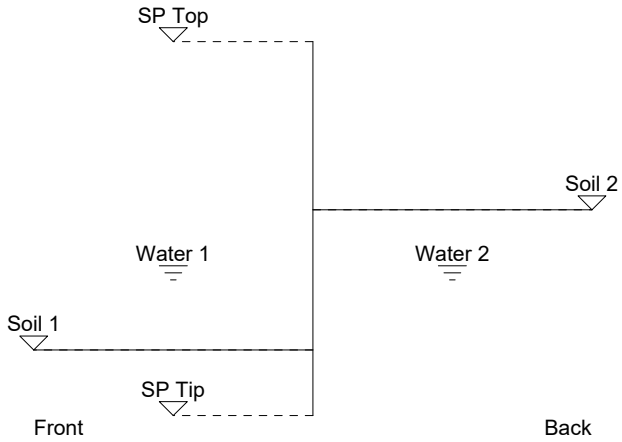


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	13.341
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

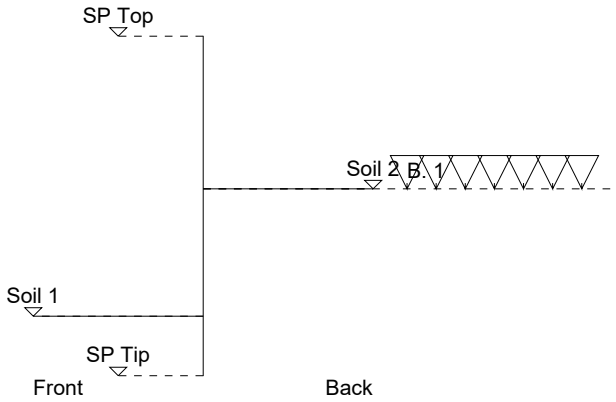
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

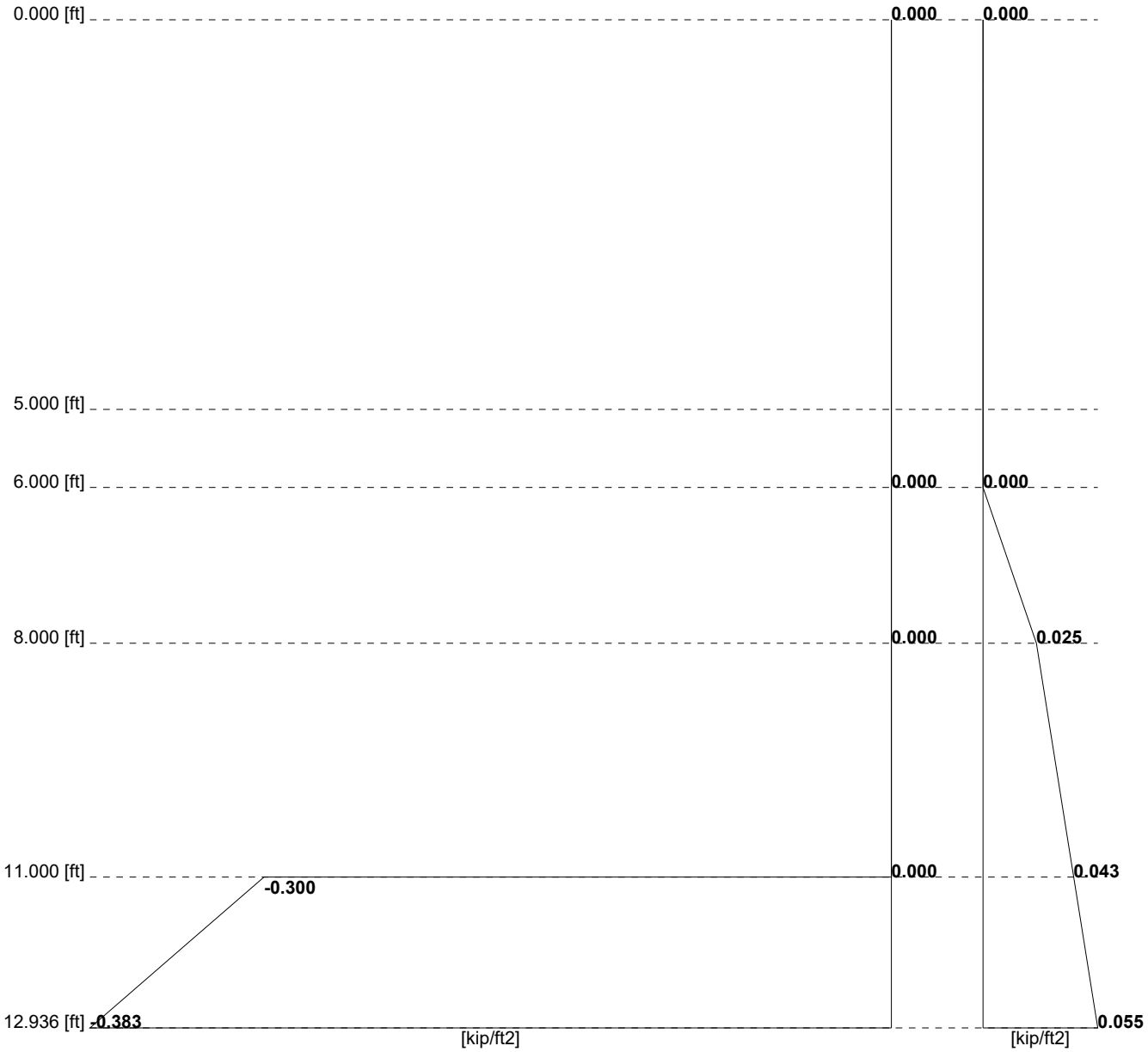
	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



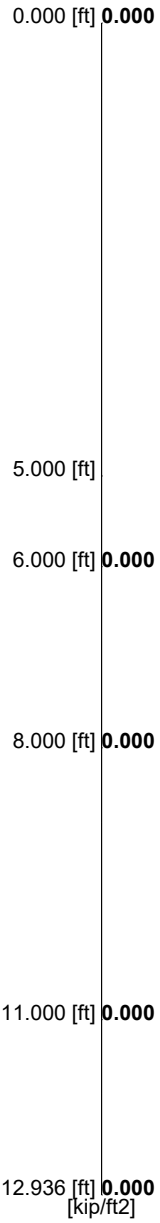
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.020	12.969
Maxmimal Moment [kipft/ft]	0.279	11.525
Normal Forces at Max. Moment [kip/ft]	0.092	12.969
Normal Forces at Min. Moment [kip/ft]	0.066	11.525
Deflection at Min. Moment [ft]	0.000	12.969
Deflection at Max. Moment [ft]	0.000	11.525
Min. Stress at Min. Moment [lb/in2]	3.926	12.969
Max. Stress at Min. Moment [lb/in2]	9.574	12.969
Min. Stress at Max. Moment [lb/in2]	-34.267	11.525
Max. Stress at Max. Moment [lb/in2]	43.929	11.525
Safety > Req. Safety = 1.500	1138.198	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	13.341	
Sheet Pile Length [ft]	13.341	
Included OverLength [ft]	0.406	
Vertical Equilibrium [kip/ft]	0.243	
Anchor Force (horiz.) [kip/ft]	0.000	

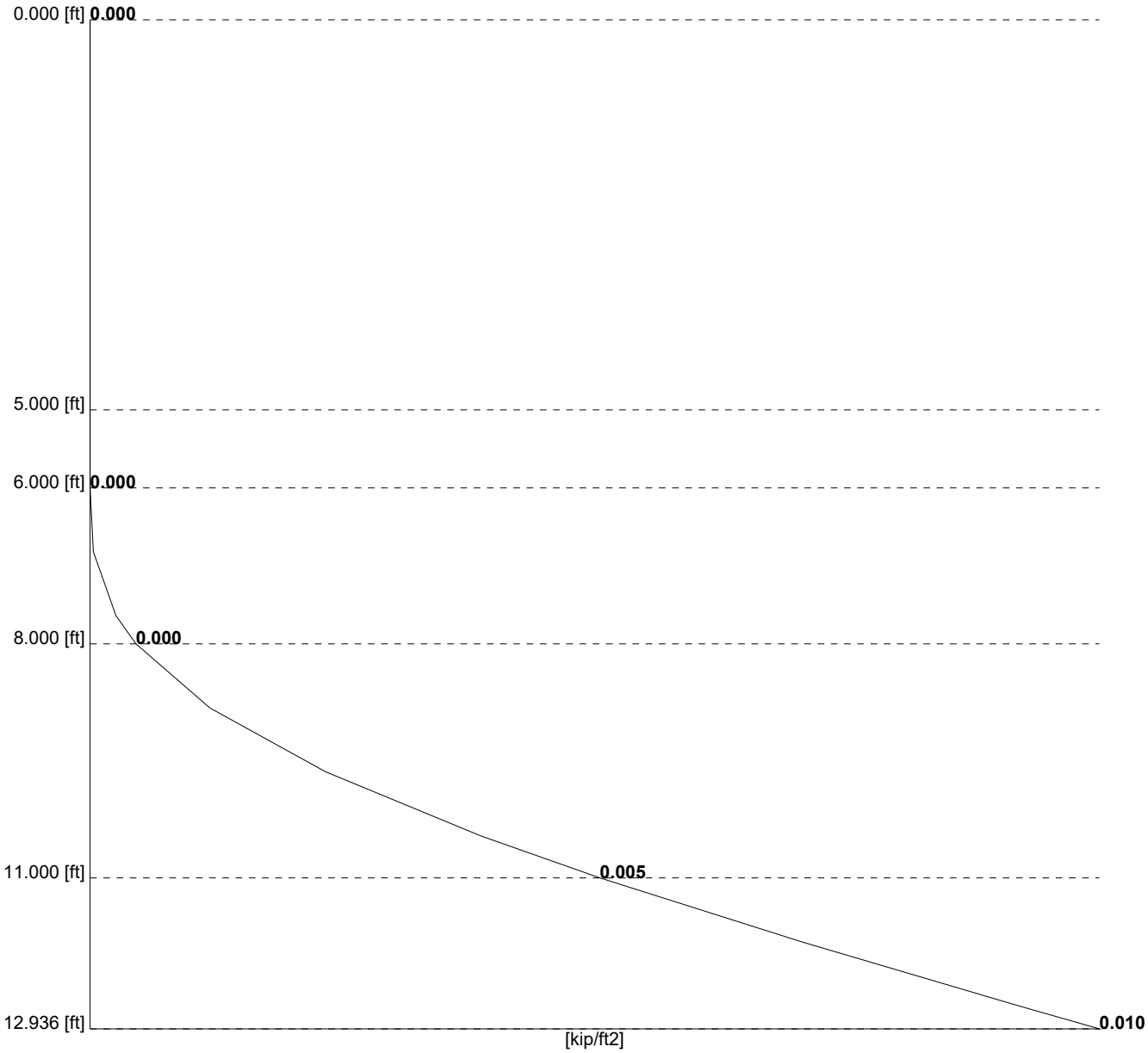
Earth Pressure Diagram



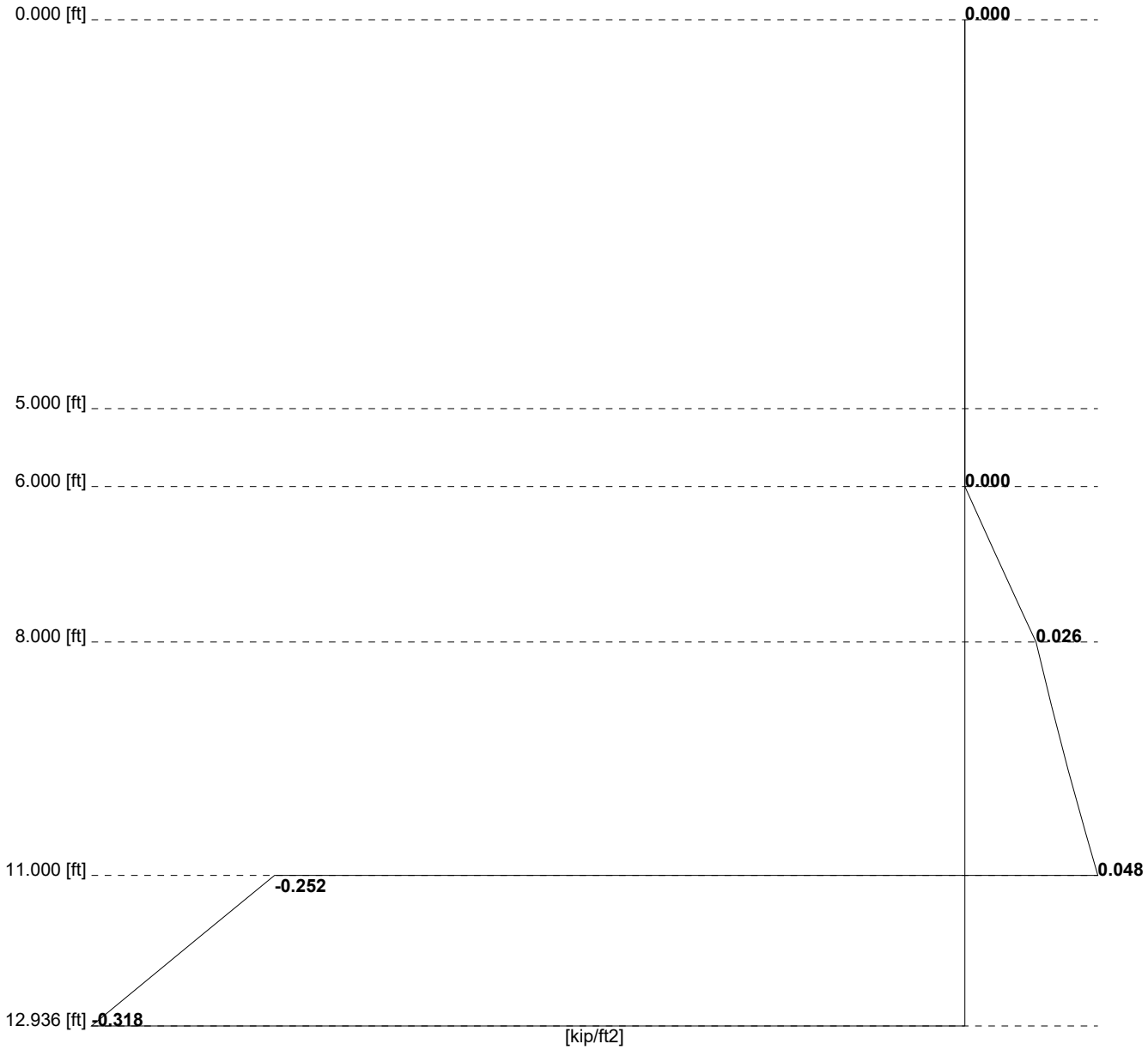
Water Pressure Diagram



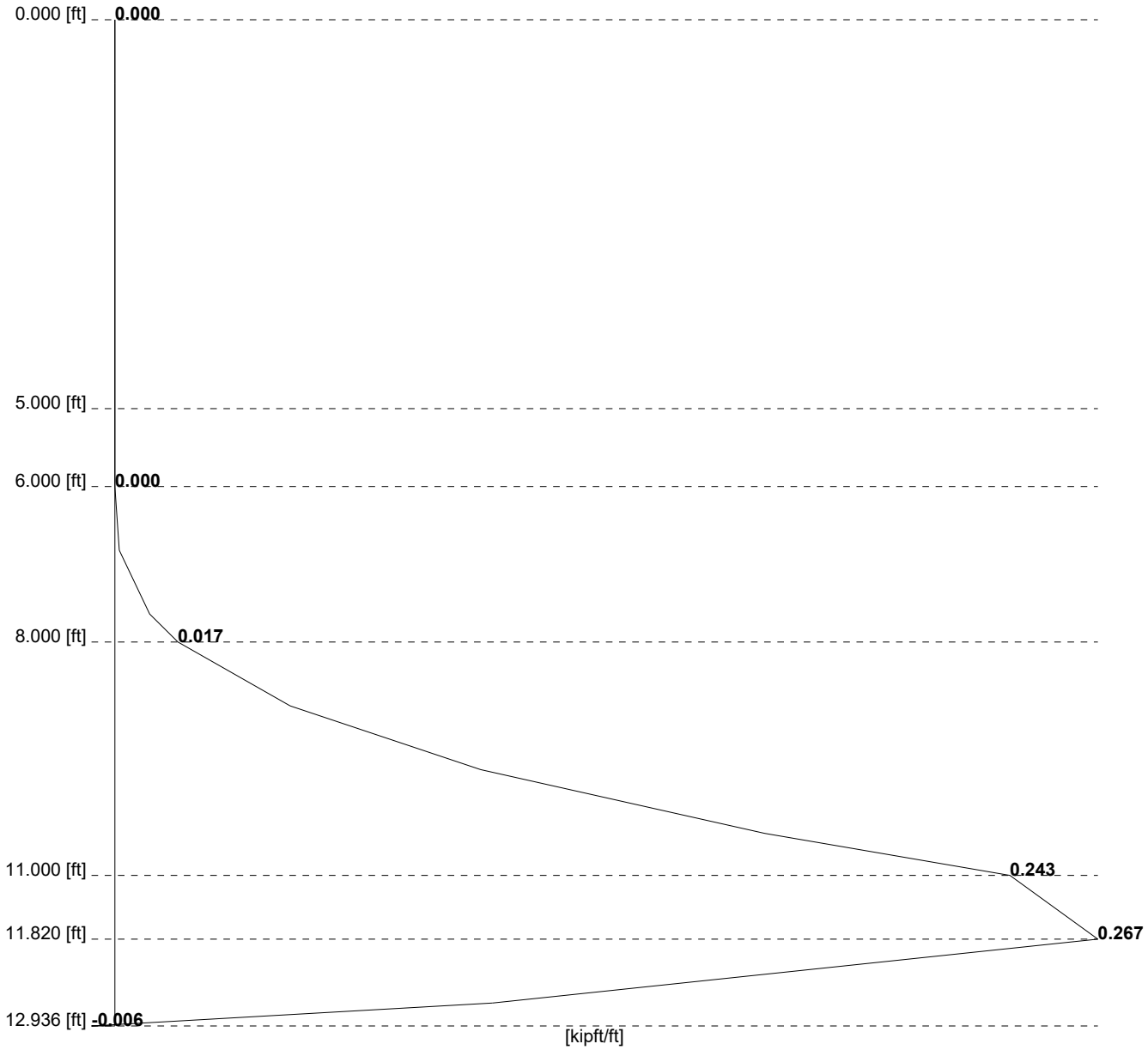
Boussinesq Diagram



Total Pressure Diagram

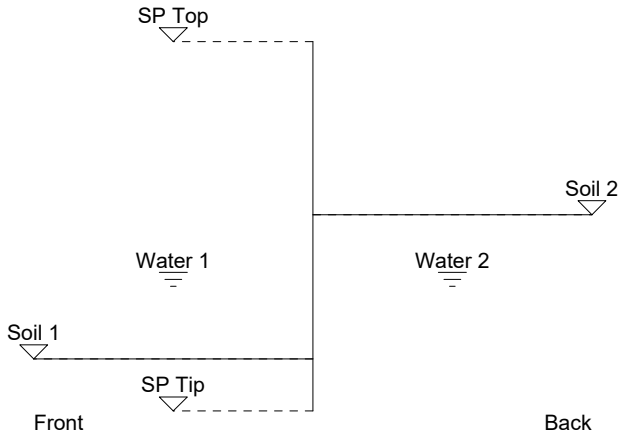


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	12.806
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	6.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	8.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

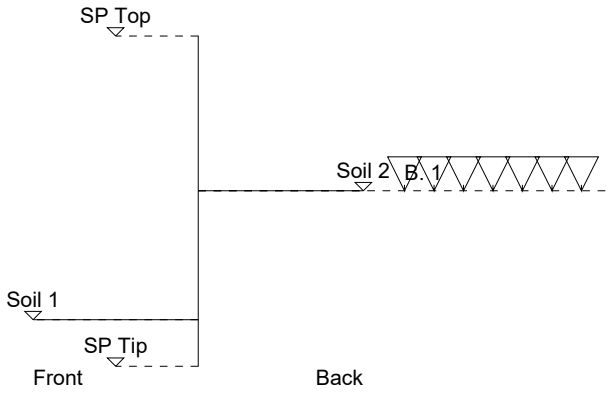
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]
Bousq. 1	8.000	16.000	6.000	0.366



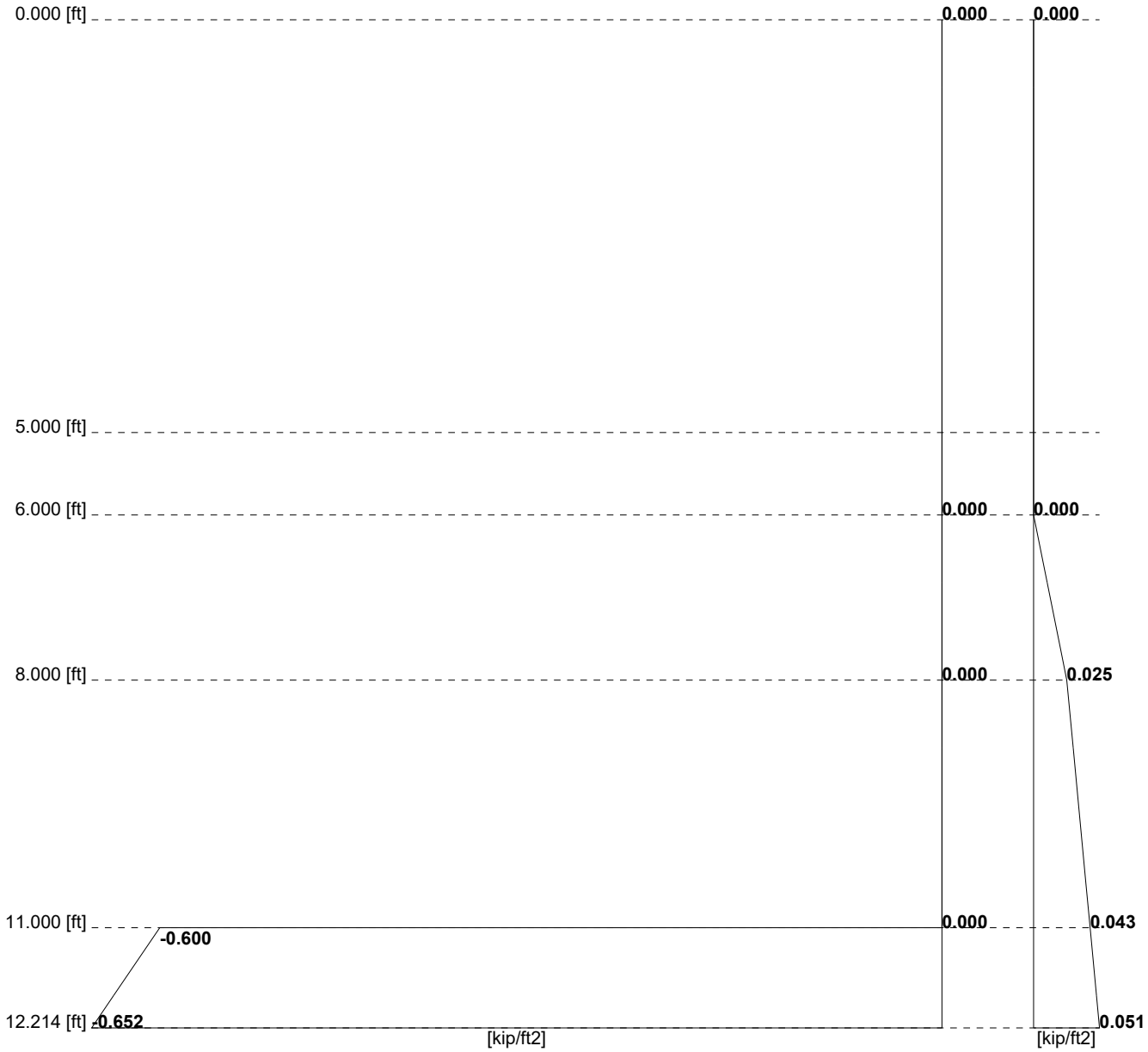
Pile Section

Name	AZ 46-700N
Inertia [in4/ft]	844.828
Modulus [in3/ft]	85.653
Area [in2/ft]	13.559
Mass [lbs/ft2]	46.145
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

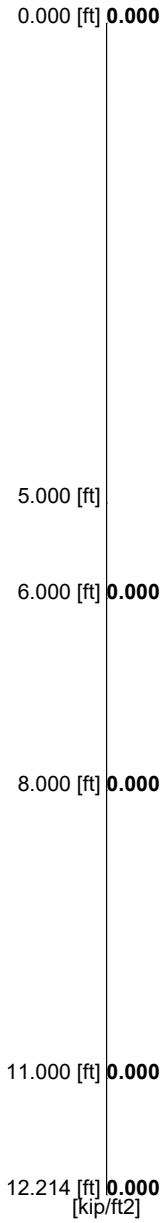
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.027	12.247
Maxmimal Moment [kipft/ft]	0.246	11.018
Normal Forces at Max. Moment [kip/ft]	0.075	12.247
Normal Forces at Min. Moment [kip/ft]	0.066	11.018
Deflection at Min. Moment [ft]	0.000	12.247
Deflection at Max. Moment [ft]	0.000	11.018
Min. Stress at Min. Moment [lb/in2]	1.724	12.247
Max. Stress at Min. Moment [lb/in2]	9.275	12.247
Min. Stress at Max. Moment [lb/in2]	-29.578	11.018
Max. Stress at Max. Moment [lb/in2]	39.240	11.018
Safety > Req. Safety = 1.500	1274.210	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	12.806	
Sheet Pile Length [ft]	12.806	
Included OverLength [ft]	0.592	
Vertical Equilibrium [kip/ft]	0.278	
Anchor Force (horiz.) [kip/ft]	0.000	

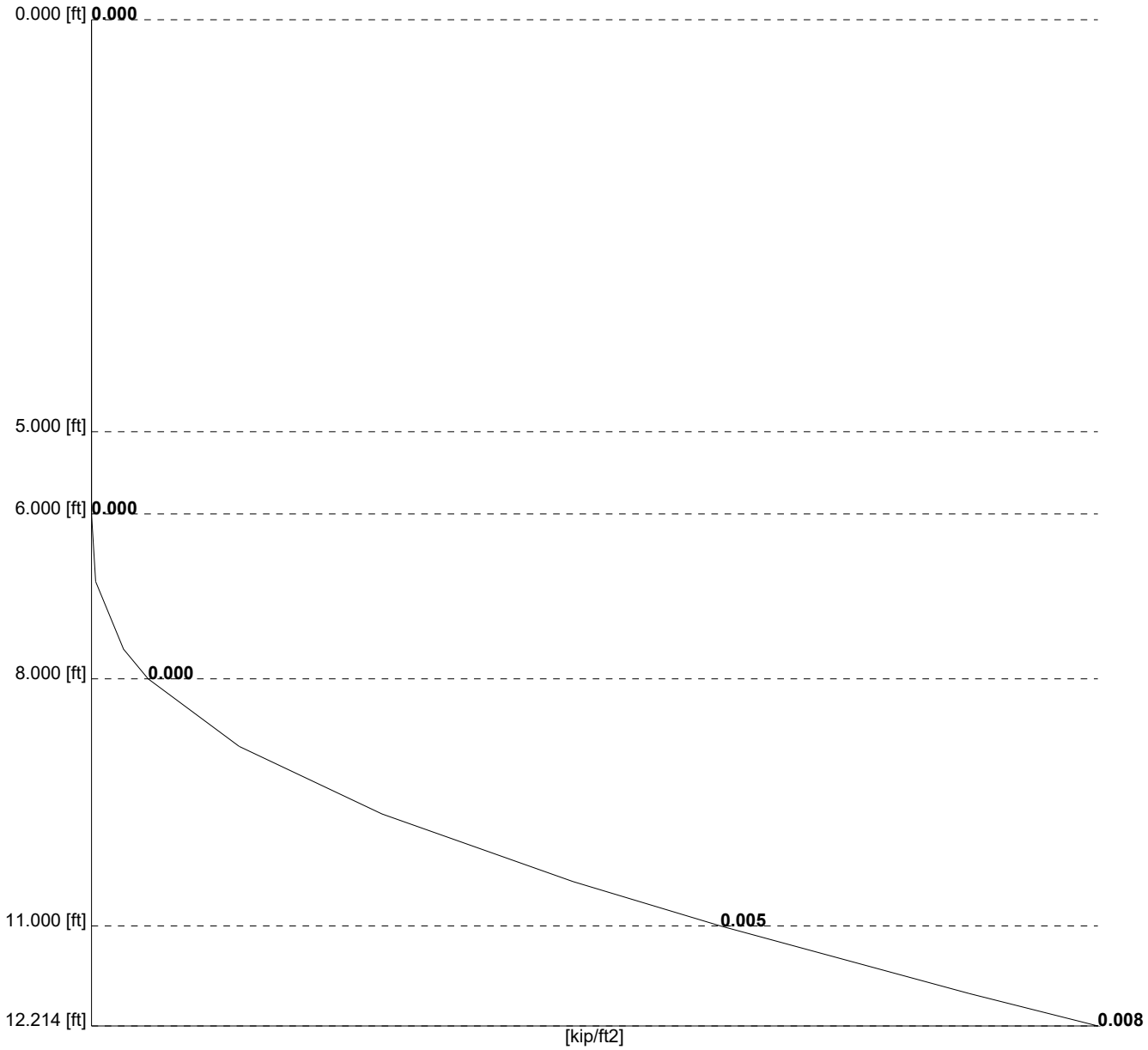
Earth Pressure Diagram



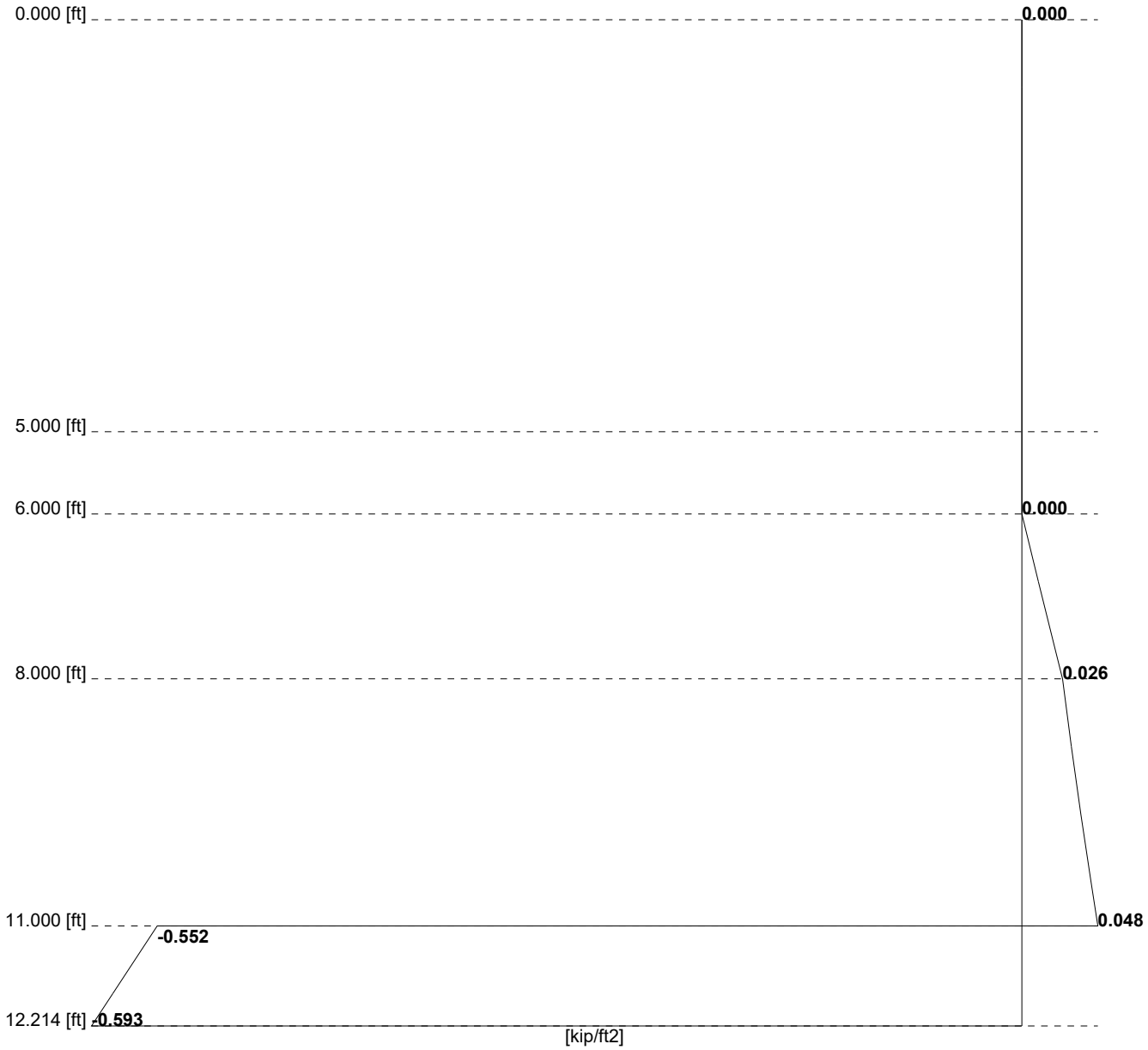
Water Pressure Diagram



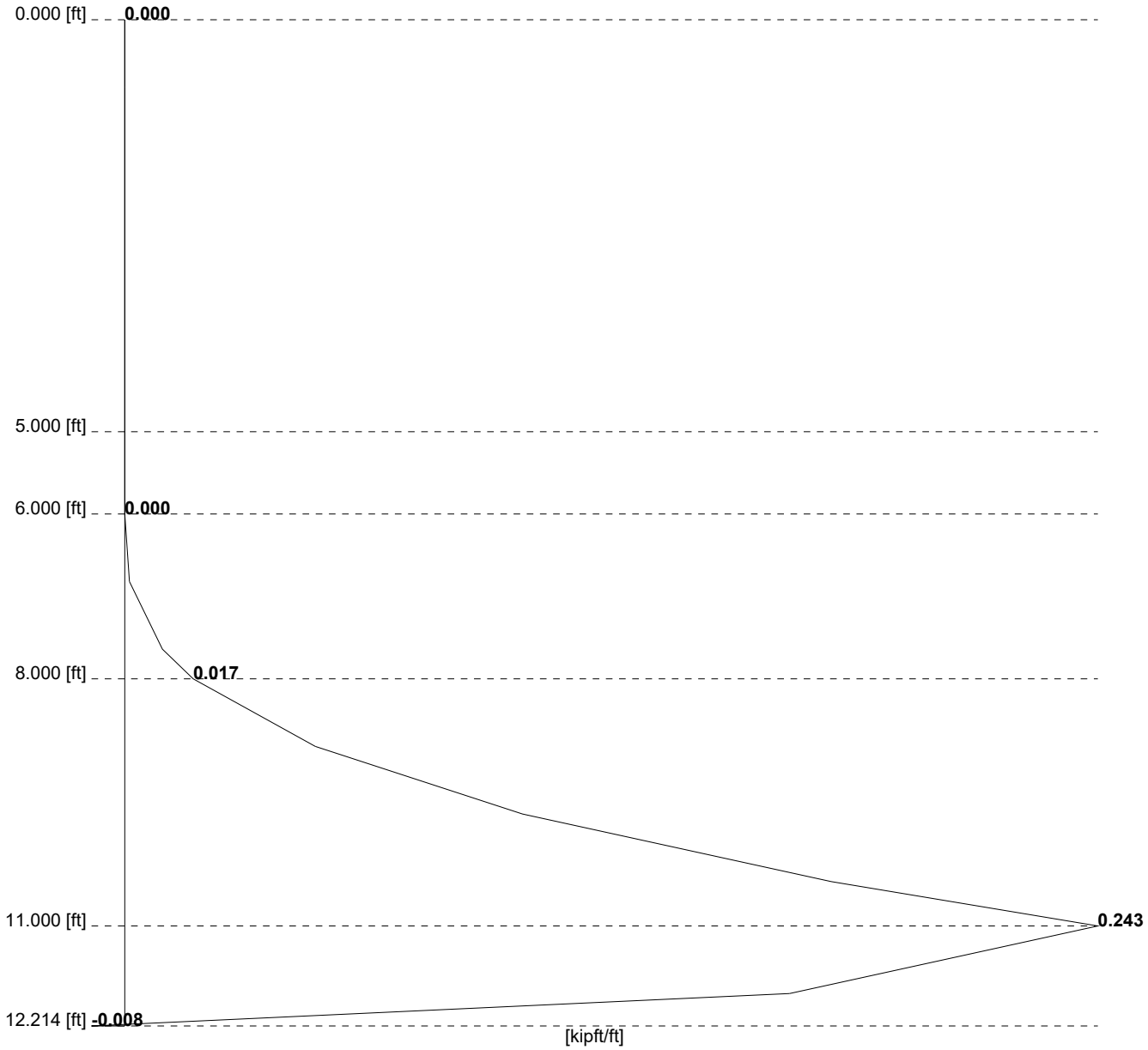
Boussinesq Diagram



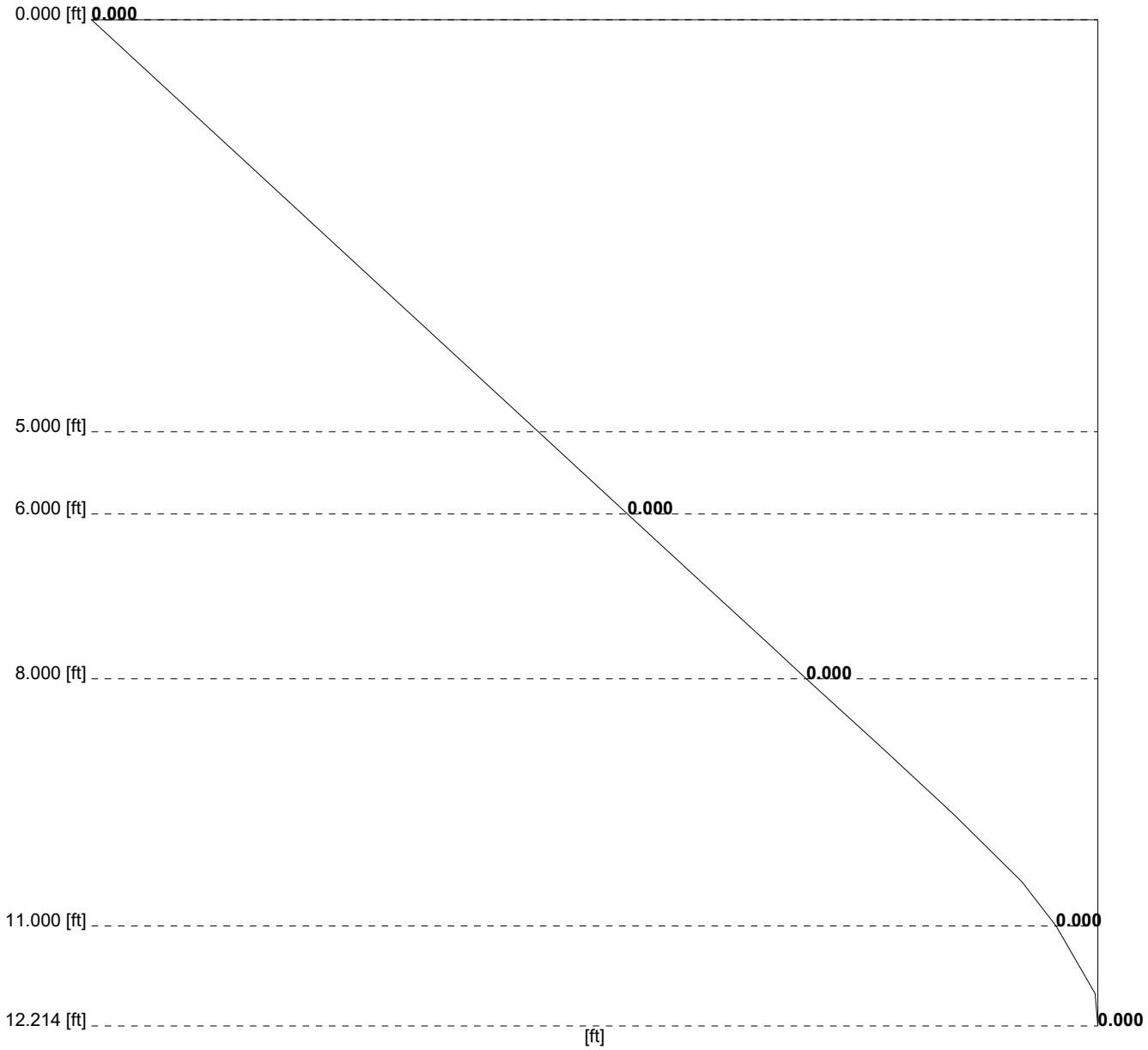
Total Pressure Diagram



Moment Diagram

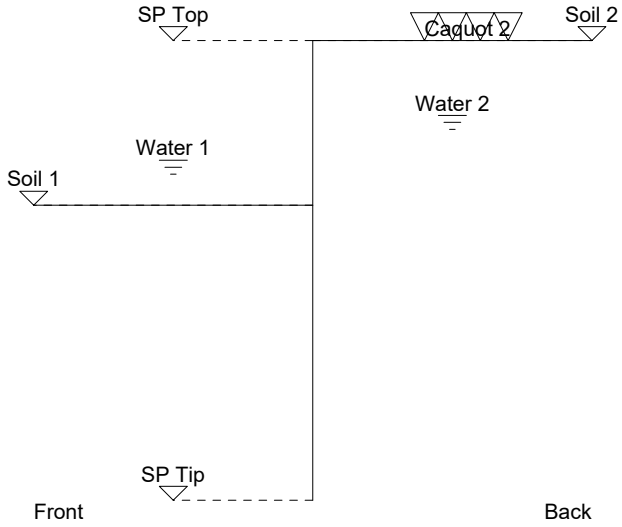


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	30.724
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 2	63.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 3	83.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

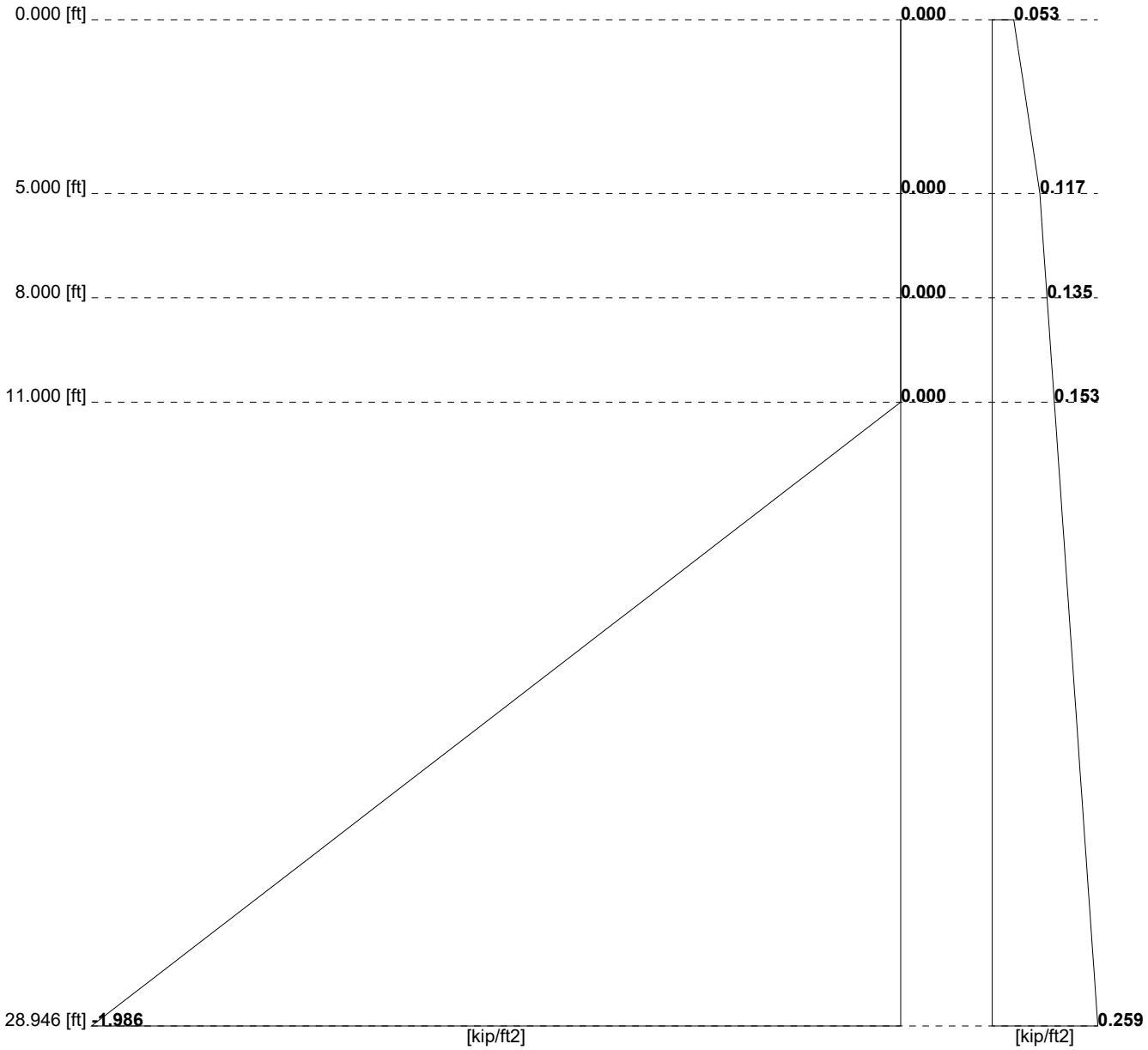
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

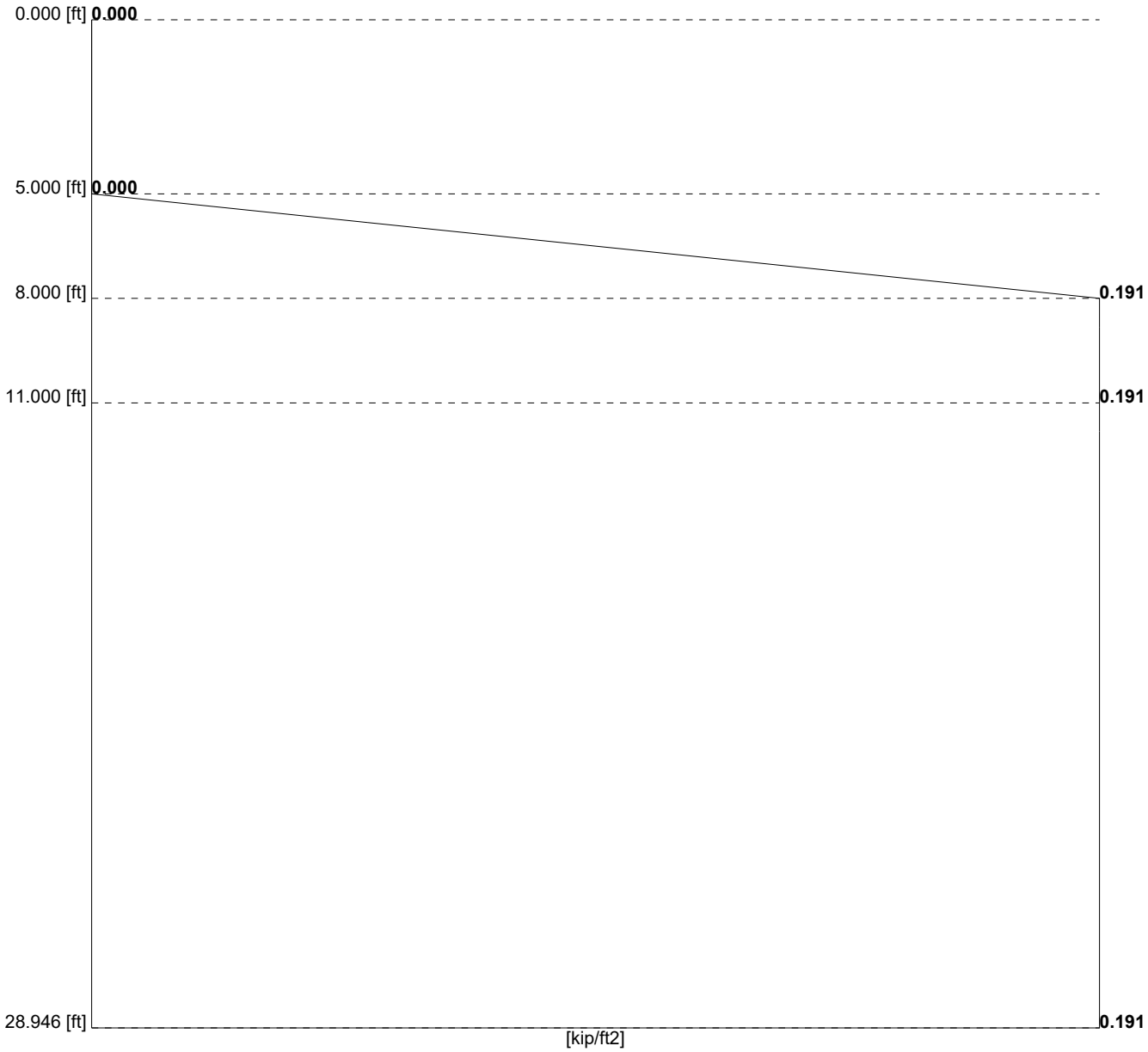
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.496	28.979
Maxmimal Moment [kipft/ft]	28.501	21.433
Normal Forces at Max. Moment [kip/ft]	-1.523	28.979
Normal Forces at Min. Moment [kip/ft]	-0.008	21.433
Deflection at Min. Moment [ft]	0.000	28.979
Deflection at Max. Moment [ft]	-0.003	21.433
Min. Stress at Min. Moment [lb/in2]	-181.850	28.979
Max. Stress at Min. Moment [lb/in2]	-42.851	28.979
Min. Stress at Max. Moment [lb/in2]	-3993.373	21.433
Max. Stress at Max. Moment [lb/in2]	3992.215	21.433
Safety > Req. Safety = 1.500	12.521	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	30.724	
Sheet Pile Length [ft]	30.724	
Included OverLength [ft]	1.777	
Vertical Equilibrium [kip/ft]	1.605	
Anchor Force (horiz.) [kip/ft]	0.000	

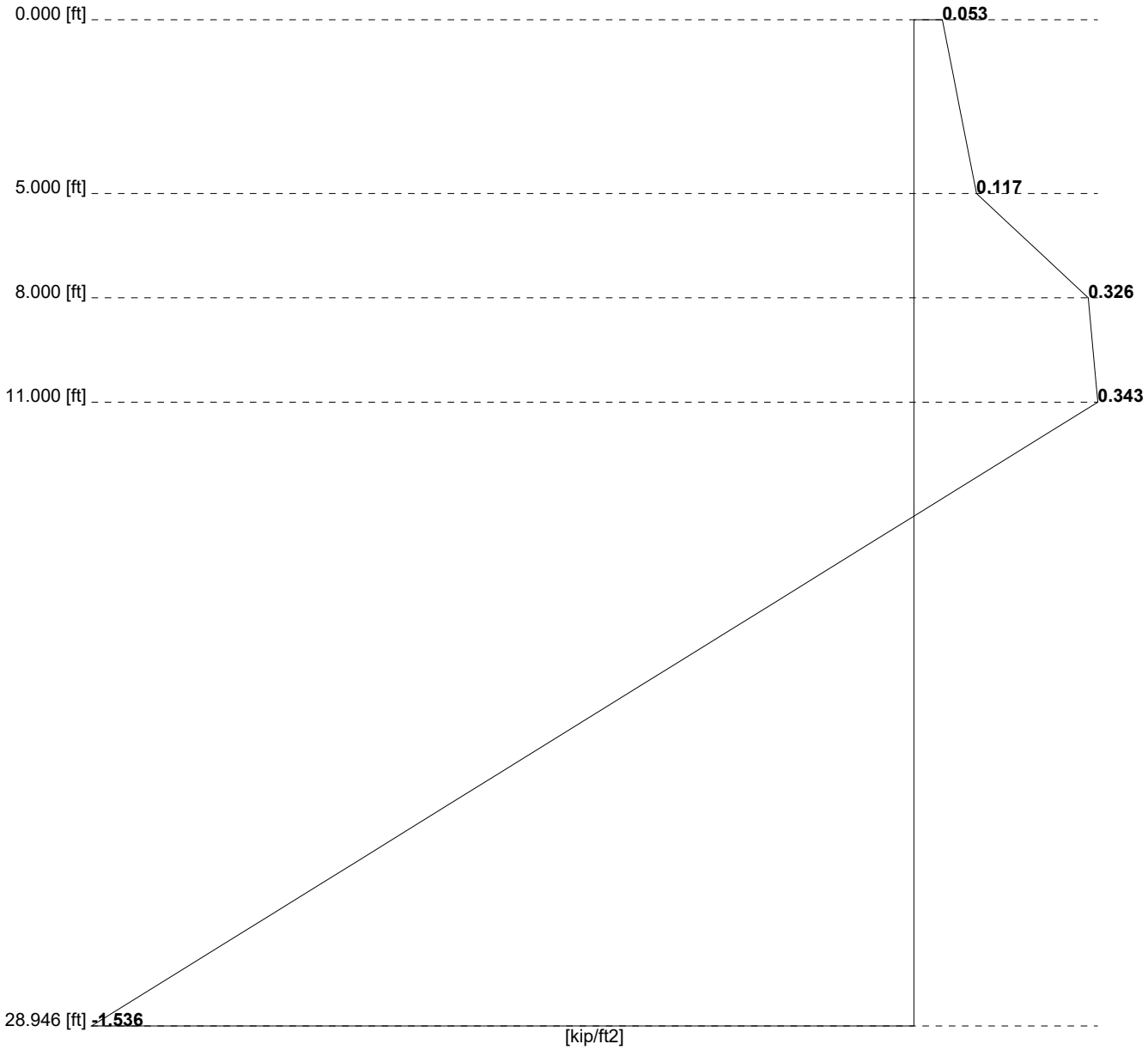
Earth Pressure Diagram



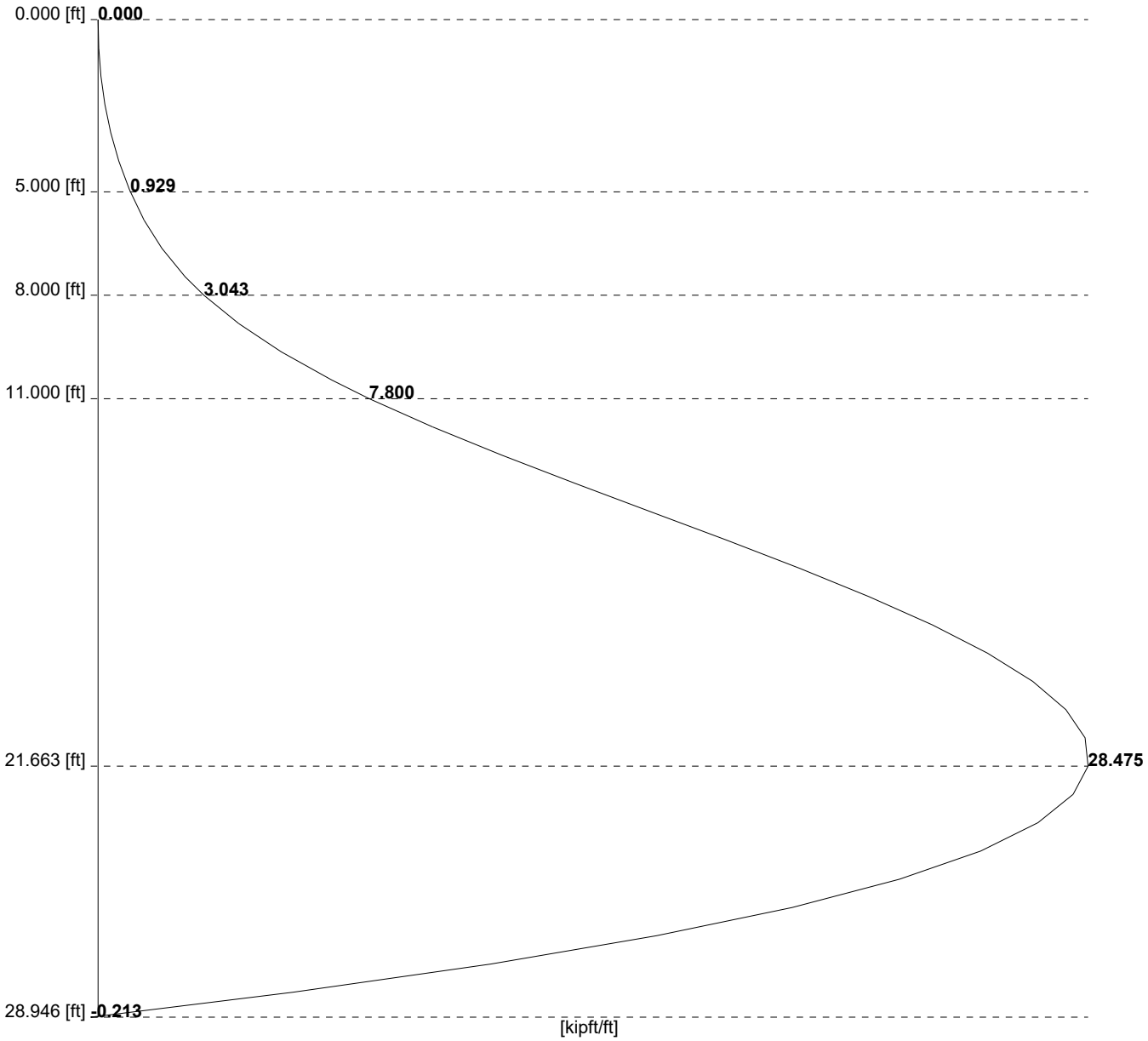
Water Pressure Diagram



Total Pressure Diagram

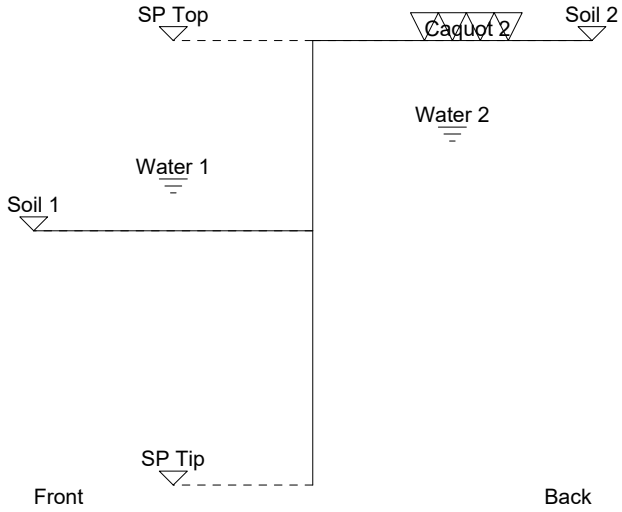


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	25.700
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 2	63.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 3	83.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 4	118.500	0.125	0.063	6.713	34.000	-18.360	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 3	63.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 4	83.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

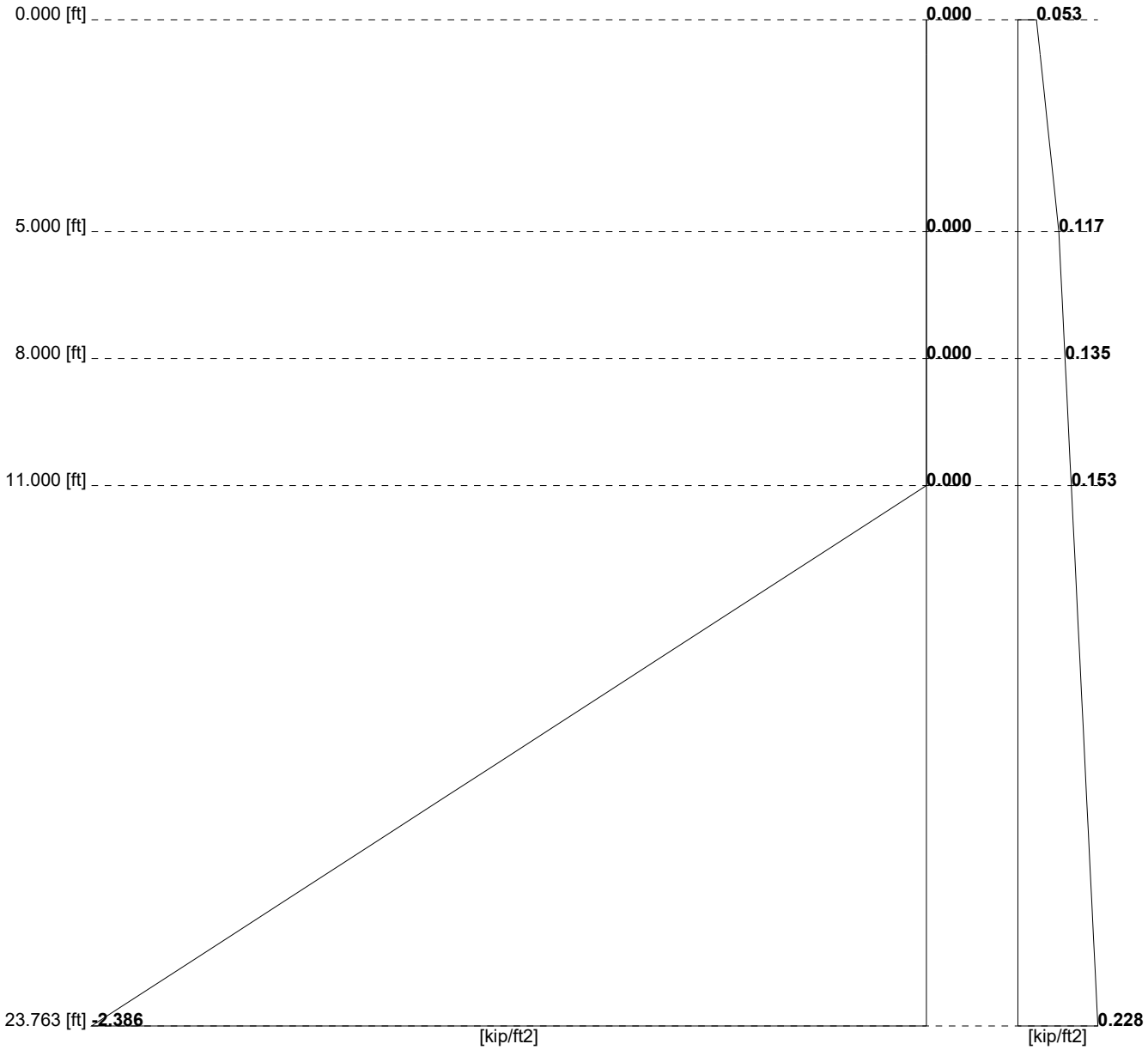
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

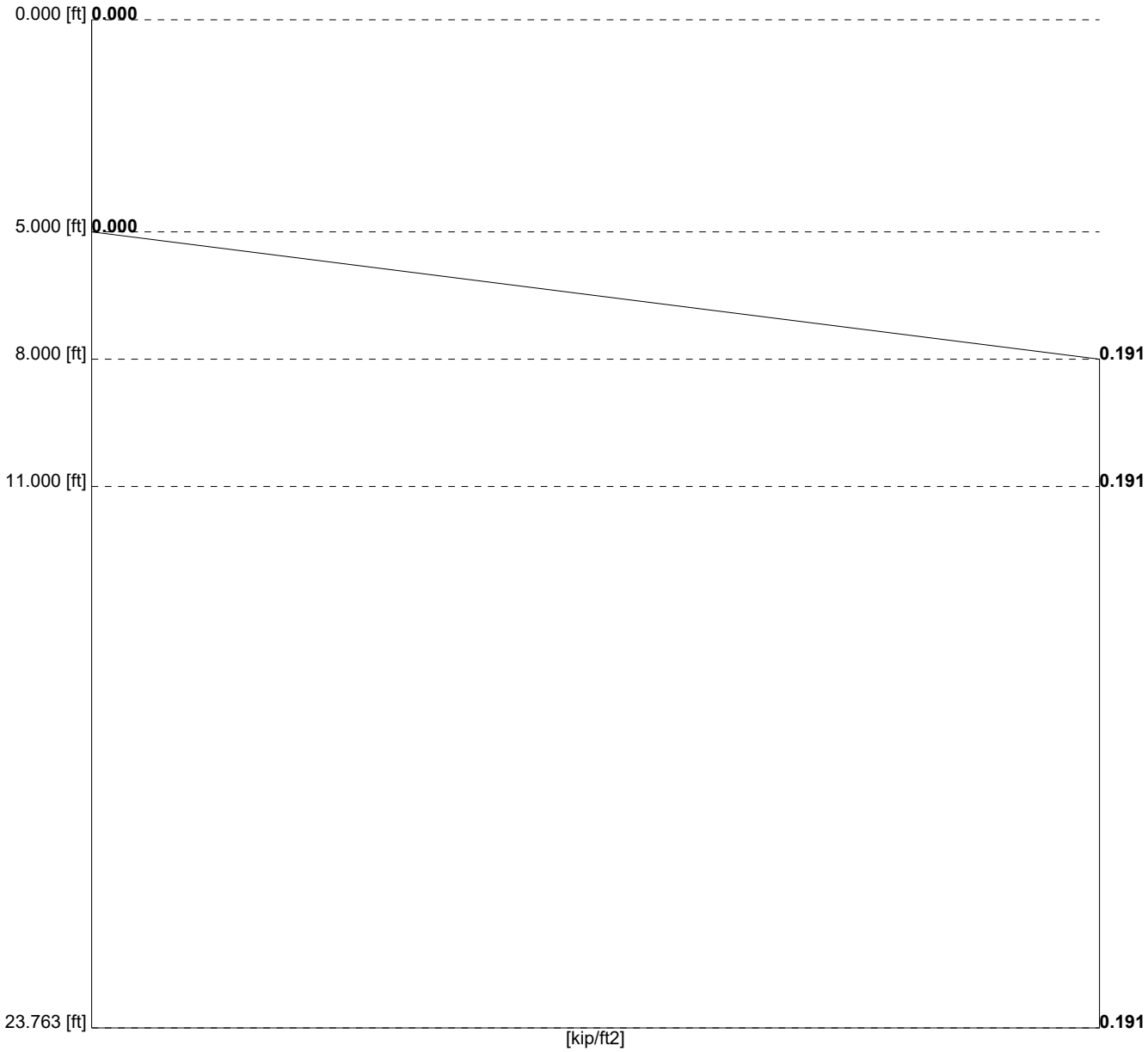
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.518	23.795
Maxmimal Moment [kipft/ft]	20.512	18.087
Normal Forces at Max. Moment [kip/ft]	-2.777	23.795
Normal Forces at Min. Moment [kip/ft]	-0.460	18.087
Deflection at Min. Moment [ft]	0.000	23.795
Deflection at Max. Moment [ft]	-0.004	18.087
Min. Stress at Min. Moment [lb/in2]	-634.970	23.795
Max. Stress at Min. Moment [lb/in2]	-248.825	23.795
Min. Stress at Max. Moment [lb/in2]	-7721.884	18.087
Max. Stress at Max. Moment [lb/in2]	7575.526	18.087
Safety > Req. Safety = 1.500	6.475	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	25.700	
Sheet Pile Length [ft]	25.700	
Included OverLength [ft]	1.938	
Vertical Equilibrium [kip/ft]	0.229	
Anchor Force (horiz.) [kip/ft]	0.000	

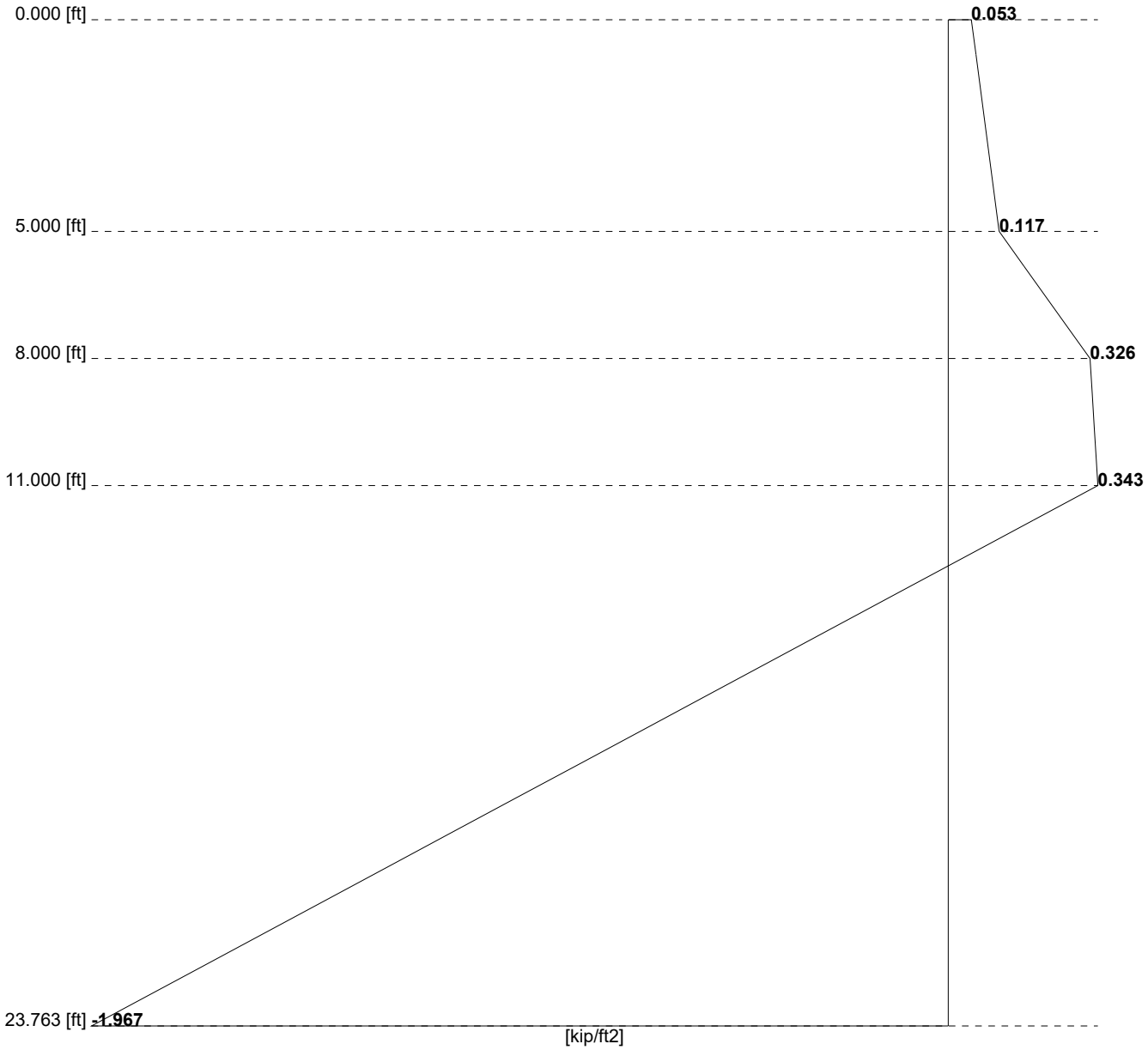
Earth Pressure Diagram



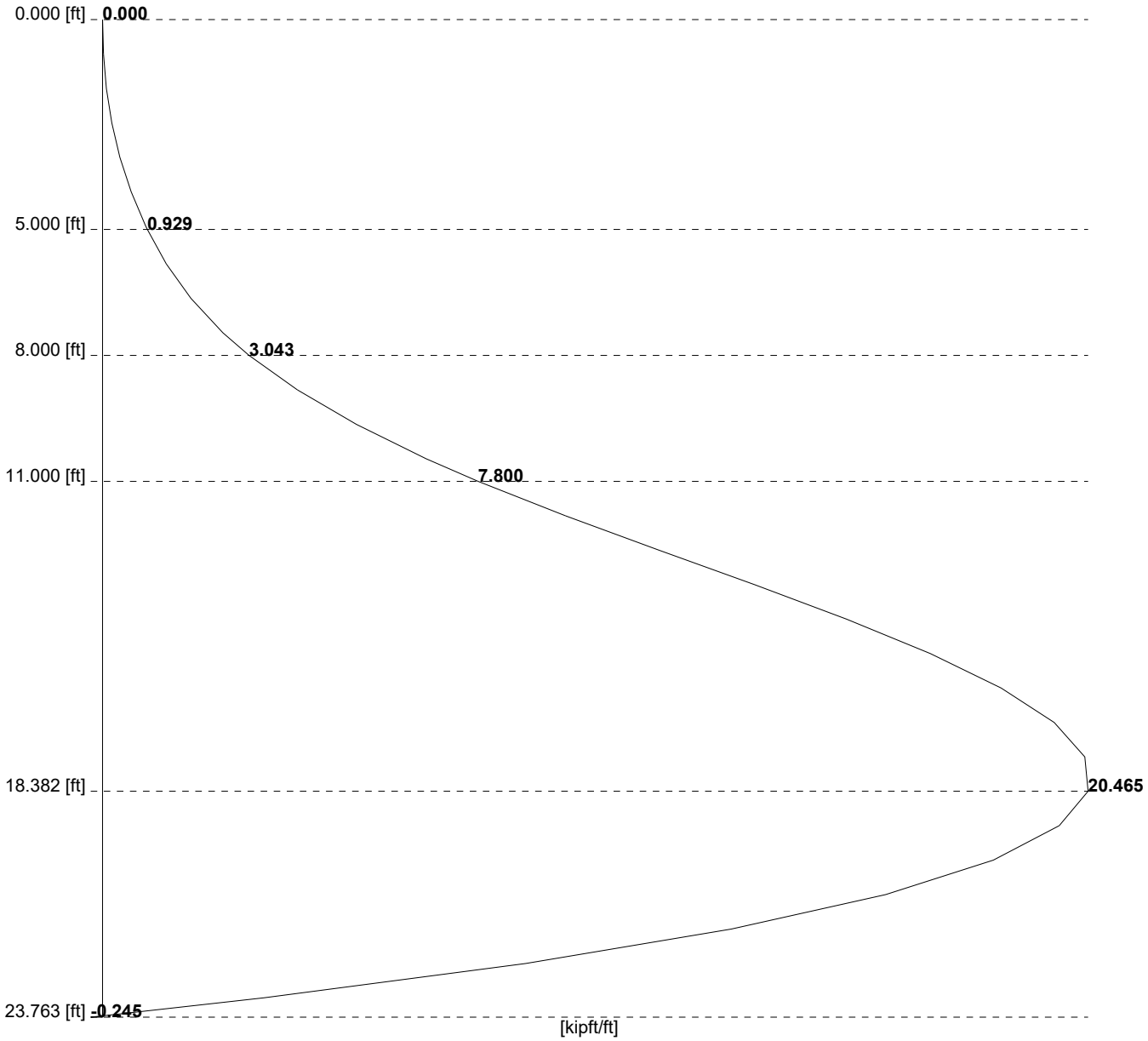
Water Pressure Diagram



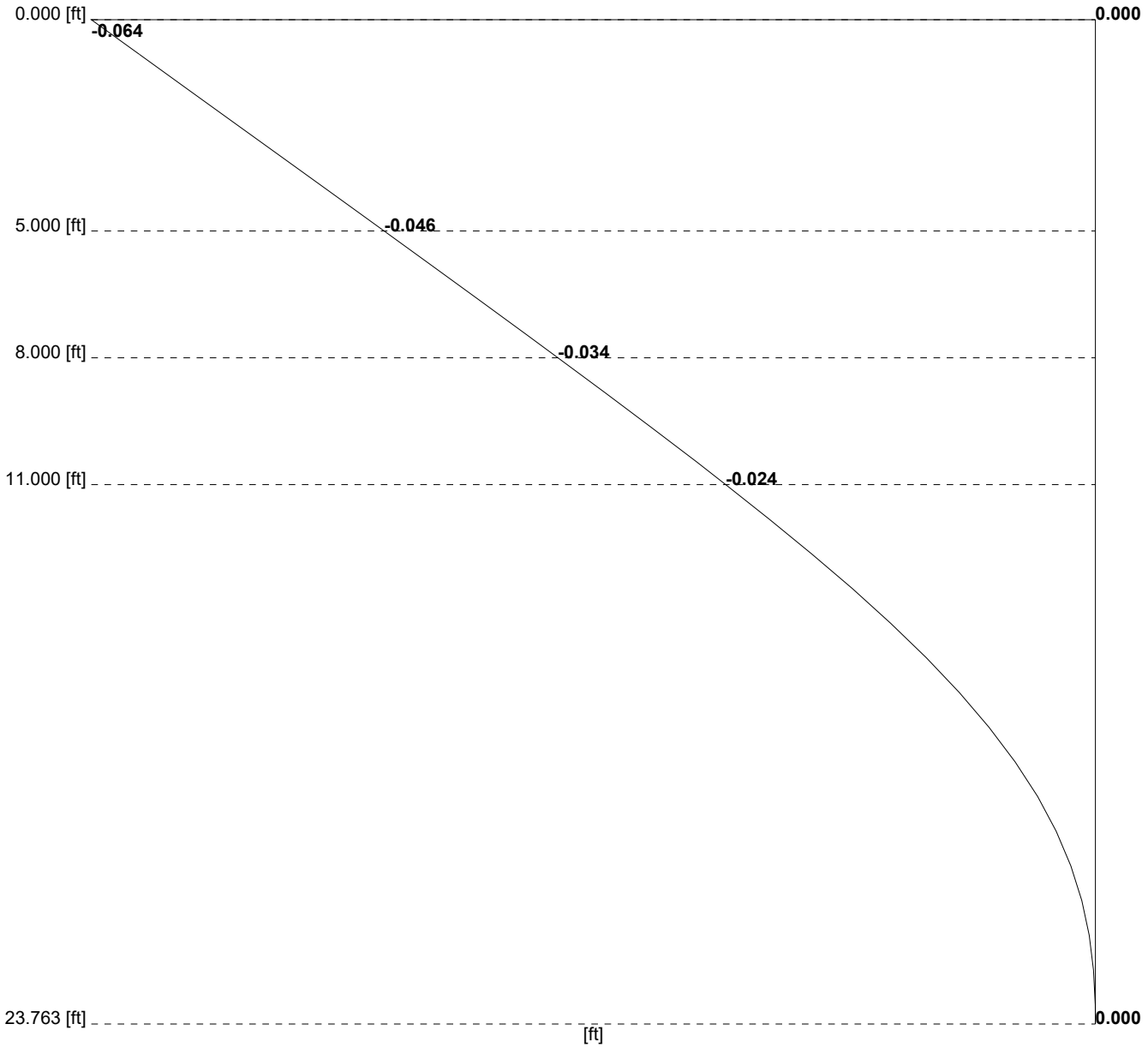
Total Pressure Diagram



Moment Diagram

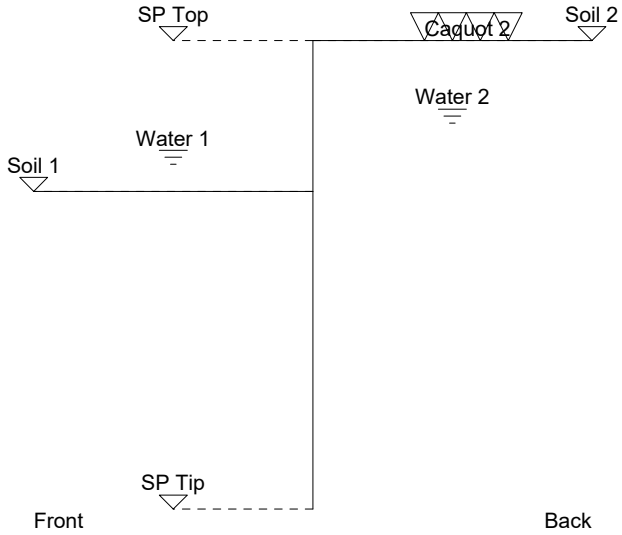


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	34.179
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 4	118.500	0.125	0.063	3.401	24.210	-13.070	0.000

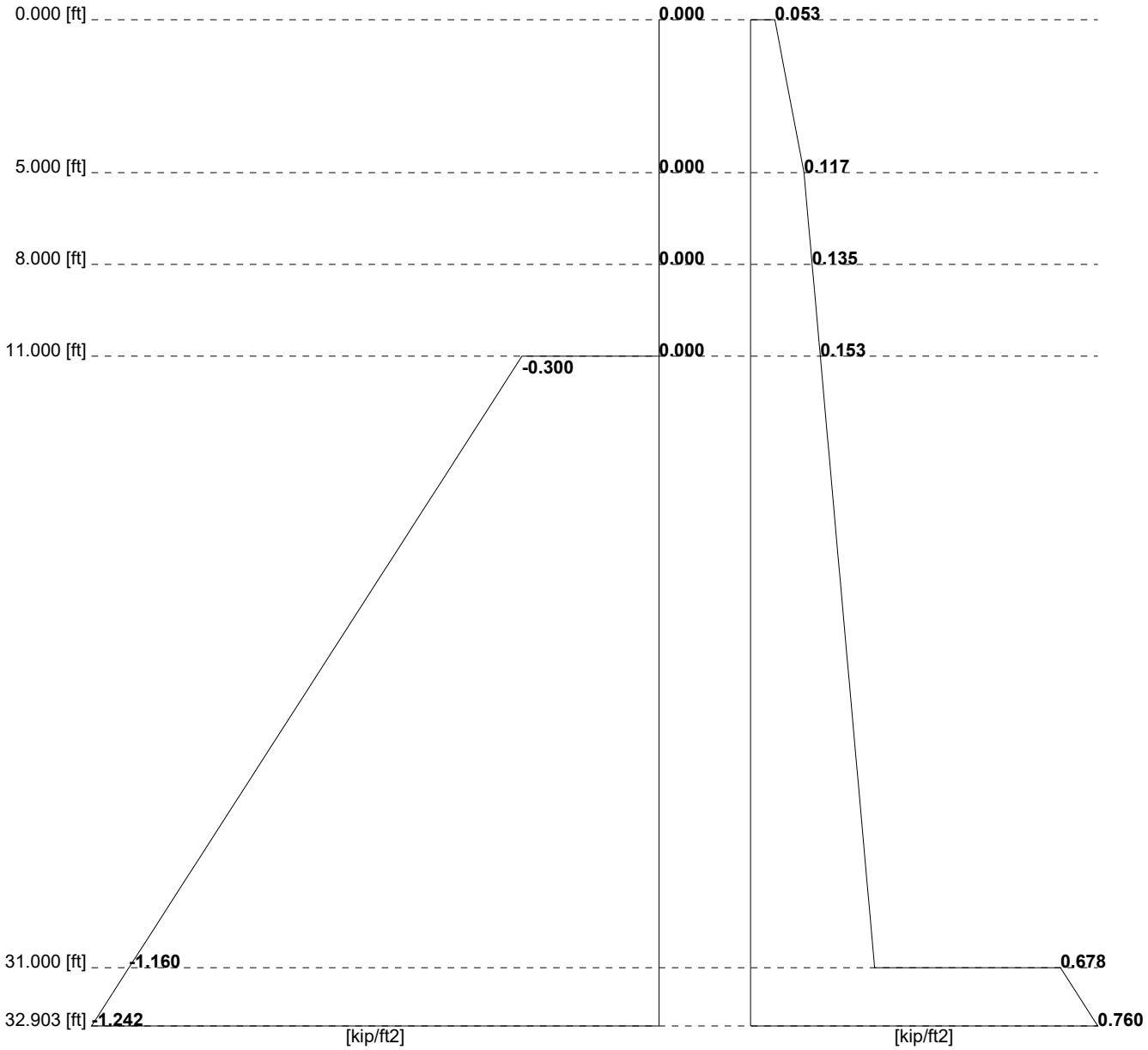
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.360	0.000

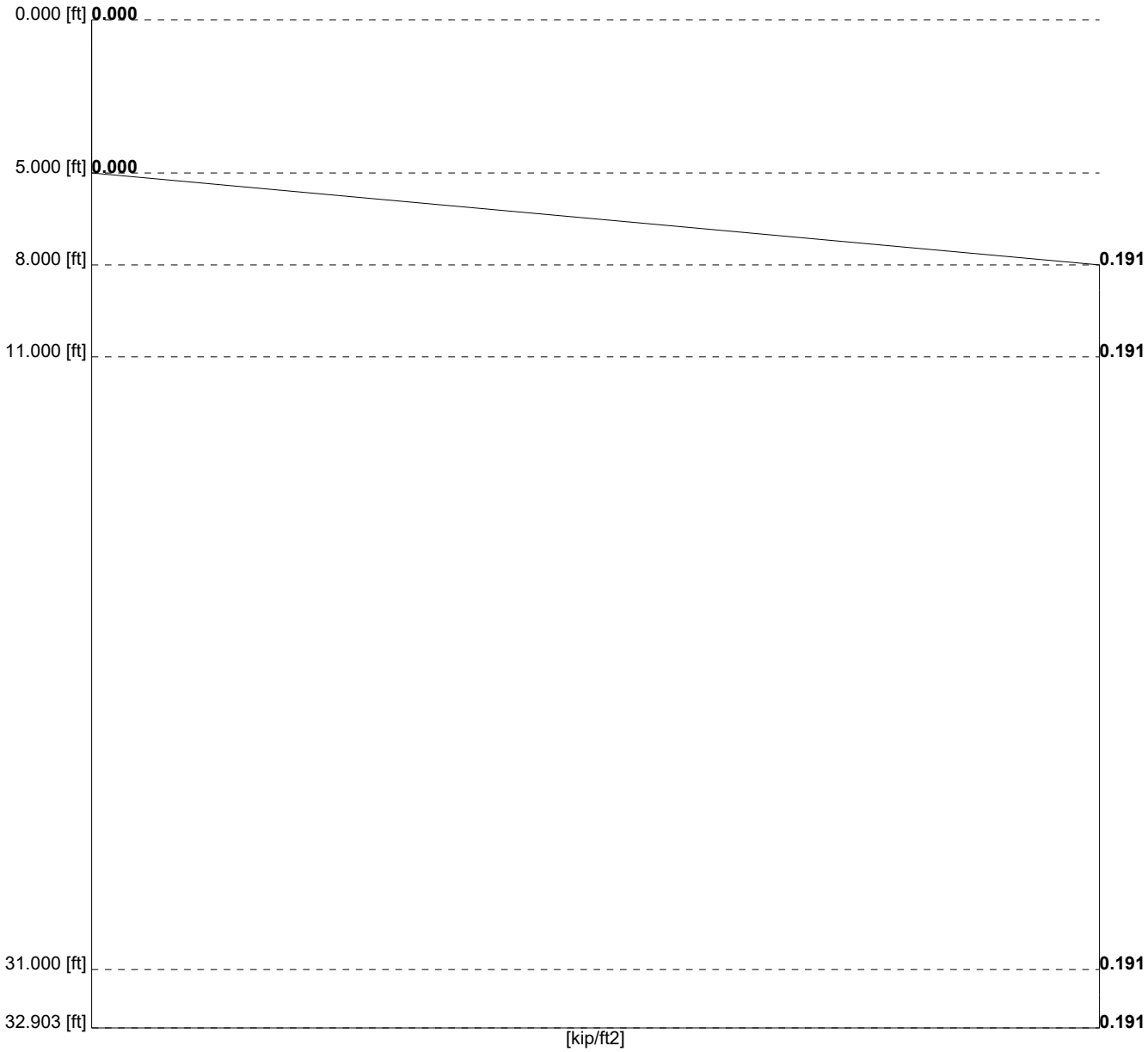
Pile Check

		Depth [ft]
Name	AZ 46-700N	
Inertia [in4/ft]	844.828	
Modulus [in3/ft]	85.653	
Area [in2/ft]	13.559	
Mass [lbs/ft2]	46.145	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.232	32.936
Maxmimal Moment [kipft/ft]	25.337	22.483
Normal Forces at Max. Moment [kip/ft]	1.990	32.936
Normal Forces at Min. Moment [kip/ft]	1.228	22.483
Deflection at Min. Moment [ft]	0.000	32.936
Deflection at Max. Moment [ft]	-0.005	22.483
Min. Stress at Min. Moment [lb/in2]	114.255	32.936
Max. Stress at Min. Moment [lb/in2]	179.248	32.936
Min. Stress at Max. Moment [lb/in2]	-3459.827	22.483
Max. Stress at Max. Moment [lb/in2]	3640.901	22.483
Safety > Req. Safety = 1.500	13.733	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	34.179	
Sheet Pile Length [ft]	34.179	
Included OverLength [ft]	1.277	
Vertical Equilibrium [kip/ft]	1.990	
Anchor Force (horiz.) [kip/ft]	0.000	

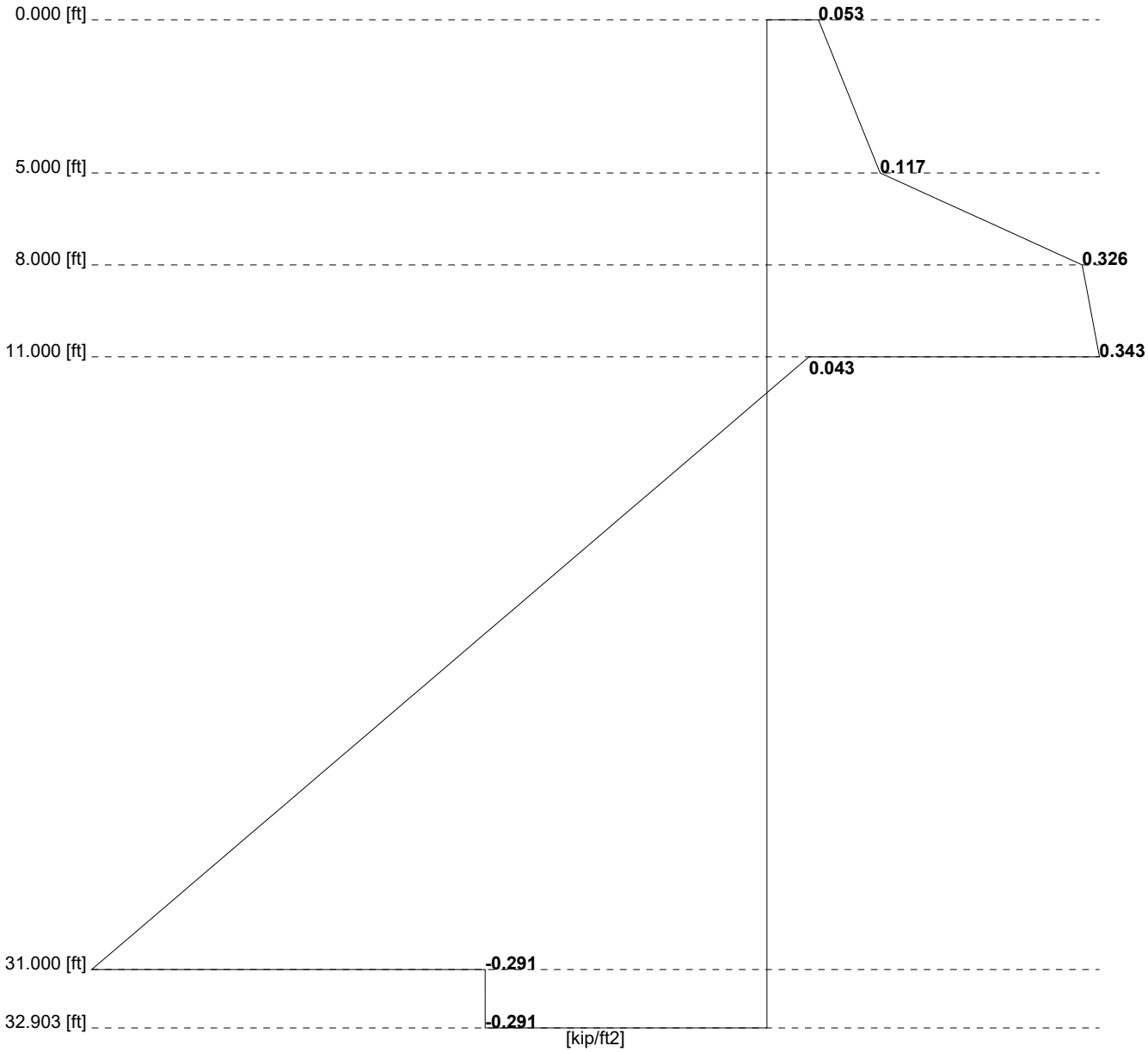
Earth Pressure Diagram



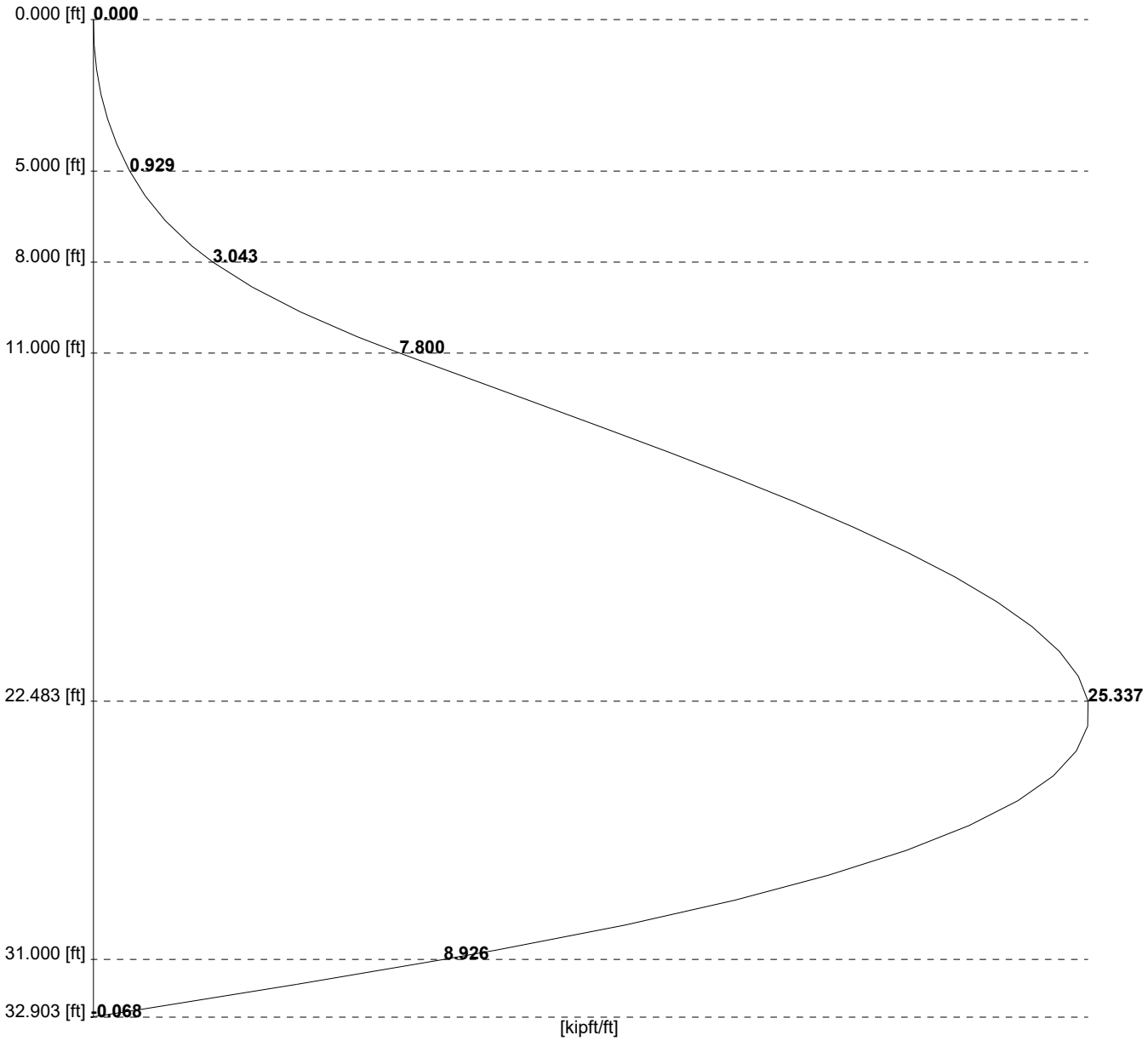
Water Pressure Diagram



Total Pressure Diagram

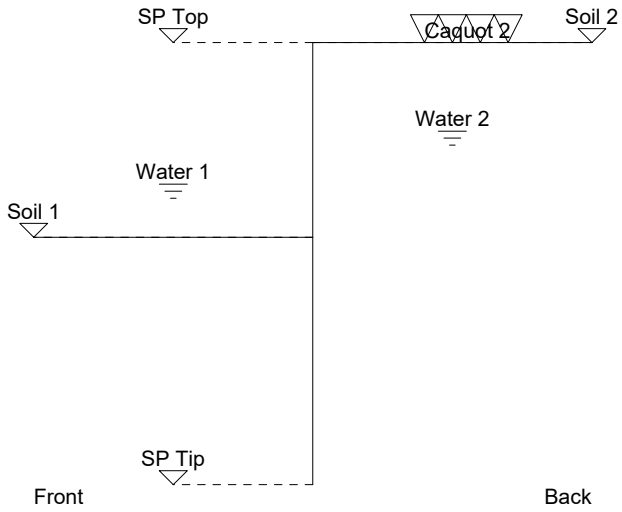


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	24.973
Soil Level in Front [ft]	11.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	8.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 2	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 3	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 4	118.500	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	31.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	43.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 3	63.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 4	83.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 5	118.500	0.125	0.063	0.243	34.000	18.000	0.000

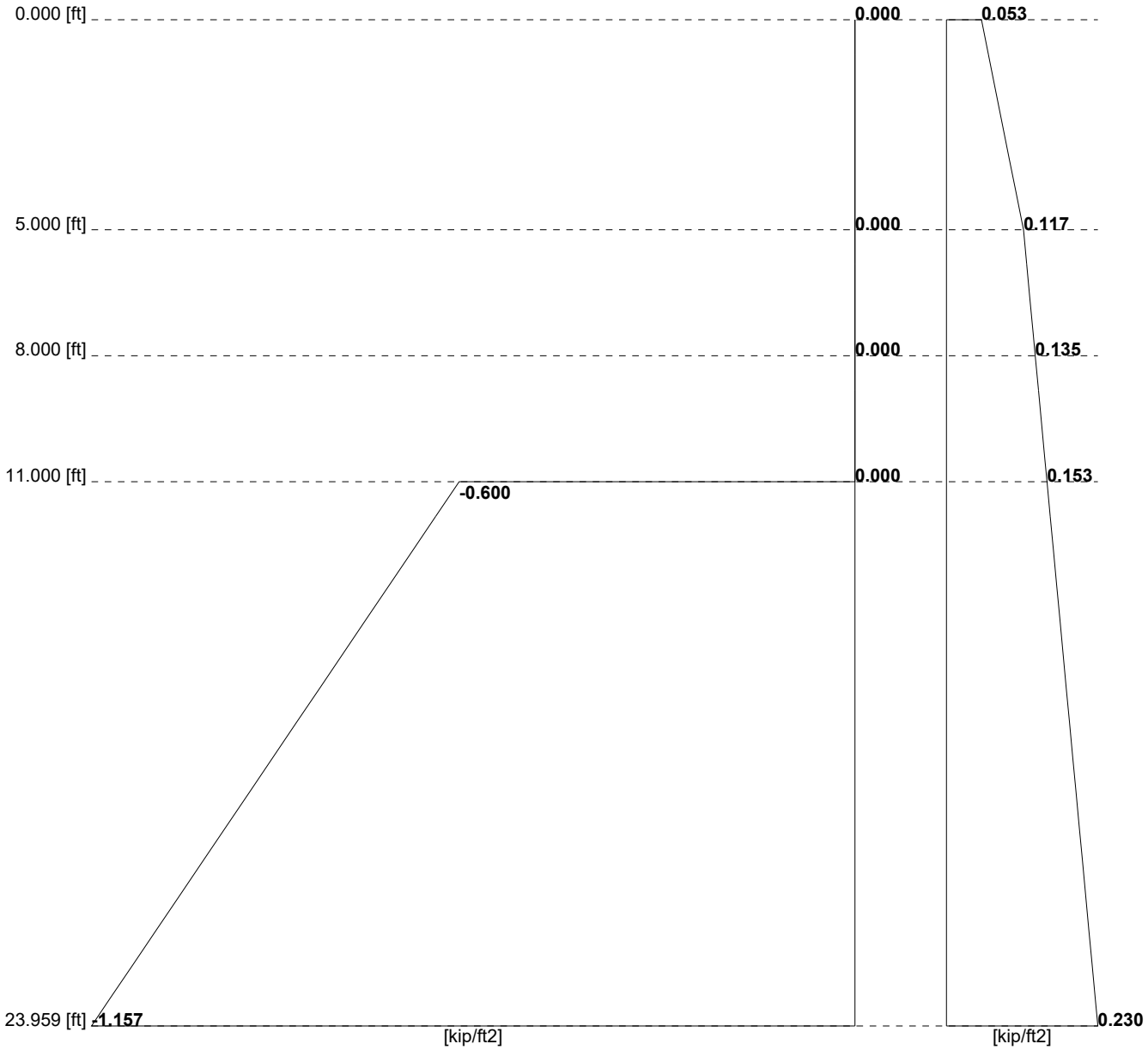
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

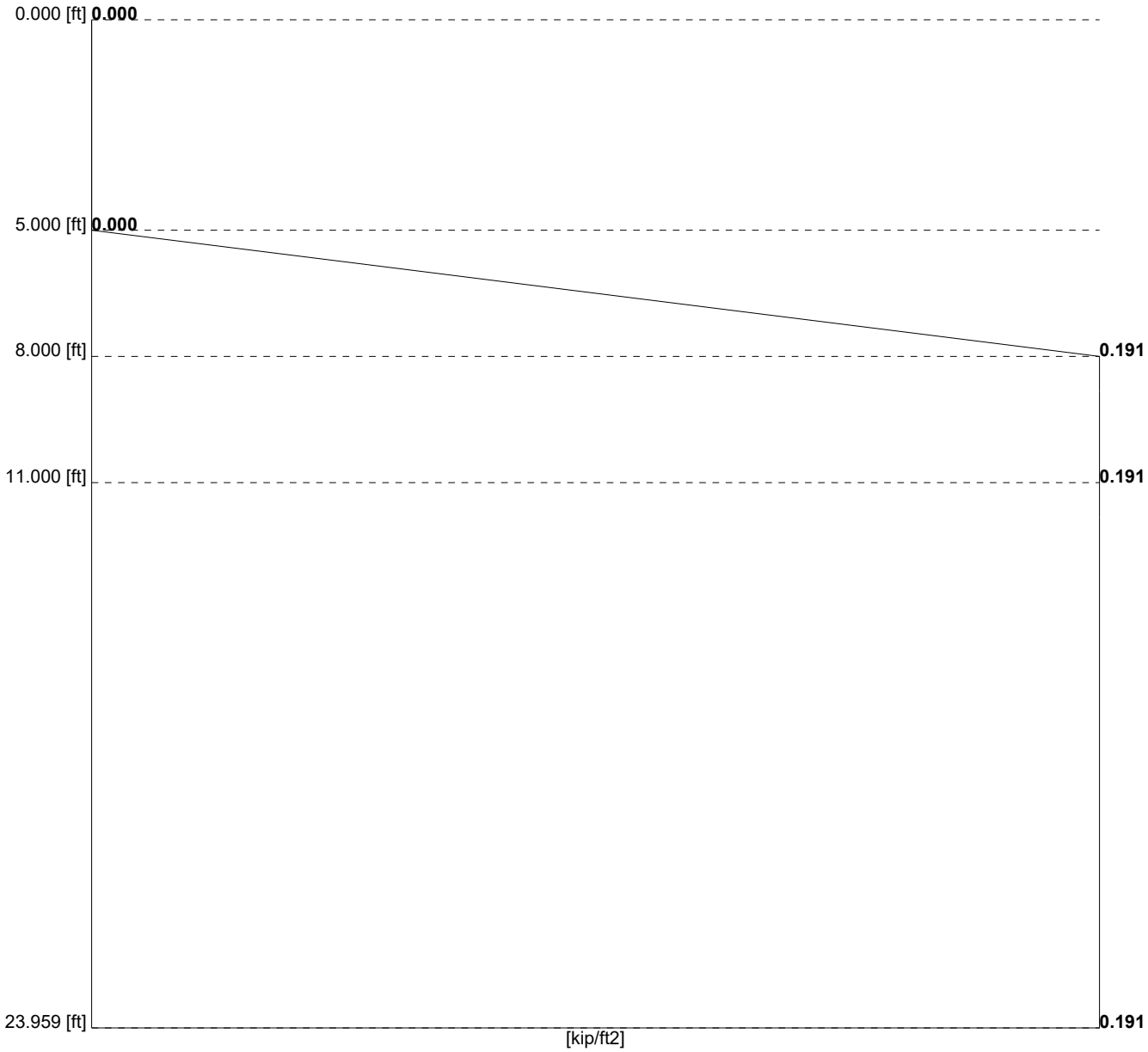
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.216	23.992
Maxmimal Moment [kipft/ft]	14.414	16.742
Normal Forces at Max. Moment [kip/ft]	1.346	23.992
Normal Forces at Min. Moment [kip/ft]	0.802	16.742
Deflection at Min. Moment [ft]	0.000	23.992
Deflection at Max. Moment [ft]	-0.004	16.742
Min. Stress at Min. Moment [lb/in2]	133.829	23.992
Max. Stress at Min. Moment [lb/in2]	294.681	23.992
Min. Stress at Max. Moment [lb/in2]	-5248.852	16.742
Max. Stress at Max. Moment [lb/in2]	5504.215	16.742
Safety > Req. Safety = 1.500	9.084	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	24.973	
Sheet Pile Length [ft]	24.973	
Included OverLength [ft]	1.013	
Vertical Equilibrium [kip/ft]	2.926	
Anchor Force (horiz.) [kip/ft]	0.000	

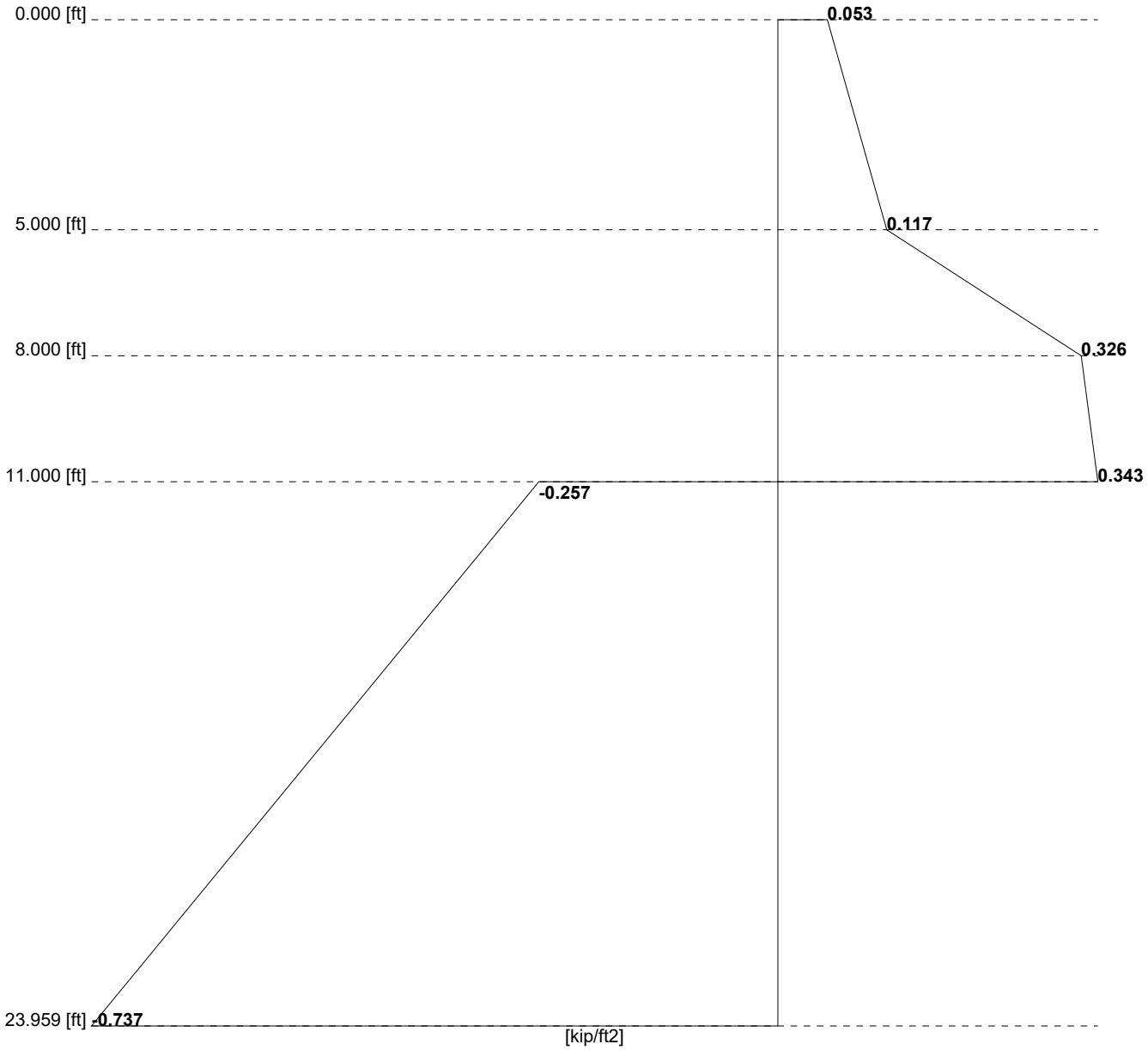
Earth Pressure Diagram



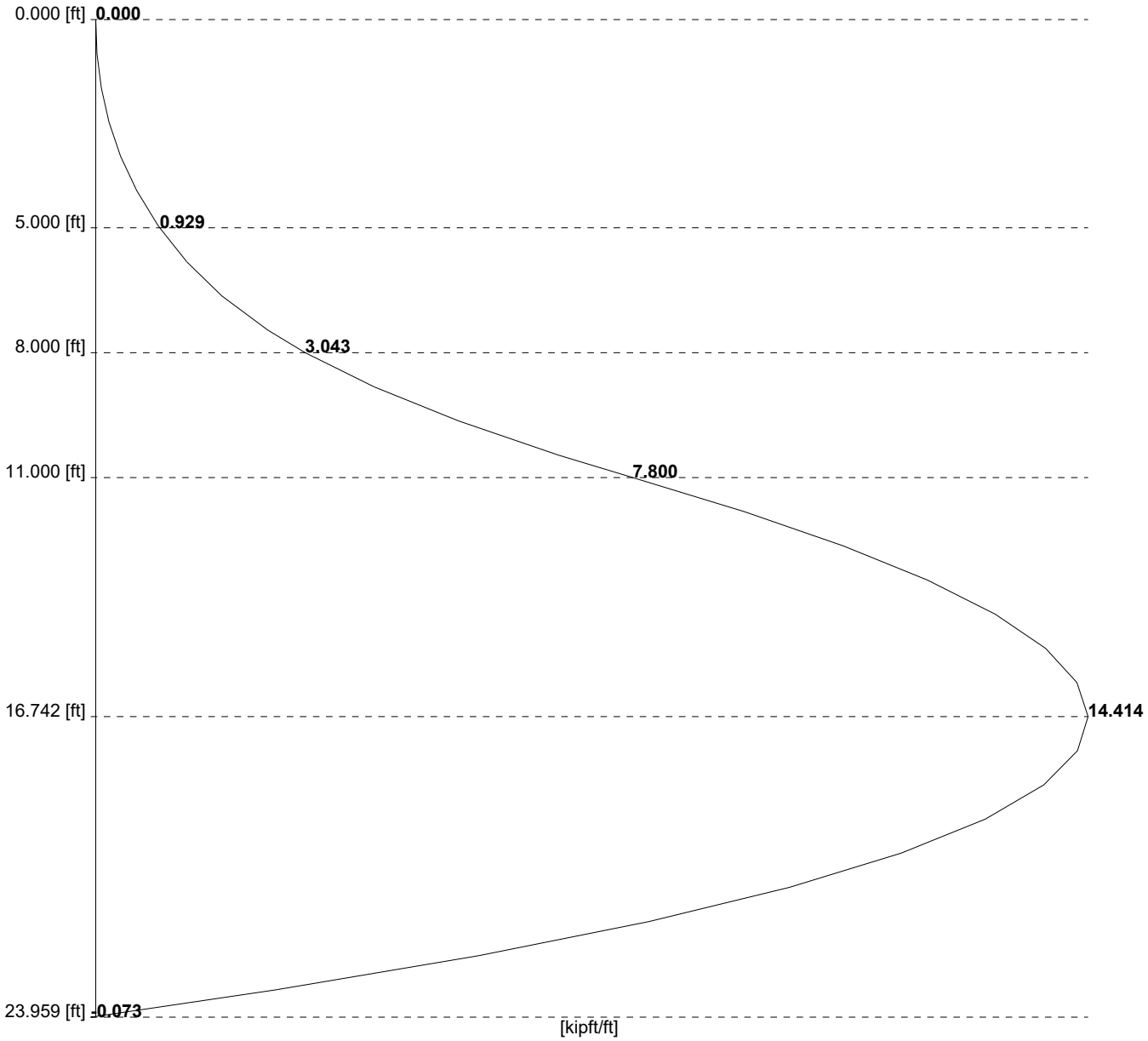
Water Pressure Diagram



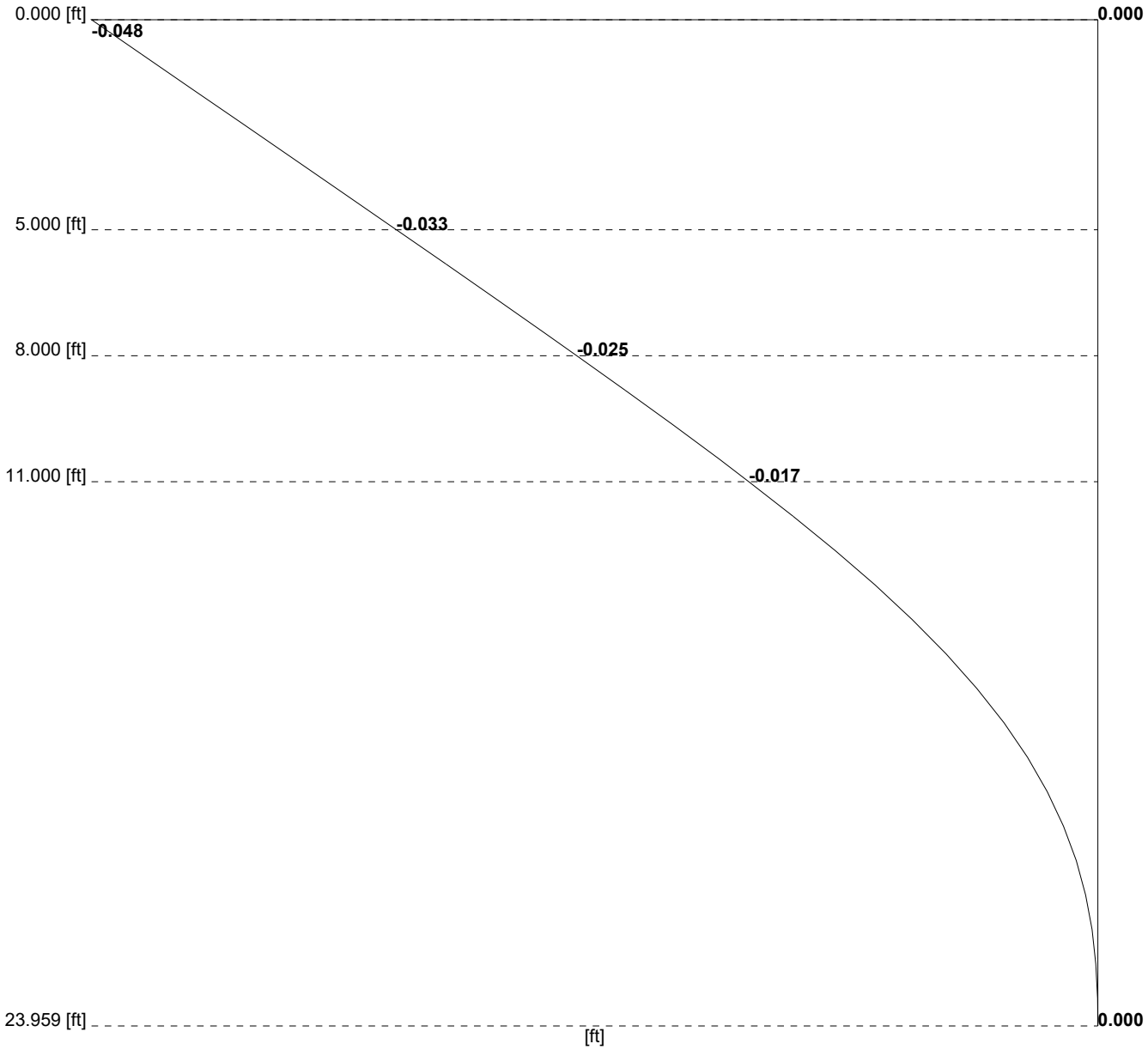
Total Pressure Diagram



Moment Diagram



Deflection Diagram

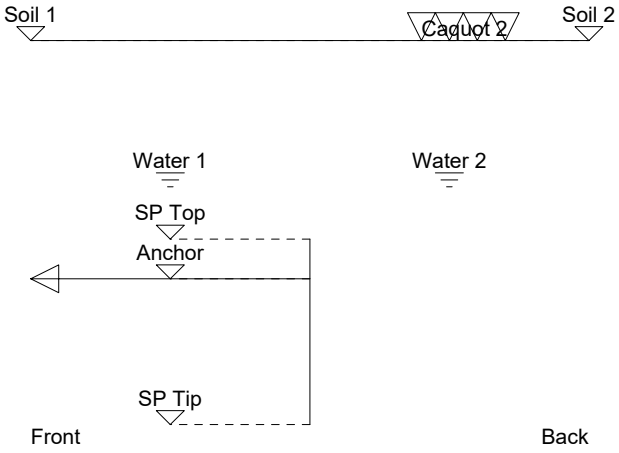


Attachment G

Anchor Wall ProSheet Outputs

Geodata

	Unit
Sheet Pile Top Level [ft]	7.500
Sheet Pile Tip Level [ft]	14.510
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	9.354
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 4	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 5	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

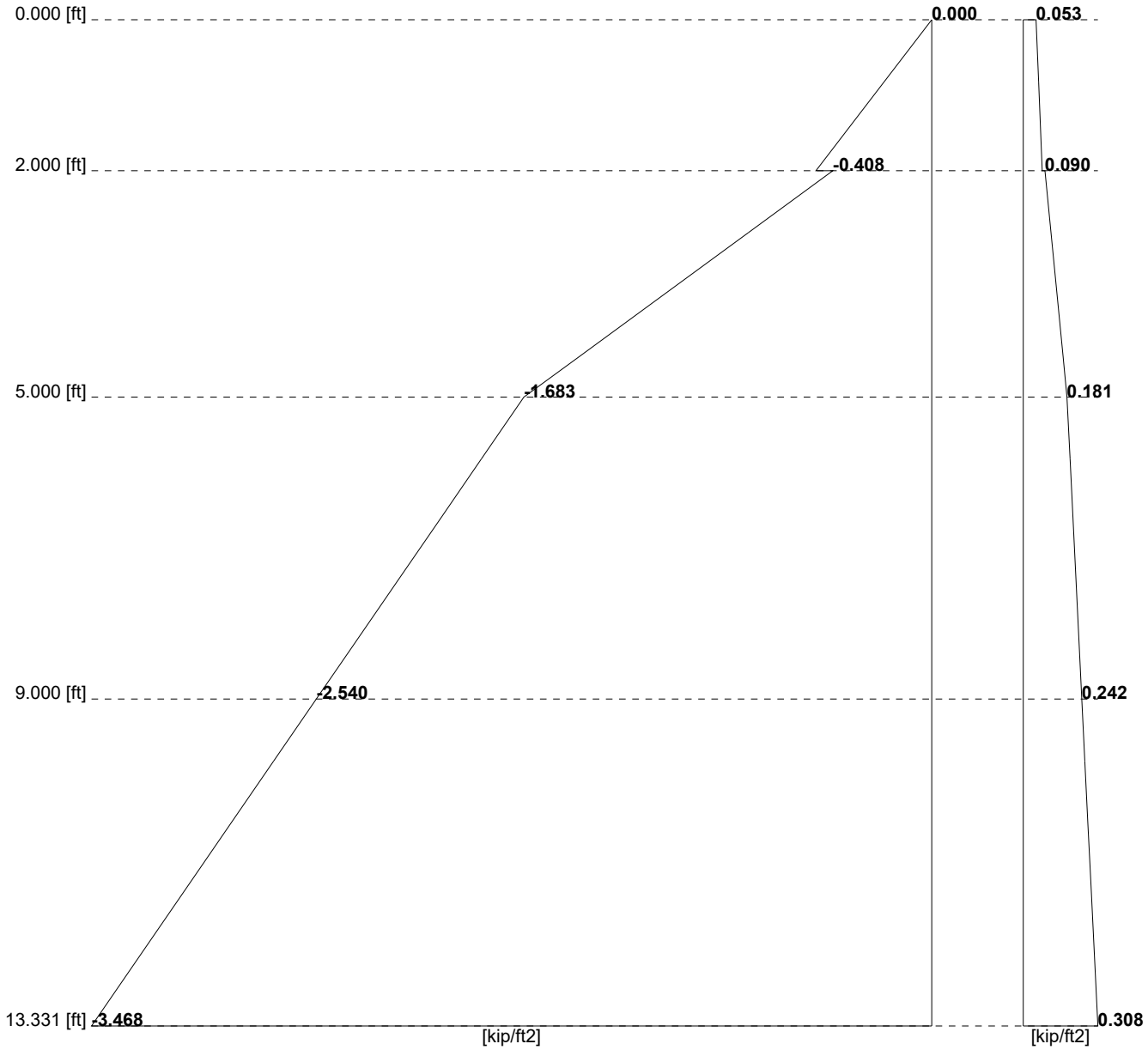
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

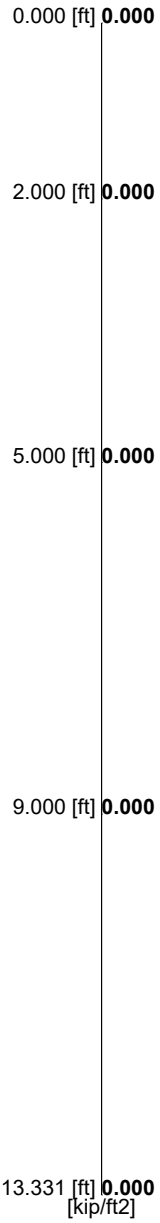
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-2.362	9.000
Maxmimal Moment [kipft/ft]	5.272	11.428
Normal Forces at Max. Moment [kip/ft]	-0.714	9.000
Normal Forces at Min. Moment [kip/ft]	-2.103	11.428
Deflection at Min. Moment [ft]	-0.001	9.000
Deflection at Max. Moment [ft]	0.000	11.428
Min. Stress at Min. Moment [lb/in2]	-994.242	9.000
Max. Stress at Min. Moment [lb/in2]	766.991	9.000
Min. Stress at Max. Moment [lb/in2]	-2300.545	11.428
Max. Stress at Max. Moment [lb/in2]	1631.227	11.428
Safety > Req. Safety = 1.500	21.734	
Sheet Pile Top Level [ft]	7.500	
Sheet Pile Tip Level [ft]	14.510	
Sheet Pile Length [ft]	7.010	
Included OverLength [ft]	1.179	
Vertical Equilibrium [kip/ft]	-1.449	
Anchor Force (horiz.) [kip/ft]	9.354	

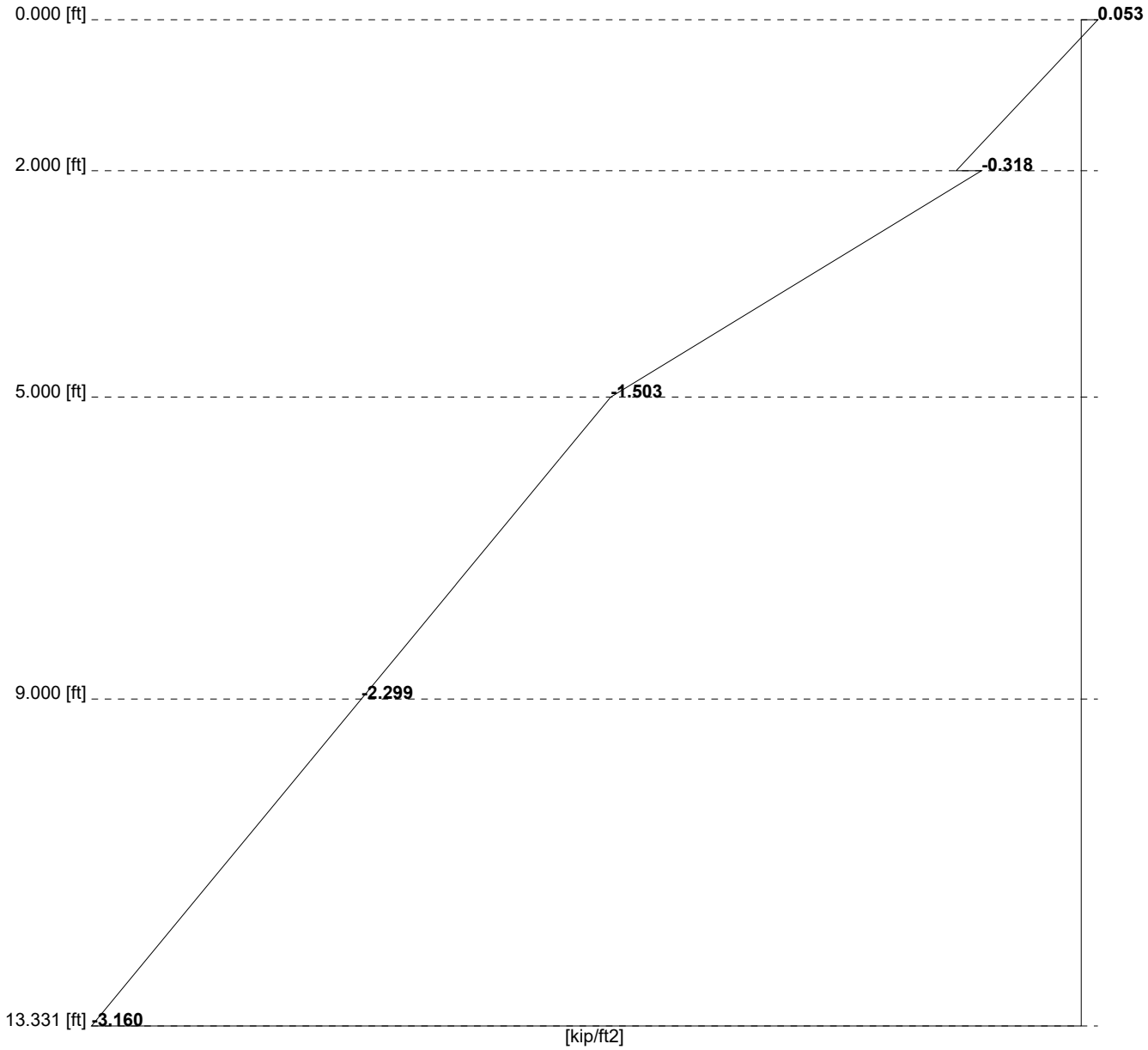
Earth Pressure Diagram



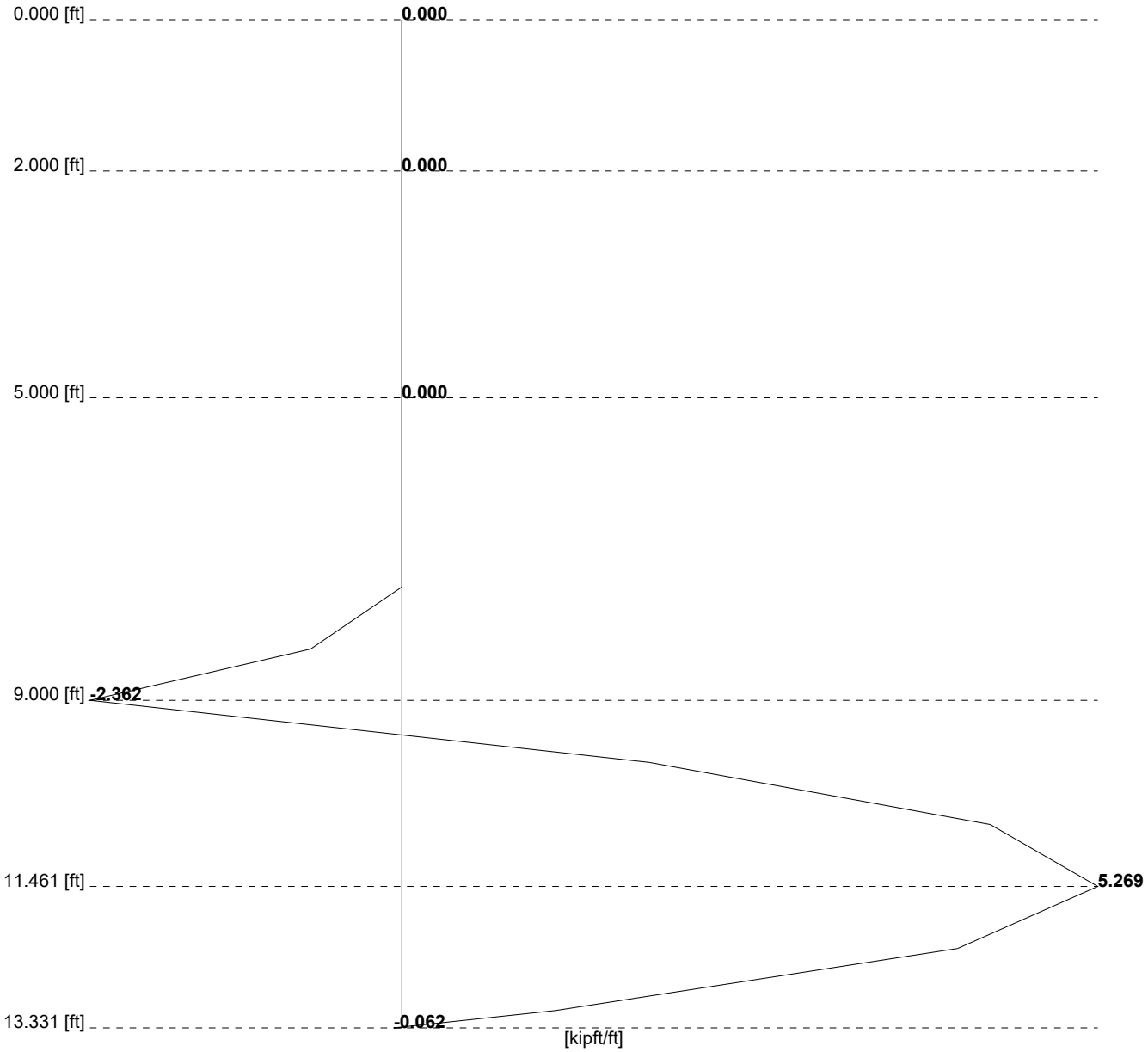
Water Pressure Diagram



Total Pressure Diagram

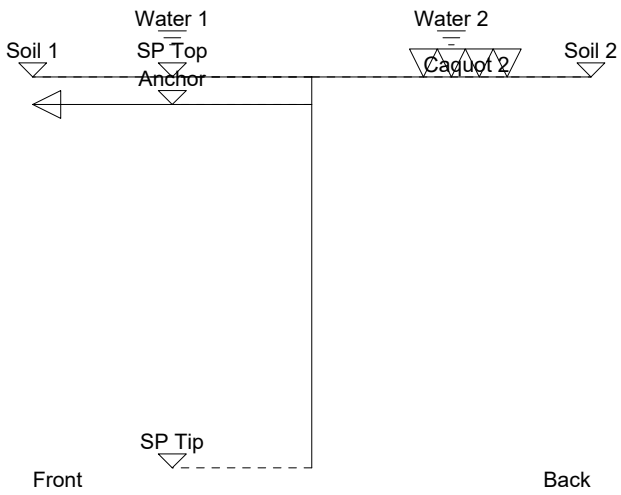


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	7.500
Sheet Pile Tip Level [ft]	28.722
Soil Level in Front [ft]	7.500
Soil Level behind [ft]	7.500
Anchorlevel [ft]	9.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	9.354
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 4	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 5	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

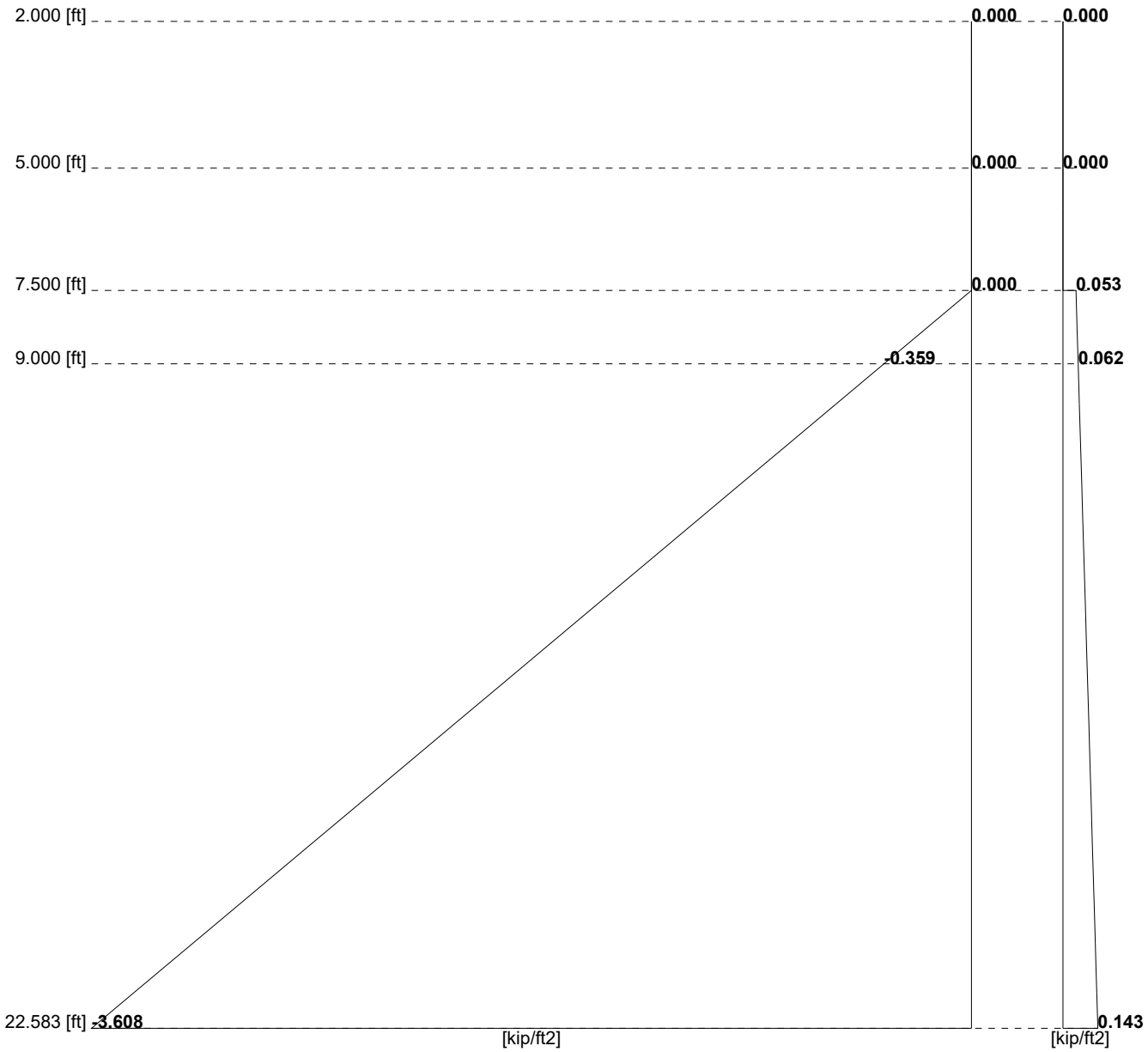
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

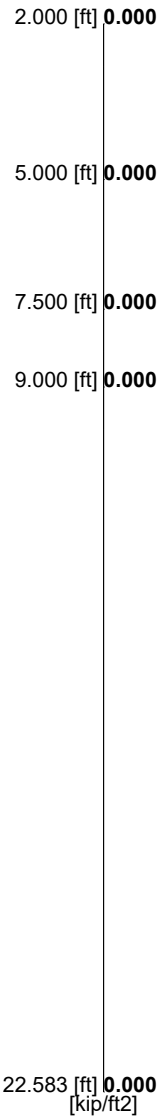
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.822	22.616
Maxmimal Moment [kipft/ft]	43.908	16.382
Normal Forces at Max. Moment [kip/ft]	-9.331	22.616
Normal Forces at Min. Moment [kip/ft]	-3.173	16.382
Deflection at Min. Moment [ft]	0.000	22.616
Deflection at Max. Moment [ft]	-0.011	16.382
Min. Stress at Min. Moment [lb/in2]	-1791.648	22.616
Max. Stress at Min. Moment [lb/in2]	-1178.220	22.616
Min. Stress at Max. Moment [lb/in2]	-16866.227	16.382
Max. Stress at Max. Moment [lb/in2]	15856.209	16.382
Safety > Req. Safety = 1.500	2.965	
Sheet Pile Top Level [ft]	7.500	
Sheet Pile Tip Level [ft]	28.722	
Sheet Pile Length [ft]	21.222	
Included OverLength [ft]	6.139	
Vertical Equilibrium [kip/ft]	-3.378	
Anchor Force (horiz.) [kip/ft]	9.354	

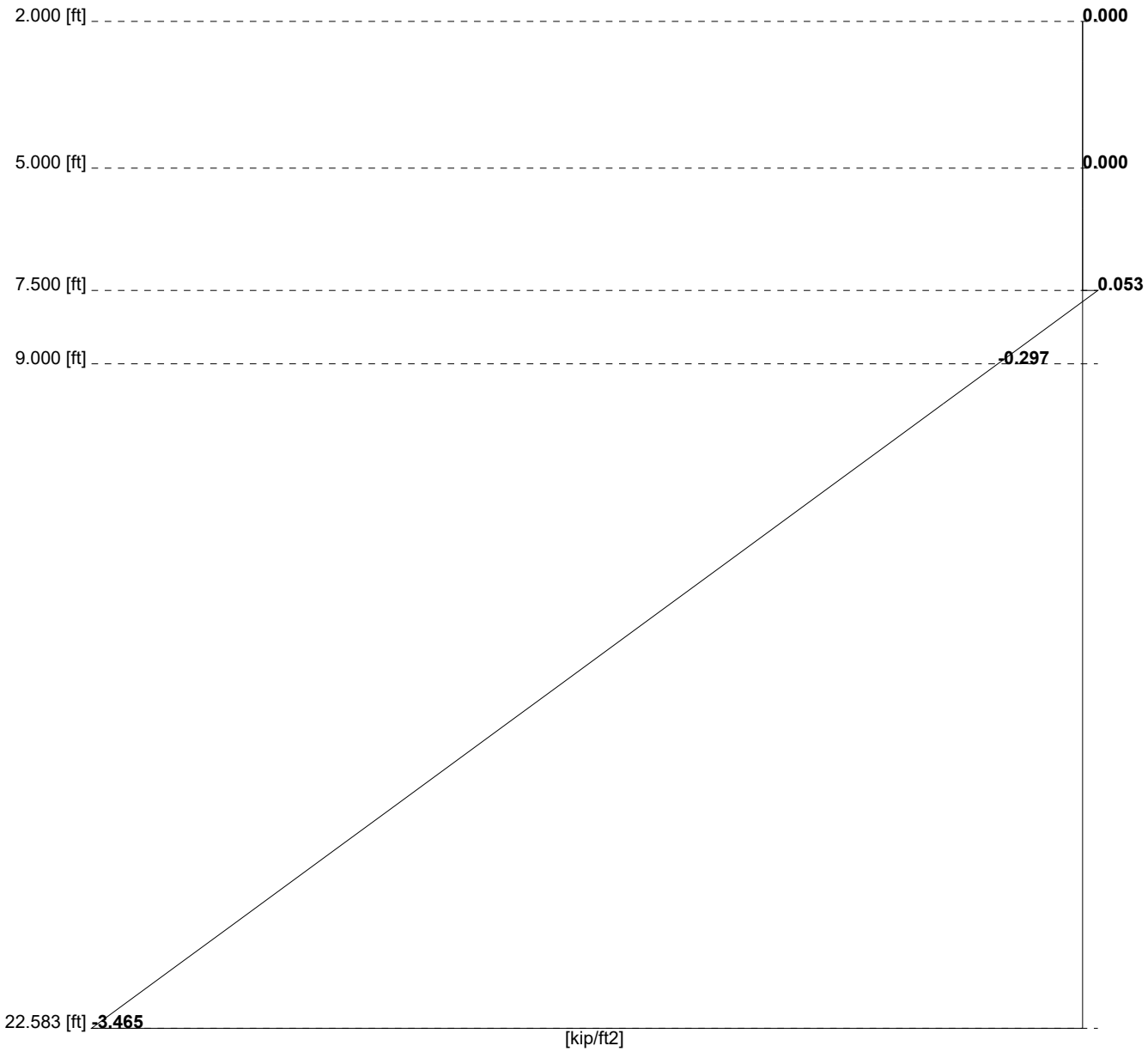
Earth Pressure Diagram



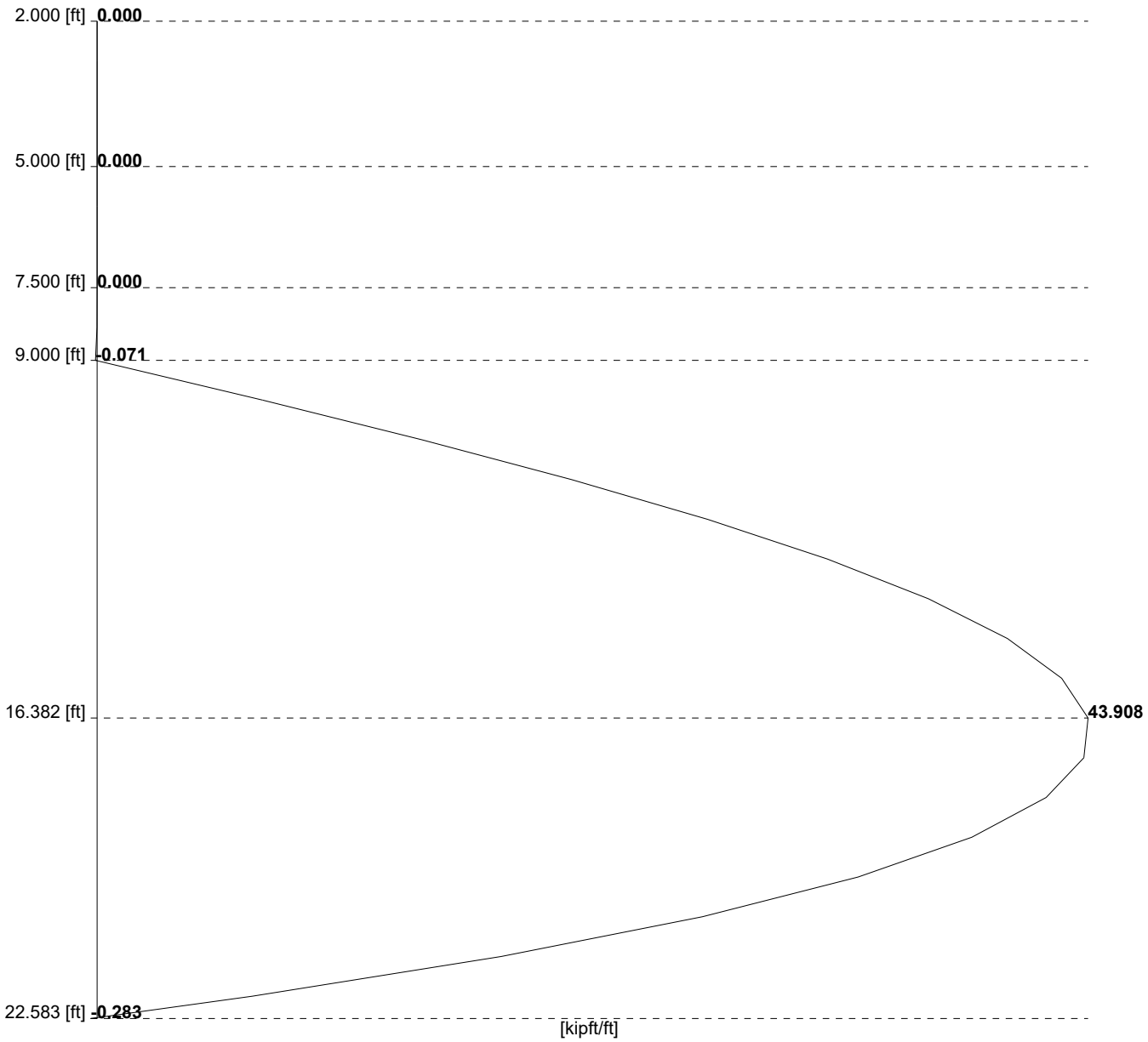
Water Pressure Diagram



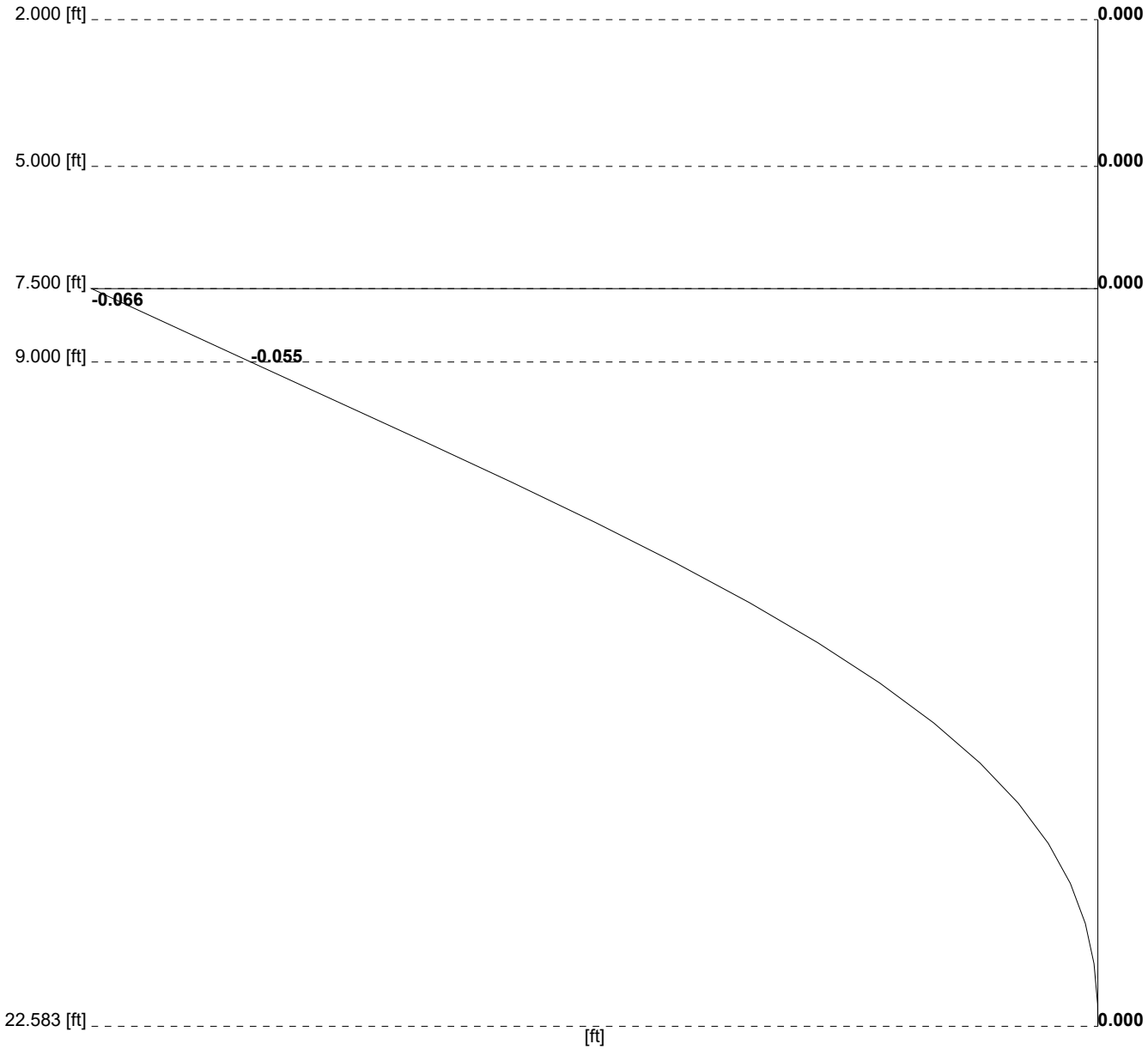
Total Pressure Diagram



Moment Diagram

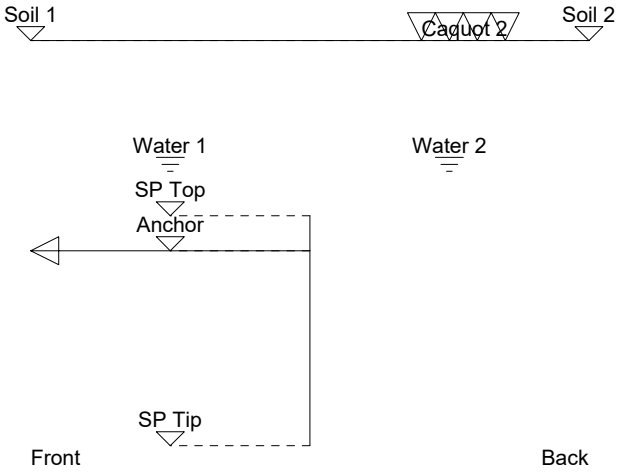


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	7.500
Sheet Pile Tip Level [ft]	17.349
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	9.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	12.452
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

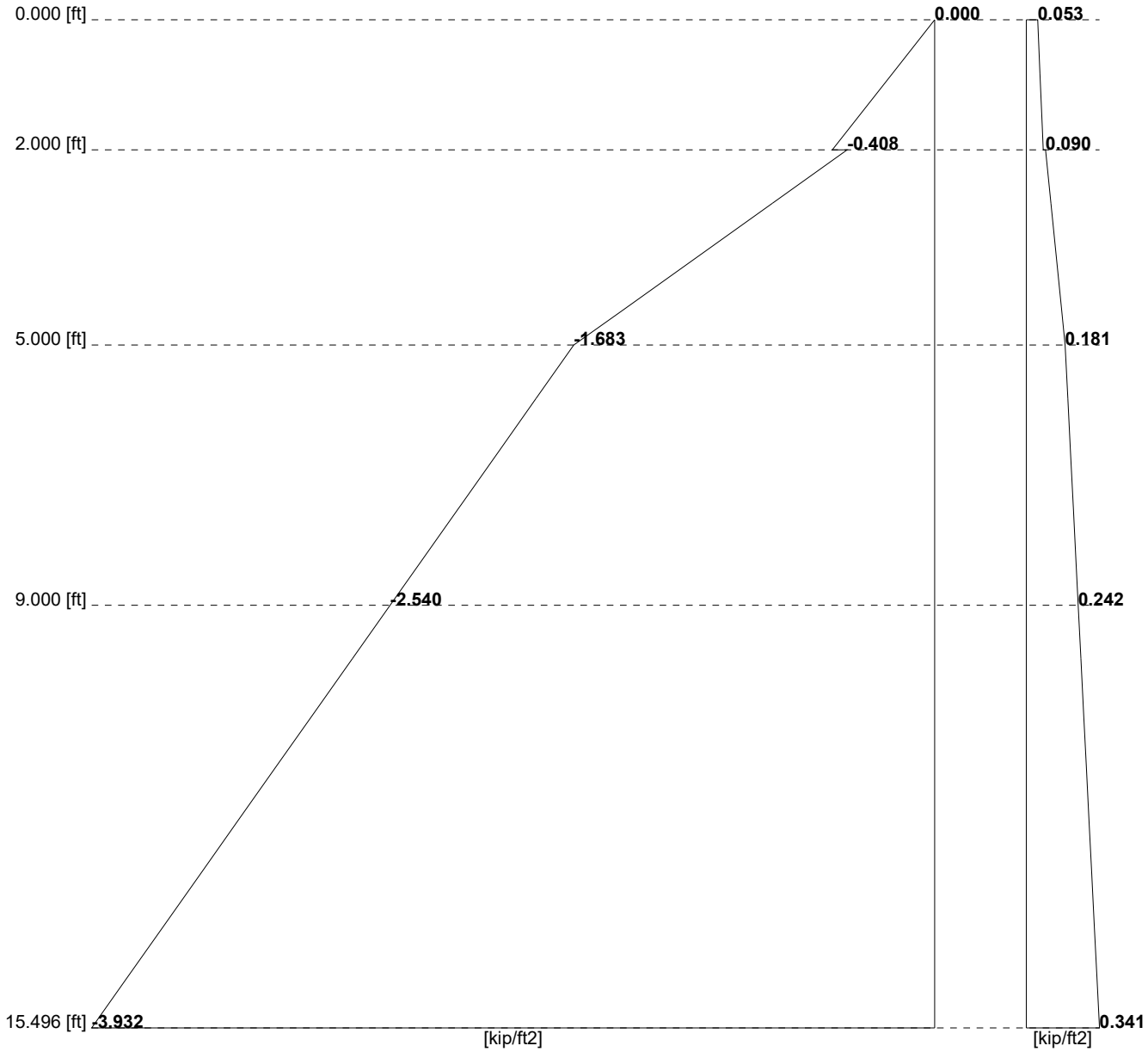
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

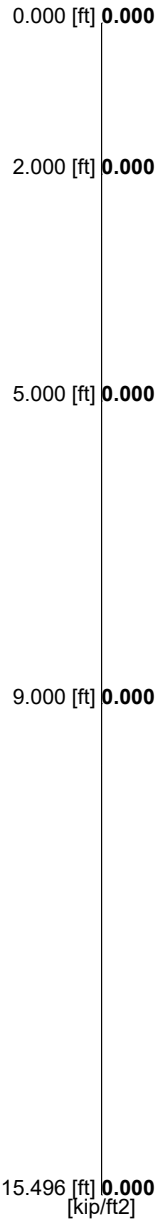
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-2.362	9.000
Maxmimal Moment [kipft/ft]	14.372	12.281
Normal Forces at Max. Moment [kip/ft]	-0.714	9.000
Normal Forces at Min. Moment [kip/ft]	-2.626	12.281
Deflection at Min. Moment [ft]	-0.004	9.000
Deflection at Max. Moment [ft]	-0.001	12.281
Min. Stress at Min. Moment [lb/in2]	-993.256	9.000
Max. Stress at Min. Moment [lb/in2]	766.005	9.000
Min. Stress at Max. Moment [lb/in2]	-5776.352	12.281
Max. Stress at Max. Moment [lb/in2]	4940.550	12.281
Safety > Req. Safety = 1.500	8.656	
Sheet Pile Top Level [ft]	7.500	
Sheet Pile Tip Level [ft]	17.349	
Sheet Pile Length [ft]	9.849	
Included OverLength [ft]	1.853	
Vertical Equilibrium [kip/ft]	-1.671	
Anchor Force (horiz.) [kip/ft]	12.452	

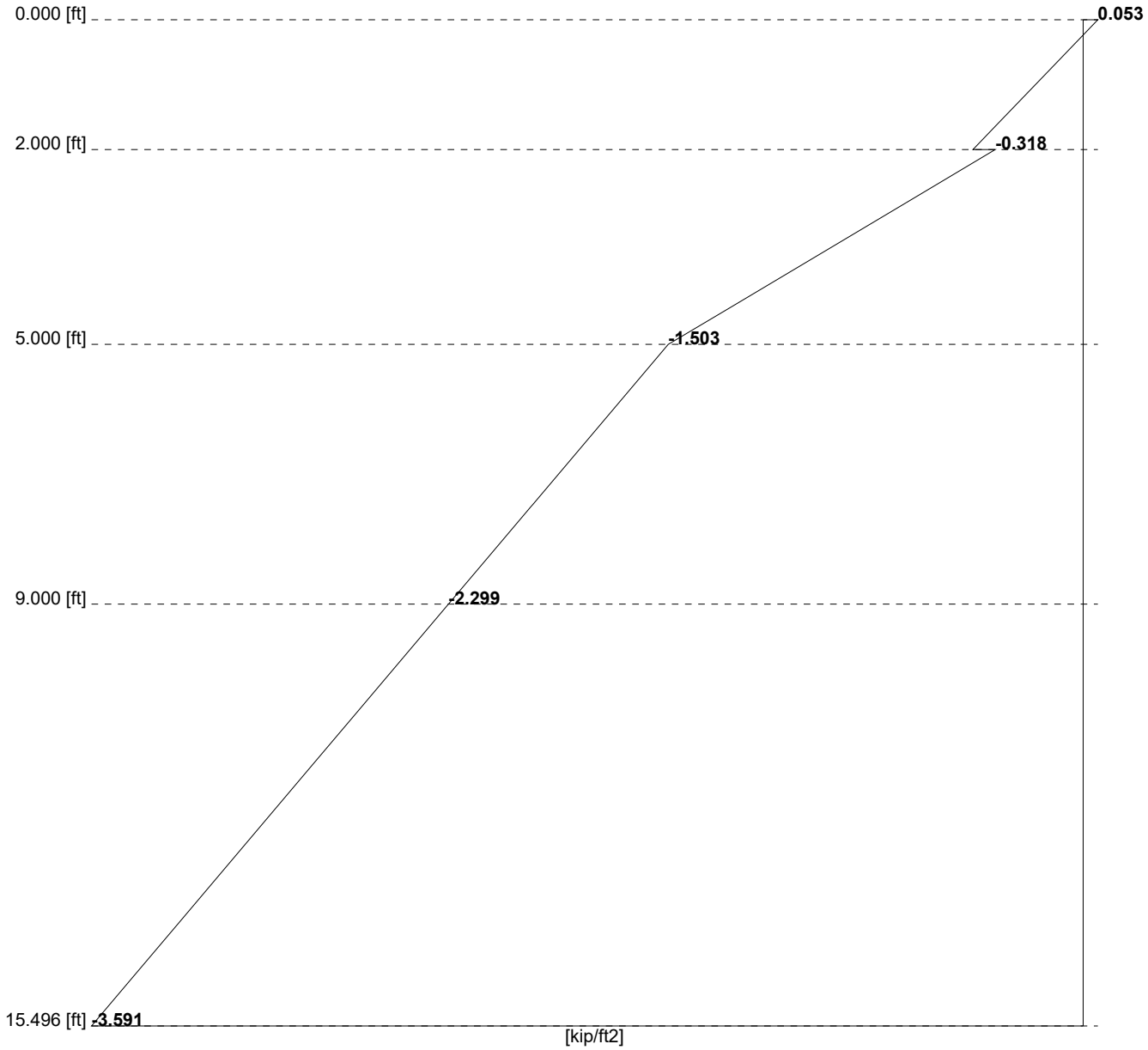
Earth Pressure Diagram



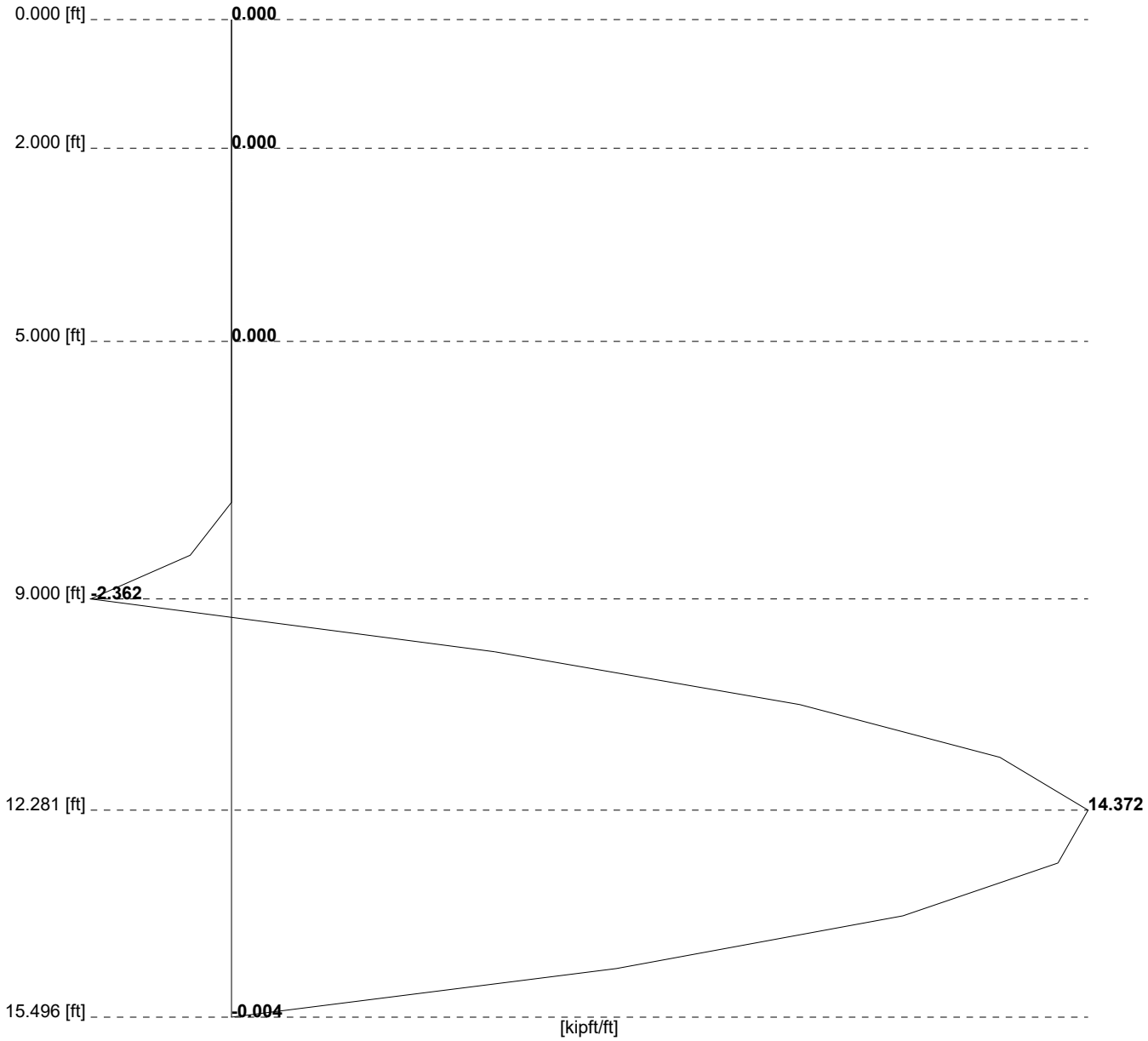
Water Pressure Diagram



Total Pressure Diagram

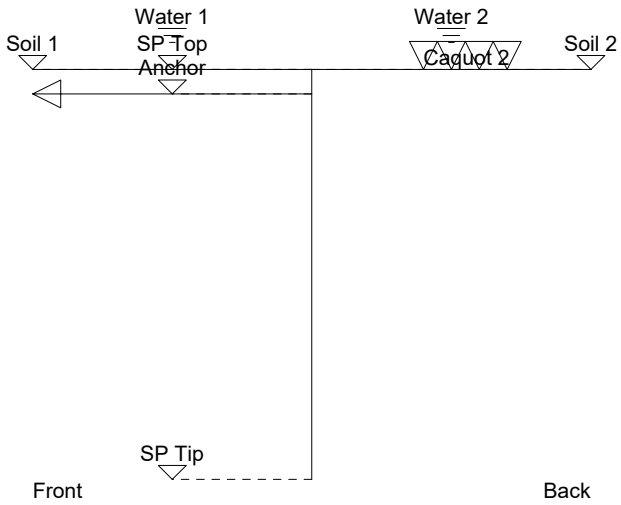


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	7.500
Sheet Pile Tip Level [ft]	32.561
Soil Level in Front [ft]	7.500
Soil Level behind [ft]	7.500
Anchorlevel [ft]	9.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	12.452
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

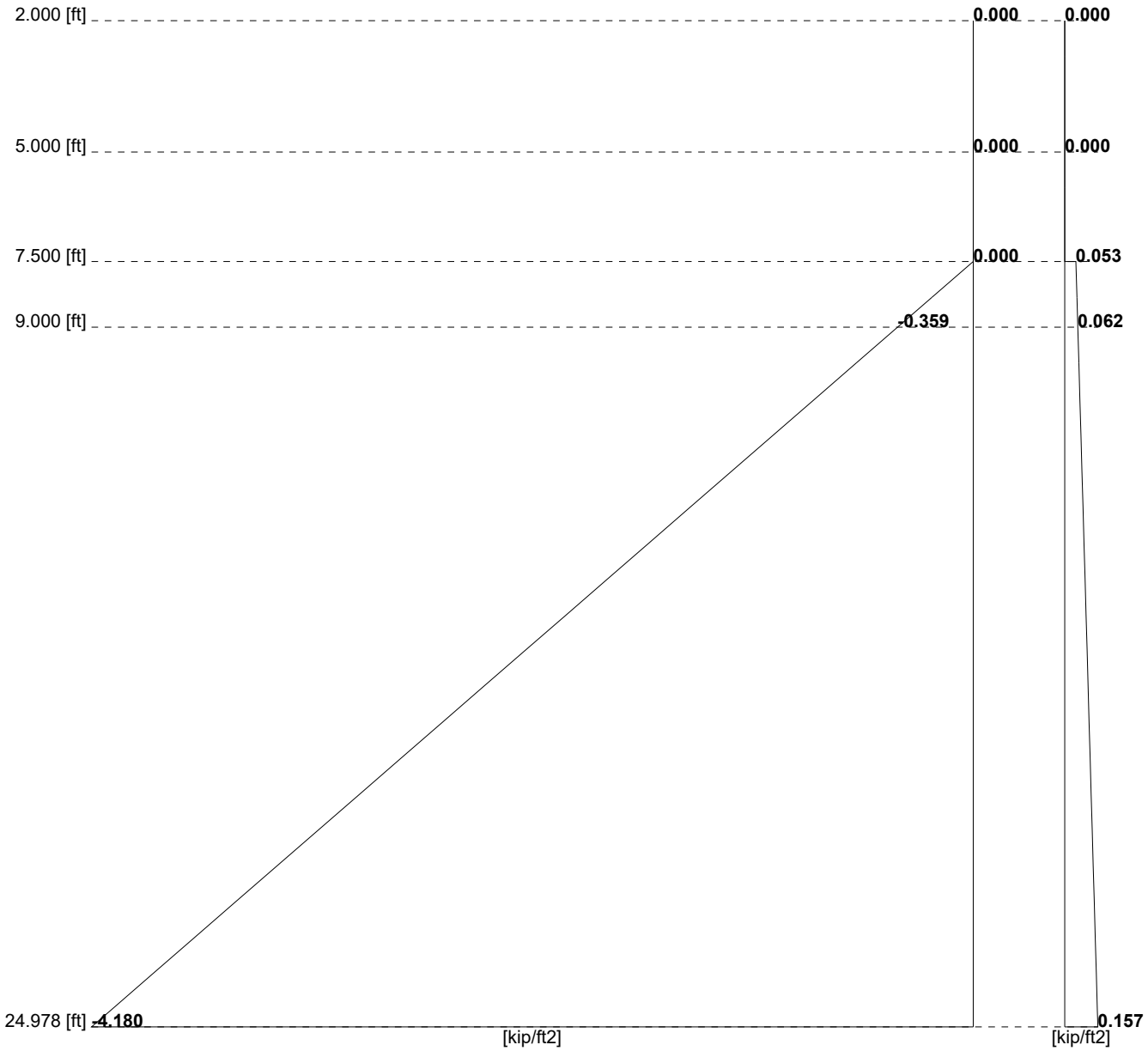
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

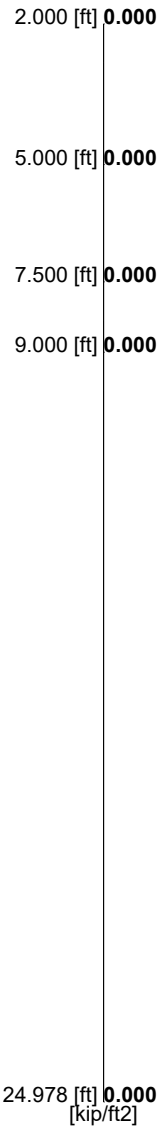
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.204	25.011
Maxmimal Moment [kipft/ft]	69.999	18.022
Normal Forces at Max. Moment [kip/ft]	-12.591	25.011
Normal Forces at Min. Moment [kip/ft]	-4.491	18.022
Deflection at Min. Moment [ft]	0.000	25.011
Deflection at Max. Moment [ft]	-0.020	18.022
Min. Stress at Min. Moment [lb/in2]	-2452.603	25.011
Max. Stress at Min. Moment [lb/in2]	-1554.936	25.011
Min. Stress at Max. Moment [lb/in2]	-26784.080	18.022
Max. Stress at Max. Moment [lb/in2]	25354.580	18.022
Safety > Req. Safety = 1.500	1.867	
Sheet Pile Top Level [ft]	7.500	
Sheet Pile Tip Level [ft]	32.561	
Sheet Pile Length [ft]	25.061	
Included OverLength [ft]	7.583	
Vertical Equilibrium [kip/ft]	-4.504	
Anchor Force (horiz.) [kip/ft]	12.452	

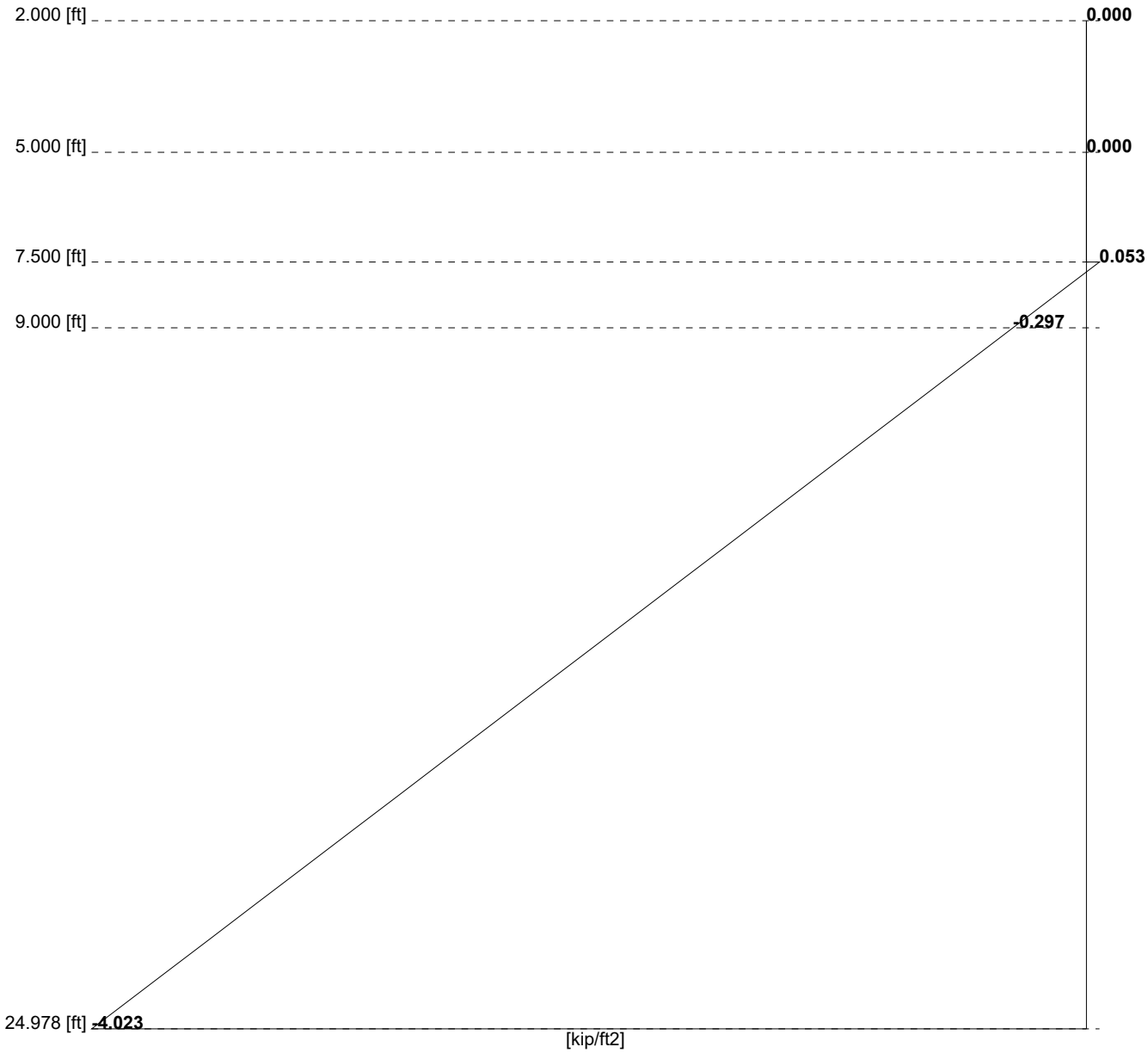
Earth Pressure Diagram



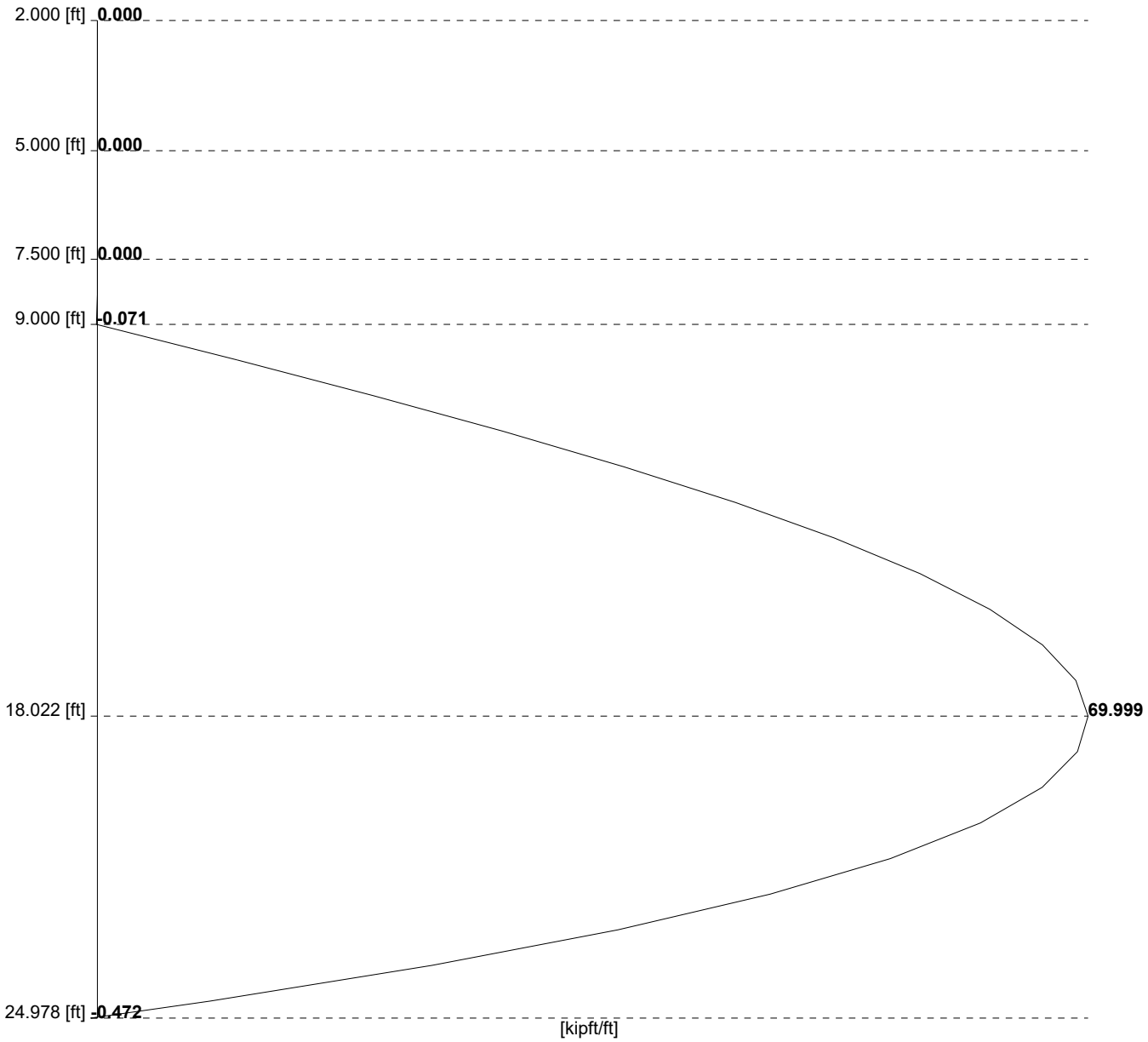
Water Pressure Diagram



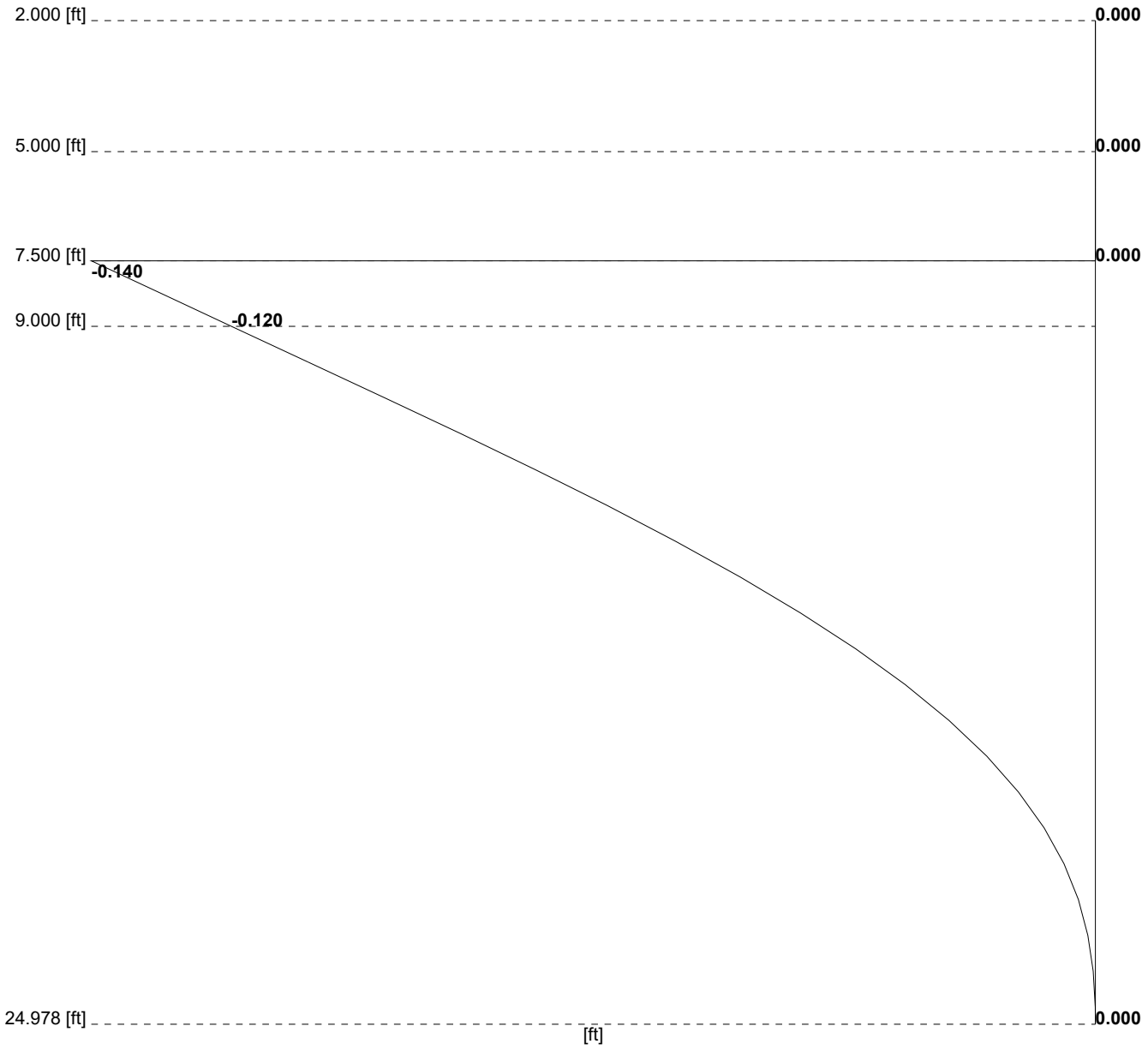
Total Pressure Diagram



Moment Diagram

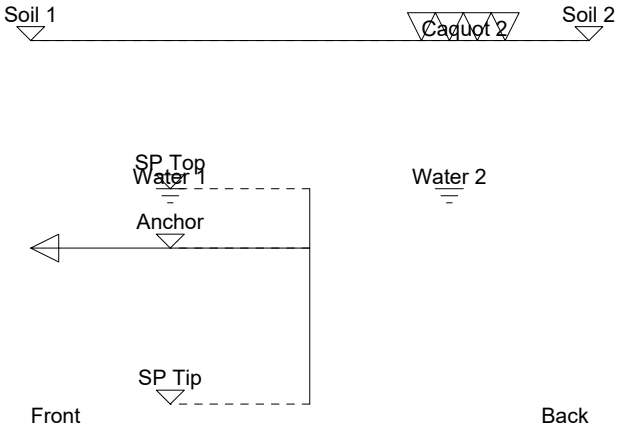


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	12.264
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	8.768
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 4	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 5	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

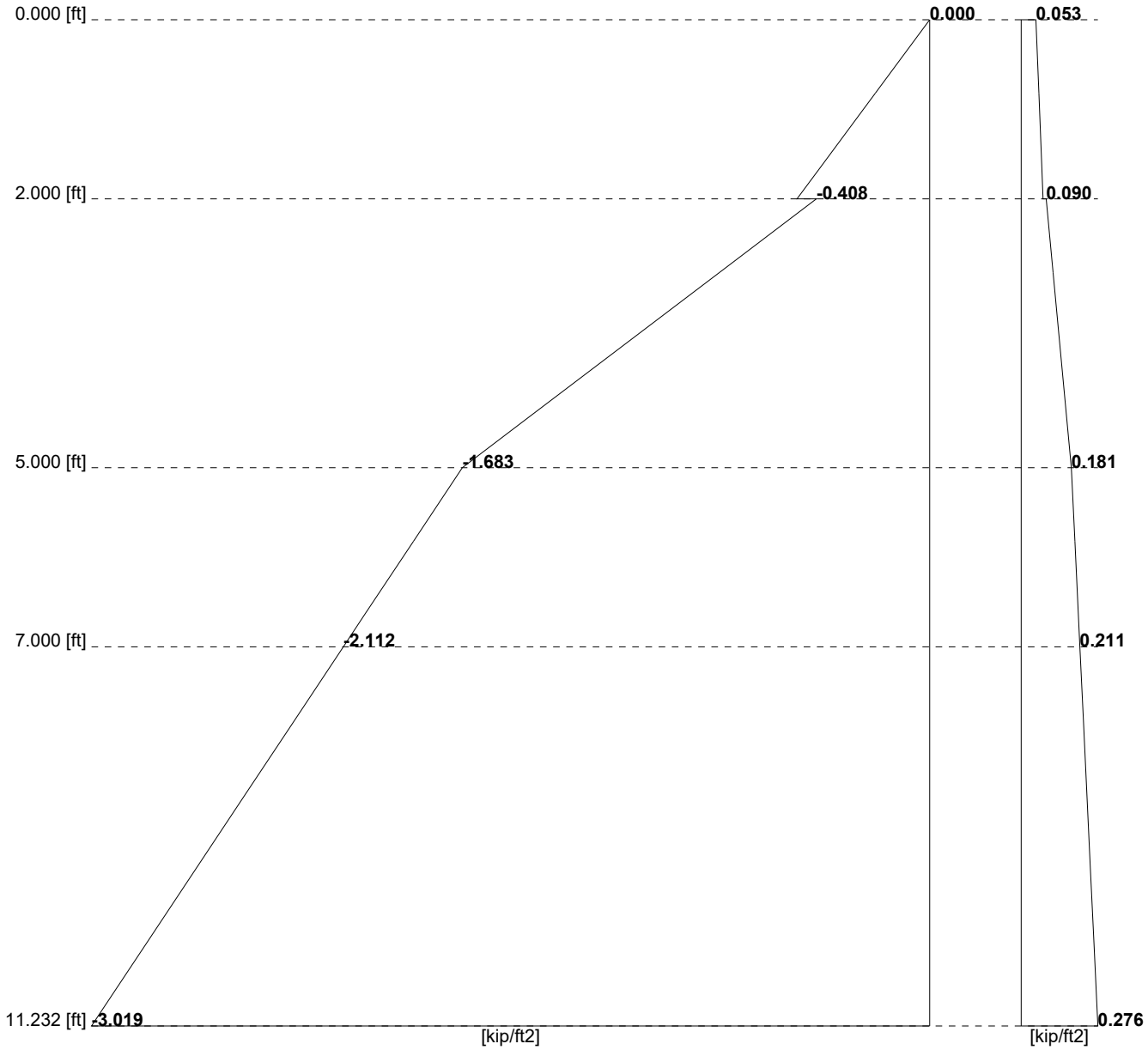
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

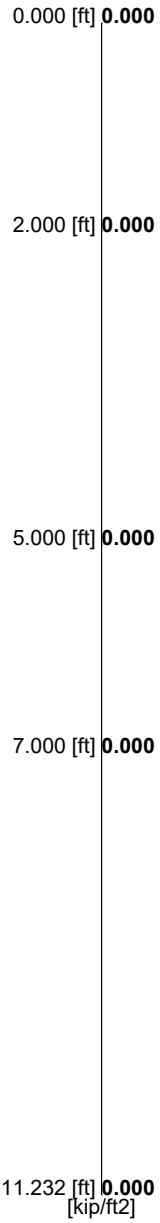
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-3.271	7.000
Maxmimal Moment [kipft/ft]	3.682	9.461
Normal Forces at Max. Moment [kip/ft]	-0.751	7.000
Normal Forces at Min. Moment [kip/ft]	-1.920	9.461
Deflection at Min. Moment [ft]	-0.001	7.000
Deflection at Max. Moment [ft]	0.000	9.461
Min. Stress at Min. Moment [lb/in2]	-1826.807	7.000
Max. Stress at Min. Moment [lb/in2]	1562.108	7.000
Min. Stress at Max. Moment [lb/in2]	-2246.333	9.461
Max. Stress at Max. Moment [lb/in2]	1569.564	9.461
Safety > Req. Safety = 1.500	22.259	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	12.264	
Sheet Pile Length [ft]	7.264	
Included OverLength [ft]	1.032	
Vertical Equilibrium [kip/ft]	-1.448	
Anchor Force (horiz.) [kip/ft]	8.768	

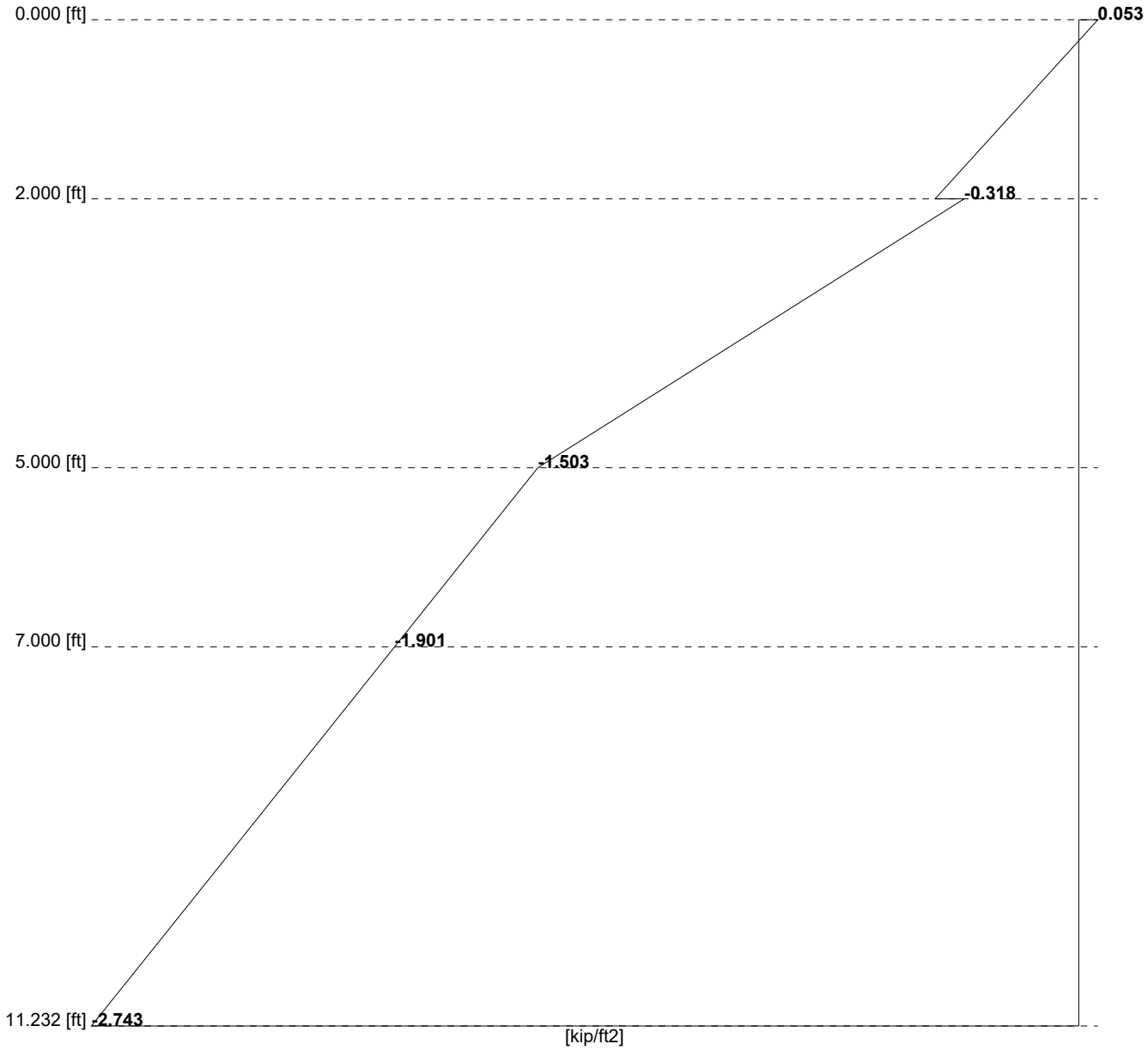
Earth Pressure Diagram



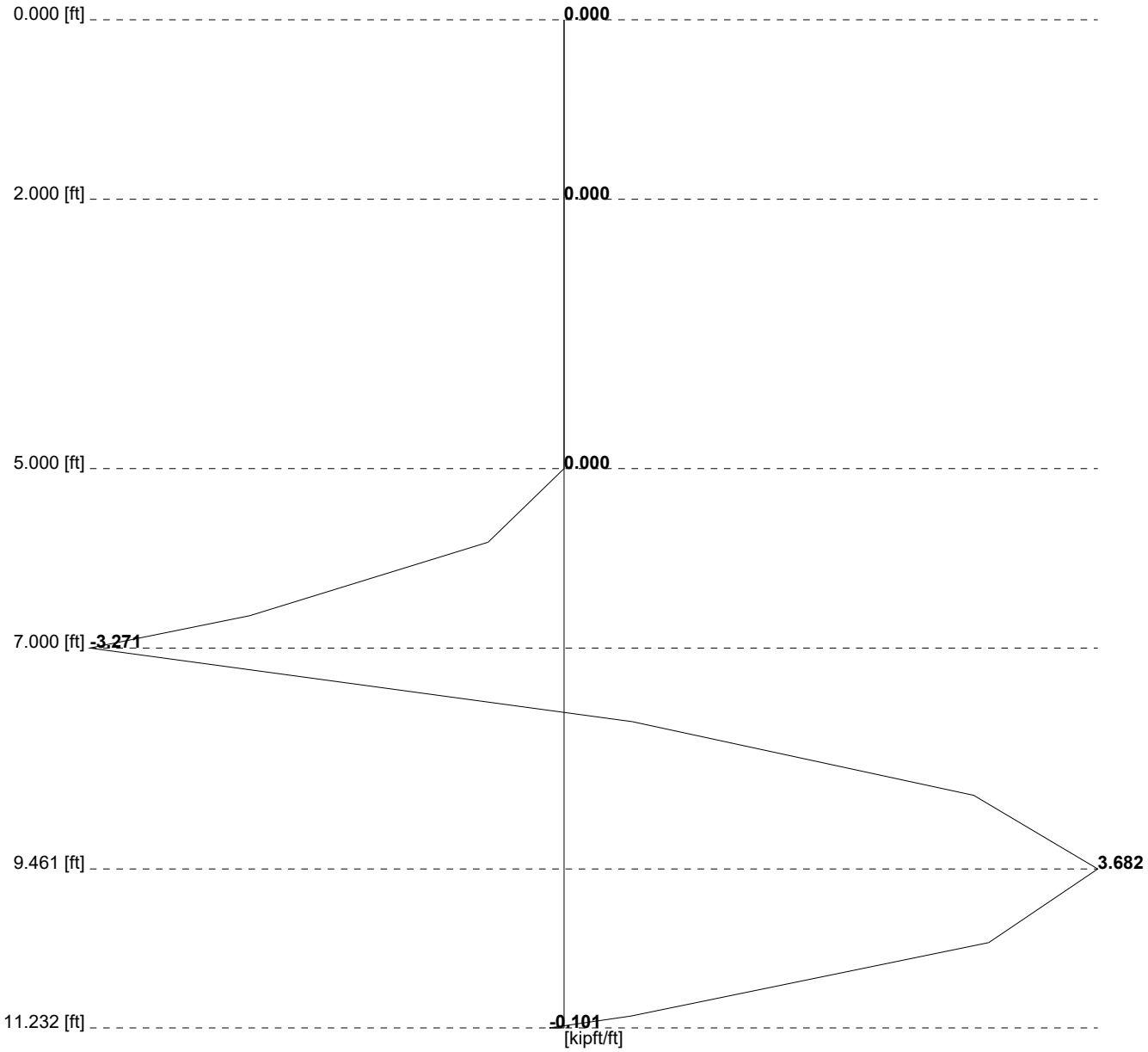
Water Pressure Diagram



Total Pressure Diagram

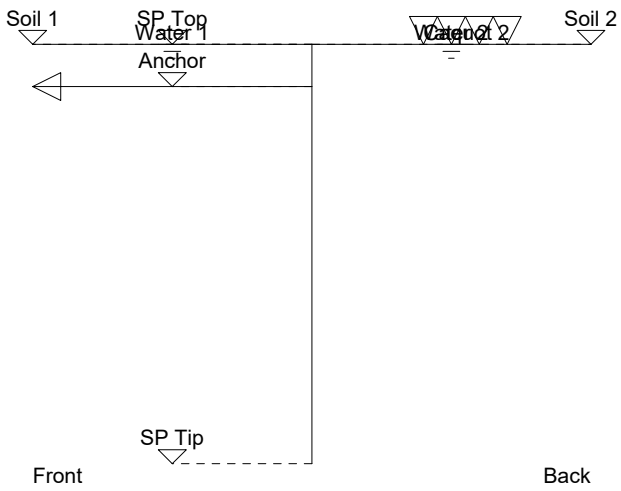


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	24.856
Soil Level in Front [ft]	5.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	8.768
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 4	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 5	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

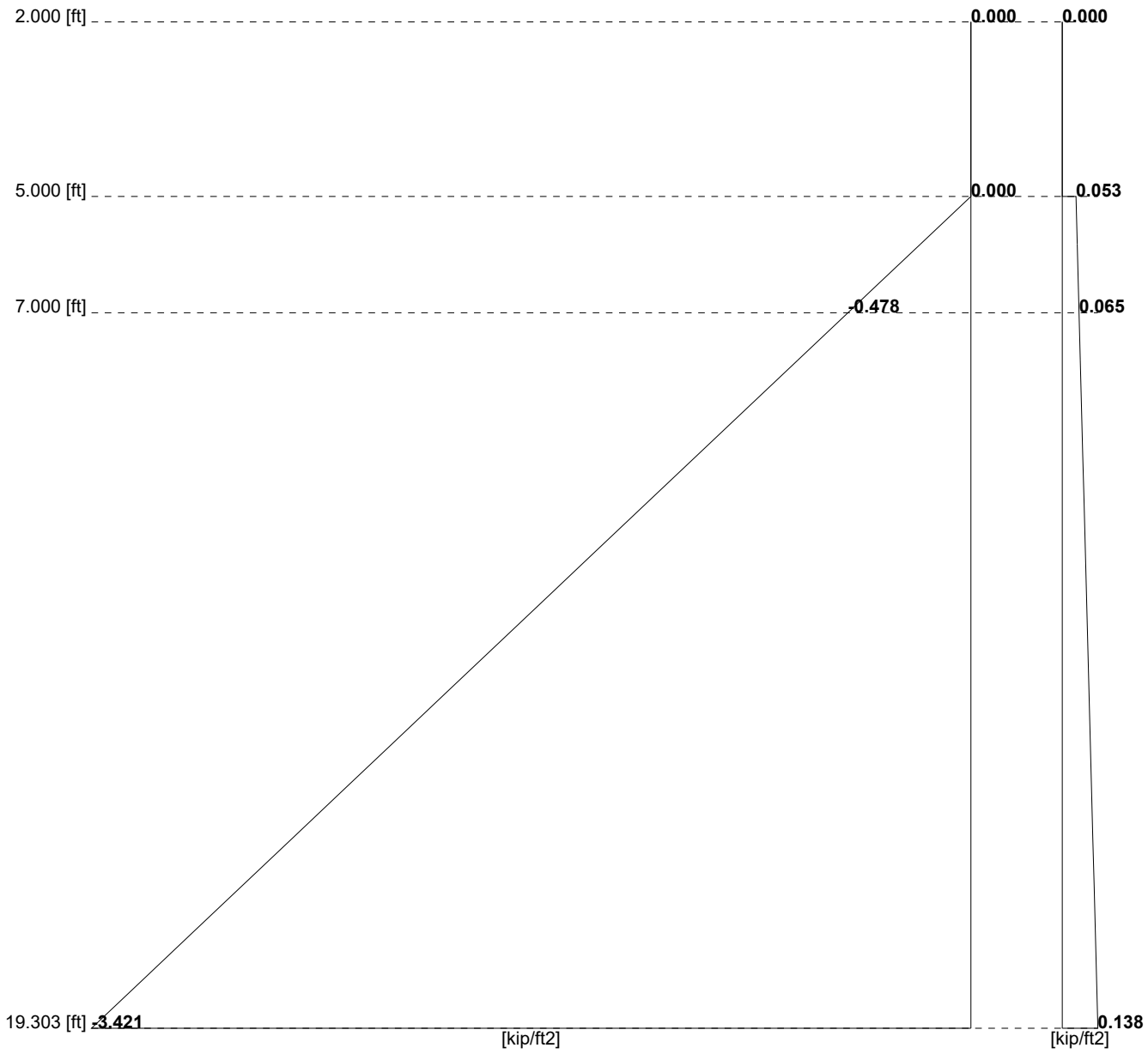
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

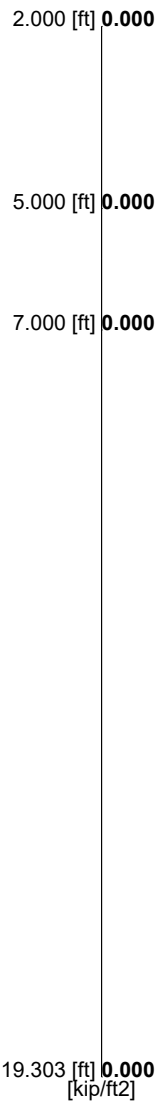
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.912	19.336
Maxmimal Moment [kipft/ft]	35.083	13.562
Normal Forces at Max. Moment [kip/ft]	0.000	19.336
Normal Forces at Min. Moment [kip/ft]	-3.551	13.562
Deflection at Min. Moment [ft]	0.000	19.336
Deflection at Max. Moment [ft]	-0.005	13.562
Min. Stress at Min. Moment [lb/in2]	-340.136	19.336
Max. Stress at Min. Moment [lb/in2]	340.136	19.336
Min. Stress at Max. Moment [lb/in2]	-13641.177	13.562
Max. Stress at Max. Moment [lb/in2]	12510.996	13.562
Safety > Req. Safety = 1.500	3.665	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	24.856	
Sheet Pile Length [ft]	19.856	
Included OverLength [ft]	5.553	
Vertical Equilibrium [kip/ft]	-3.149	
Anchor Force (horiz.) [kip/ft]	8.768	

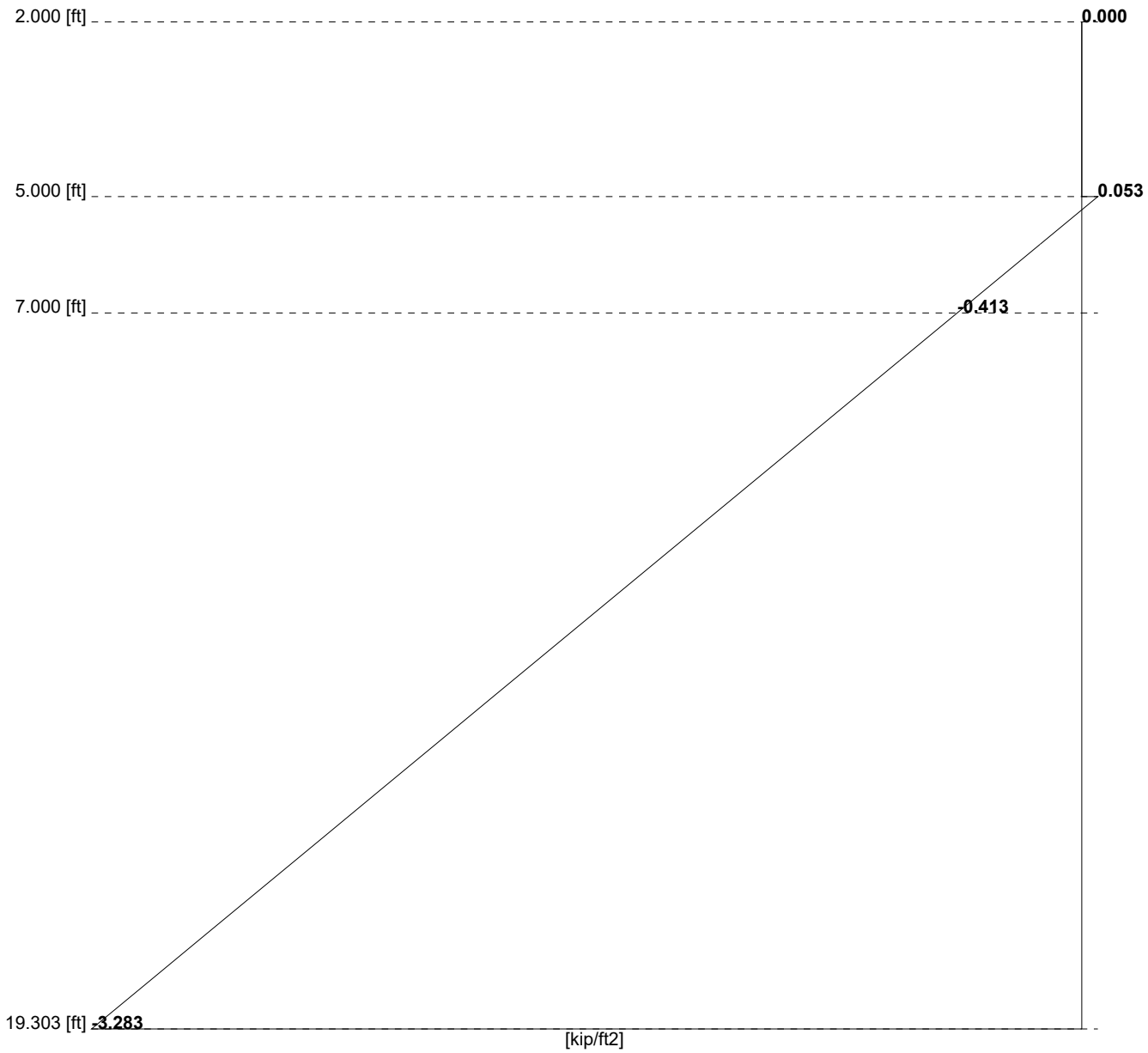
Earth Pressure Diagram



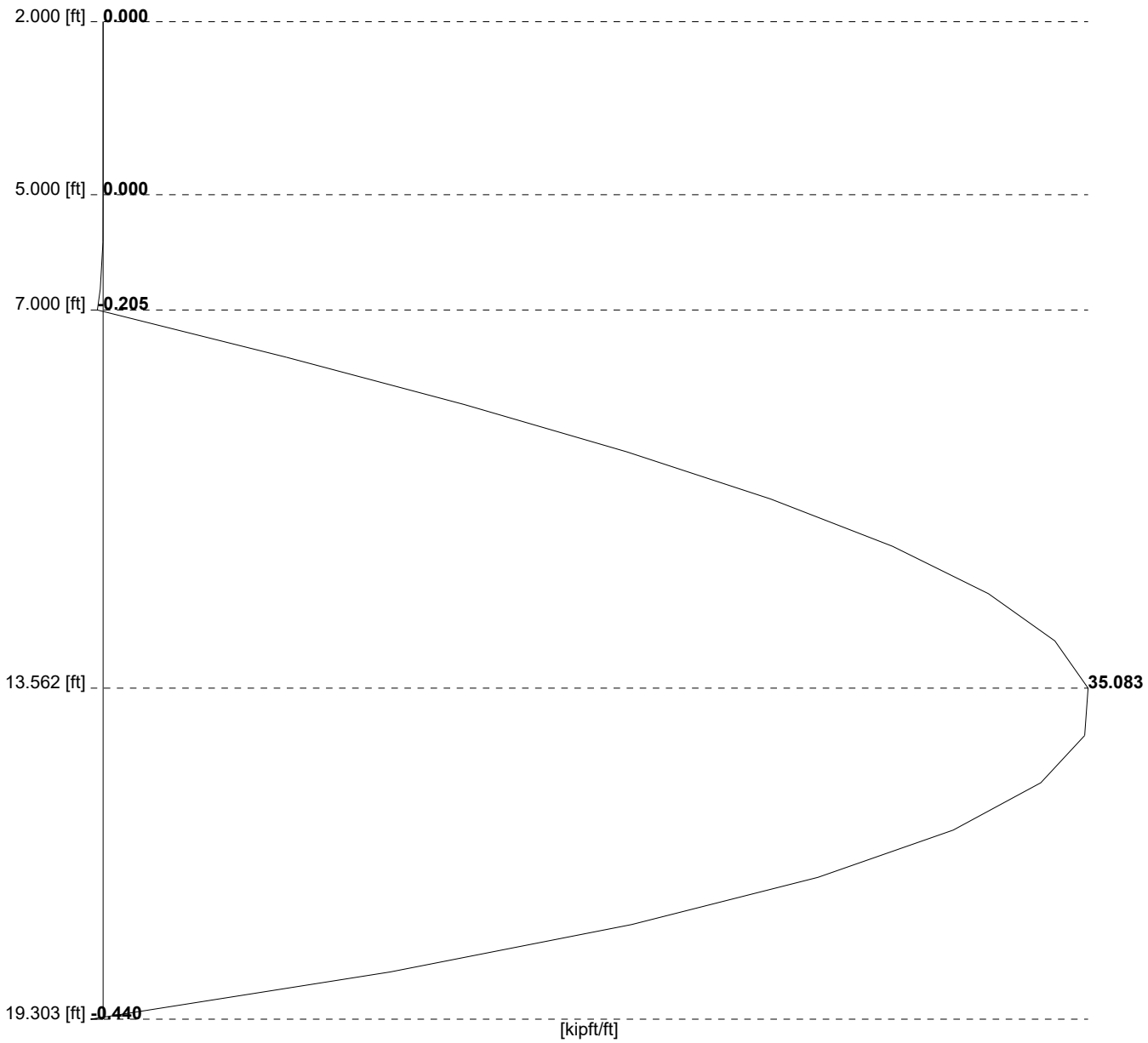
Water Pressure Diagram



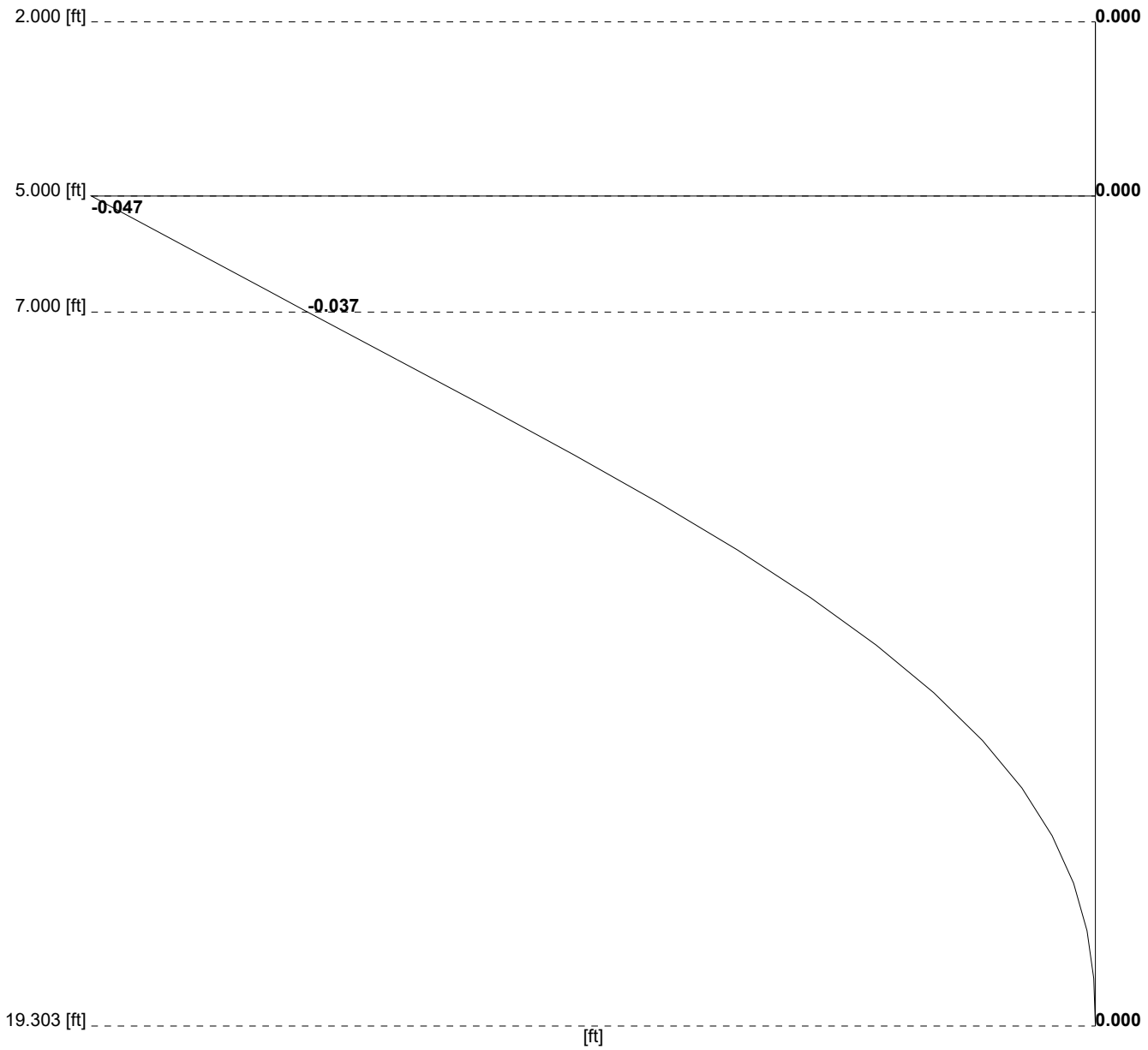
Total Pressure Diagram



Moment Diagram

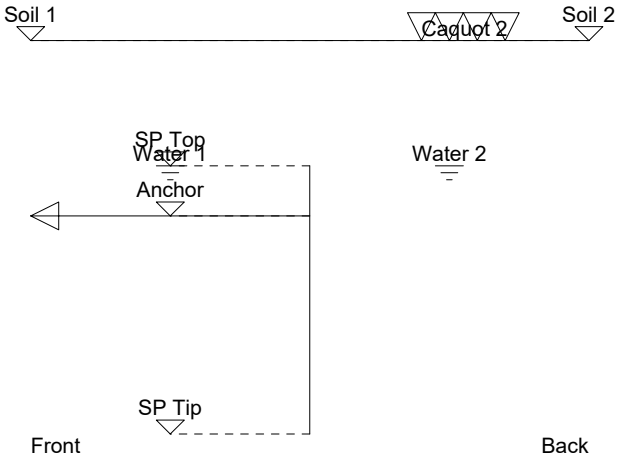


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	15.710
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	11.940
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

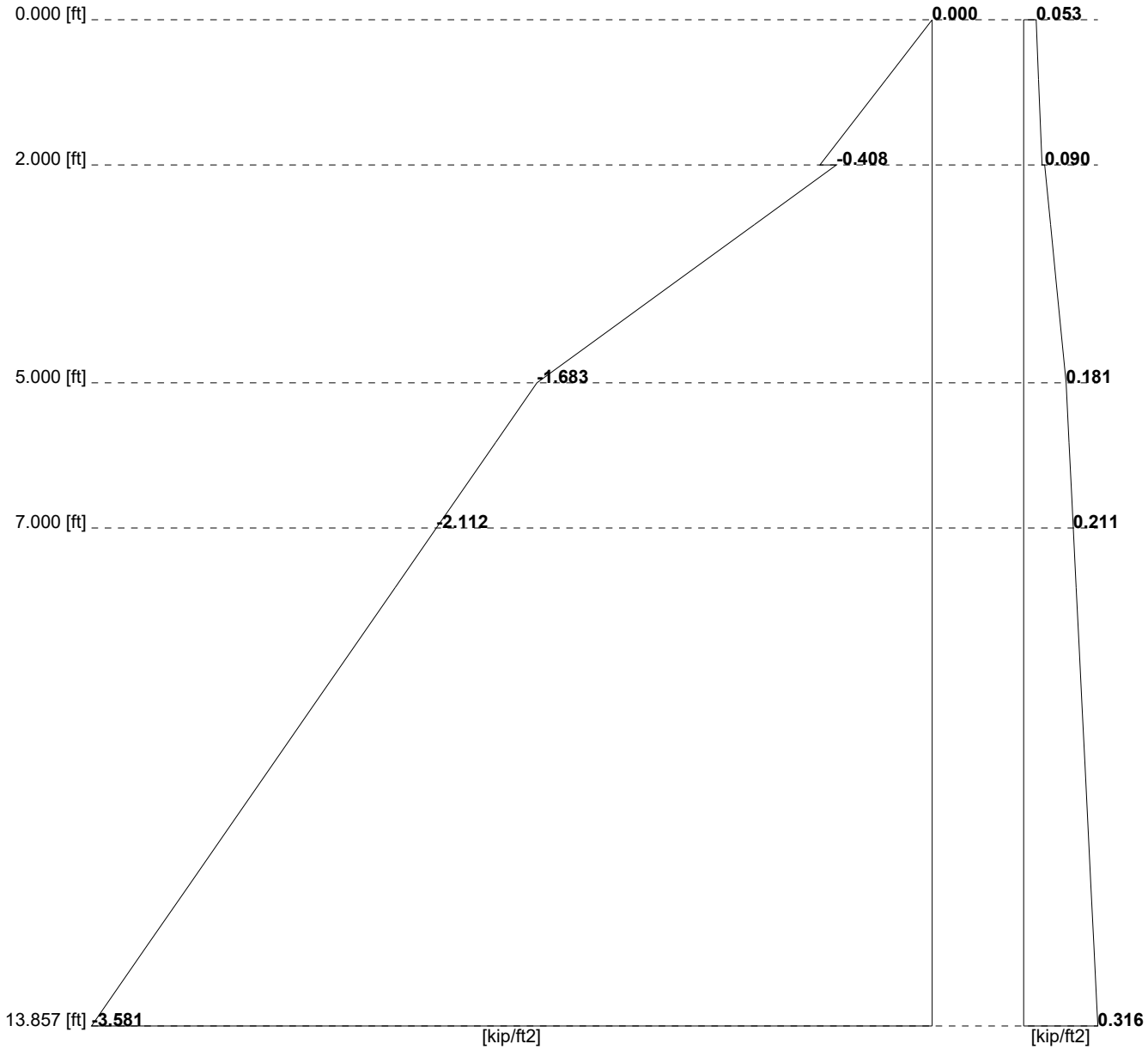
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

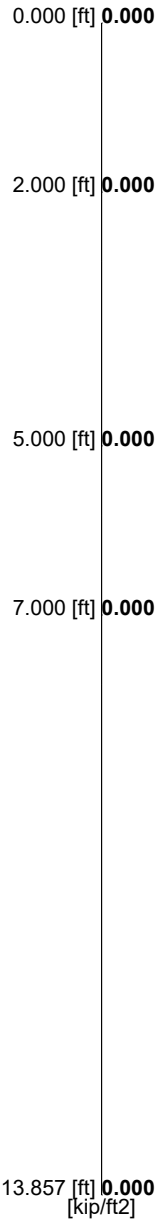
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-3.271	7.000
Maxmimal Moment [kipft/ft]	13.630	10.773
Normal Forces at Max. Moment [kip/ft]	-0.751	7.000
Normal Forces at Min. Moment [kip/ft]	-2.850	10.773
Deflection at Min. Moment [ft]	-0.008	7.000
Deflection at Max. Moment [ft]	-0.001	10.773
Min. Stress at Min. Moment [lb/in2]	-1824.083	7.000
Max. Stress at Min. Moment [lb/in2]	1559.384	7.000
Min. Stress at Max. Moment [lb/in2]	-7562.973	10.773
Max. Stress at Max. Moment [lb/in2]	6558.533	10.773
Safety > Req. Safety = 1.500	6.611	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	15.710	
Sheet Pile Length [ft]	10.710	
Included OverLength [ft]	1.853	
Vertical Equilibrium [kip/ft]	-1.635	
Anchor Force (horiz.) [kip/ft]	11.940	

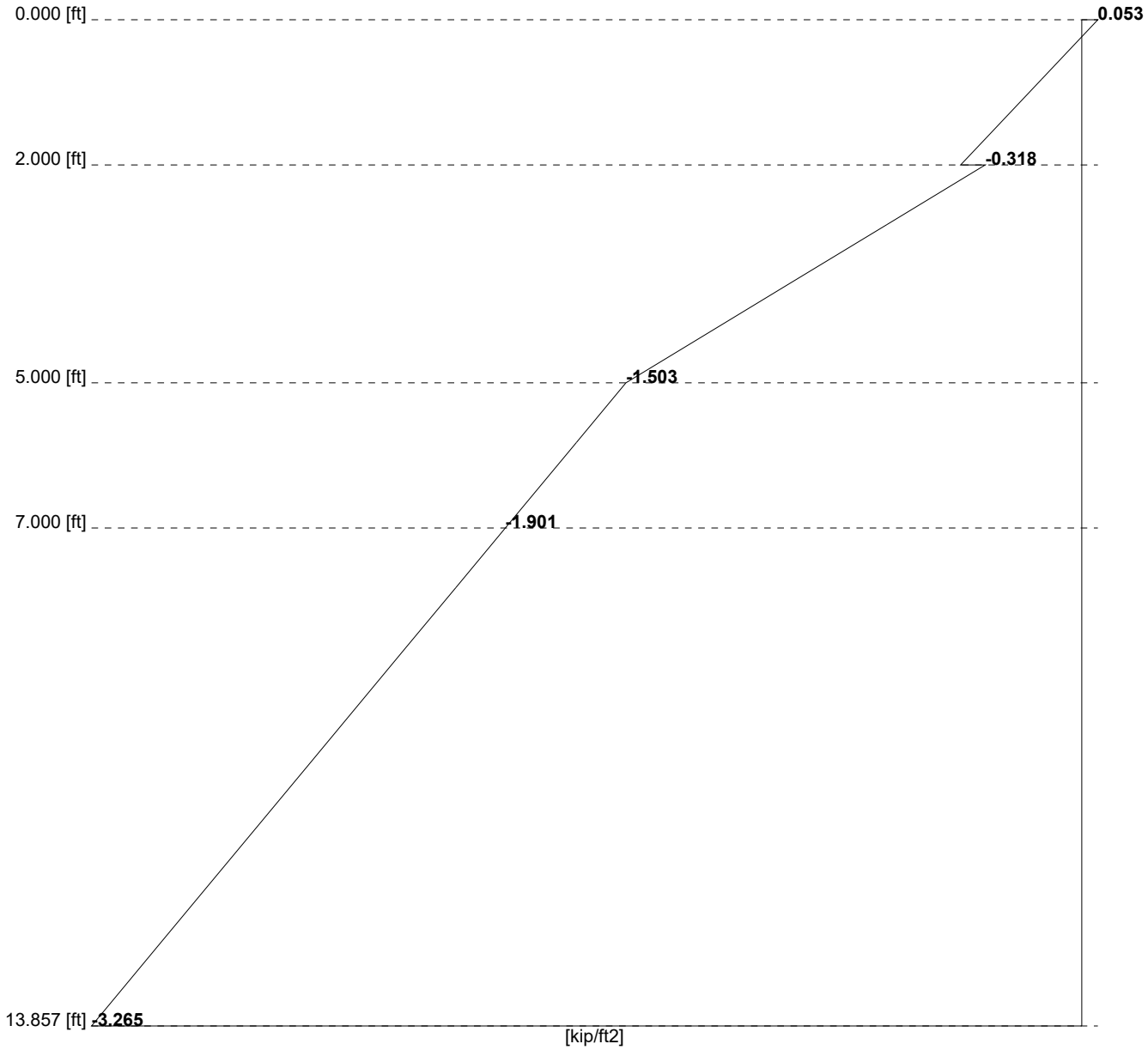
Earth Pressure Diagram



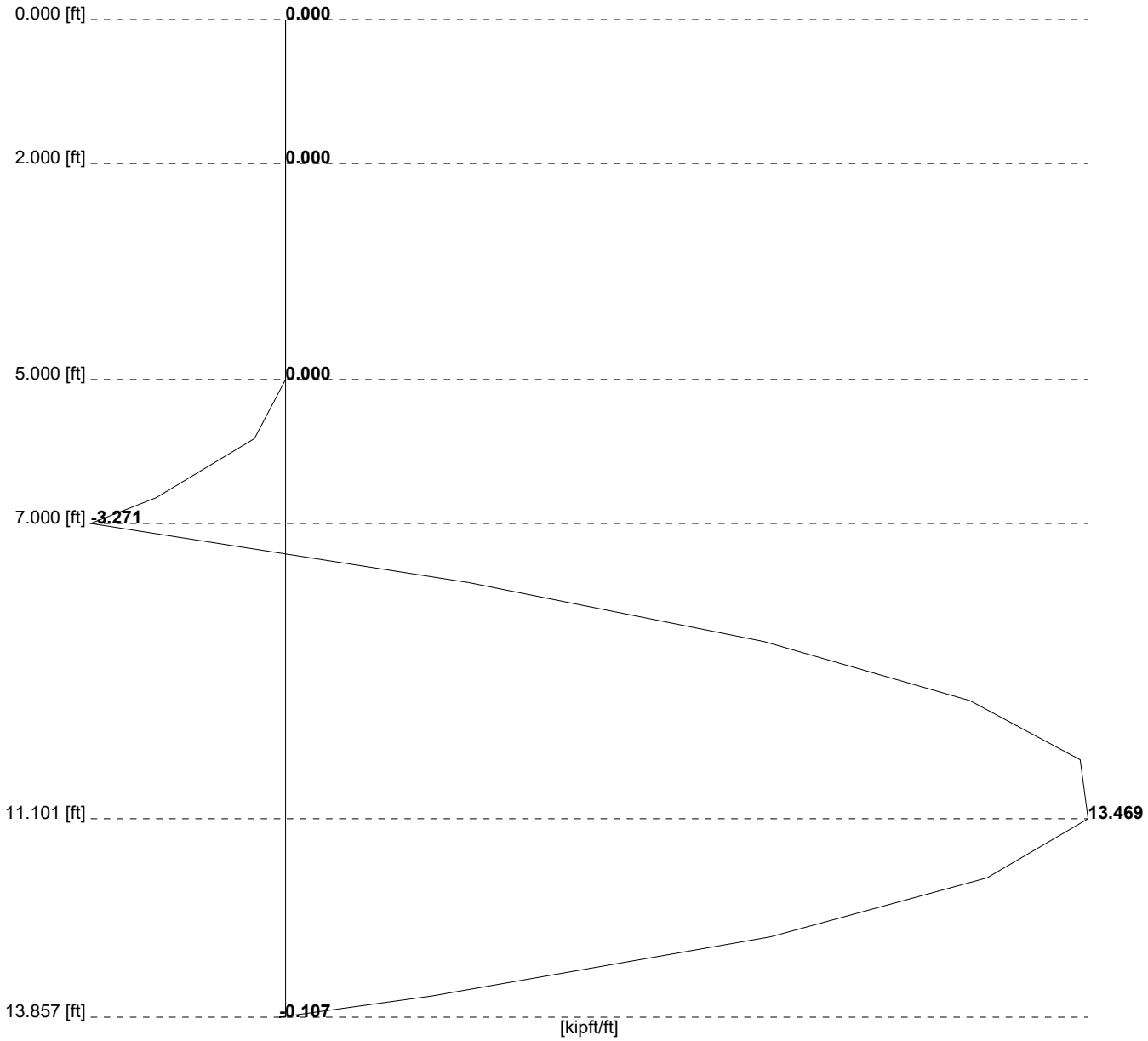
Water Pressure Diagram



Total Pressure Diagram

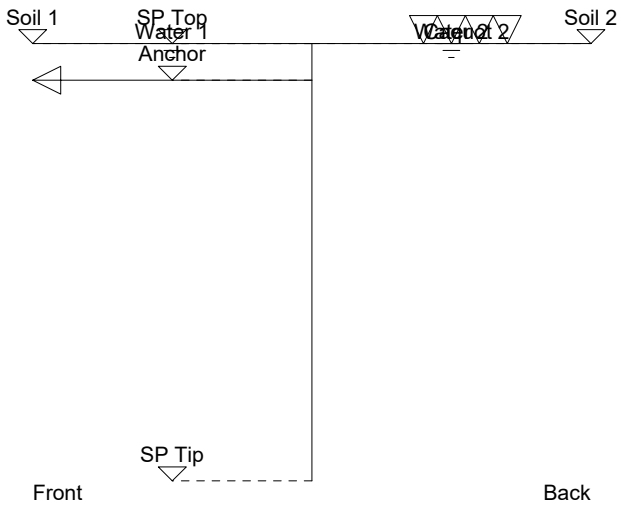


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	28.820
Soil Level in Front [ft]	5.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	11.940
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

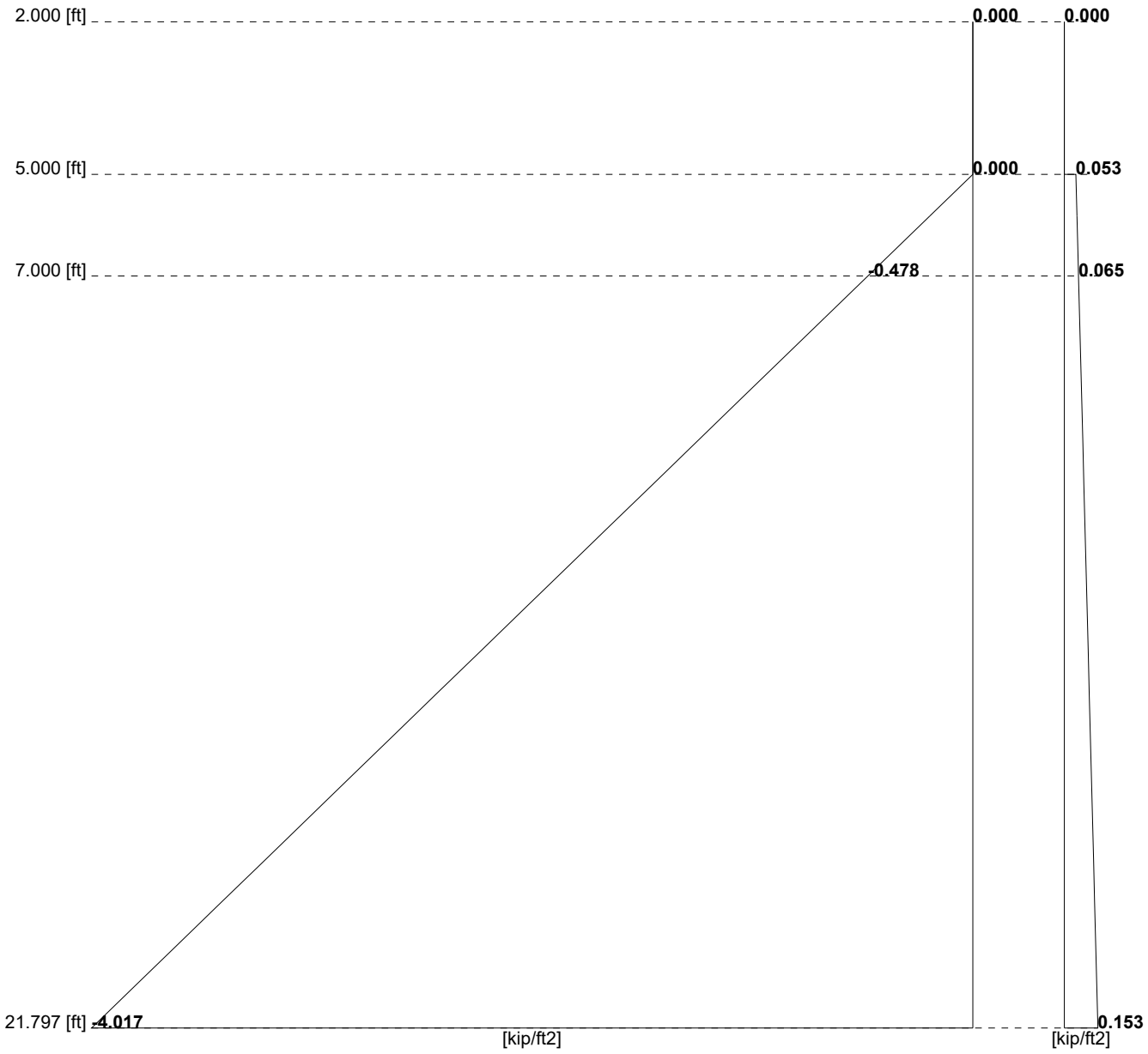
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

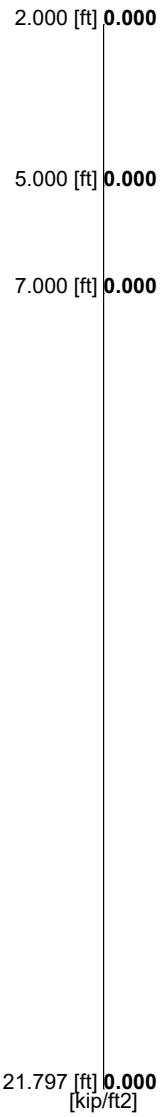
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-0.205	7.000
Maxmimal Moment [kipft/ft]	59.420	15.202
Normal Forces at Max. Moment [kip/ft]	-0.131	7.000
Normal Forces at Min. Moment [kip/ft]	-4.216	15.202
Deflection at Min. Moment [ft]	-0.088	7.000
Deflection at Max. Moment [ft]	-0.016	15.202
Min. Stress at Min. Moment [lb/in2]	-92.896	7.000
Max. Stress at Min. Moment [lb/in2]	51.208	7.000
Min. Stress at Max. Moment [lb/in2]	-22804.273	15.202
Max. Stress at Max. Moment [lb/in2]	21462.361	15.202
Safety > Req. Safety = 1.500	2.193	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	28.820	
Sheet Pile Length [ft]	23.820	
Included OverLength [ft]	7.023	
Vertical Equilibrium [kip/ft]	-4.339	
Anchor Force (horiz.) [kip/ft]	11.940	

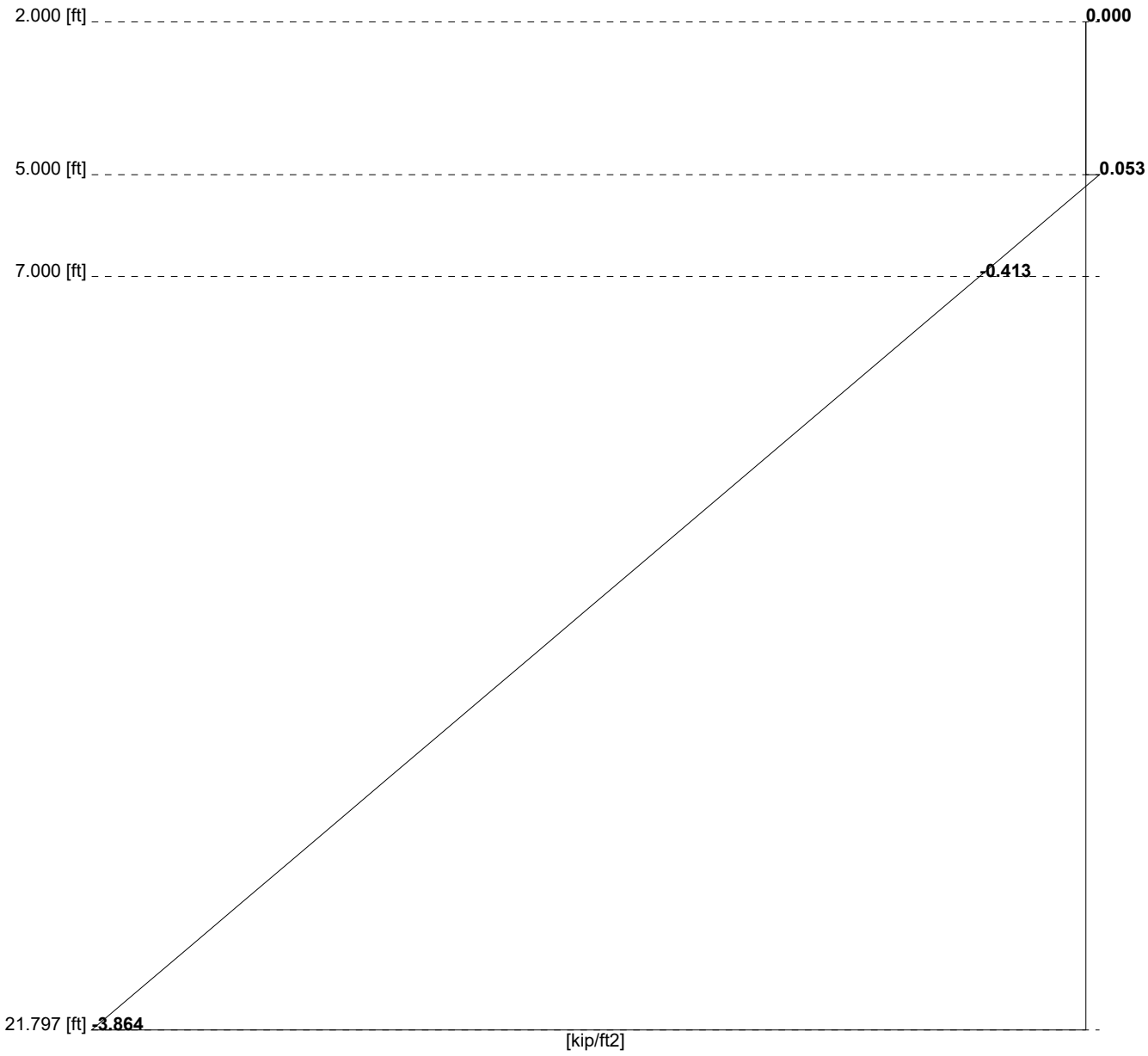
Earth Pressure Diagram



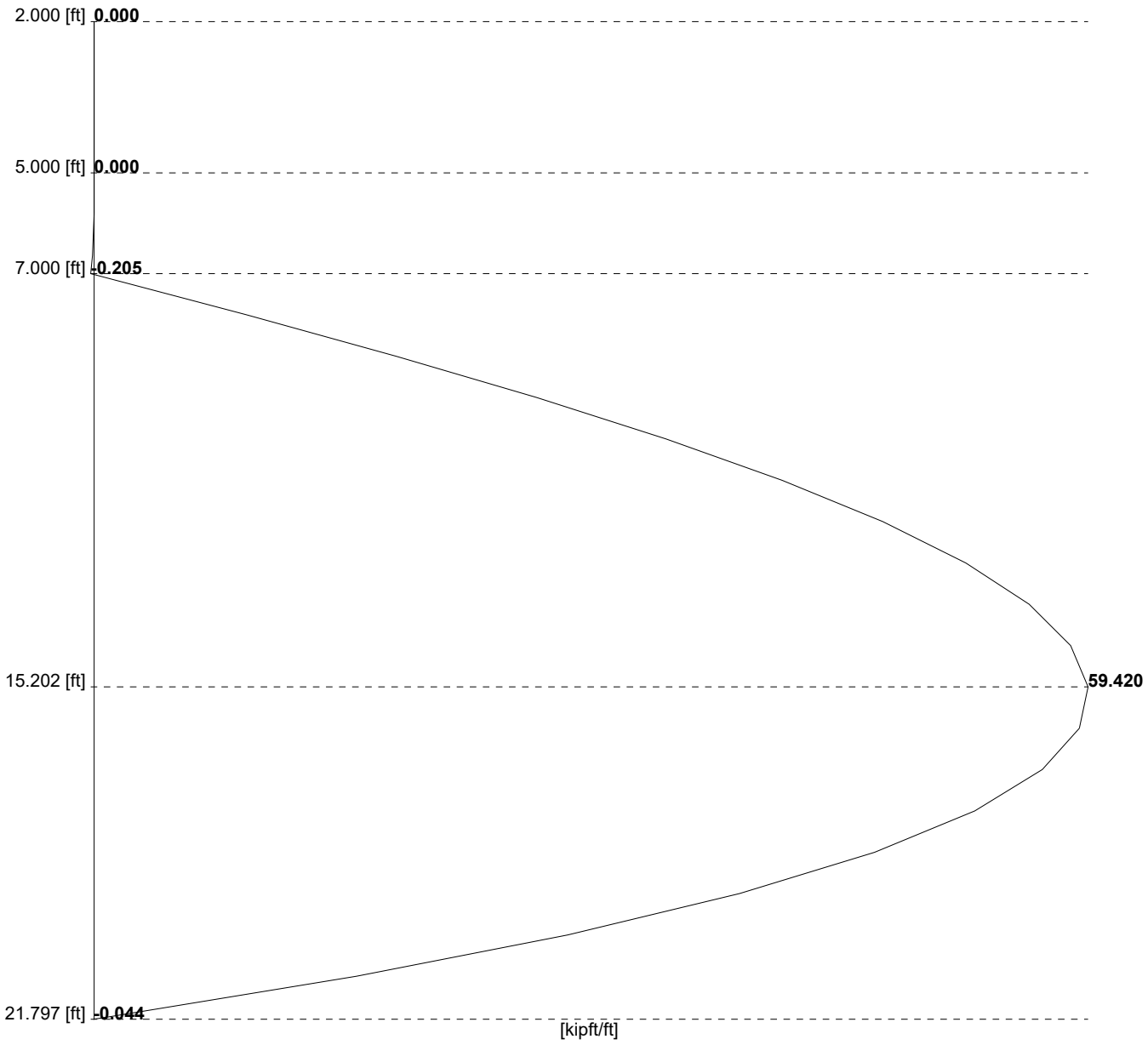
Water Pressure Diagram



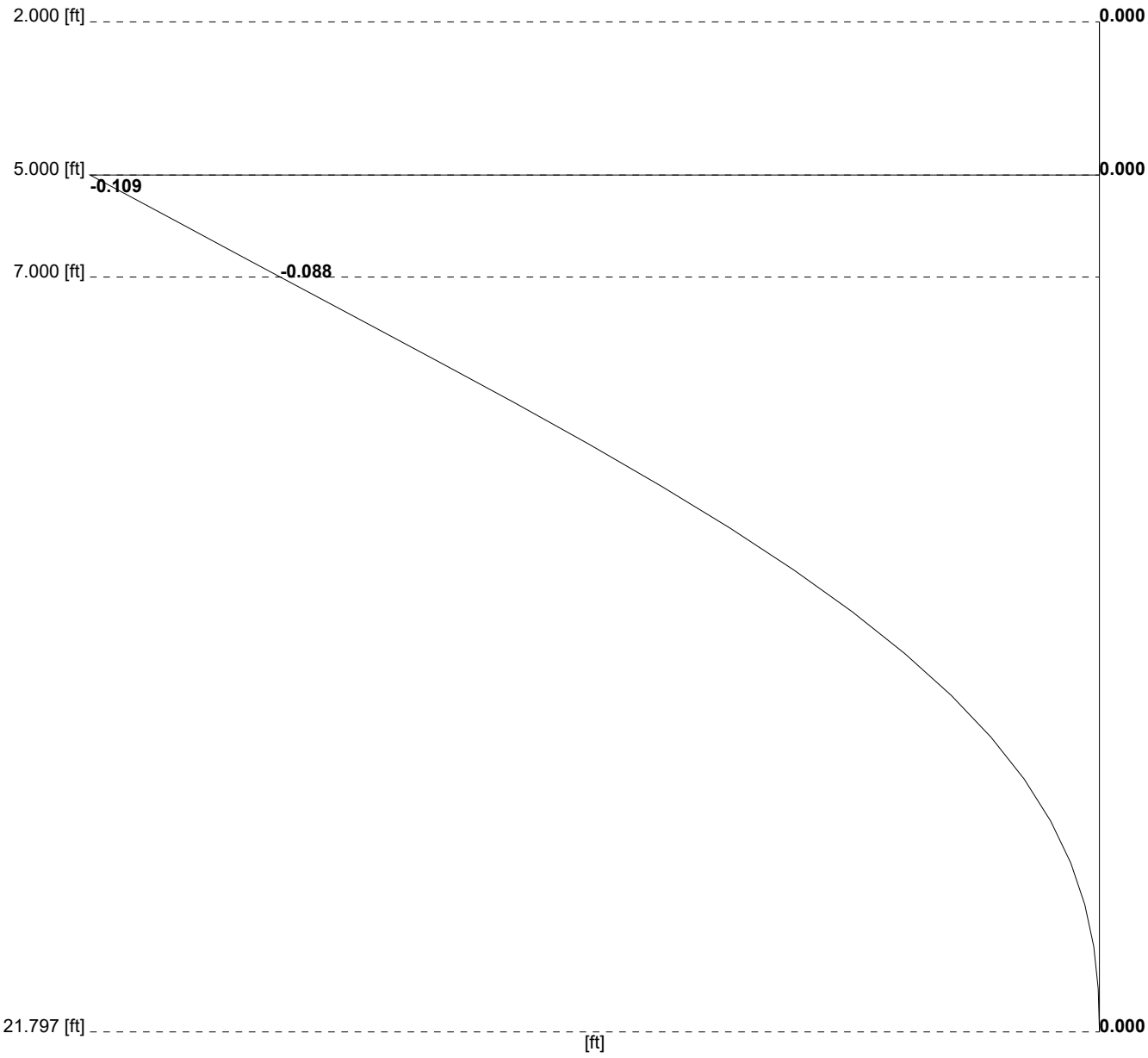
Total Pressure Diagram



Moment Diagram

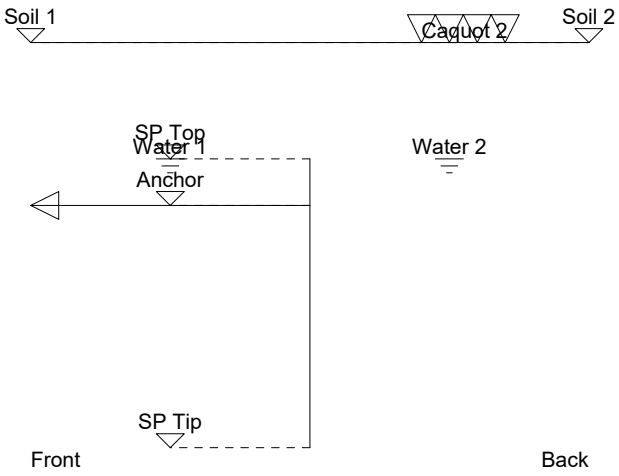


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	17.414
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	13.752
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 4	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 5	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

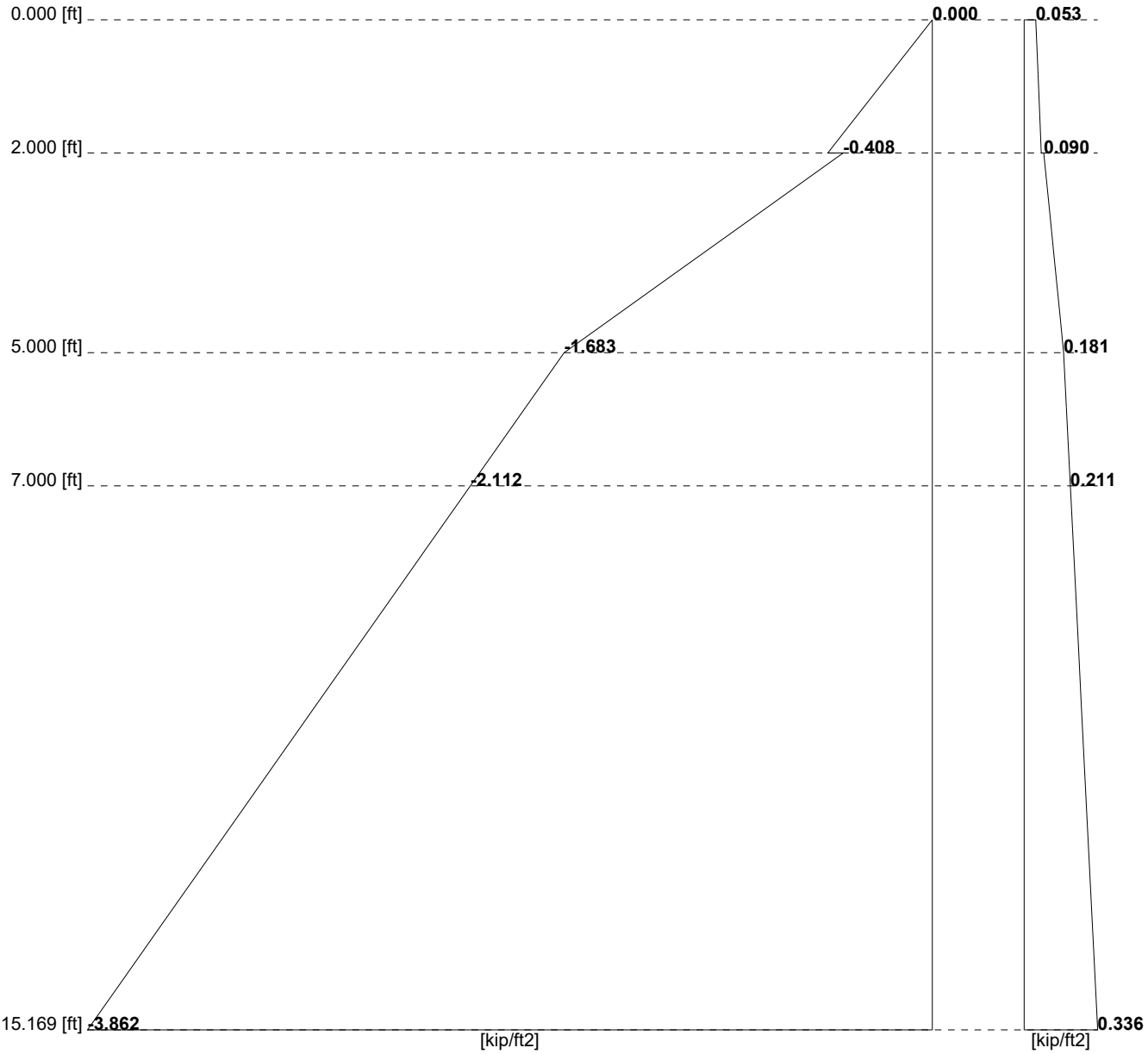
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

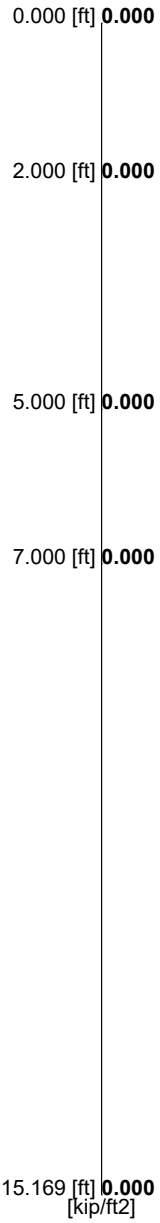
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-3.271	7.000
Maxmimal Moment [kipft/ft]	20.900	11.101
Normal Forces at Max. Moment [kip/ft]	-0.751	7.000
Normal Forces at Min. Moment [kip/ft]	-2.850	11.101
Deflection at Min. Moment [ft]	-0.017	7.000
Deflection at Max. Moment [ft]	-0.004	11.101
Min. Stress at Min. Moment [lb/in2]	-1820.599	7.000
Max. Stress at Min. Moment [lb/in2]	1555.900	7.000
Min. Stress at Max. Moment [lb/in2]	-11326.258	11.101
Max. Stress at Max. Moment [lb/in2]	10321.818	11.101
Safety > Req. Safety = 1.500	4.415	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	17.414	
Sheet Pile Length [ft]	12.414	
Included OverLength [ft]	2.244	
Vertical Equilibrium [kip/ft]	-1.743	
Anchor Force (horiz.) [kip/ft]	13.752	

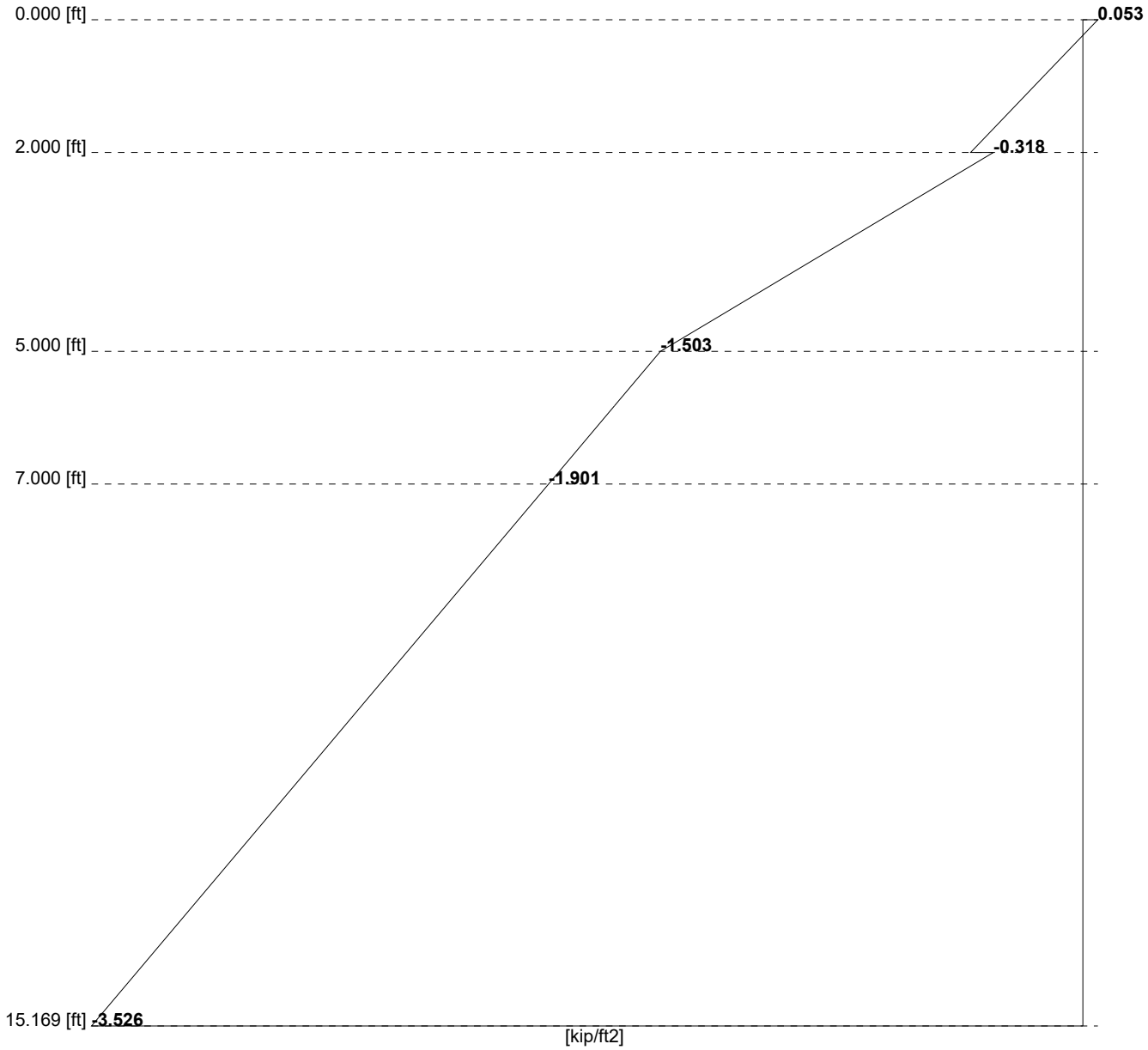
Earth Pressure Diagram



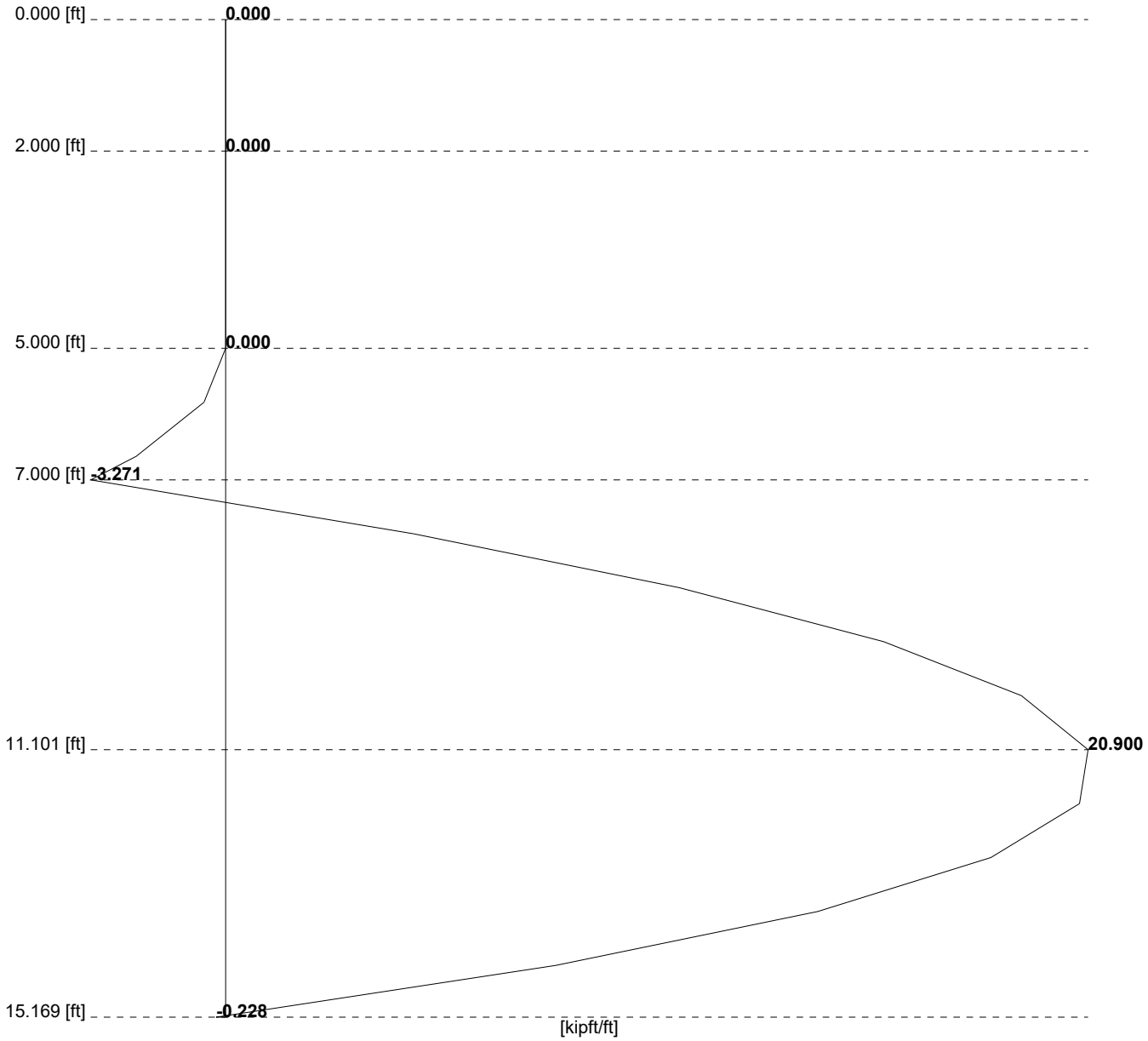
Water Pressure Diagram



Total Pressure Diagram

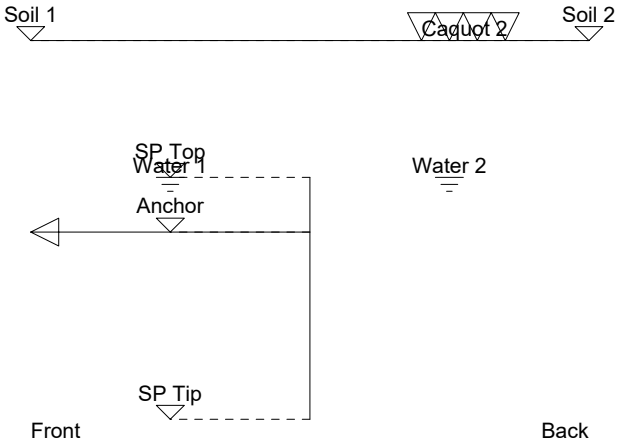


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	13.846
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	13.752
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 4	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 5	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

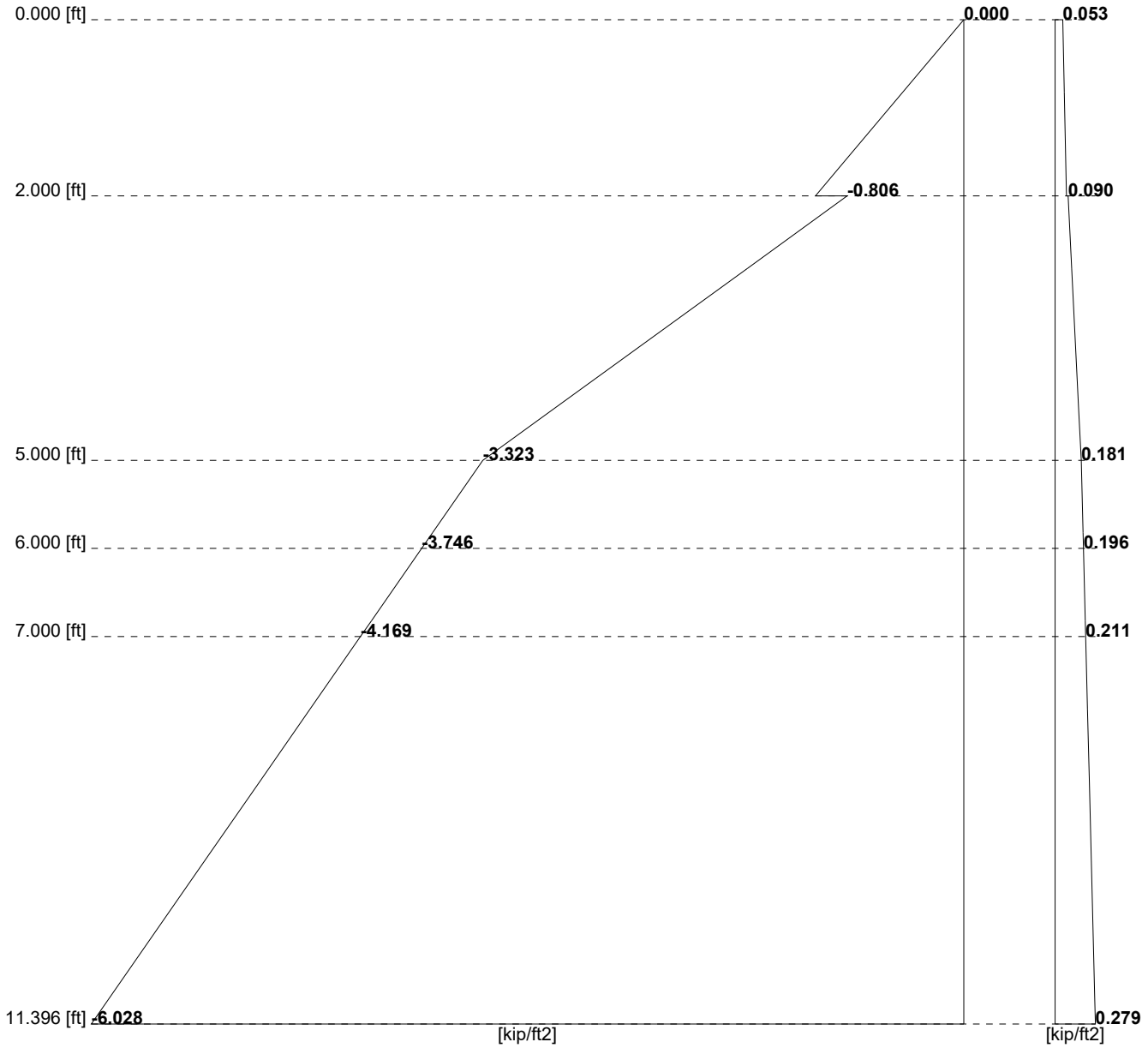
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

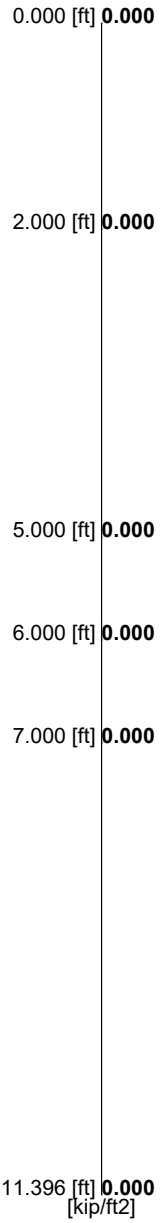
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-2.828	7.000
Maxmimal Moment [kipft/ft]	10.397	9.428
Normal Forces at Max. Moment [kip/ft]	-2.356	7.000
Normal Forces at Min. Moment [kip/ft]	-5.998	9.428
Deflection at Min. Moment [ft]	-0.002	7.000
Deflection at Max. Moment [ft]	0.000	9.428
Min. Stress at Min. Moment [lb/in2]	-1428.271	7.000
Max. Stress at Min. Moment [lb/in2]	678.288	7.000
Min. Stress at Max. Moment [lb/in2]	-4831.037	9.428
Max. Stress at Max. Moment [lb/in2]	2922.011	9.428
Safety > Req. Safety = 1.500	10.350	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	13.846	
Sheet Pile Length [ft]	8.846	
Included OverLength [ft]	2.450	
Vertical Equilibrium [kip/ft]	-5.872	
Anchor Force (horiz.) [kip/ft]	13.752	

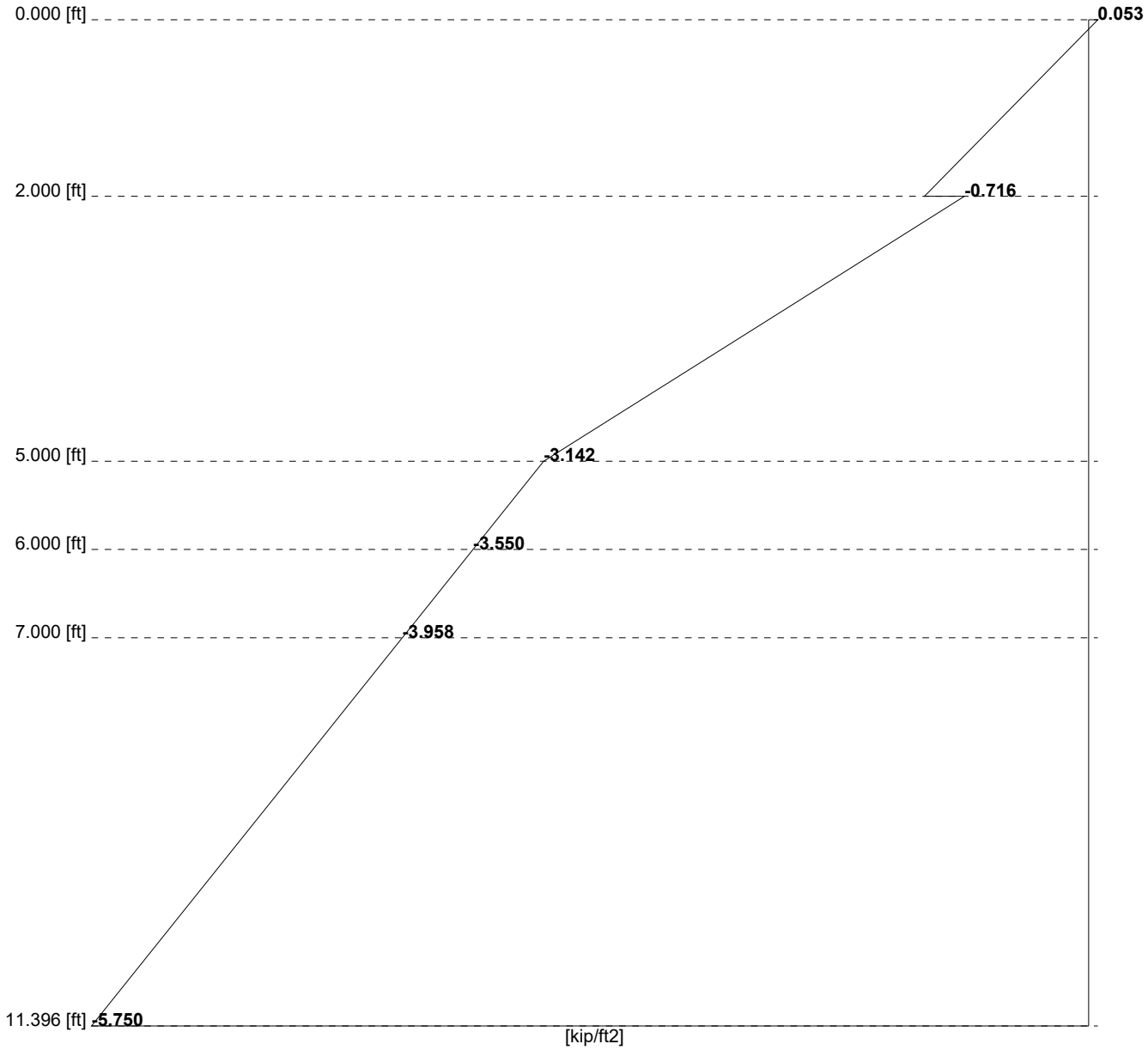
Earth Pressure Diagram



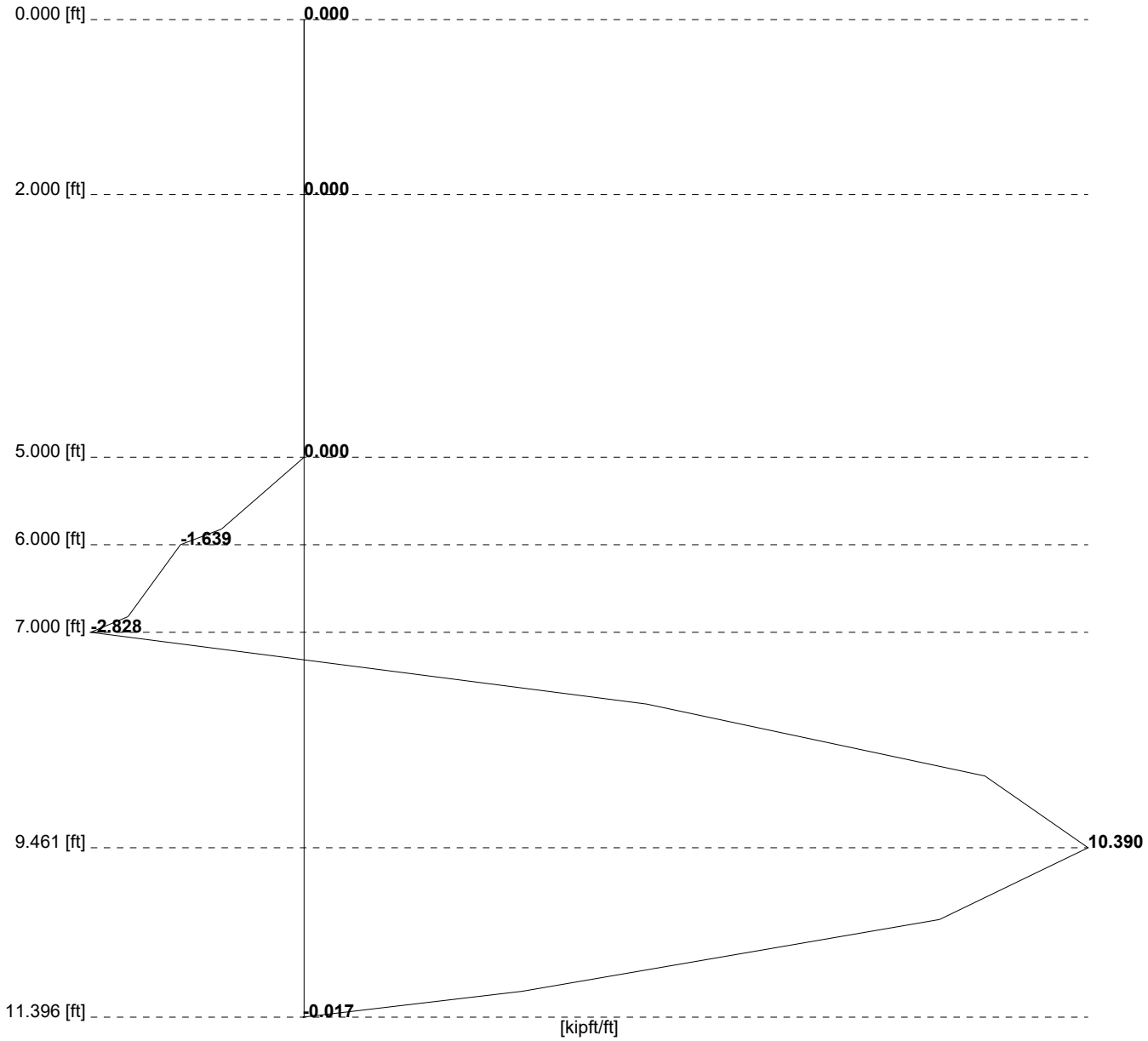
Water Pressure Diagram



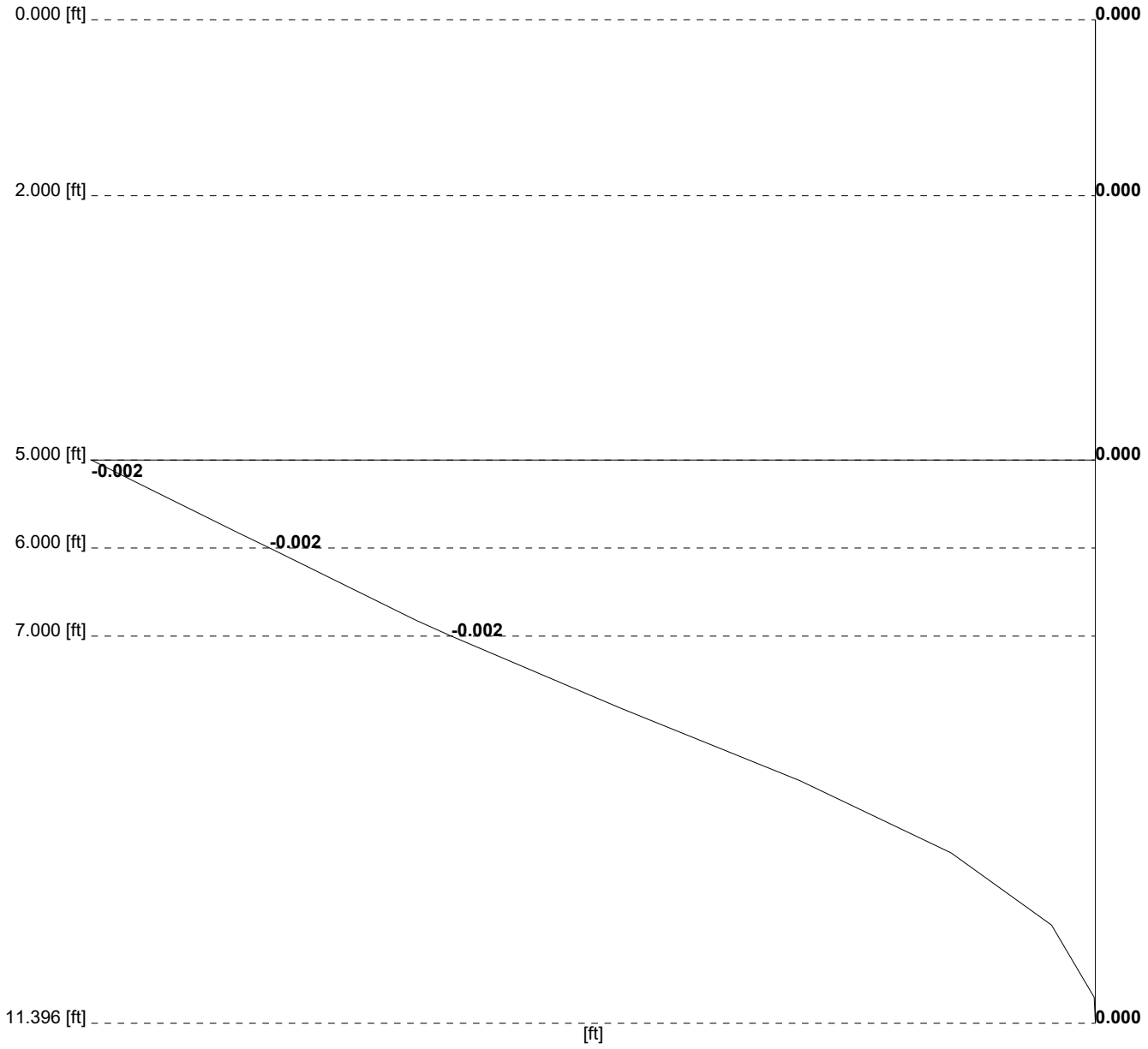
Total Pressure Diagram



Moment Diagram

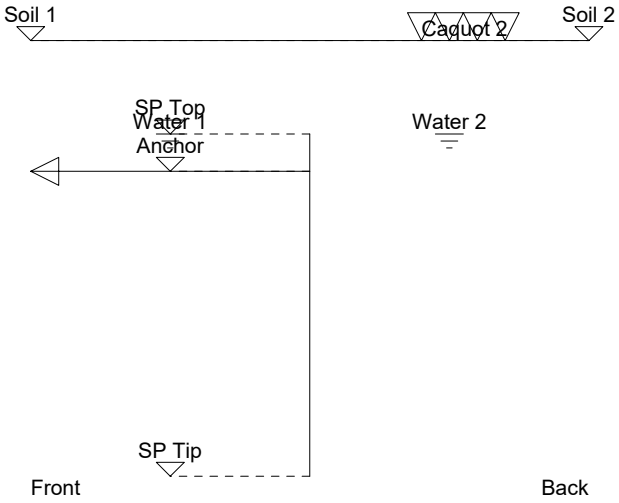


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	23.327
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	21.174
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

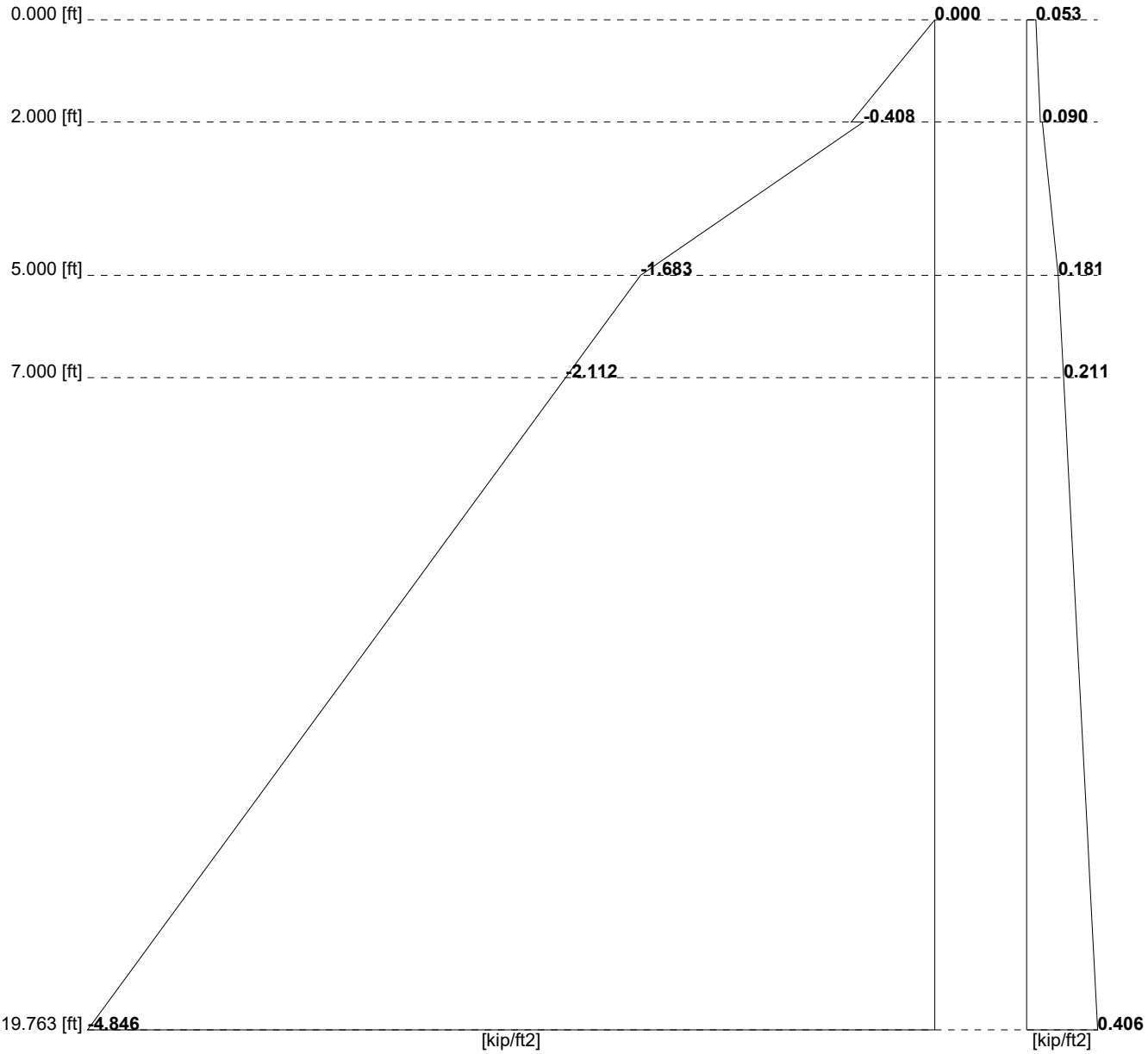
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

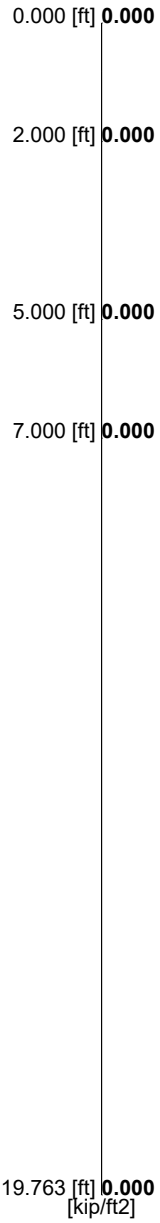
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-3.271	7.000
Maxmimal Moment [kipft/ft]	63.052	13.562
Normal Forces at Max. Moment [kip/ft]	-0.751	7.000
Normal Forces at Min. Moment [kip/ft]	-5.070	13.562
Deflection at Min. Moment [ft]	-0.118	7.000
Deflection at Max. Moment [ft]	-0.018	13.562
Min. Stress at Min. Moment [lb/in2]	-1781.214	7.000
Max. Stress at Min. Moment [lb/in2]	1516.514	7.000
Min. Stress at Max. Moment [lb/in2]	-33517.035	13.562
Max. Stress at Max. Moment [lb/in2]	31730.152	13.562
Safety < Req. Safety = 1.500	1.492	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	23.327	
Sheet Pile Length [ft]	18.327	
Included OverLength [ft]	3.565	
Vertical Equilibrium [kip/ft]	-2.214	
Anchor Force (horiz.) [kip/ft]	21.174	

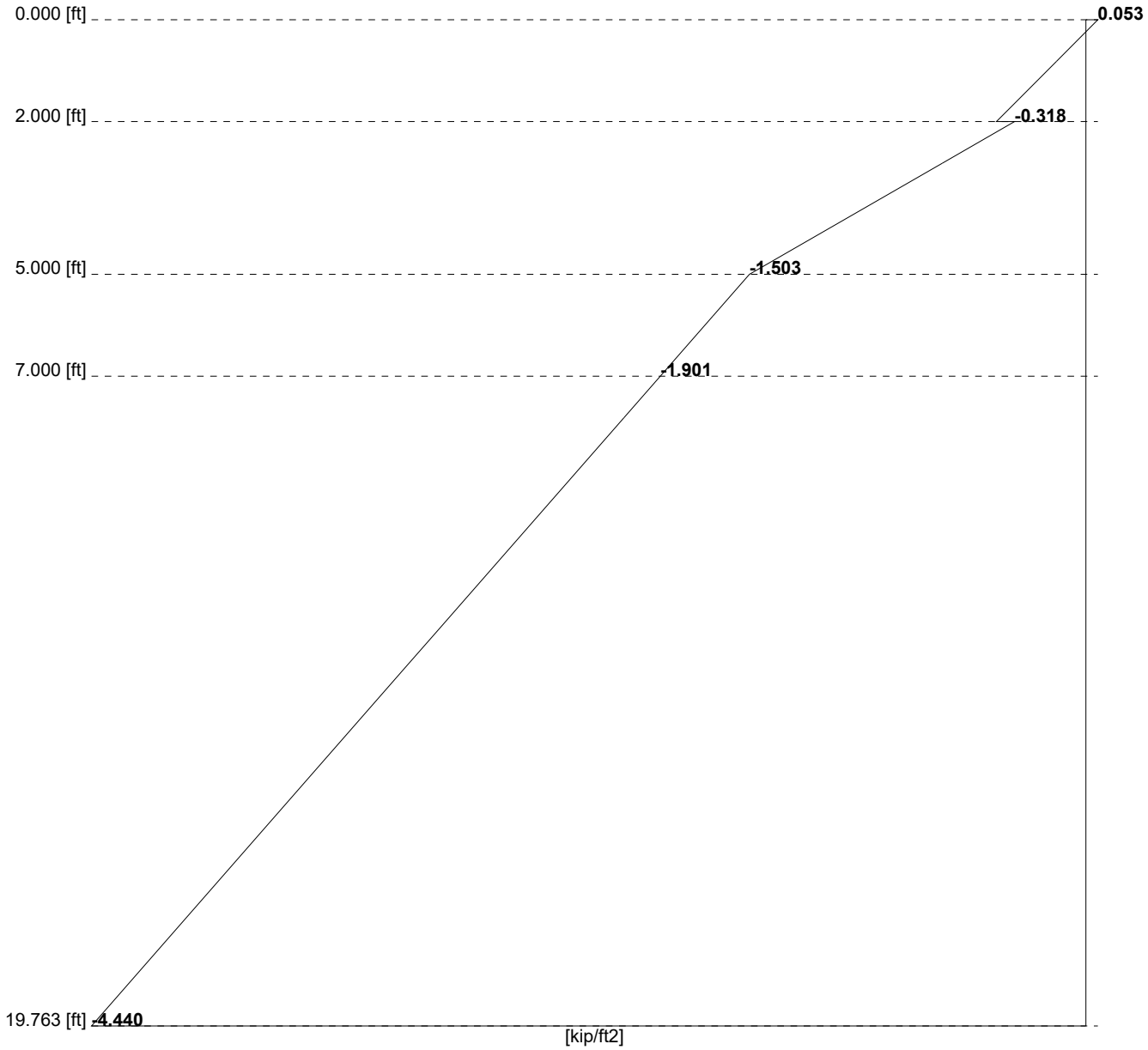
Earth Pressure Diagram



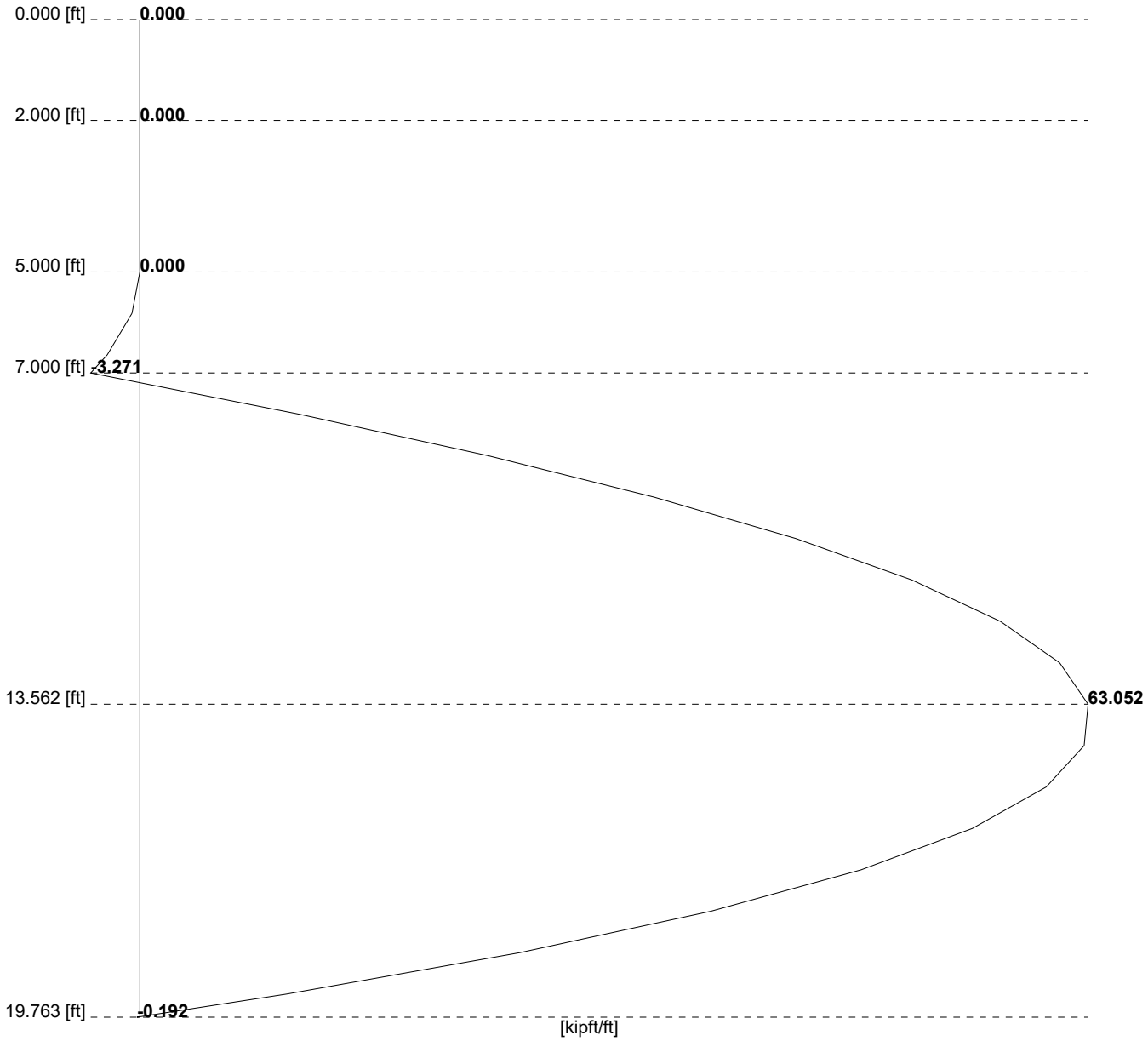
Water Pressure Diagram



Total Pressure Diagram

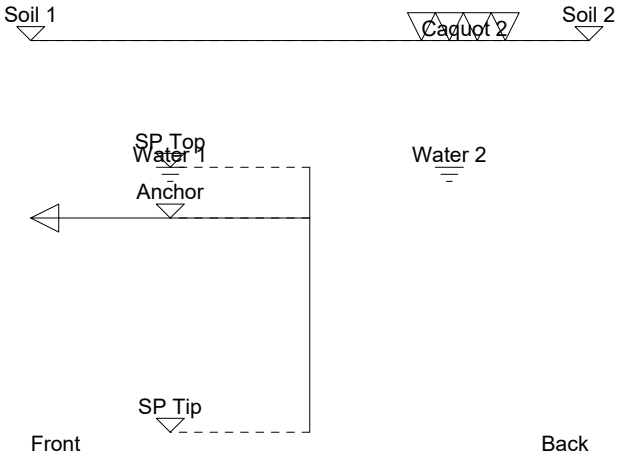


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	5.000
Sheet Pile Tip Level [ft]	15.450
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	7.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	21.174
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

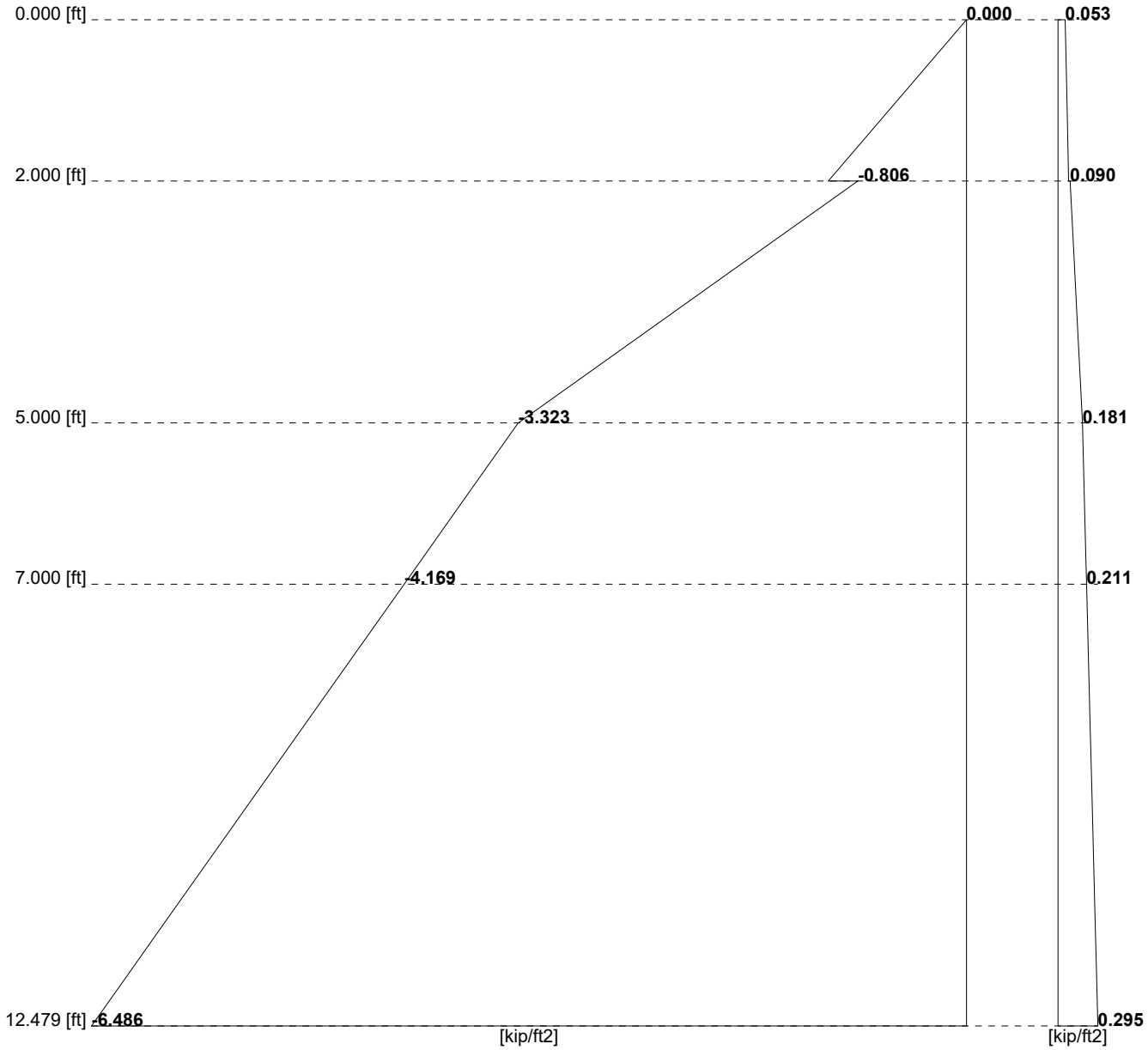
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

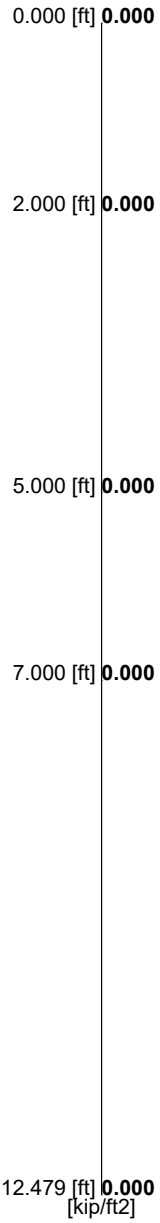
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-6.828	7.000
Maxmimal Moment [kipft/ft]	15.763	10.084
Normal Forces at Max. Moment [kip/ft]	-2.356	7.000
Normal Forces at Min. Moment [kip/ft]	-7.394	10.084
Deflection at Min. Moment [ft]	-0.003	7.000
Deflection at Max. Moment [ft]	-0.001	10.084
Min. Stress at Min. Moment [lb/in2]	-2918.273	7.000
Max. Stress at Min. Moment [lb/in2]	2168.290	7.000
Min. Stress at Max. Moment [lb/in2]	-7053.224	10.084
Max. Stress at Max. Moment [lb/in2]	4699.910	10.084
Safety > Req. Safety = 1.500	7.089	
Sheet Pile Top Level [ft]	5.000	
Sheet Pile Tip Level [ft]	15.450	
Sheet Pile Length [ft]	10.450	
Included OverLength [ft]	2.971	
Vertical Equilibrium [kip/ft]	-6.988	
Anchor Force (horiz.) [kip/ft]	21.174	

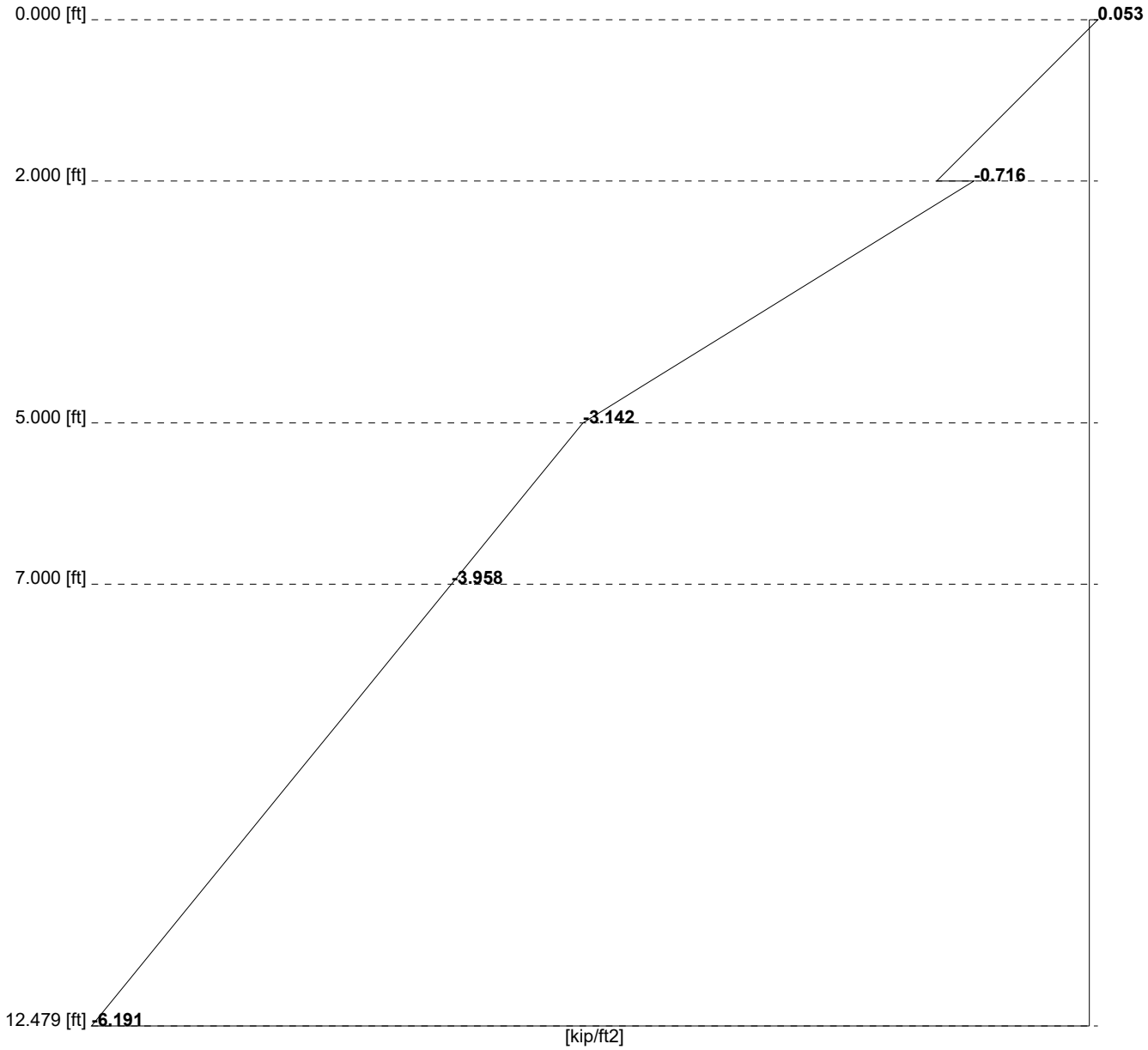
Earth Pressure Diagram



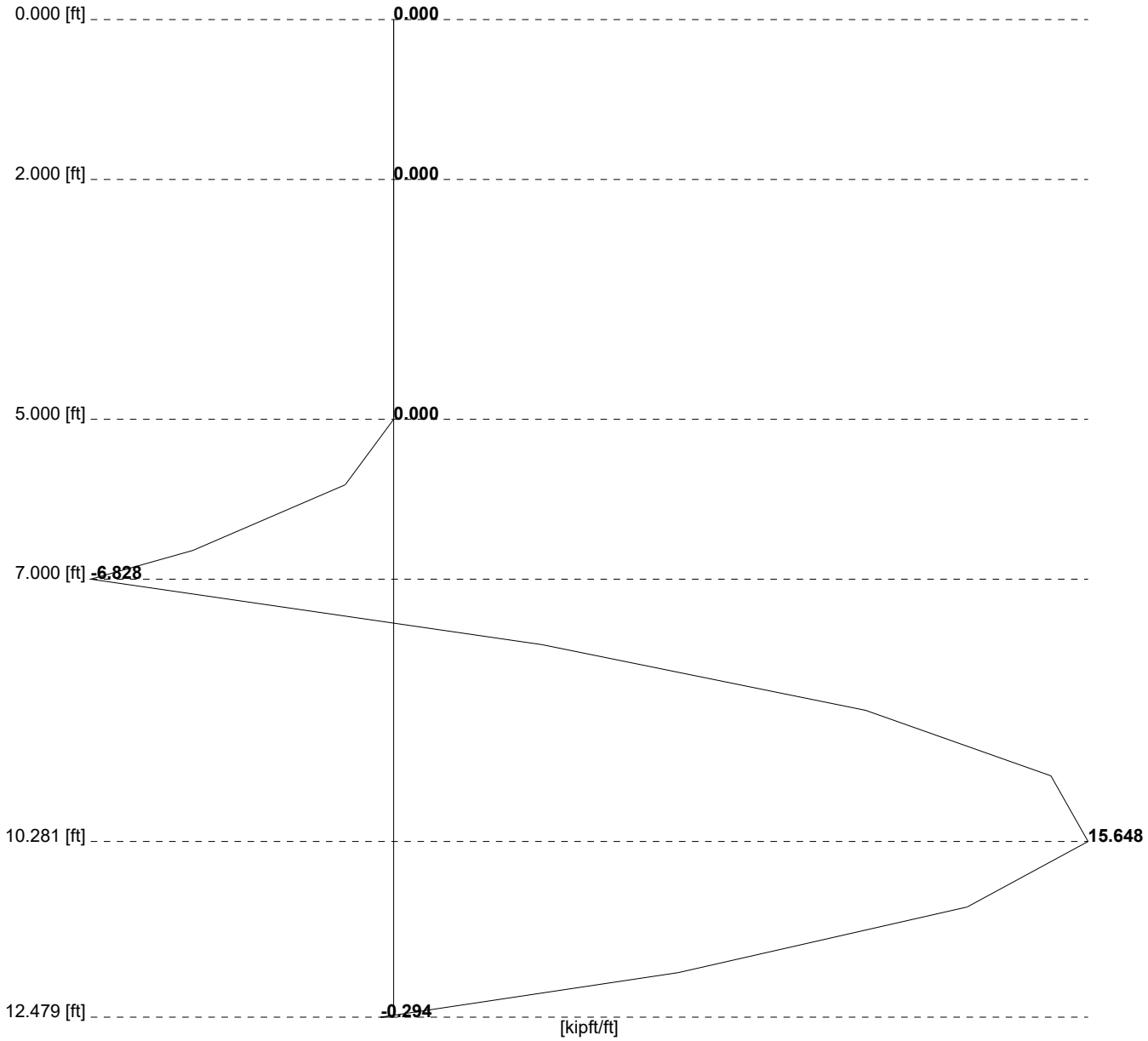
Water Pressure Diagram



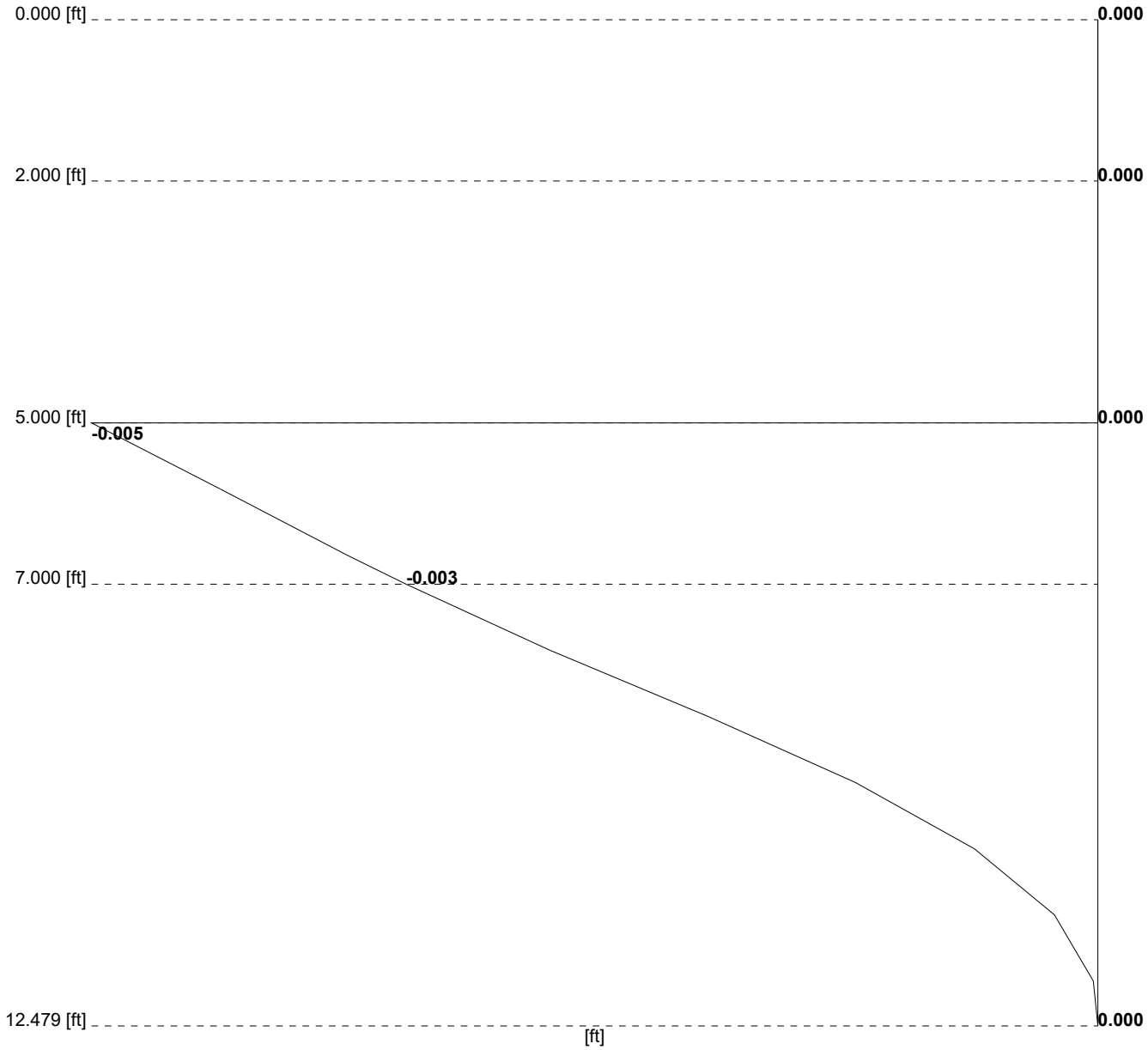
Total Pressure Diagram



Moment Diagram

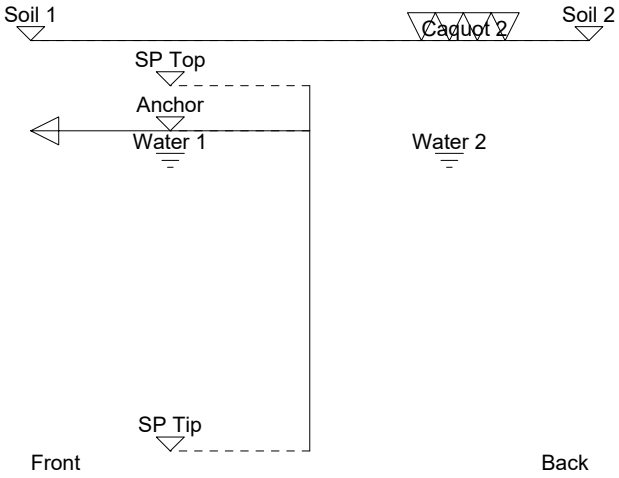


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	2.000
Sheet Pile Tip Level [ft]	18.194
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	12.914
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	2.573	19.520	-10.540	0.000
Layer 4	66.000	0.105	0.043	2.813	21.050	-11.370	0.000
Layer 5	86.000	0.105	0.043	2.943	21.830	-11.790	0.000
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

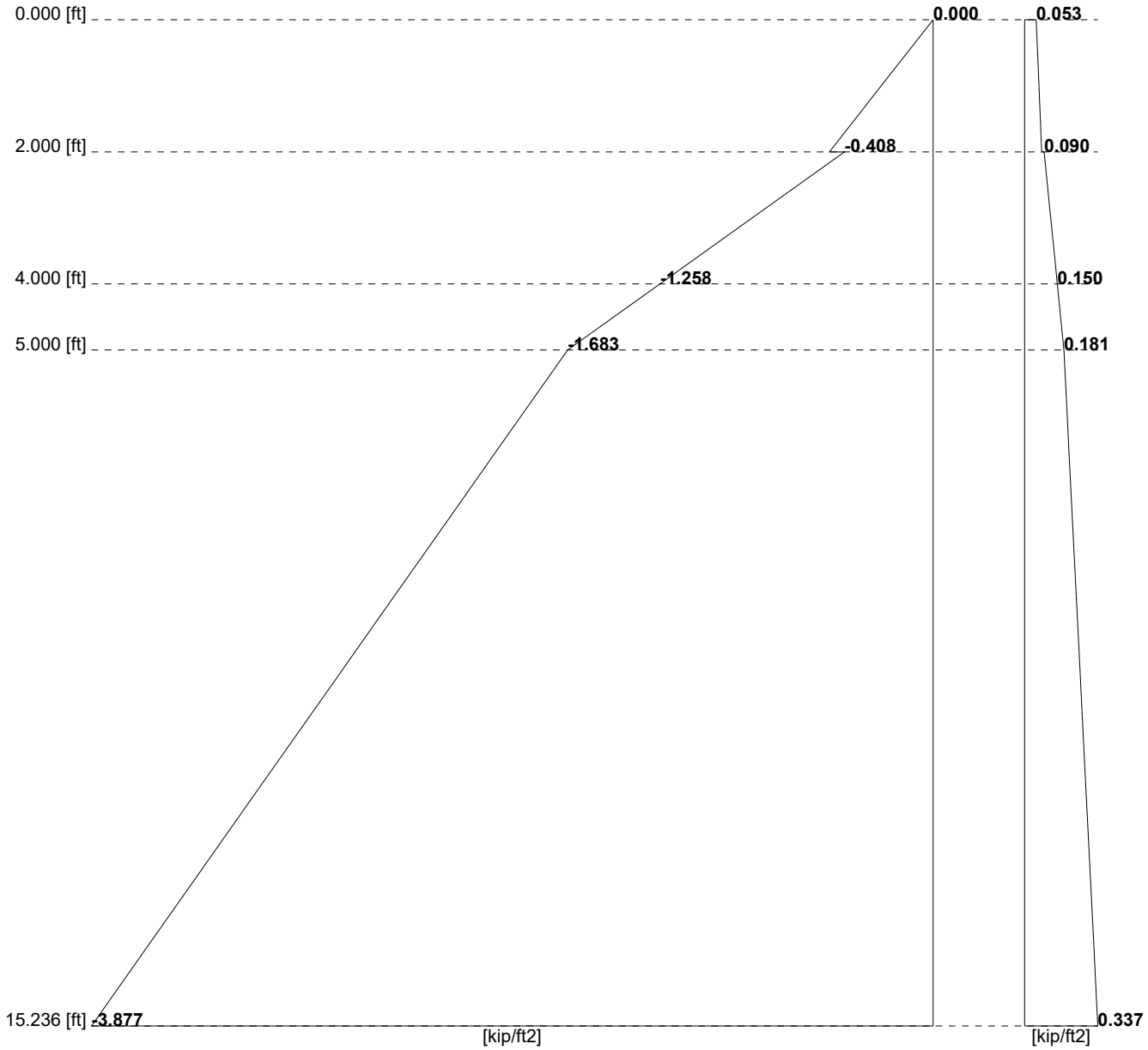
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

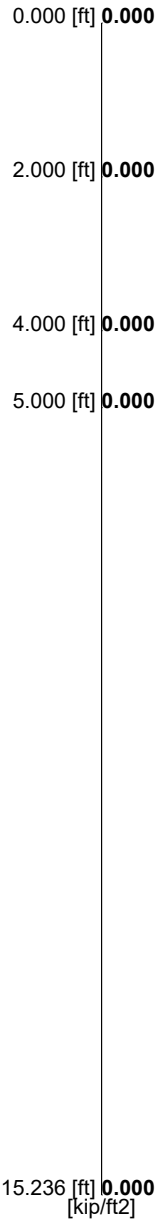
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.163	4.000
Maxmimal Moment [kipft/ft]	37.667	9.921
Normal Forces at Max. Moment [kip/ft]	-0.307	4.000
Normal Forces at Min. Moment [kip/ft]	-2.763	9.921
Deflection at Min. Moment [ft]	-0.055	4.000
Deflection at Max. Moment [ft]	-0.012	9.921
Min. Stress at Min. Moment [lb/in2]	-647.990	4.000
Max. Stress at Min. Moment [lb/in2]	539.729	4.000
Min. Stress at Max. Moment [lb/in2]	-19988.879	9.921
Max. Stress at Max. Moment [lb/in2]	19015.127	9.921
Safety > Req. Safety = 1.500	2.501	
Sheet Pile Top Level [ft]	2.000	
Sheet Pile Tip Level [ft]	18.194	
Sheet Pile Length [ft]	16.194	
Included OverLength [ft]	2.958	
Vertical Equilibrium [kip/ft]	-1.131	
Anchor Force (horiz.) [kip/ft]	12.914	

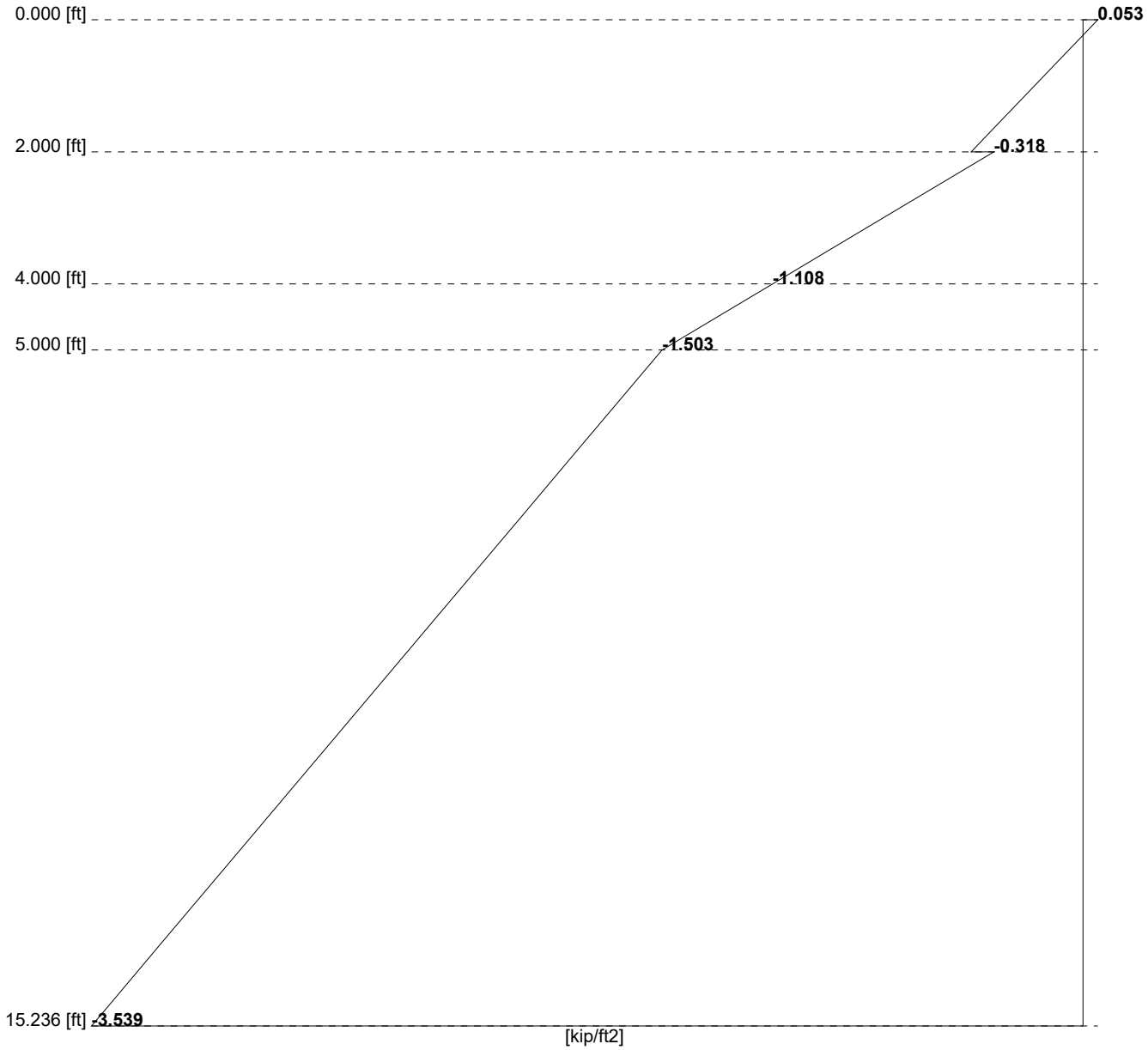
Earth Pressure Diagram



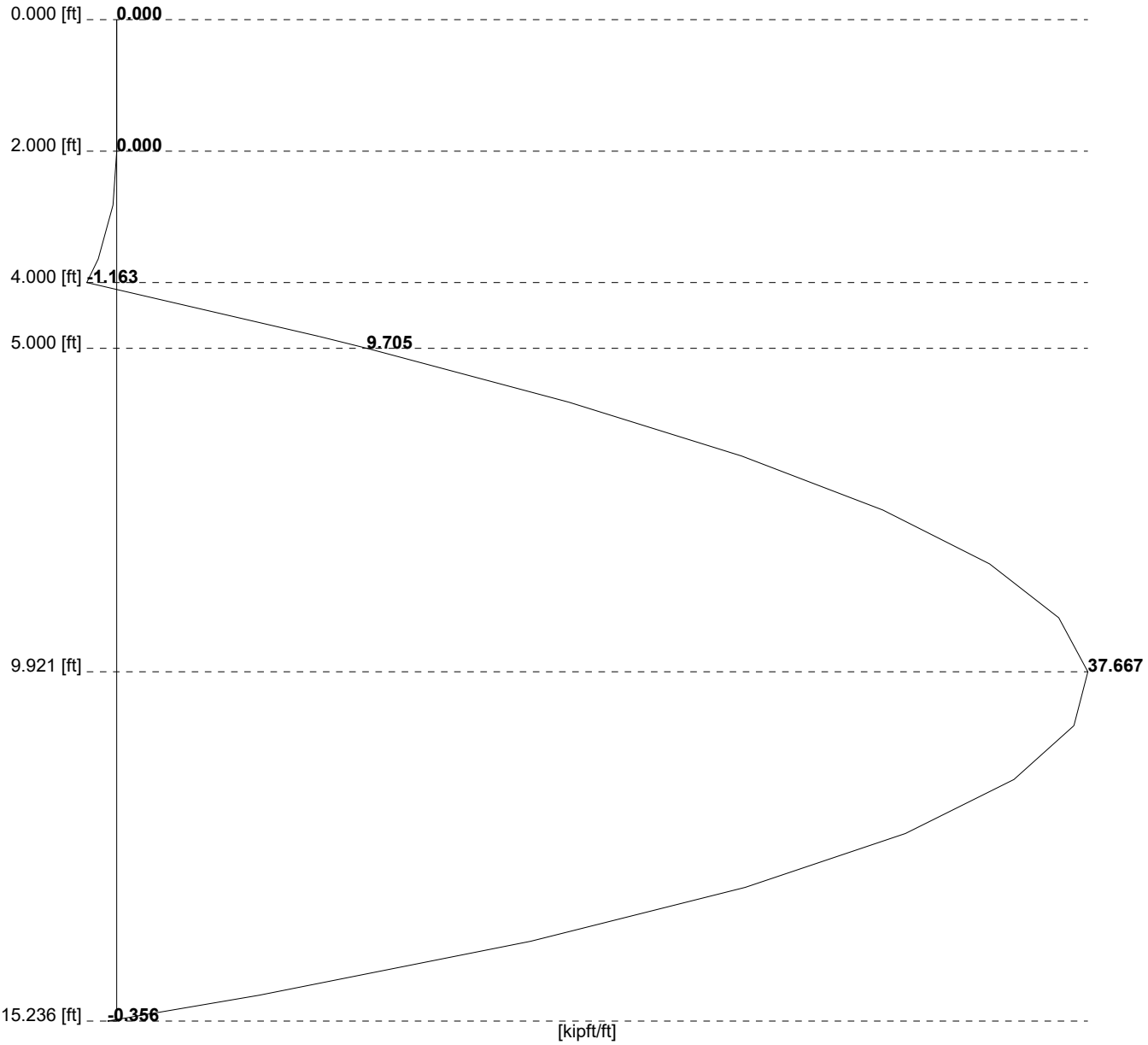
Water Pressure Diagram



Total Pressure Diagram

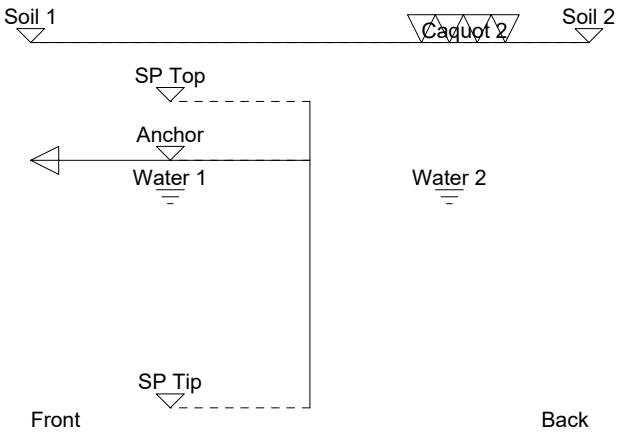


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	2.000
Sheet Pile Tip Level [ft]	12.409
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	12.914
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	4.348	28.000	-15.120	0.000
Layer 4	66.000	0.105	0.043	4.970	30.000	-16.200	0.000
Layer 5	86.000	0.105	0.043	5.364	31.000	-16.740	0.000
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	0.314	28.000	15.120	0.000
Layer 4	66.000	0.105	0.043	0.288	30.000	16.200	0.000
Layer 5	86.000	0.105	0.043	0.276	31.000	16.740	0.000
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

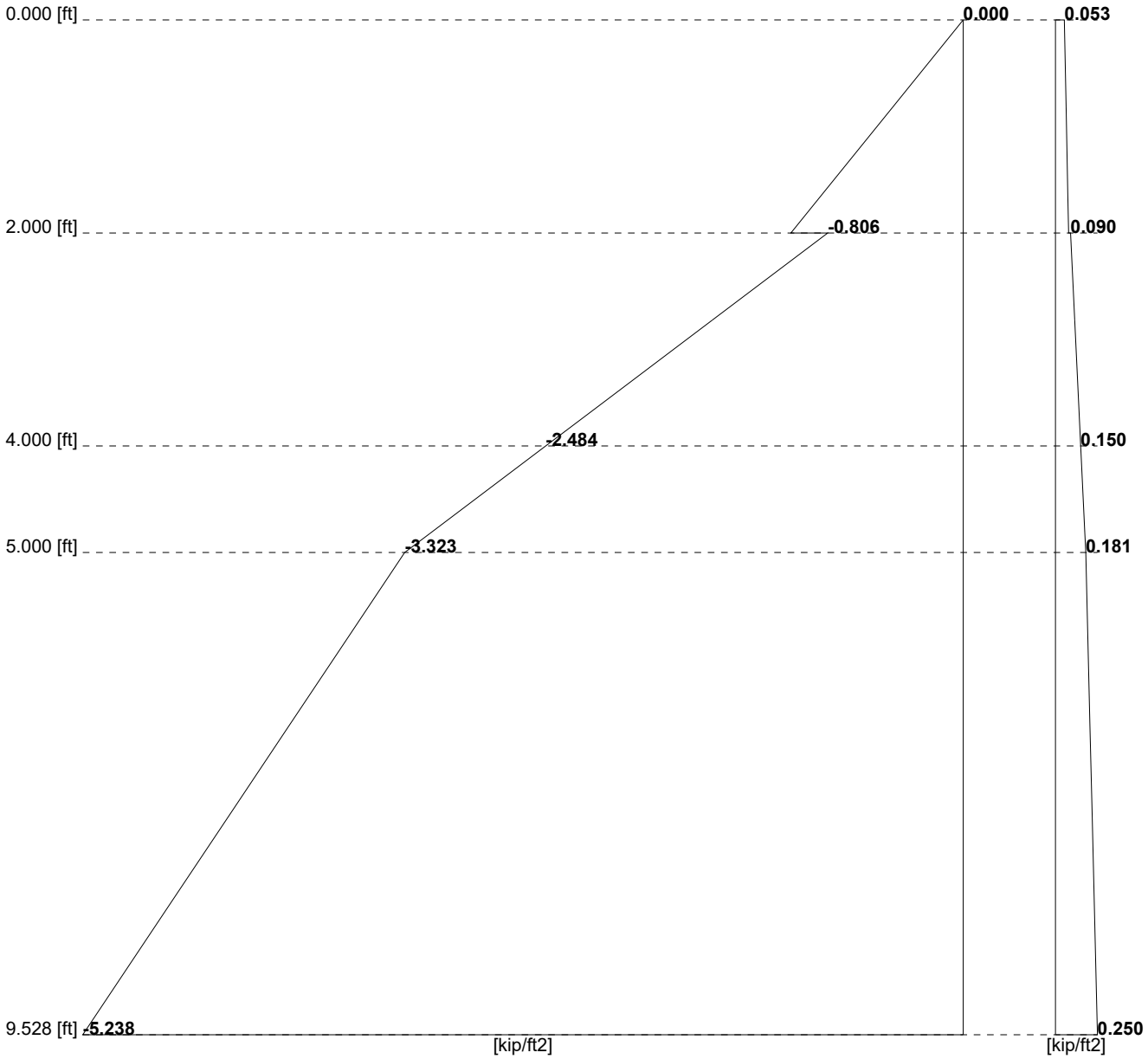
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

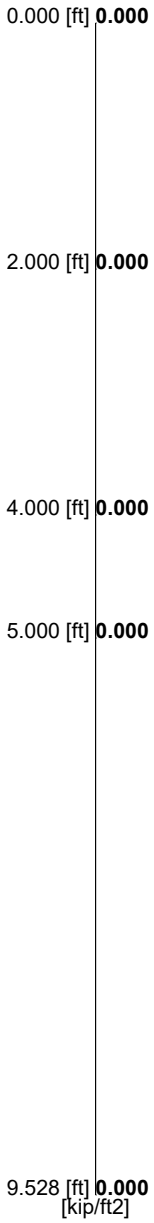
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-2.510	4.000
Maxmimal Moment [kipft/ft]	13.216	6.640
Normal Forces at Max. Moment [kip/ft]	-1.012	4.000
Normal Forces at Min. Moment [kip/ft]	-4.896	6.640
Deflection at Min. Moment [ft]	-0.003	4.000
Deflection at Max. Moment [ft]	0.000	6.640
Min. Stress at Min. Moment [lb/in2]	-1095.932	4.000
Max. Stress at Min. Moment [lb/in2]	773.826	4.000
Min. Stress at Max. Moment [lb/in2]	-5706.905	6.640
Max. Stress at Max. Moment [lb/in2]	4148.462	6.640
Safety > Req. Safety = 1.500	8.761	
Sheet Pile Top Level [ft]	2.000	
Sheet Pile Tip Level [ft]	12.409	
Sheet Pile Length [ft]	10.409	
Included OverLength [ft]	2.881	
Vertical Equilibrium [kip/ft]	-4.262	
Anchor Force (horiz.) [kip/ft]	12.914	

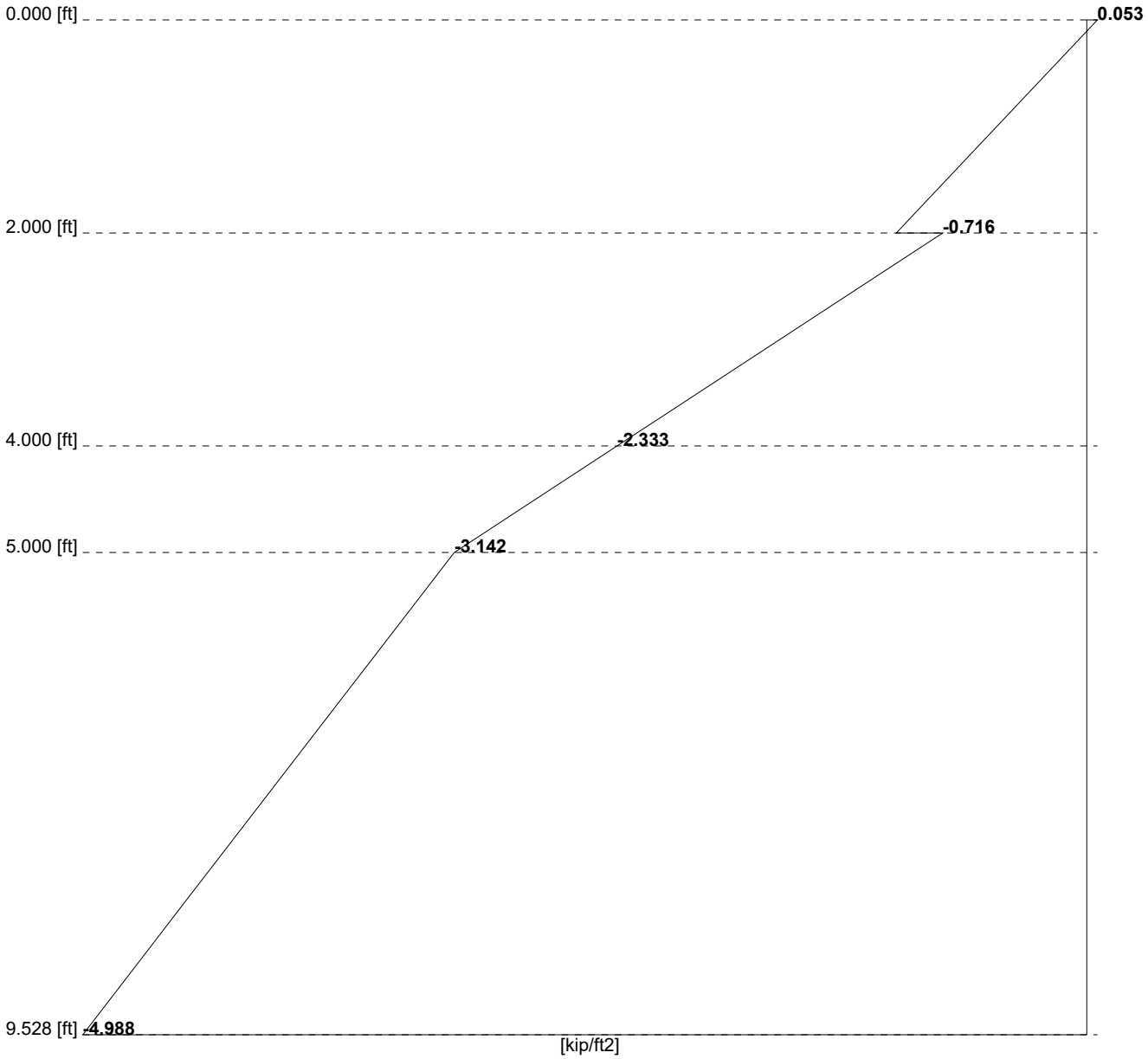
Earth Pressure Diagram



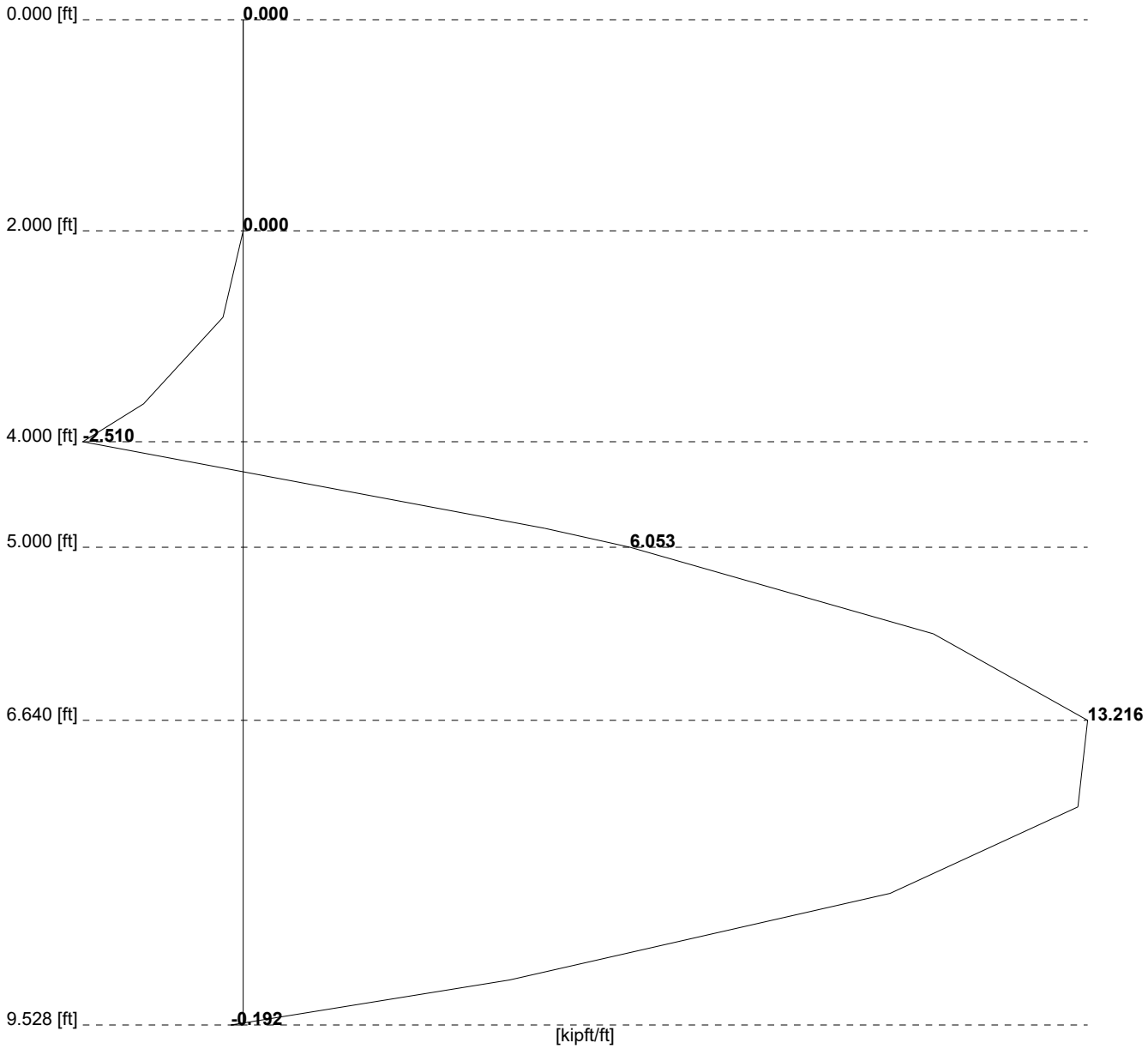
Water Pressure Diagram



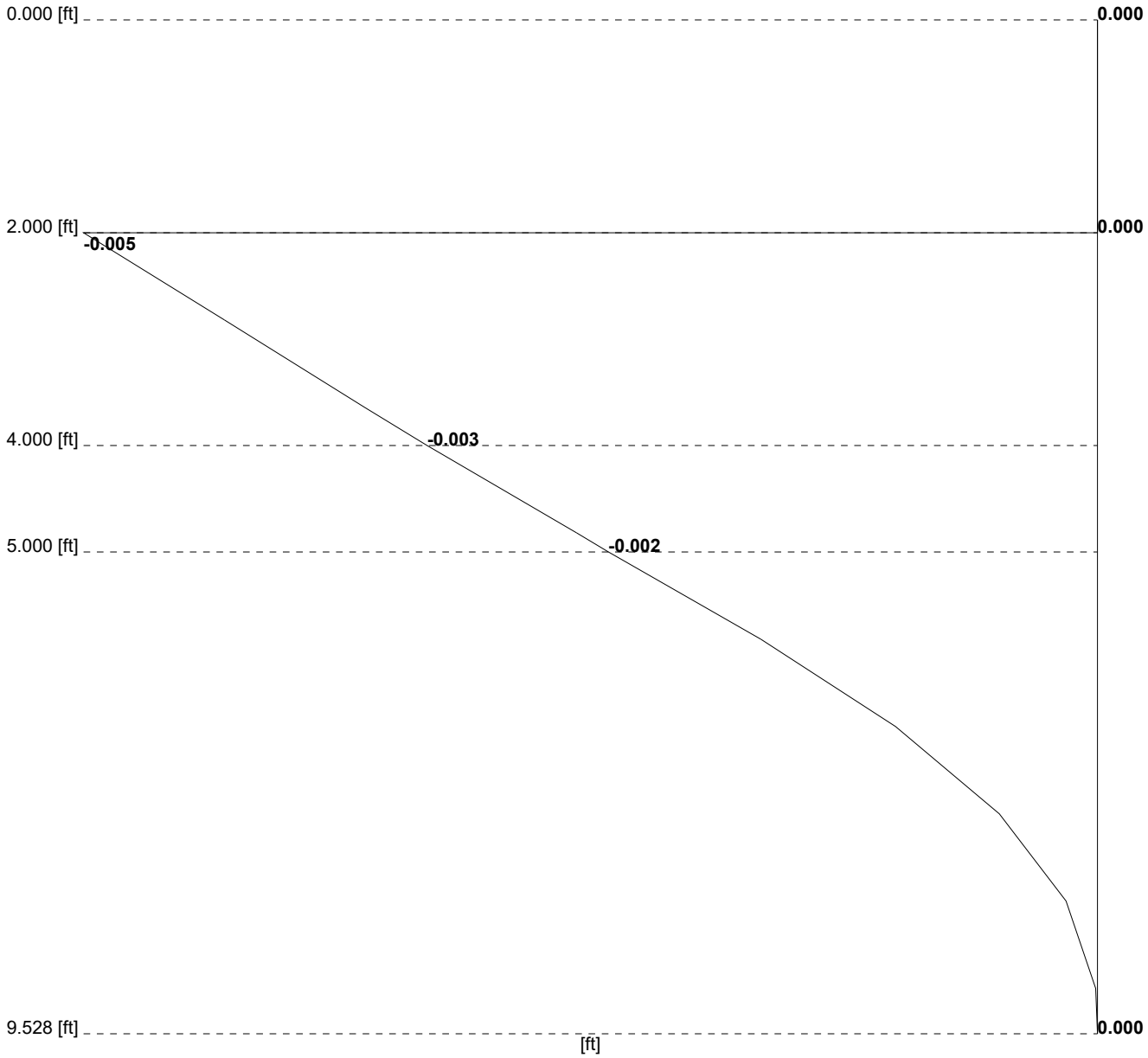
Total Pressure Diagram



Moment Diagram

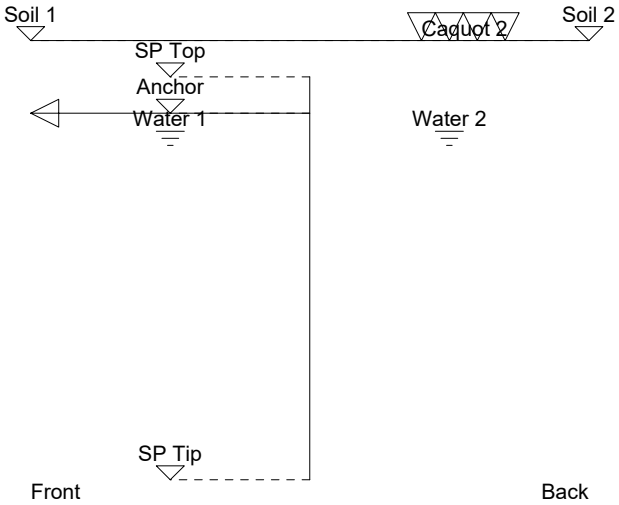


Deflection Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	2.000
Sheet Pile Tip Level [ft]	24.207
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	20.249
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	3.983	26.670	-14.400	0.000
Layer 2	34.000	0.125	0.063	3.401	24.210	-13.070	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.150
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.450
Layer 6	120.000	0.125	0.063	3.401	24.210	-13.070	0.000

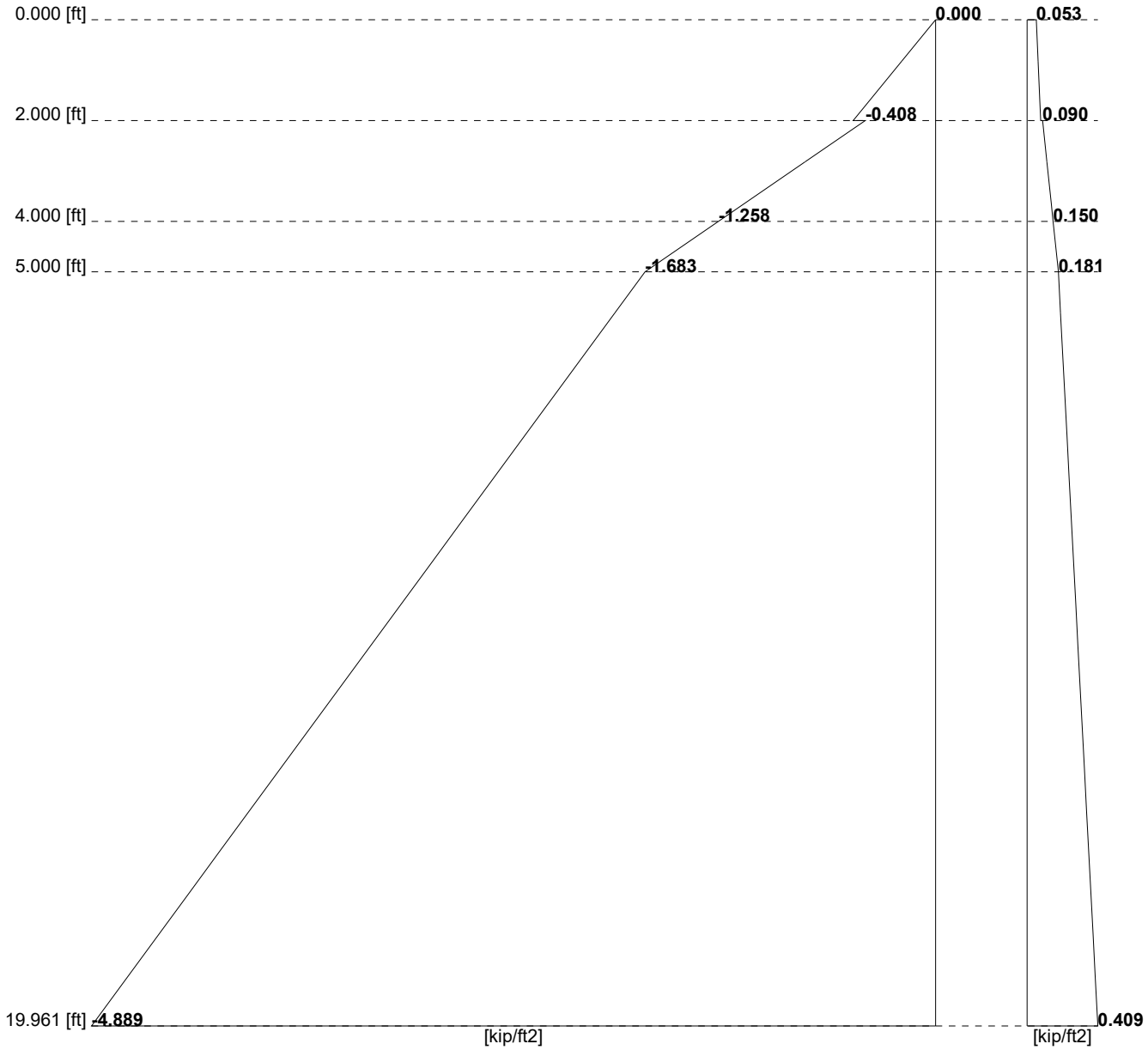
Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

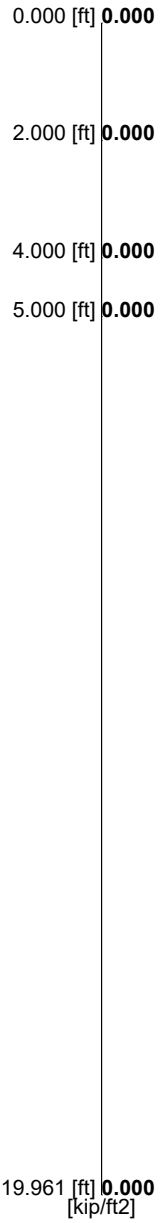
Pile Check

		Depth [ft]
Name	AZ 12-770	
Inertia [in4/ft]	156.927	
Modulus [in3/ft]	23.157	
Area [in2/ft]	5.674	
Mass [lbs/ft2]	19.314	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-1.163	4.000
Maxmimal Moment [kipft/ft]	92.072	12.382
Normal Forces at Max. Moment [kip/ft]	-0.307	4.000
Normal Forces at Min. Moment [kip/ft]	-4.253	12.382
Deflection at Min. Moment [ft]	-0.266	4.000
Deflection at Max. Moment [ft]	-0.054	12.382
Min. Stress at Min. Moment [lb/in2]	-614.509	4.000
Max. Stress at Min. Moment [lb/in2]	506.249	4.000
Min. Stress at Max. Moment [lb/in2]	-48340.797	12.382
Max. Stress at Max. Moment [lb/in2]	46841.805	12.382
Safety < Req. Safety = 1.500	1.034	
Sheet Pile Top Level [ft]	2.000	
Sheet Pile Tip Level [ft]	24.207	
Sheet Pile Length [ft]	22.207	
Included OverLength [ft]	4.246	
Vertical Equilibrium [kip/ft]	-1.502	
Anchor Force (horiz.) [kip/ft]	20.249	

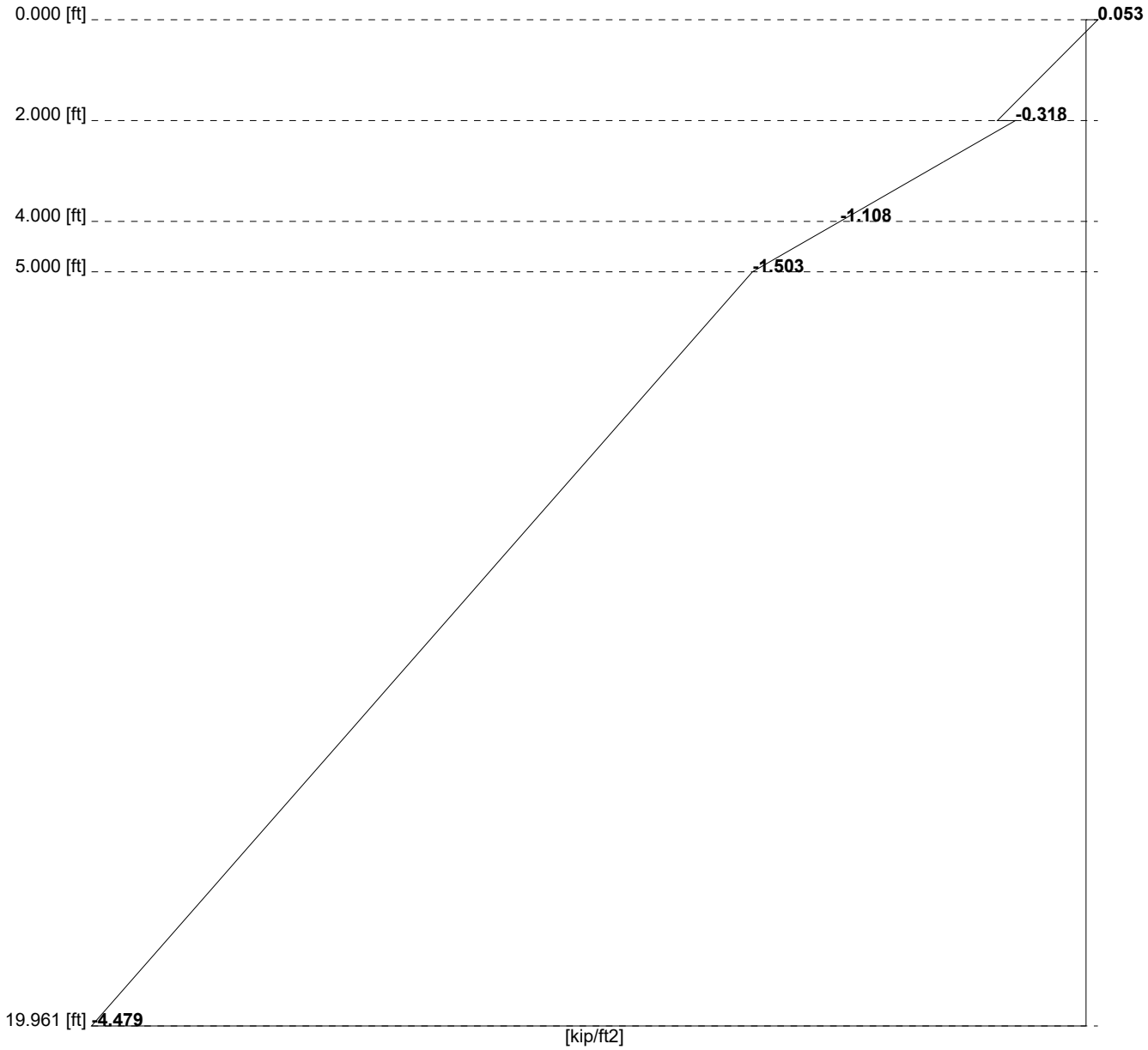
Earth Pressure Diagram



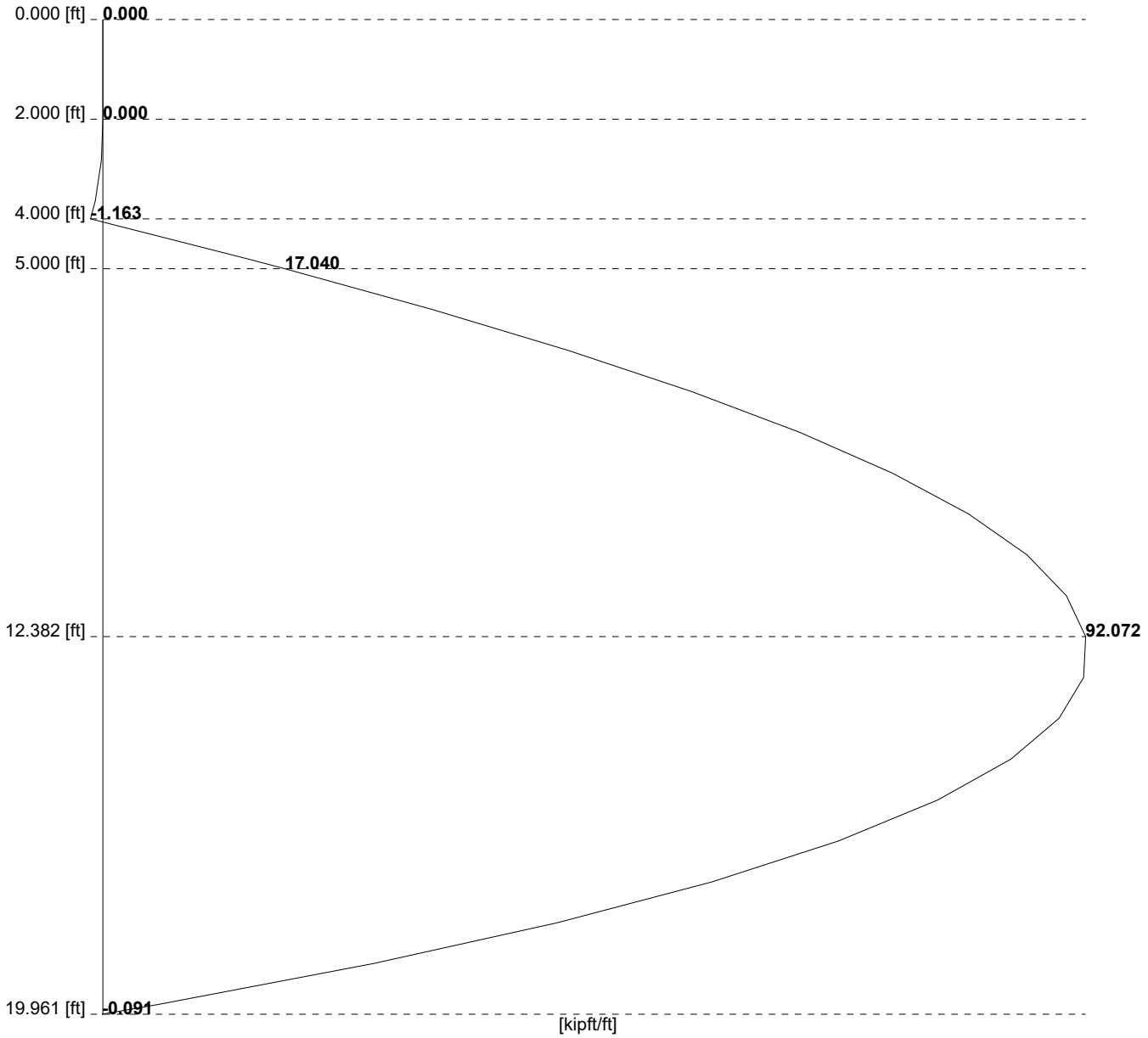
Water Pressure Diagram



Total Pressure Diagram

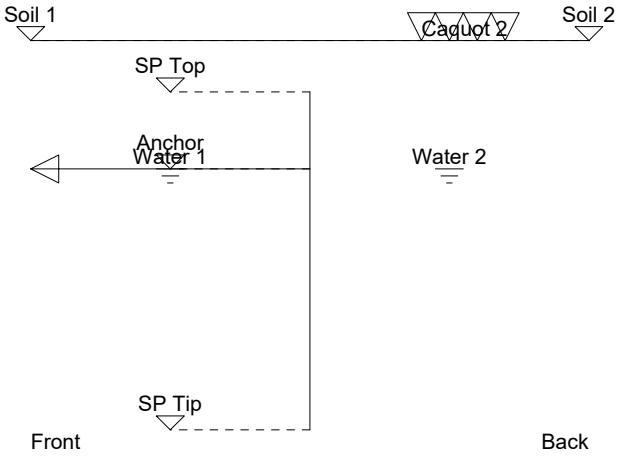


Moment Diagram



Geodata

	Unit
Sheet Pile Top Level [ft]	2.000
Sheet Pile Tip Level [ft]	15.164
Soil Level in Front [ft]	0.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	5.000
Water Level in Front [ft]	5.000
Water Level behind [ft]	5.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.250
Anchor Inclination [Deg]	0.000
Anchor Force*Safty Factor [kip/ft]	20.249
Earth Support	Fixed



Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	8.542	37.000	-19.980	0.000
Layer 2	34.000	0.125	0.063	6.713	34.000	-18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	6.636	34.000	-18.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	2.000	0.060	0.028	0.212	37.000	19.980	0.000
Layer 2	34.000	0.125	0.063	0.243	34.000	18.360	0.000
Layer 3	46.000	0.105	0.043	1.000	0.000	0.000	0.300
Layer 4	66.000	0.105	0.043	1.000	0.000	0.000	0.600
Layer 5	86.000	0.105	0.043	1.000	0.000	0.000	0.900
Layer 6	120.000	0.125	0.063	0.243	34.000	18.000	0.000

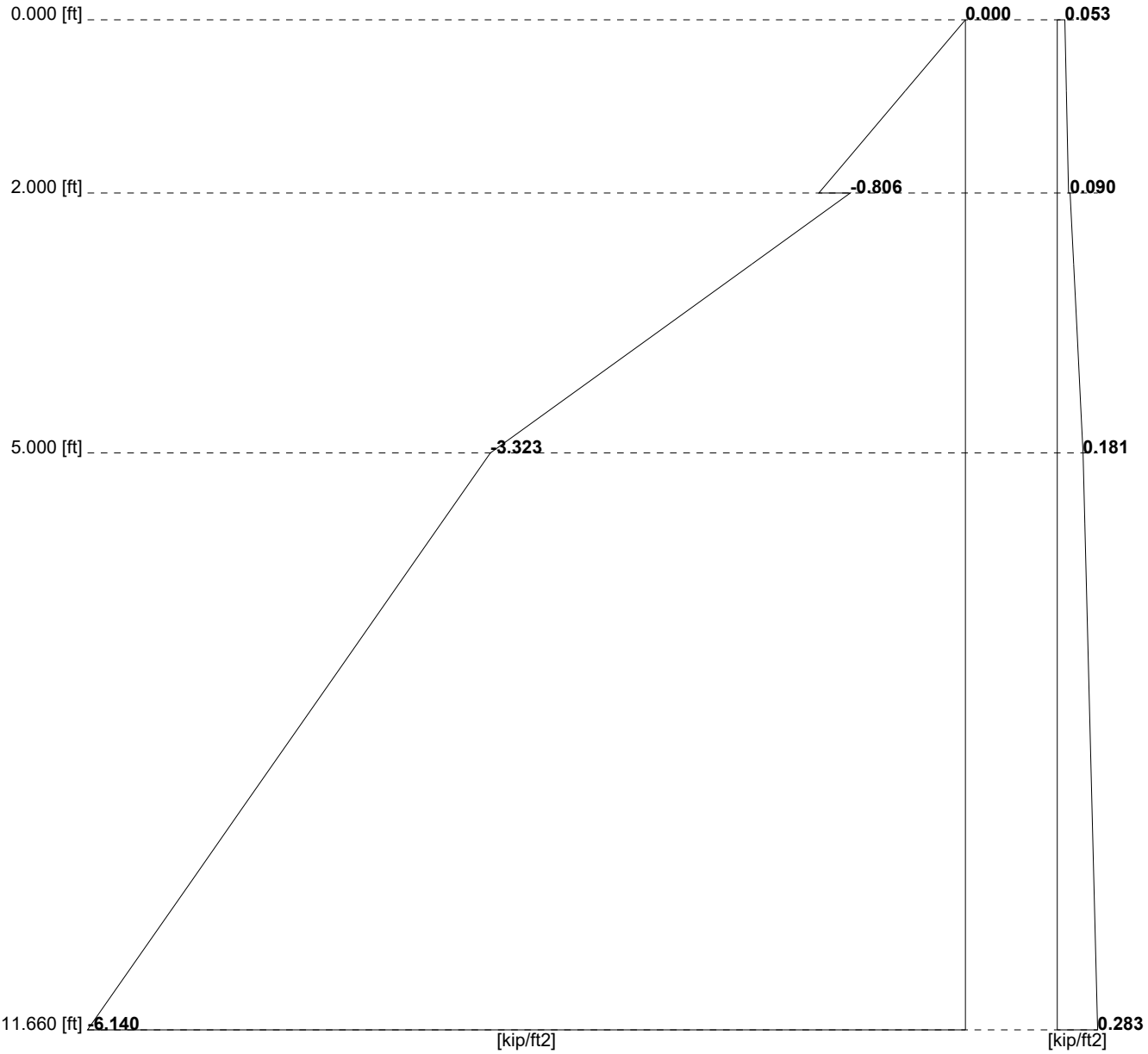
Pile Section

Name	AZ 17-700
Inertia [in4/ft]	265.304
Modulus [in3/ft]	32.178
Area [in2/ft]	6.284
Mass [lbs/ft2]	21.383
Steel Grade [lb/in2]	50000.000
Requested Safety	1.500

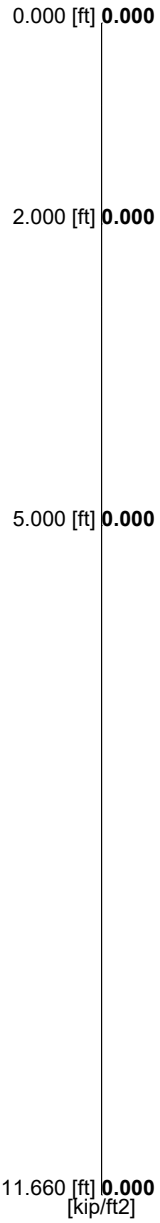
Pile Check

		Depth [ft]
Name	AZ 17-700	
Inertia [in4/ft]	265.304	
Modulus [in3/ft]	32.178	
Area [in2/ft]	6.284	
Mass [lbs/ft2]	21.383	
Steel Grade [lb/in2]	50000.000	
Minimal Moment [kipft/ft]	-6.861	5.000
Maxmimal Moment [kipft/ft]	21.695	8.740
Normal Forces at Max. Moment [kip/ft]	-1.921	5.000
Normal Forces at Min. Moment [kip/ft]	-7.335	8.740
Deflection at Min. Moment [ft]	-0.007	5.000
Deflection at Max. Moment [ft]	-0.001	8.740
Min. Stress at Min. Moment [lb/in2]	-2859.245	5.000
Max. Stress at Min. Moment [lb/in2]	2247.929	5.000
Min. Stress at Max. Moment [lb/in2]	-9254.976	8.740
Max. Stress at Max. Moment [lb/in2]	6920.267	8.740
Safety > Req. Safety = 1.500	5.402	
Sheet Pile Top Level [ft]	2.000	
Sheet Pile Tip Level [ft]	15.164	
Sheet Pile Length [ft]	13.164	
Included OverLength [ft]	3.504	
Vertical Equilibrium [kip/ft]	-6.714	
Anchor Force (horiz.) [kip/ft]	20.249	

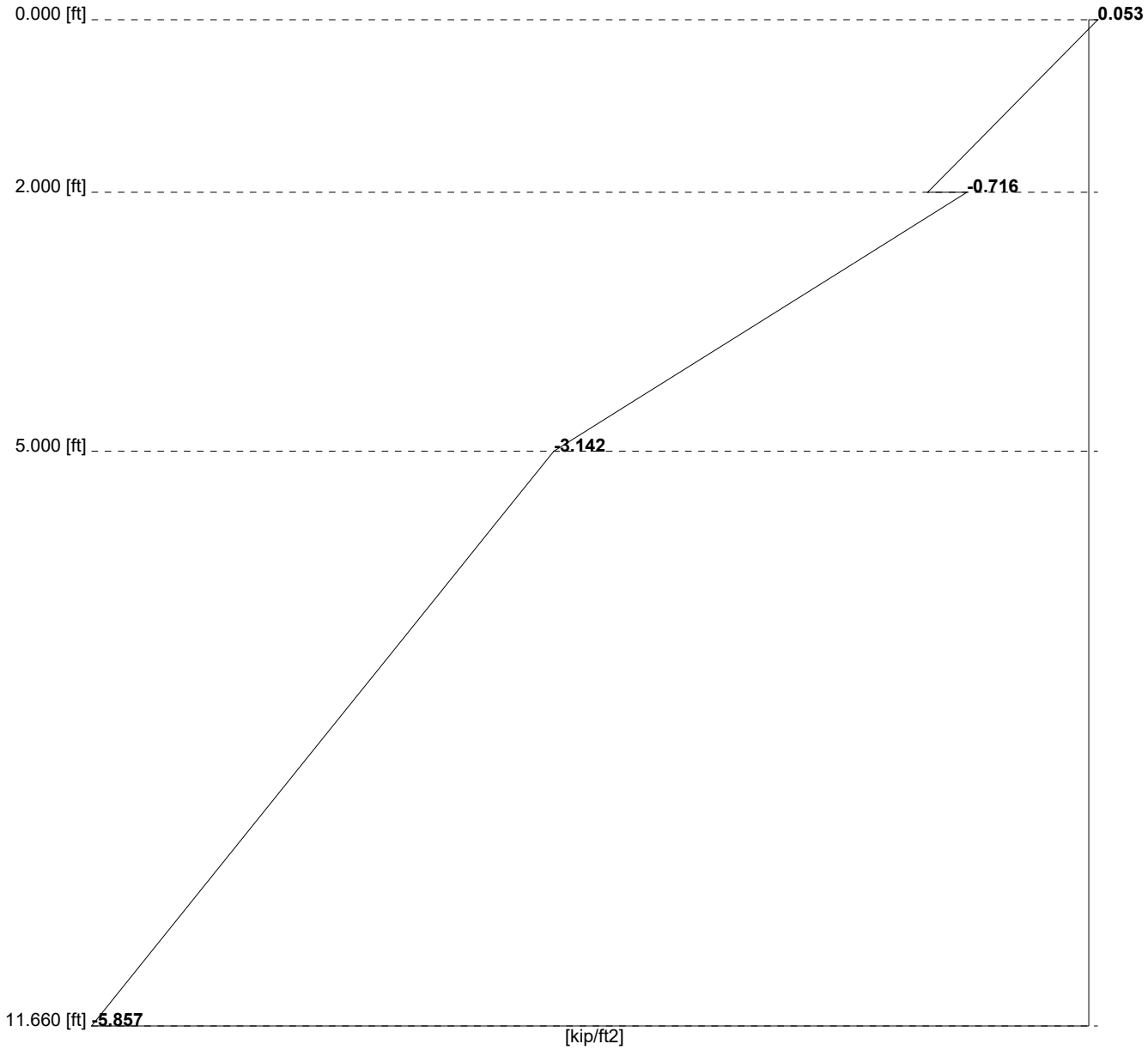
Earth Pressure Diagram



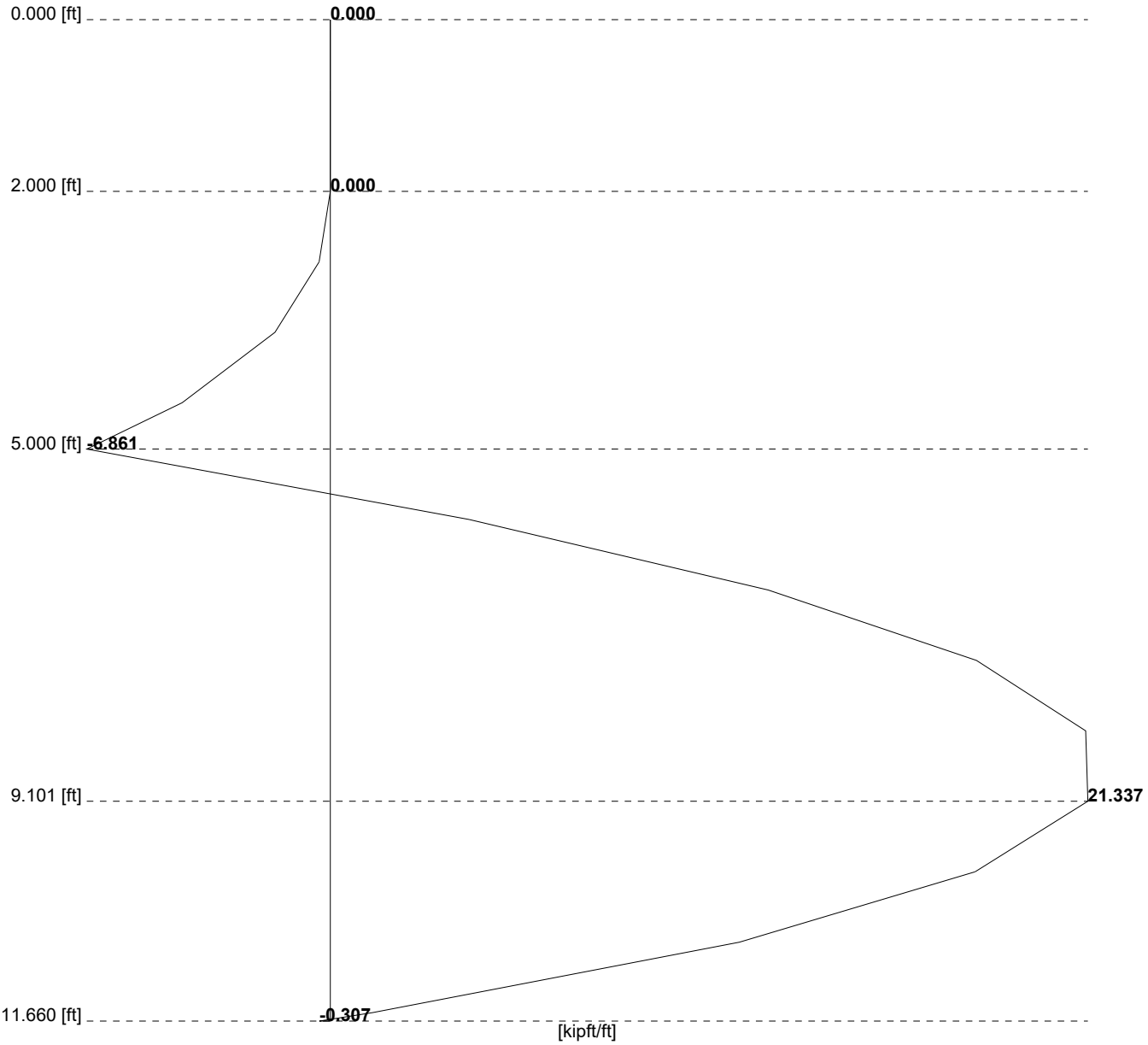
Water Pressure Diagram



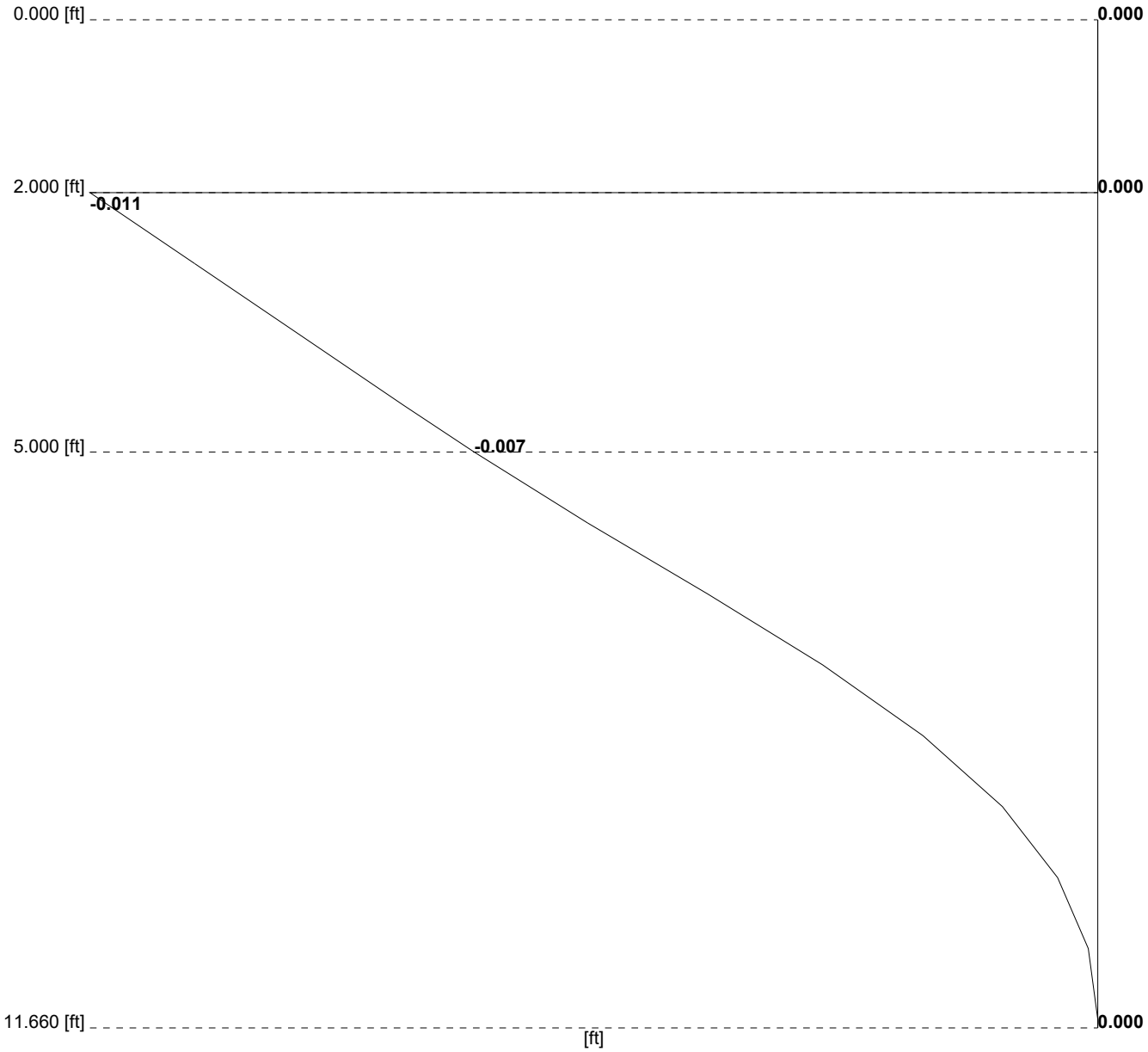
Total Pressure Diagram



Moment Diagram



Deflection Diagram

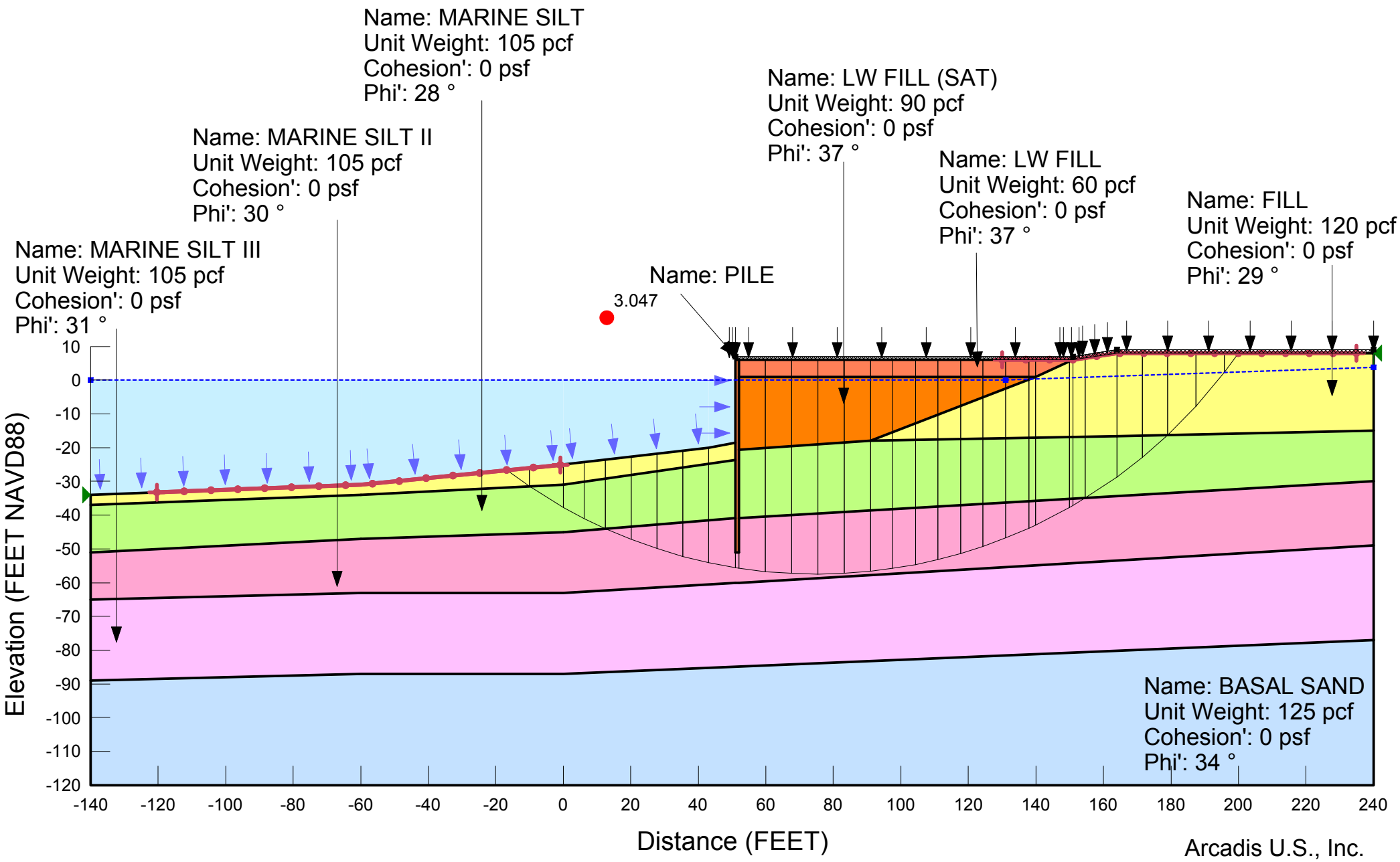


ARCADIS Design & Consultancy for natural and built assets

Attachment H

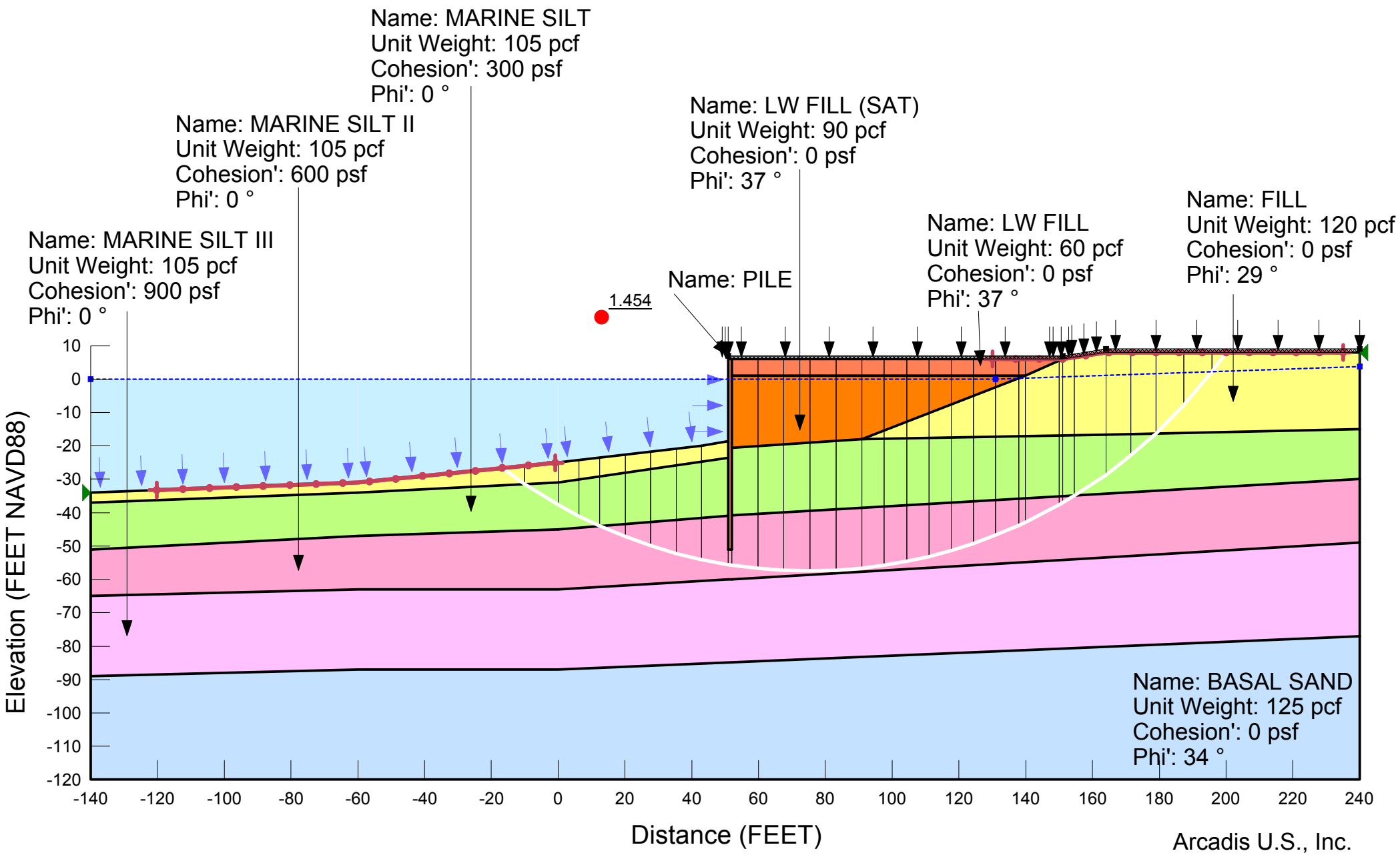
Global Slope Stability Analysis

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Date: 10/12/2017
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Method: Spencer
FOS: 3.047
Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top : 6 ft Bottom: -51 ft



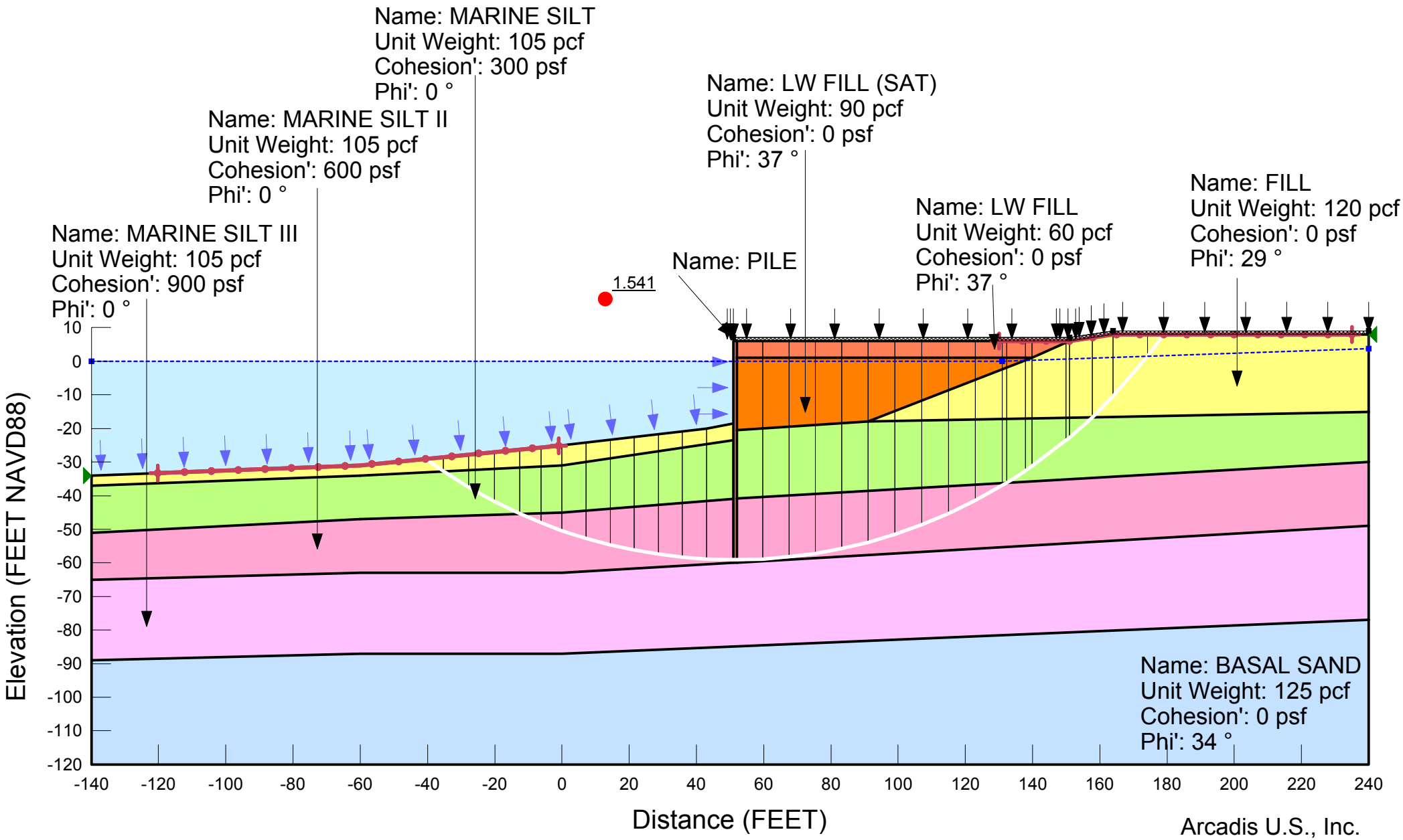
Arcadis U.S., Inc.

File Name: HOH C5-01 Cross Section w 57 Pile Undrained_101217.gsz
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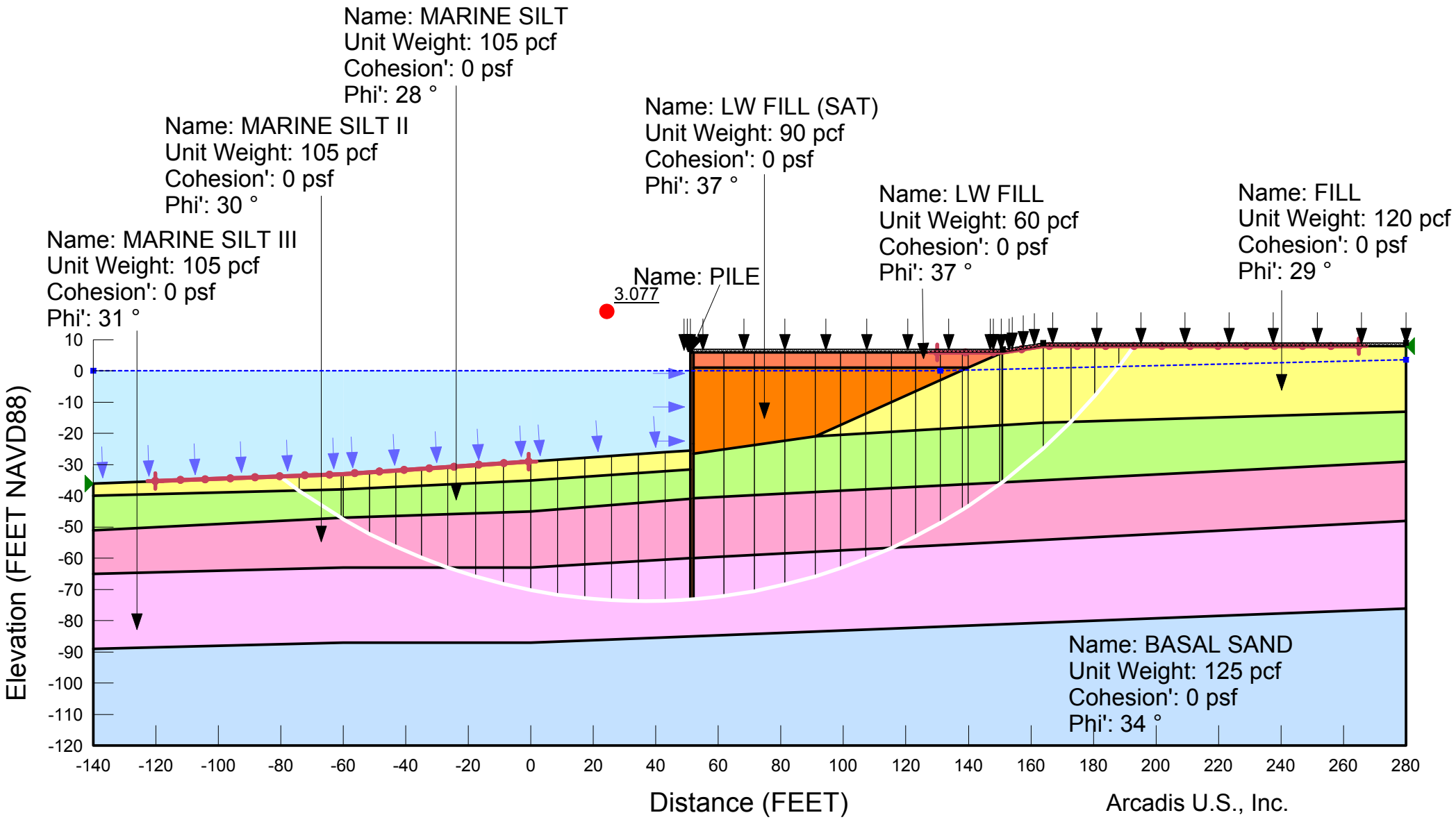
Arcadis U.S., Inc.

File Name: HOH C5-01 Cross Section w Controlling Undrained_101217.gsz
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Method: Spencer
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Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top : 6 ft Bottom: -59 ft



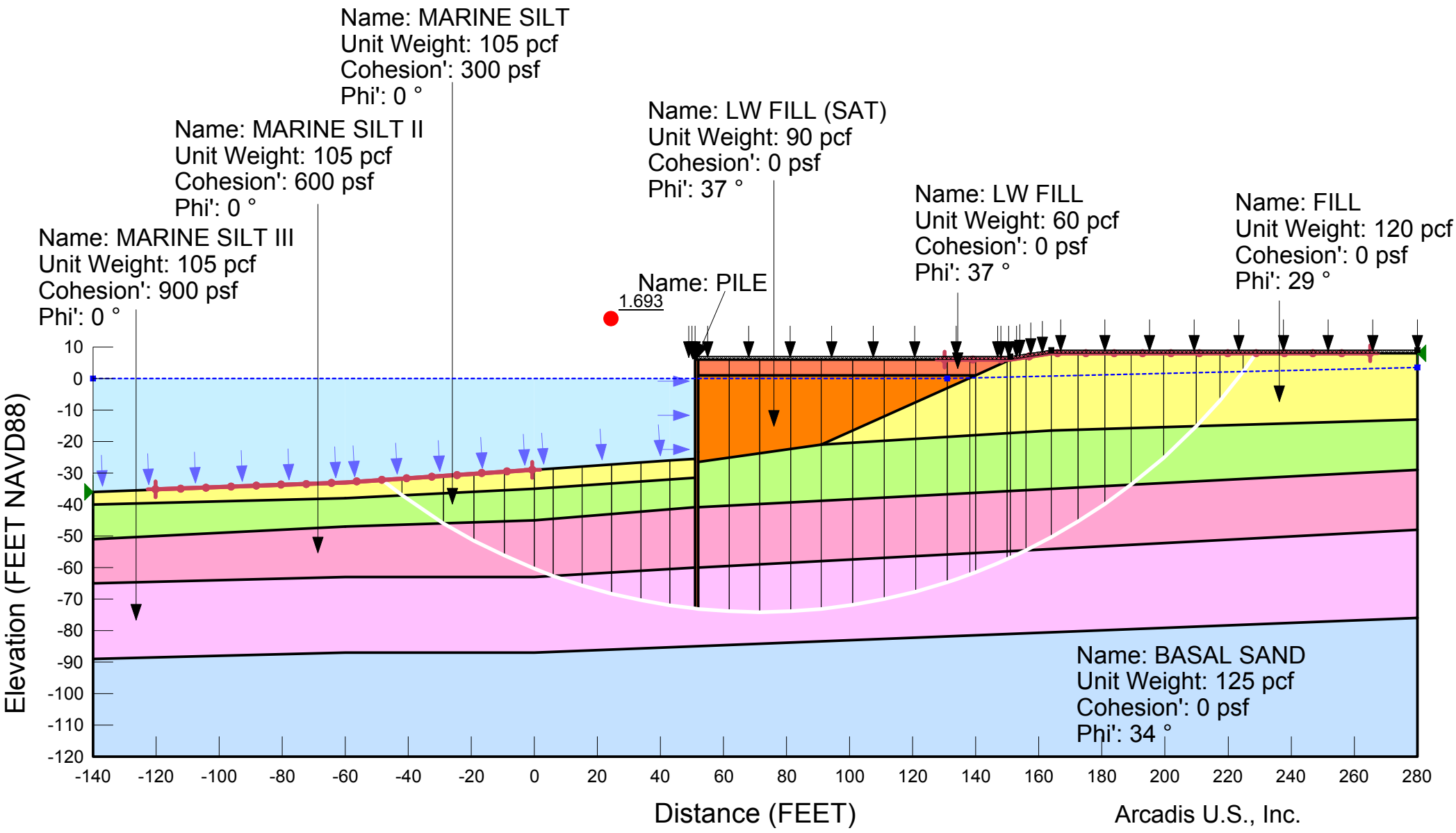
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Date: 10/12/2017
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Method: Spencer
FOS: 3.077
Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top : 6 ft Bottom: -73 ft



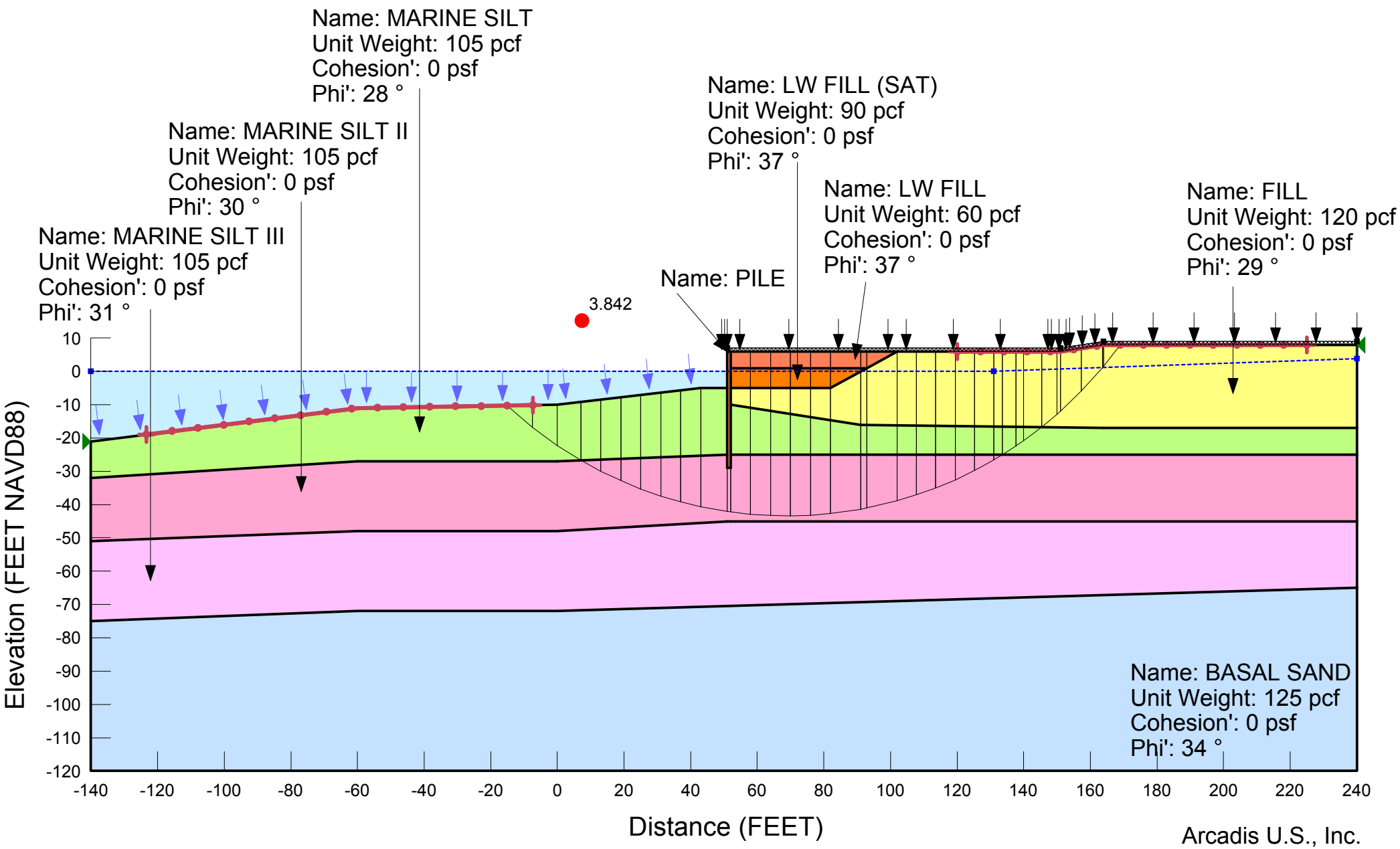
Arcadis U.S., Inc.

File Name: HOH C5-02 Cross Section w 79 Pile Undrained_101217.gsz
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Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top : 6 ft Bottom: -73 ft



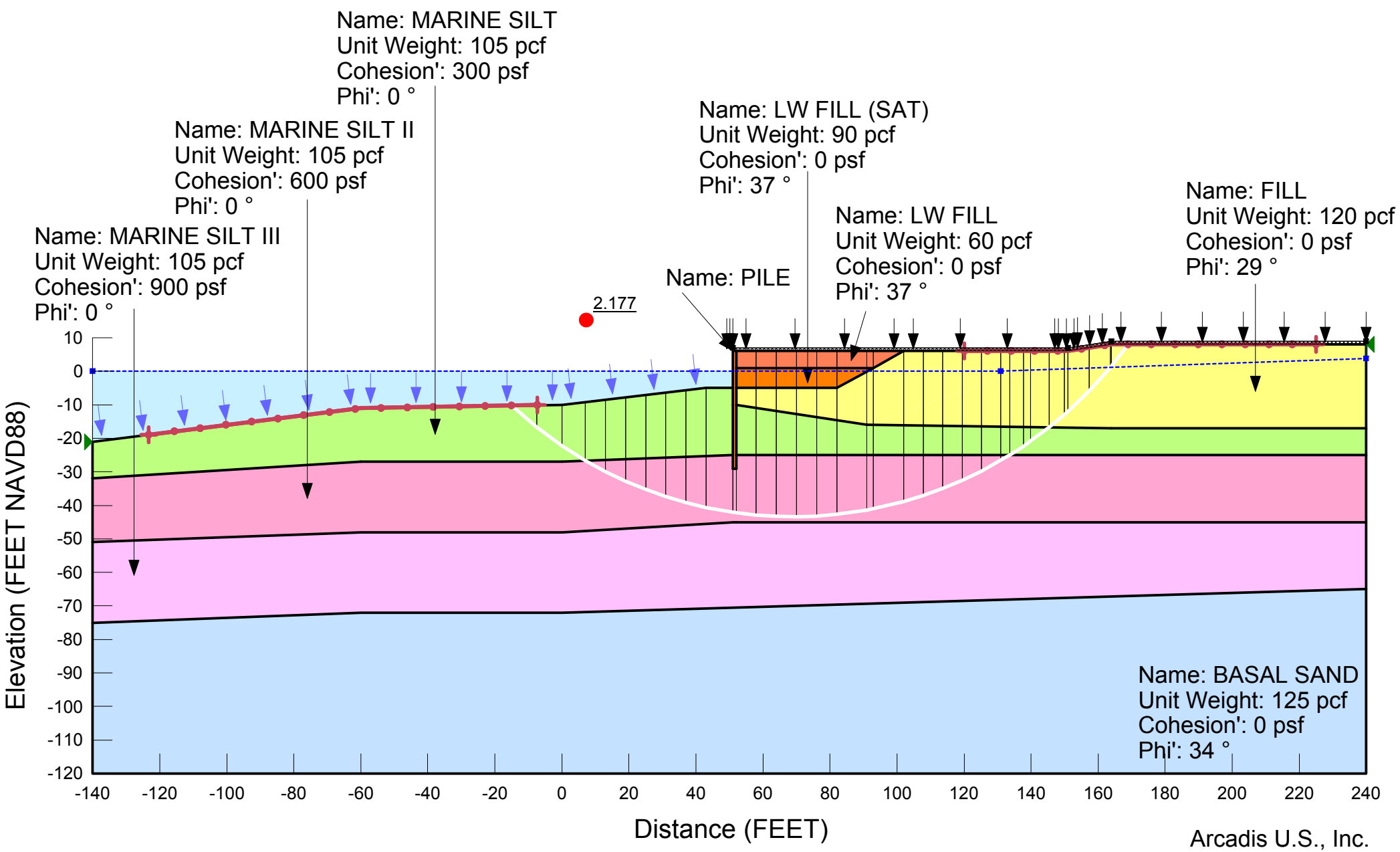
Arcadis U.S., Inc.

File Name: HOH C5-03 Cross Section w 35 Pile Drained.gsz
Date: 10/12/2017
Last Solved Date: 10/12/2017
Method: Spencer
FOS: 3.842
Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top: 6 ft Bottom: -29 ft



Arcadis U.S., Inc.

File Name: HOH C5-03 Cross Section w 35 Pile undrained.gsz
Date: 10/12/2017
Last Solved Date: 10/12/2017
Method: Spencer
FOS: 2.177
Surcharge (Uniform Load): 100 pcf
Pile Elevations: Top: 6 ft Bottom: -29 ft



Arcadis U.S., Inc.

2006 Pre-Design Investigation Report References

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

MATCHLINE - SEE FIGURE 5.1A

FORMER BLDG #53

FORMER BLDG #52B

FORMER BLDG #52A

FORMER BLDG #54

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

N/F THE HARBOR AT HASTINGS ASSOCIATES
100 River Street

#22A, #22B, #22C, #22, #79A, #57, #51, #51A, #52, #72, #72A

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A▲▲▲A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

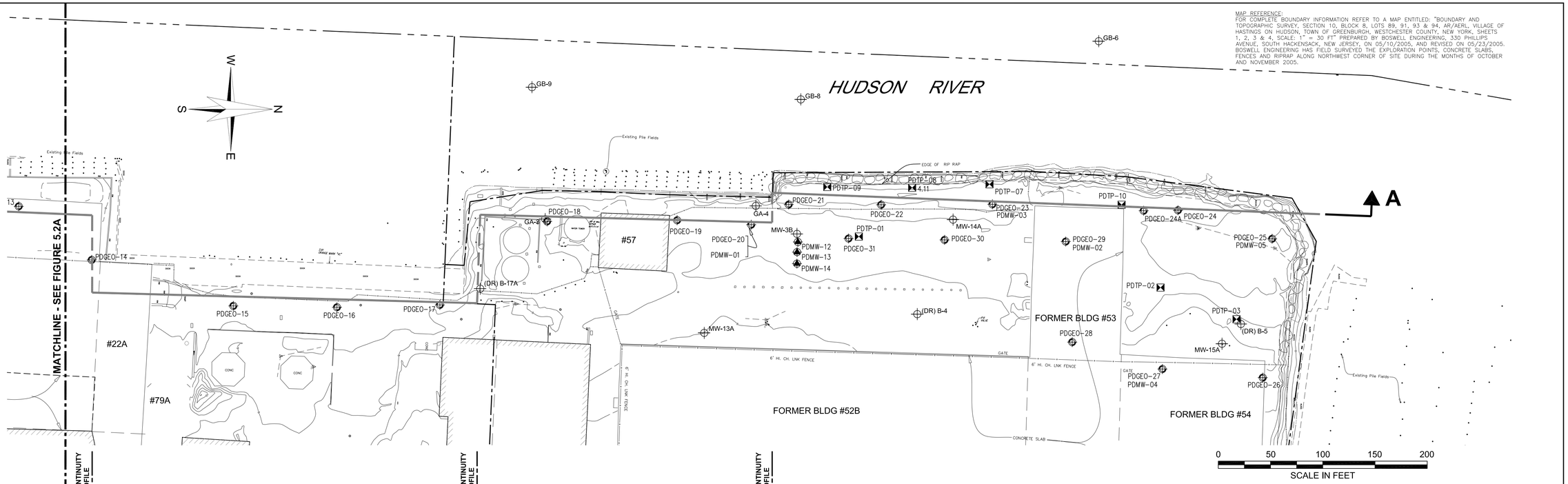
SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

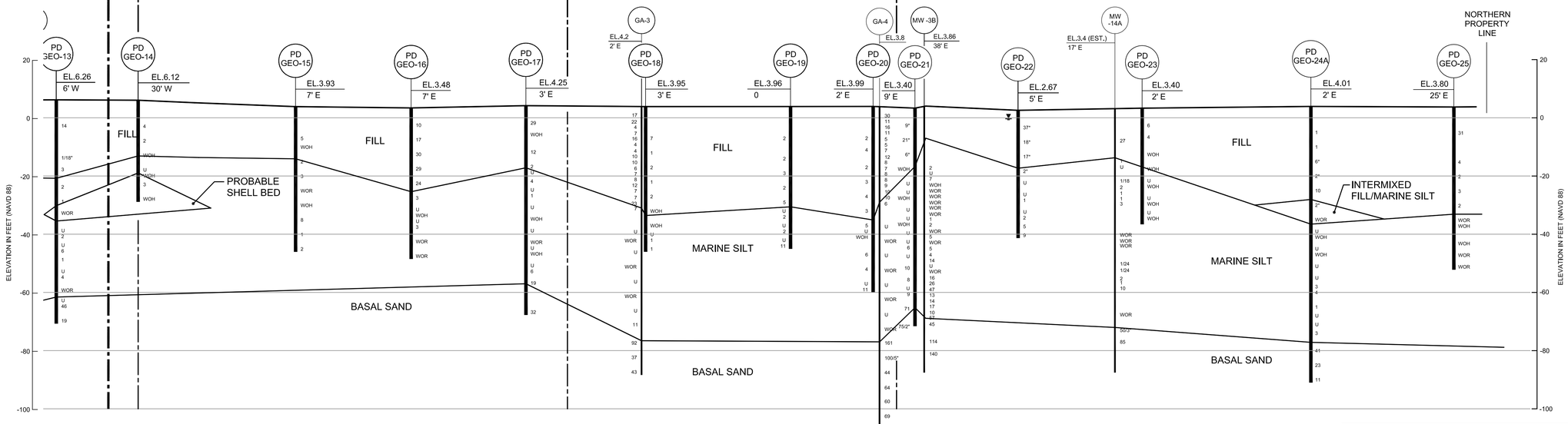
SCALE: AS SHOWN
JULY 2006

FIGURE D5.1B

28612-116 D093 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.





PROFILE A-A

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY & ALDRICH
ENSR | AECOM

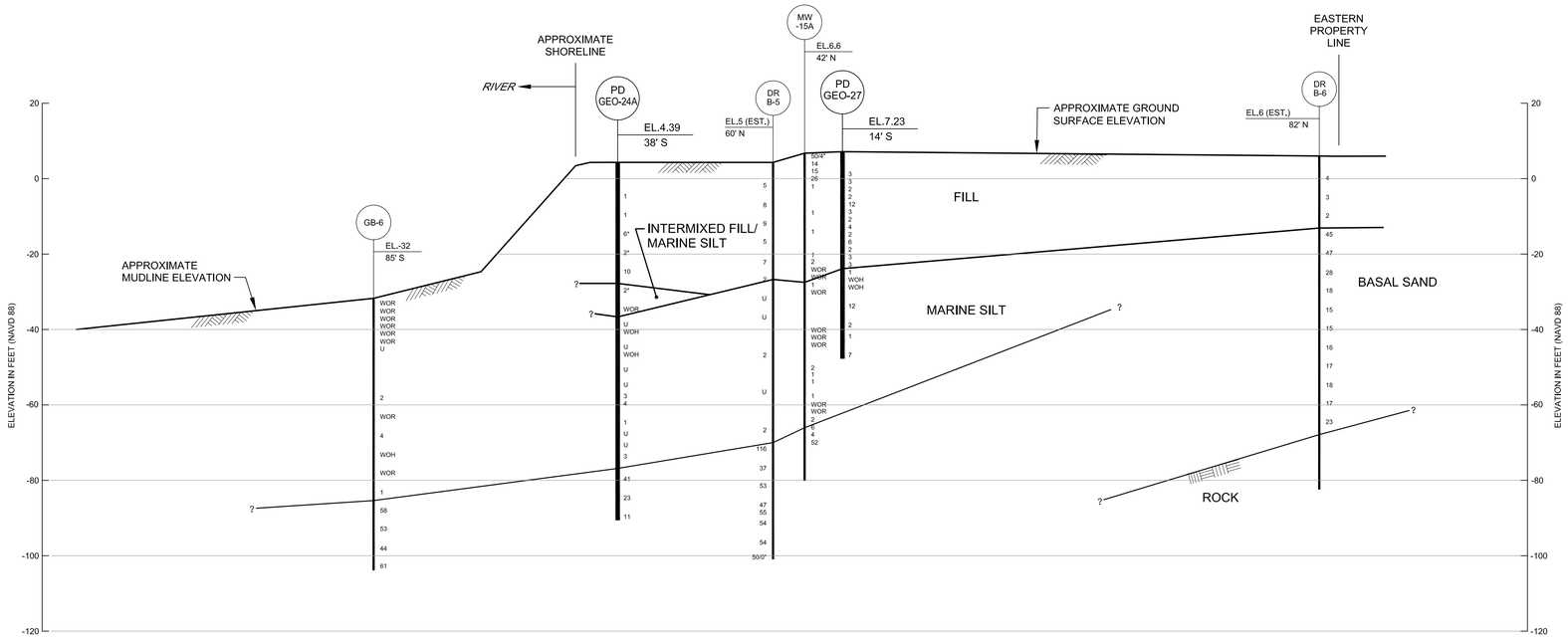
OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE PLAN AND GEOTECHNICAL SUBSURFACE PROFILE A-A

SCALE: AS SHOWN
JULY 2006

FIGURE D5.2B

28612-116 D095 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG



PROFILE H-H

HORIZ. 0 50 100

VERT. 0 20 40

SCALE IN FEET

LEGEND:

PD GEO-1 — EXPLORATION DESIGNATION

EL.4.28 / 25' S — APPROXIMATE GROUND SURFACE ELEVATION (FEET) AT EXPLORATION; APPROXIMATE OFFSET FROM PROFILE BASELINE IN FEET

MAJOR STRATUM BOUNDARY BETWEEN DIFFERENT SOIL TYPES

20 — SAMPLE LOCATION AND INTERVAL

U — LOCATION OF SHELBY TUBE SAMPLE

** DENOTES 3-IN. SPLIT SPOON USED FOR SPT.

NOTES:

1. REFER TO FIGURE 5.1 FOR LOCATION AND ORIENTATION OF THE SUBSURFACE PROFILES.
2. ELEVATIONS REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. THE STRATIFICATION LINES SHOWN ON THE GRAPHIC REPRESENTATION OF THE TEST BORINGS REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. THE TRANSITION BEWEEN MATERIALS IS APPROXIMATE AND MAY BE GRADUAL.
4. THESE PROFILES WERE DEVELOPED BY INTERPOLATION BETWEEN WIDELY SPACED BORINGS. ONLY AT THE BORING LOCATIONS SHOULD IT BE CONSIDERED AS AN APPROXIMATELY ACCURATE REPRESENTATION AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS.
5. FOR SOME OF THE HISTORICAL BORINGS, THE BASAL SAND BOUNDARY WAS RE-INTERPRETED TO BE CONSISTENT WITH THE INTERPRETATION ADOPTED DURING THE PDI. REFER TO INDIVIDUAL LOGS FOR DETAILS.
6. BUILDING LIMITS ARE NOT SHOWN ON THESE PROFILES.

HALEY & ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

GEOTECHNICAL SUBSURFACE PROFILE H-H

SCALE: AS SHOWN
JULY 2006

FIGURE D5.6

28612-116 D099 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

Attachment I

Tie Rod Analysis

ARCADIS

Tie Rod Analysis
Former Anaconda Wire Cable Plant Site
Atlantic Richfield Compnay

By: AJB Date: 09/29/17
Checked: RPK Date:

Objective:
Determine tie rod requirments for shoring systems.

References:

1 Williams Form Engineering Corp. 2011. Product Conversion Chart.
2 Arcadis 2015 Shoring Suite Results.

Assumptions:	**Variable**	**Unit**	**Value**
Yield Stregnth of Rods[1]			
A36 Tie Rod Bar:	f_v	kips	36
Grade 75 - All Thread Bar:		kips	75
Grade 150 ksi - All Thread Bar:		kips	150

Tie rod force was calculated using the program Shoring Suite. See table below.

Calculations:
Allowable tensile stress of Rods

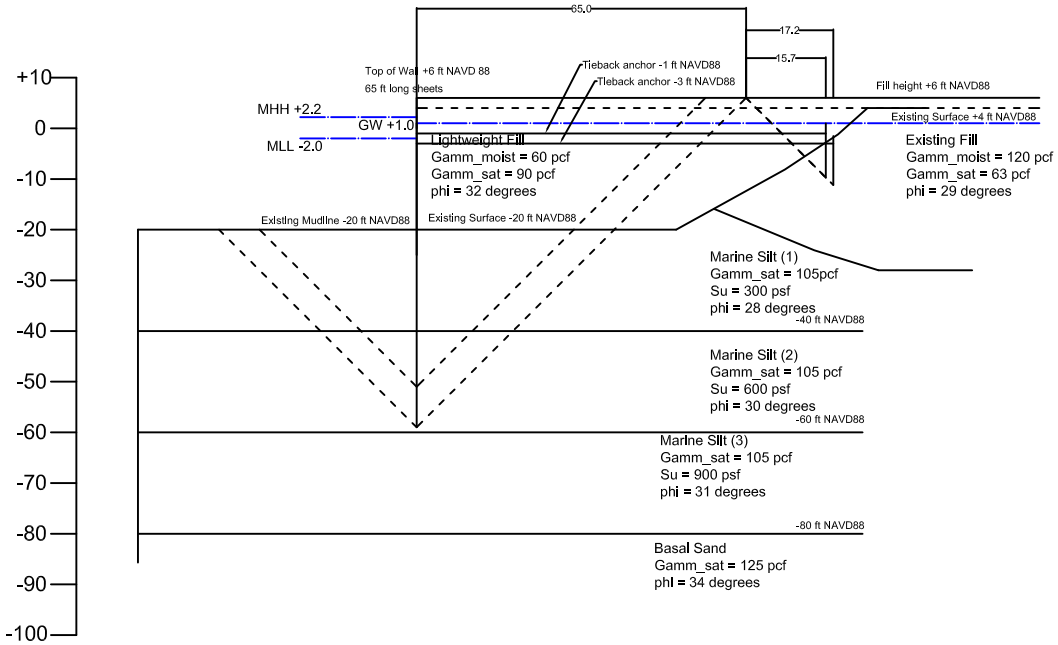
A36 Tie Rod Bar:	$f_t = 0.4 * f_y$	f_t	kips 14.4
Grade 75 - All Thread Bar:			kips 30
150 ksi - All Thread Bar:			kips 60

Available net tension area of threaded tie rod: $A_{net} = T_{rod}/f_t$

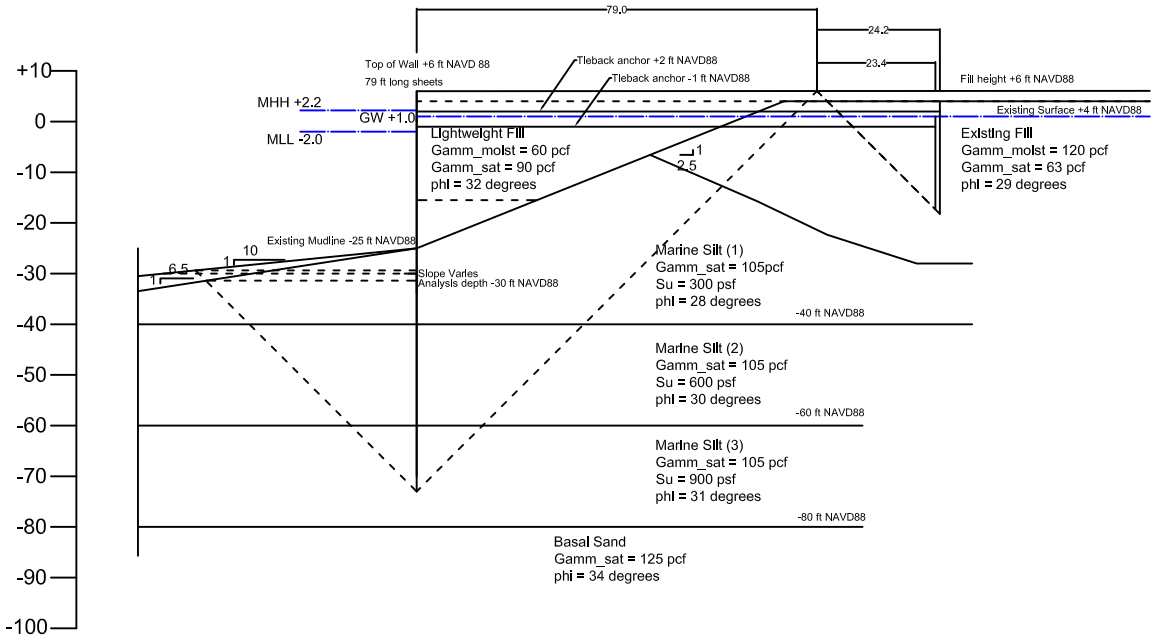
Tie-rod diameter: $D = \sqrt{\frac{4 * A}{\pi}}$

			A_{net}	Required Diameter	Actual Diameter
Analysis ID	Anchor Elevation	Tie-Back Force (T_{rod})	Grade 75	Grade 75	Grade 75
		kip	in	in	in
01	-3	57.3	1.9	1 5/9	1 3/4
	-1	54.9	1.8	1 1/2	1 3/4
02	-1	97.4	3.2	2	2 1/4
	2	93.1	3.1	2	2 1/4

Analysis ID: 01-TB



Analysis ID: 02-TB



Upland Preliminary Design

Client: Atlantic Richfield Company **Project:** B0001701.0000

Prepared by: L. Selleck and A. Baird **Date:** 10/12/2017

Title: Upland Preliminary Design – Harbor at Hastings

Reviewed By: R. Kilkenny **Date:** 11/06/2017
A. Chwalibog **Date:** 11/29/2017

SUBJECT

Calculations for the installation and fill behind new bulkhead alignment at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

OBJECTIVE

Determine assumptions and requirements to:

- Calculate total settlement of three soil profiles extending from the shoreline to the boundary of the developable limits of OU-1.
- Fill to a proposed grade of +8 ft. NAVD 88 in the Open Space area, and +11 ft. NAVD 88 at the developable limits.
- Accelerate total consolidation time and minimize potential risk to utilities with applied surcharge loads.
- Evaluate global stability of sloped shoreline for two conditions:
    - While precompression surcharge load is present (preload condition).
    - After precompression surcharge load is taken off (final grading condition).

ATTACHMENTS

A. Geotechnical Laboratory Data Summary

B. Soil Profile Evaluation Locations

C. Consolidation Settlement Calculations

D. Slope/W Results

ABBREVIATIONS

ARC	Atlantic Richfield Company
Arcadis	Arcadis U.S., Inc.
$C_{c\varepsilon}$	modified compression index
DNAPL	dense non-aqueous phase liquid
ft.	feet
H&A	Haley & Aldrich of New York
NAVD 88	North American Vertical Datum of 1988
OCR	Overconsolidation ratio
OU	Operable Unit
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
psf	pound per square foot

REFERENCES

Atlantic Richfield Company (ARC). 2016. Former Anaconda Wire and Cable Company Design Team Briefing. January.

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Holtz, R.D. and Kovacs, W.D. 1981. An Introduction to Geotechnical Engineering.

Ocean Surveys, Inc. 2012. Bathymetry Survey Dated: December 10 to December 16, 2012. Drawing Dated: February 5, 2013. Parsons. 2006. Supplemental Feasibility Study Report for Operable Unit No. 2. April.

Terzaghi, Peck, Mesri. 1996. Soil Mechanics in Engineering Practice. Third Edition.

U.S. Army Corps of Engineers. 1994. *Design of Sheet Pile Walls*. Manual No. 1110-2-2504. March.

Wendel Architecture, Engineering, Surveying and Landscape Architecture, PC. Topographic Survey Dated: May 2013 and June 2014. Drawing Dated: 22 July 2014.

ENGINEERED REMEDY – GENERAL

The Site is located at 1 River Street, Hastings-on-Hudson, New York. The installation of a sheet pile wall within the Hudson River will provide containment and allow for the recovery of liquid PCB DNAPL offshore of the northwest corner of the site. After wall construction, fill will be added to the upland portion of the site. Consolidation settlement is calculated to anticipate and accelerate consolidation times and therefore minimize potential risk to underground utilities. This report summarizes the calculations for consolidation settlement in the upland portion of the Site, extending from the sloped shoreline to the developable limits of Operable Unit 1 (OU1), which is the on-site soils area west of the railroad tracks.

ASSUMPTIONS

General Assumptions

1. Vertical coordinates are North American Vertical Datum of 1988. Horizontal coordinates (northing and easting) are U.S. State Plane coordinates in U.S. survey feet and are referenced to the North American Datum of 1983, New York State East Zone. Topographic and surface features were surveyed by Wendel Architecture, Engineering, Surveying & Landscape Architecture, PC (2013 and 2014). Bathymetry surface was surveyed by Ocean Surveys, Inc. (Ocean Surveys, Inc. 2012). Current surface features may have varied since the time of the surveys.

2. Utility locations are shown in the Pipe Demolition Drawing Set (Appendix A of Preliminary Design Report), and are approximate and based on surveyed mark outs and drawings from Haley and Aldrich (H&A) 2015 PDI drawings and 2014 Wendel Topographic Survey Drawings.

Imported Backfill Assumptions

1. General fill will be used to raise ground elevation to the proposed level and as a surcharge load to accelerate consolidation time. For design, a typical sand fill was used with typical properties. The fill properties used for analysis are included in Table 1.

Construction Sequencing Assumptions

After installation of the NEA bulkhead, the upland area will be sloped along the Sloped Shoreline and general fill placed to raise the rest of the upland area to the final proposed elevations. Construction is assumed to proceed with:

1. Complete installation of the NEA bulkhead and filling of the NEA to +6 ft. NAVD88.

2. Cut and slope the Slope Shoreline with additional fill as needed to meet the proposed elevations.

3. Apply surcharge loads to design locations to accelerate consolidation times for select areas.

4. Regrade to surcharge fill and add additional fill to rest of the upland site to the proposed final elevations.

Soil Profile Assumptions

1. The geotechnical design sections were interpreted using topographic survey data (Wendel 2014), bathymetry data (Ocean Surveys 2012) and soil boring data from H&A (H&A 2006). A summary of H&A data is included in Attachment A.

2. Table 1 below summarizes the soil strengths used in the design. Marine silt and basal sand parameters are based on H&A boring log data (H&A 2006). Overconsolidation ratio (OCR) data was assumed unreliable due to sample disturbance, so a normally consolidated OCR was applied to the Marine Silt layer. The Marine Silt was analyzed as one layer due to the reduced thickness in the upland and general soil strength and consolidation parameters observed.

Table 1: Soil Properties

Soil Parameter	General Fill	Marine Silt	Basal Sand
OCR	--	1.0	--
Modified compression index, $C_{c\varepsilon}$	--	0.253	--
Modified recompression index, $C_{r\varepsilon}$	--	0.0768	--
Moist Unit Weight, γ_m (pcf)	120	--	--
Saturated Unit Weight, γ_{sat} (pcf)	125	106	125
Submerged Unit Weight γ_{sub} (pcf)	62.6	43.7	62.6
Coefficient of Consolidation, C_v (in^2/min)	--	1.892E-02	--

3. Settlement is evaluated for three scenario profiles based on soil borings located at varying distances from the sloped shoreline (H&A 2006). The sections were selected considering the main area of interested for the precompression is along the new utility corridor to reduce any further settlements in the future which could damage new pipe installations. The pipe locations are shown in Appendix A of the Preliminary Design Report. Sections are summarized in Table 2 below and relevant soil boring locations are shown in plan view in Attachment B.

Table 2: Upland Design Sections

Analysis Section	Soil Boring ID	Area Description
Upland 01	PDGEO18	Sloped shoreline (nearshore area)
Upland 02	PDGEO17	Open space (transition area)
Upland 03	DRB10	Developable Area of OU-1

4. The sloped shoreline is assumed to have shallow grading up to a final elevation of +8 ft. NAVD 88, and the open space has a required final elevation of +8 ft. NAVD 88. At the upland limits of the developable area of OU-1 (boring DRB10), settlement is evaluated for final ground surface elevations of +11 ft. NAVD 88 and a check for potential further filling for future development to +14 ft. NAVD 88. The soil profiles and existing layer elevations are summarized in Table 3:

Table 3: Settlement Evaluation Scenarios

Fill Name	Layer Top Elevations (ft. NAVD 88)		
	PDGEO18	PDGEO17	DRB10
Fill	4	4	6
Marine Silt	-33.55	-17.25	-8.9
Basal Sand	-67	-55	-26

Slope Stability Assumptions

1. Soil layers for the slope stability analysis of the Sloped Shoreline are summarized above.

2. For the purpose of this design, estimates for the engineering properties of the soil layers were determined from engineering judgment and referenced:

    a. field standard penetration test (SPTs) resistances (N Values), also corrected to $(N_1)_{60}$, (H&A 2015)
    b. field vane shear tests (H&A 2011)
    c. laboratory test data collected during previous investigations (H&A, 2006, 2011 and 2015)

    The estimation was based on information found in Design of Sheet Pile Walls (U.S. Army Corps of Engineers. 1994) and Soil Mechanics in Engineering Practice (Terzaghi, Peck, Mesri. 1996). Boring locations for historical investigations are provided in Attachment B.

3. Due to the existing overburden load and consolidation of the Marine Silt under the existing fill in the upland, the shear strength of this layer was adjusted for upland and in water measurements. The in-water strengths are based on in-situ vane shear tests and the upland are correlated to plasticity index relations after Gardner 1977 (USACE 1994) and laboratory triaxial tests (H&A 2015).

4. The table below summarizes the soil parameters used in the slope stability analysis.

Table 4: Soil Properties

Layer	Elevation (NAVD88)	$(N_1)_{60}$	γ (moist)	γ (sat)	Φ	δ	Su (in-water / upland)
	(ft)		*(pcf)*	*(pcf)*	*(deg)*	*(deg)*	*(psf)*
Existing Fill (Upland)	+4 to -20	8 ~ 10	120	125	30	15.66	
Marine Silt (1)	-20 to -35	WOR		105	28	15.12	300 / 650
Marine Silt (2)	-35 to -50	WOR		105	30	16.20	600 / 800
Marine Silt (3)	-50 to -70	WOR		105	31	16.74	900 / 1000
Basal Sand	-70 to BOM	18		125	34	18.36	

Notes:
Bgs – below ground surface
pcf – pounds per cubic foot
deg – degrees
psf – pounds per square foot
BOM – Bottom of Model
γ - Unit weight
Φ - Angle of friction
Su – Shear Strength
δ – Drained Interface

5. Stability was analyzed to determine an adequate Factor of Safety (FOS) value for the different loading conditions. The minimum FOS values are as follows:
    a. Precompression – minimum FOS of 1.25 for temporary condition
    b. Final Grade – minimum FOS of 1.50

SETTLEMENT CALCULATIONS

All calculations are included in Attachment C. Consolidation calculations are based on Terzaghi one-dimensional consolidation equations (Terzaghi 1996). Precompression to accelerate consolidation settlement is based on equations presented in Das (Das 2006).

Initial Stress

Initial stress profile for the existing site conditions are produced based on total stress which is calculated at incremental depths from the top of the soil surface (Das, 2006):

$$\sigma_{vo} = h\gamma$$

Where:
σ_{v0} = total stress at point A (psf)
h = height from top of the soil column to point A (ft.)
γ = saturated unit weight of soil (pcf)

Porewater pressure is calculated for soil depths beneath the groundwater surface (Das, 2006):

$$u = h_a\gamma_w$$

Where:
u = porewater pressure at point A (psf)

h_a = distance between point A and the groundwater surface (ft.)
γ_w = unit weight of water (pcf)

Porewater pressure is then subtracted from total stress for values beneath the water table to calculate effective stress (σ'_{vo}). This value accounts for the buoyant forces of groundwater (Das, 2006).

$$\sigma'_{vo} = \sigma_{vo} - u$$

The initial stresses in the compressible layer, i.e. Marine Silt, are used to relate pressure increases due to filling and the resulting time-dependent consolidation of the layer due to drainage of excess pore water pressures.

Primary Consolidation

Primary consolidation is calculated for the Marine Silt layers based on the effective stresses, preconsolidation pressure, and change in pressure due to added cap material. Preconsolidation pressure is calculated using the overconsolidation ratio (OCR) (Das, 2006):

$$p'_c = \sigma'_{v0}\ x\ OCR$$

The general fill is assumed for the cap with a unit weight of 120 pcf. Initial fill height is assumed to be equal to the proposed difference in elevation. Final fill heights were raised based on cumulative consolidation calculations in order to maintain the intended final elevations post-settlement. Change in pressure due to additional fill is calculated using the following equation:

$$\Delta p = h_{cap}\gamma_{bulk,cap}$$

Consolidation settlement is calculated at each half-foot increment, and cumulative consolidation is determined using the equation for primary settlement in normally consolidated clays (Das, 2006 and Holtz, 1981):

$$S_c = C_{c\varepsilon} h \log\left(\frac{\sigma'_{v0} + \Delta p}{\sigma'_{v0}}\right)$$

Where:
S_c = primary settlement (feet)
$C_{c\varepsilon}$ = modified compression index
h = change in height (feet)
σ_{v0}' = average effective overburden pressure (psf)
Δp = increase in effective pressure (psf)

Table 5 summarizes the expected magnitude of primary consolidation for each scenario profile.

Table 5: Magnitude of Expected Consolidation

Analysis Section	Existing Ground Surface (ft. NAVD 88)	Design Final Ground Surface (ft. NAVD 88)	Total Expected Primary Consolidation (ft.)	Total Fill Required (ft.)
Upland 01	4	8	0.7	4.7
Upland 02	4	8	1.1	5.1
Upland 03 (to +11 ft. NAVD 88)	6	11	0.8	5.8
Upland 03 (to +14 ft. NAVD 88)	6	14	1.1	9.1

Secondary Consolidation

The magnitude of secondary consolidation is determined using the following equation (Das, 2006):

$$S_s = C_{\alpha\varepsilon} h \log\left(\frac{t}{t_p}\right)$$

Where:

S_s = secondary settlement (feet)
h = change in height (feet)
$C_{\alpha\varepsilon}$ = modified secondary compression index
t = design life (years): 100 years
t_p = time to end of primary consolidation (years)

The design life for the bulkhead is considered for 100 years and therefore the total magnitude of secondary compression calculated for that time period. Table 6 summarizes the estimated magnitude of secondary consolidation for each scenario profile.

Table 6: Magnitude of Estimated Secondary Consolidation

Analysis Section	Total Expected Secondary Consolidation (ft.)
Upland 01	0.42
Upland 02	0.48
Upland 03	0.22

Consolidation Time

Using an average coefficient of consolidation (C_v) obtained from lab results (H&A, 2006), consolidation times are calculated using the following equation (Das, 2006):

$$t = \frac{T_v H_{dr}^2}{C_v}$$

Where:

T_v = dimensionless time factor based off percent consolidation
H_{dr} = length of drainage path (half the distance of marine silt layer thickness for two-way drainage) (ft.)
C_v = coefficient of consolidation

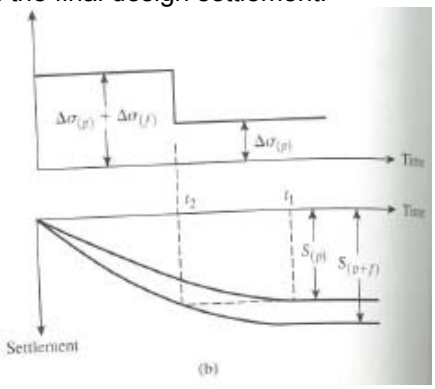
Consolidation times for each scenario profile are summarized in Table 7. The variable t_n denotes the time it takes for the soil to reach n% of its total consolidation settlement.

Table 7: Time to Consolidation (without surcharge loading)

Analysis Section	C_v (ft^2/sec)	Consolidation Time (years)			
		t_{50}	t_{90}	t_{95}	t_{99}
Upland 01	2.18933E-06	0.8	3.4	4.6	7.2
Upland 02	2.18933E-06	1.0	4.4	5.8	9.2
Upland 03 (to +11 ft. NAVD 88)	2.18933E-06	0.2	0.9	1.2	1.9
Upland 03 (to +14 ft. NAVD 88)	2.18933E-06	0.2	0.9	1.2	1.9

Precompression Surcharge

To accelerate consolidation times, surcharge loads are applied to each scenario profile. With surcharge loads, less time is needed to reach the final design settlement.



Preload stress, which is the additional stress induced by the surcharge load, is calculated based on the surcharge fill height:

$$\sigma_f = h_{surcharge}\gamma_{general\ fill,cap}$$

Percent consolidation required to reach the design settlement is calculated using the preload stress, initial design change in pressure, and the average effective overburden stress, which is taken from the initial stress profile (Das, 2006):

$$U = \frac{\log[1 + \frac{\Delta p}{\sigma'_{vo}}]}{\log\left[1 + \frac{\Delta p}{\sigma'_{vo}}\left[1 + \frac{\sigma_f}{\Delta p}\right]\right]}$$

Where:

U = percent consolidation
Δp = change in pressure due to design fill load (psf)
σ_{v0}' = average effective overburden pressure (psf)
σ_f = preload pressure (psf)

A time factor is determined based on the required percent consolidation and time to settlement of final design load can be calculated. Times to consolidation using surcharge are shown in Table 8.

Table 8: Time to Consolidation (with surcharge loading)

Analysis Section	Surcharge Fill Height (ft.)	Time to Settlement of Final Design Load (years)
Upland 01	6	1.5
Upland 02	6	2.8
Upland 03 (to +11 ft. NAVD 88)	6	1.0
Upland 03 (to +14 ft. NAVD 88)	6	1.5

SLOPE STABILITY CALCULATIONS

The global slope stability analysis for the sloped shoreline was performed using the Slope/W computer program by GeoSlope International Ltd (GeoSlope). Slope/W requires soil properties and soil strata to be input, and then determines slip surfaces with the lowest safety factor. The analysis was performed using the Spencer method, which satisfies both moment and force equilibrium. Circular searches with forced exit and entry locations were performed to evaluate failure surfaces for the developed cross sections. The limits of the exit/entry locations were varied to estimate the critical failure surface.

Analyses were conducted for drained and undrained conditions for both the temporary precompression load profile and the final upland elevation profile to find the critical failure surface and associated factor of safety.

Cross sections with their associated failure surfaces and FOS can be seen in the Slope/W results (Attachment D). A summary of the factors of safety can be seen below in Table 9.

Table 9: Analysis Results

Soil Condition	Final Slope to +11 ft	Final Slope to +14 ft	Precompression Load
	FS	FS	FS
Drained	1.543	1.543	1.539
Undrained	1.518	1.505	1.330

SUMMARY

Table 10 summarizes the consolidation settlements and times at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

Table 10: Consolidation Estimates

Analysis Section	Total Expected Primary Consolidation	Fill Height Required Without Surcharge	Time to Consolidation Without Surcharge	Time to Consolidation With Surcharge
	ft.	ft.	years	years
Upland 01	0.7	4.7	7.2	1.5
Upland 02	1.1	5.1	9.2	2.8
Upland 03 (to +11 ft. NAVD 88)	0.8	5.8	1.9	1.0
Upland 03 (to +14 ft. NAVD 88)	1.1	9.1	1.9	1.5

Attachment A

Geotechnical Laboratory Data

Summary

Haley & Aldrich 2006—Pre-Design Investigation Report

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

FORMER BLDG #15

MOBIL OIL CORPORATION
(formerly of Zinsser & Company, Inc.)

N/F UHLICH COLOR COMPANY, INC.

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

MATCHLINE - SEE FIGURE 5.4B

#22A #79A #19 #18 #17 #23 #22 #22C

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A▲▲A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1A

28612-116 D092
J:\GRAPHICS\28612\28612-116-D092.DWG

LED: "BOUNDARY AND
& 94, AR/AERL, VILLAGE OF
OUNTY, NEW YORK, SHEETS
INEERING, 330 PHILLIPS
ND REVISED ON 05/23/2005.
POINTS, CONCRETE SLABS,
G THE MONTHS OF OCTOBER

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

MATCHLINE - SEE FIGURE 5.1A

#57 #22A #79A #22B #22 #22 #22C #72A #72 #51 #51A #52

FORMER BLDG #53 FORMER BLDG #52B FORMER BLDG #54 FORMER BLDG #52A

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

N/F THE HARBOR AT HASTINGS ASSOCIATES
100 River Street

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A A A A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

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1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
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5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1B

28612-116 D093 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION		SPECIFIC GRAVITY	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	UU TRIAXIAL		CU TRIAXIAL					UNIT WEIGHT	
					BURMISTER	USCS			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					1/2 σdev	% STRAIN	1/2 σdev (lab)	1/2 σdev (corrected)	% STRAIN	σ'con	(TRX)	(K)
								(%)						(%)	(%)	(%)	(%)	(psf)		(psf)	(psf)		(psi)	(pcf)	(pcf)
JAR SAMPLES																									
PDGEO-04	4.08	S-9	47	-42.92				35.3						66.4	54.4	12									
PDGEO-09	5.94	S-12	61	-55.06				22.1						20.0	15.6	4.4									
PDGEO-13	6.26	S-5	52	-45.74				24.2						10.3	8.0	2.3									
PDGEO-15	3.93	S-6	34	-30.07				63.2						89.0	72.9	16.1									
PDGEO-15	3.93	S-7	39	-35.07				27.4						24.2	18.2	6.0									
PDGEO-18	3.95	S-7	46	-42.05				28.9						33.5	30.6	2.9									
PDGEO-20	3.99	S-10	63	-59.01				22.6						20.1	16.4	3.7									
PDGEO-24A	4.39	S-10	78	-73.61				38.1						72.3	54.6	17.7									
PDGEO-17	4.25	S-10	61	-56.75				13.3						8.2	7.2	1.0									
PDGEO-21	3.40	S-8	55	-51.6				22.2						17.1	14.7	2.4									
PDGEO-28	6.96	S-16	70	-63.04				21.4						16.2	12.5	3.7									
DIRECT PUSH TUBES																									
PDGEO-01	4.28	U-1	36	-31.72	SILT & CLAY or CLAY & SILT	CL	2.508	51.4	33	23	10	2.8		92.2	77.8	14.4	4.5	605	8.1					99	99.1
PDGEO-01	4.28	U-2	40	-35.72				50.8												734	512	12.3	10.9	102.4	
PDGEO-01	4.28	U-3	53	-48.72	SILT & CLAY	CL		47.5	27	18	9	3.3		78.8	63.6	15.2	3.0	727	15					106.7	107
PDGEO-04	4.08	U-1	37	-32.92	CLAY & SILT	CL		46.2	35	22	13	1.9		90.6	76.8	13.8	4.4			871	605	14.1	10.3	105.3	105.2
PDGEO-04	4.08	U-2	45	-40.92	SILT & CLAY	CL		37.4	26	18	8	2.4					2.3	569	15					113.4	118.1
PDGEO-05	4.31	U-1	29	-24.69	CLAY & SILT	ML		52.7	40	27	13	2.0		86.8	71.0	15.8	3.8	612	8.5					105.2	
PDGEO-05	4.31	U-2	34	-29.69				51.0												1188	832	10.7	9.9	105.5	100.2
PDGEO-07	6.08	U-1	29	-22.92	CLAY & SILT	ML		55.5	47	28	19	1.4						151	7					104.2	
PDGEO-07	6.08	U-2	34	-27.92				62.1						94.3	77.9	16.4	3.8			662	459	15	10.4	99.1	108
PDGEO-09	5.94	U-1	36	-30.06	silty CLAY	MH		58.9	51	29	22	1.4		89.9	68.9	21.0	5.3	274	9.1	828	579	15	10.1	103.8	
PDGEO-09	5.94	U-2	41	-35.06				55.4																	108.5
PDGEO-09	5.94	U-3	47	-41.06	CLAY & SILT	CL		44.0	36	22	14	1.6		84.1	68.0	16.1	3.3	619	15	1138	800	15	12.3	105.4	
PDGEO-09	5.94	U-4	51	-45.06				47.5																	
PDGEO-09	5.94	U-5	55	-49.06	SILT & CLAY	CL		37.5	29	21	8	2.1		82.7	70.2	12.5	2.5	202	11	1166	823	15	13.9	115.8	
PDGEO-16	3.48	U-1	39	-35.52	silty CLAY	MH		56.3	51	28	23	1.2		88.8	68.5	20.3	5.3	403	13					102.8	
PDGEO-17	4.25	U-1	43	-38.75	silty CLAY	MH		64.9	60	33	27	1.2		92.9	69.4	23.5	5.7			900	632	11.1	11.3	105.4	99.9
PDGEO-17	4.25	U-2	49	-44.75				39.5										104	4	1087	760	14	13	103.0	
PDGEO-17	4.25	U-3	55	-50.75	SILT & CLAY	CL-ML		52.1	28	21	7	4.4		56.9	45.2	11.7	2.6	1116	0.5					110.3	111.8
HYDRAULIC PISTON TUBES																									
PDGEO-06	4.47	U-1	30.5	-26.03	CLAY & SILT	ML		40.5	41	27	14	1.0		35.1	29.0	6.1				1015	702	15	9.1	105.5	
PDGEO-11	6.12	U-1	36	-29.88	CLAY & SILT	ML or MH		59.1	50	32	18	1.5		65.7	54.6	11.1	5.1			1174	816	15	10.2	109.2	
PDGEO-11	6.12	U-2	41	-34.88				57.5										706	8					98.3	
PDGEO-11	6.12	U-3	44	-37.88	CLAY & SILT	ML		59.2	46	29	17	1.8		92.6	78.4	14.2	4.7			1202	842	15	11.7	102.1	
PDGEO-13	6.26	U-1	45	-38.74	CLAY & SILT	CL		45.3	34	20	14	1.8		45.6	34.9	10.7	5.0	432	14					104.1	
PDGEO-13	6.26	U-2	50	-43.74				58.0												770	539	8	13.0	105.5	100.4
PDGEO-13	6.26	U-3	59	-52.74	CLAY & SILT	CL		46.9	34	20	14	1.9		54.2	39.2	15.0	1.5	835	4.8	1174	826	6	15.0		
PDGEO-19	3.96	U-1	36	-32.04	CLAY & SILT	CL		58.9	41	24	17	2.1						943	12					107.5	110.5
PDGEO-19	3.96	U-2	41	-37.04			2.514							90.1	73.9	16.2	3.8			929	642	8.8	11.8	105.5	104.5
PDGEO-19	3.96	U-3	46	-42.04	CLAY & SILT	CL		51.7	40	24	16	1.7						950	6					115.5	108.7
PDGEO-20	3.99	U-1	43	-39.01	CLAY & SILT	CL		58.0	43	24	19	1.8		89.2	67.2	22	4.6	835	5.2					105.8	106.4
PDGEO-21	3.40	U-1	26	-22.6	silty CLAY	CH		69.2	62	32	30	1.2		92.2	73.6	18.6	7.1	583	7					93.0	101.7
PDGEO-21	3.40	U-2	29	-25.6			2.346	68.7												821	573	6.1	8.4	96.2	
PDGEO-21	3.40	U-3	35	-31.6	CLAY & SILT	CL		60.8	34	23	11	3.4		92.3	74.1	18.2	2.9			979	686	15	9.6	103.1	104.4
PDGEO-21	3.40	U-4	38	-34.6				58.6										497	9					99.9	
PDGEO-21	3.40	U-5	43	-39.6	SILT & CLAY	CL		36.9	32	23	9	1.5		92.5	72.2	20.3	2.0			878	618	15	11.2	107.3	
PDGEO-21	3.40	U-6	46	-42.6				29.0																	
PDGEO-21	3.40	U-6	46	-42.6				60.1																	100.2
PDGEO-21	3.40	U-6	46	-42.6				39.1										526	5					108.4	
PDGEO-21	3.40	U-7	62	-58.6	CLAY & SILT	CL		51.6	38	21	17	1.8		89.5	69.3	20.2	1.0	1217	15						
PDGEO-22	2.67	U-1	29	-26.33				54.5										439	15					102.3	
PDGEO-22	2.67	U-2	35	-32.33	silty CLAY	MH		61.8	58	32	26	1.1		93.2	77.6	15.6	6.1			878	614	15	9.2	105.2	103.7
PDGEO-23	3.40	U-1	25	-21.6	silty CLAY	MH		63.8	70	42	28	0.8		92.8	75.2	17.6	8.1			655	454	10.8	7	105.5	96.5
PDGEO-23	3.40	U-2	31	-27.6				80.3																	

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION		SPECIFIC GRAVITY	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	UU TRIAXIAL		CU TRIAXIAL				UNIT WEIGHT	
					BURMISTER	USCS			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					1/2 σdev	% STRAIN	1/2 σdev (lab)	1/2 σdev (corrected)	% STRAIN	σ'con	(TRX)	(K)
								(%)						(%)	(%)	(%)	(%)	(psf)		(psf)	(psf)		(psi)	(pcf)	(pcf)
PDGEO-23	3.40	U-3	36	-32.6	CLAY & SILT	ML	2.566	64.7	48	30	18	1.9	0.83	94.1	80.3	13.8	4.7			821	575	5	9.2	105.5	103.9
PDGEO-24A	4.39	U-1	43	-38.61	SILT & CLAY	CL	2.610	56.7	30	21	9	4.0		85.7	72.4	13.3	3.6								103.0
PDGEO-24A	4.39	U-2	49	-44.61				47.6												1706	1178	15	13.8	110.2	
PDGEO-24A	4.39	U-3	55	-50.61	CLAY & SILT	CL		41.6	37	22	15	1.3		94.8	76.5	18.3	2.2	58	5.5					106.2	111.0
PDGEO-24A	4.39	U-4	72	-67.61				31.5												2988	2090	15	18.3	125.2	
PDGEO-24A	4.39	U-5	75	-70.61	SILT & CLAY	CL-ML		37.0	25	19	6	3.0		55.4	42.4	13	3.1	936	9	1519.2	1064	15	18.9		
PDGEO-28	6.96	U-1	38	-31.04	CLAY & SILT	CL		58.2	44	27	17	1.8		82.3	66.3	16	4.5	871	7					106	
PDGEO-28	6.96	U-2	42	-35.04				57.7												1051	728	14.1	11.9	105.5	107.1
PDGEO-28	6.96	U-3	51	-44.04	SILT & CLAY / CLAY & SILT	CL		34.6	30	20	10	1.5		75	57.0	18	2.5	504	15					116	114
PDGEO-28	6.96	U-4	58	-51.04				46.4												1872	1310	15	15.0	105.4	
PDGEO-29	6.80	U-1	43	-36.2				49.2												1066	734	13.2	12.5	101.9	
PDGEO-29	6.80	U-2	46	-39.2	CLAY & SILT	MH		65.1	52	38	14	1.9		79.1	66.4	12.7	4.8	778	12					100.0	
PDGEO-30	3.28	U-1	33	-29.72	CLAY & SILT	CL		63.5	36	22	14	3.0	1.06	55.7	44.1	11.6	4.8	900	3					101.9	105
PDGEO-30	3.28	U-2	40	-36.72				58.8										540	5	886	617	15	11.1	100.7	108.7
PDGEO-31	3.42	U-1	21	-17.58	silty CLAY	MH		78.1	64	36	28	1.5	0.84	94.8	78.6	16.2	7.2			3010	2087	12.5	6.7	105.4	93.1
PDGEO-31	3.42	U-2	26	-22.58				80.4										281	7					93.0	101.2
PDGEO-31	3.42	U-3	31	-27.58	CLAY & SILT	CL		69.3	45	27	18	2.4	0.91	93.2	77.6	15.6	4.4			634	444	15	8.7	105.5	103.4

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CONSOLIDATION PARAMETERS								HYDRAULIC CONDUCTIVITY	LABORATORY NOTES
					Corrected						Lab			
					Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	Pp (tsf)	Pp (psf)	(cm/sec)	
JAR SAMPLES														
PDGEO-04	4.08	S-9	47	-42.92										
PDGEO-09	5.94	S-12	61	-55.06										
PDGEO-13	6.26	S-5	52	-45.74										
PDGEO-15	3.93	S-6	34	-30.07										
PDGEO-15	3.93	S-7	39	-35.07										
PDGEO-18	3.95	S-7	46	-42.05										
PDGEO-20	3.99	S-10	63	-59.01										
PDGEO-24A	4.39	S-10	78	-73.61										
PDGEO-17	4.25	S-10	61	-56.75										
PDGEO-21	3.40	S-8	55	-51.6										
PDGEO-28	6.96	S-16	70	-63.04										
DIRECT PUSH TUBES														
PDGEO-01	4.28	U-1	36	-31.72									5.32E-08	
PDGEO-01	4.28	U-2	40	-35.72	1.1	2200	0.20	0.09	10.0	1.1	0.79	1580		SAMPLE CONTAINED 1 PIECE OF 7/8" GRAVEL.
PDGEO-01	4.28	U-3	53	-48.72									1.39E-07	
PDGEO-04	4.08	U-1	37	-32.92									3.26E-07	
PDGEO-04	4.08	U-2	45	-40.92	0.64	1280	0.21	0.06	11.0	0.6	1.08	2160	9.70E-05	SAMPLE HAD HIGH CONTENT OF M-F SAND AND SHELLS
PDGEO-05	4.31	U-1	29	-24.69	0.5	1000	0.245	0.04	9.5	0.6	0.45	900		SAMPLE CONTAINED LAYERS OF SMALL TO MEDIUM SIZE SHELLS; GSA COARSE FRACTION INCLUDED SAND, SHELL FRAGMENTS
PDGEO-05	4.31	U-2	34	-29.69									6.65E-07	SAMPLE HAD SHALLOW GROOVE ALONG 1 SIDE ENTIRE LENGTH, POSS. FROM SAMPLER PUSHING SHELL/STONE; WOOD CHIPS PRESENT IN CU SAMPLE
PDGEO-07	6.08	U-1	29	-22.92	0.61	1220	0.34	0.09	16.5	0.8	0.7	1400		SAMPLE CONTAINED GRAVEL, LARGE SHELLS, AND A 1/2" AIR VOID.
PDGEO-07	6.08	U-2	34	-27.92									3.87E-07	SAMPLE CONTAINED A FEW SMALL SHELLS
PDGEO-09	5.94	U-1	36	-30.06	0.81	1620	0.28	0.09	11.5	0.9	1	2000		UU SAMPLE HAD FEW LARGE SHELLS, STRESS-STRAIN CURVE ATYPICAL
PDGEO-09	5.94	U-2	41	-35.06	1.01	2020	0.22	0.06	11.0	1.0	1.1	2200	8.51E-08	
PDGEO-09	5.94	U-3	47	-41.06	2.1	4200	0.34	0.13	19.5	1.8	2.1	4200		
PDGEO-09	5.94	U-4	51	-45.06	0.21	420	0.22	0.07	15.0	0.2	1.1	2200		SAMPLE TOO WET FOR K TEST - SOIL IN "FLOWING" CONDITION
PDGEO-09	5.94	U-5	55	-49.06	1.4	2800	0.20	0.08	10.0	1.1	1.8	3600		
PDGEO-16	3.48	U-1	39	-35.52	0.9	1800	0.29	0.13	15.5	0.9	2.4	4800		CU TEST NOT PERFORMED DUE TO INSUFFICIENT QUANTITY OF ACCEPTABLE SAMPLE.
PDGEO-17	4.25	U-1	43	-38.75									2.11E-07	
PDGEO-17	4.25	U-2	49	-44.75	0.34	680	0.23	0.05	14.5	0.3	0.47	940		TRACE SHELL FRAGMENTS.
PDGEO-17	4.25	U-3	55	-50.75									5.82E-07	
HYDRAULIC PISTON TUBES														
PDGEO-06	4.47	U-1	30.5	-26.03	1.0	2000	0.26	0.07	15.5	1.3	0.53	1060		GSA COARSE PORTION INCLUDES SAND AND SHELL FRAGMENTS
PDGEO-11	6.12	U-1	36	-29.88										
PDGEO-11	6.12	U-2	41	-34.88										
PDGEO-11	6.12	U-3	44	-37.88										
PDGEO-13	6.26	U-1	45	-38.74										CONSOL TEST NOT PERFORMED DUE TO LARGE SHELL IN SAMPLE
PDGEO-13	6.26	U-2	50	-43.74									3.75E-07	SILTY, SOME FINE SHELL FRAGMENT LAYERS.
PDGEO-13	6.26	U-3	59	-52.74	0.46	920	0.42	0.05	16.5	0.3	0.67	1340		
PDGEO-19	3.96	U-1	36	-32.04	0.65	1300	0.27	0.05	7.0	0.7	1.1	2200	2.14E-07	
PDGEO-19	3.96	U-2	41	-37.04									2.18E-07	GSA COARSE FRACTION INCLUDES SAND AND SHELL FRAGMENTS
PDGEO-19	3.96	U-3	46	-42.04	0.9	1800	0.31	0.08	14.5	0.8	0.91	1820	4.35E-07	SAMPLE CONTAINED SOME SHELLS AND SMALL SANDY LENSES/LAYERS
PDGEO-20	3.99	U-1	43	-39.01									1.30E-07	
PDGEO-21	3.40	U-1	26	-22.6									2.30E-07	
PDGEO-21	3.40	U-2	29	-25.6	0.81	1620	0.29	0.07	10.5	1.07	0.72	1440		
PDGEO-21	3.40	U-3	35	-31.6									7.13E-07	
PDGEO-21	3.40	U-4	38	-34.6	0.3	600	0.21	0.04	9.0	0.32	0.28	560		
PDGEO-21	3.40	U-5	43	-39.6	0.68	1360	0.25	0.10	17.0	0.64	0.41	820		
PDGEO-21	3.40	U-6	46	-42.6										
PDGEO-21	3.40	U-6	46	-42.6									8.81E-07	
PDGEO-21	3.40	U-6	46	-42.6										
PDGEO-21	3.40	U-7	62	-58.6										CU TEST NOT PERFORMED; SAMPLE DEFORMED AS IT WAS EXTRACTED DUE TO VERY WET, SOFT, SOMEWHAT GRANULAR TEXTURE; CONSOL TEST NOT PERFORMED DUE TO SHELL IN SAMPLE
PDGEO-22	2.67	U-1	29	-26.33										UU TEST - HORIZONTAL SANDY LAYER NEAR CENTER OF SPECIMEN; INSUFFICIENT INTACT MATERIAL TO PERFORM K TEST
PDGEO-22	2.67	U-2	35	-32.33	0.79	1580	0.27	0.09	13.0	0.94	0.62	1240	1.43E-07	
PDGEO-23	3.40	U-1	25	-21.6	0.55	1100	0.25	0.09	8.5	0.90	0.41	820	1.69E-07	
PDGEO-23	3.40	U-2	31	-27.6	0.63	1260	0.21	0.10	16.5	0.85	0.45	900		UU TEST NOT PERFORMED; INSUFFICIENT TESTABLE SAMPLE RECOVERED

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CONSOLIDATION PARAMETERS								HYDRAULIC CONDUCTIVITY	LABORATORY NOTES
					Corrected						Lab			
					Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	Pp (tsf)	Pp (psf)	(cm/sec)	
PDGEO-23	3.40	U-3	36	-32.6									8.35E-07	
PDGEO-24A	4.39	U-1	43	-38.61									2.77E-07	UU TEST NOT PERFORMED; SAMPLE CONSISTED OF INTERLAYERED SHELLS AND SILT; FELL APART UPON EXTRUSION/HANDLING
PDGEO-24A	4.39	U-2	49	-44.61	0.81	1620	0.27	0.06	10.0	0.68	0.87	1740		
PDGEO-24A	4.39	U-3	55	-50.61									3.42E-07	
PDGEO-24A	4.39	U-4	72	-67.61	0.8	1600	0.11	0.07	9.0	0.48	0.55	1100		
PDGEO-24A	4.39	U-5	75	-70.61										
PDGEO-28	6.96	U-1	38	-31.04	0.62	1240	0.24	0.05	9.5	0.7	0.86	1720		
PDGEO-28	6.96	U-2	42	-35.04	1.4	2800	0.32	0.09	17.0	1.4	1.1	2200	7.53E-06	
PDGEO-28	6.96	U-3	51	-44.04	0.6	1200	0.17	0.09	12.0	0.5	0.43	860	6.38E-07	
PDGEO-28	6.96	U-4	58	-51.04	0.83	1660	0.16	0.04	7.0	0.6	1.43	2860		SANDY SILT LAYES THROUGHOUT SAMPLE. ABUNDANT SHELL FRAGMENTS.
PDGEO-29	6.80	U-1	43	-36.2	0.98	1960	0.46	0.11	19.0	0.93	1.1	2200		
PDGEO-29	6.80	U-2	46	-39.2										K TEST NOT PERFORMED DUE TO INSUFFICIENT QUANTITY OF MATERIAL RECOVERED FROM TUBE
PDGEO-30	3.28	U-1	33	-29.72	0.61	1220	0.20	0.08	9.0	0.7	1.2	2400	2.73E-07	K SAMPLE CONTAINED A FEW LARGE SHELLS.; GSA COARSE PORTION INCLUDES SAND, SHELL FRAGMENTS
PDGEO-30	3.28	U-2	40	-36.72									4.37E-07	UU SAMPLE, LAYER OF SHELLS NEAR BOTTOM
PDGEO-31	3.42	U-1	21	-17.58	0.35	700	0.35	0.12	15.0	0.6	0.48	960	1.96E-07	
PDGEO-31	3.42	U-2	26	-22.58									1.04E-07	SAMPLE DARKER IN COLOR AND CONTAINED ABUNDANT SHELLS AND FINE GRAVEL IN BOTTOM THIRD.
PDGEO-31	3.42	U-3	31	-27.58	0.4	800	0.24	0.08	15.5	0.5	0.43	860	3.75E-07	

NOTES
1. Elevations are in feet and refer to the NAVD88 datum.
2. For CU data, "lab" designation indicates raw lab data; "corrected" indicates data corrected by Haley & Aldrich to account for in situ mean effective stress. See report text for details.
3. For consolidation data, "lab" designation indicates parameters determined by lab; "corrected" indicates parameters determined by Haley & Aldrich. See report text for details.

LEGEND
LLoven - liquid limit by oven-dried method
LLair - liquid limit by air-dried method
σdev - deviator stress at failure
σ'con - effective confining stress
TRX - triaxial test
K - hydraulic conductivity test
Pp - preconsolidation pressure
CR - compression ratio (strain per log cycle stress)
RR - recompression ratio (strain per log cycle stress)
εvo - strain at in situ effective stress

Haley & Aldrich 2015—Pre-Design Investigation Report



POSTOLOWSKI, KEVIN Printed: 7/20/2015 11:39 AM Layout: FIGURE 7-1
\\DTRCOMMON\28612 HASTINGS\286\CAD\28612-286_008 AS-DRILLED TEST PITS R6.DWG

LEGEND

- PD2-GR-009 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.
- PD2-GL-001 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED ON LAND DURING PRE-DESIGN INVESTIGATION IN 2013.
- PD2-TP-2 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION IN 2014.
- PROPERTY LINE
- RAIL ROAD
- EXISTING STRUCTURES
- CONCEPTUAL LOCATION OF NORTHWEST BULKHEAD EXTENSION WALL. ALIGNMENT SHOWN IS APPROXIMATE ONLY AND SUBJECT TO CHANGE.

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
3. GRID SYSTEM IS THE NEW YORK STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAD 83, U.S. SURVEY FEET.
4. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND ARE BASED ON DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2009 AND OBTAINED FROM THE NEW YORK STATE GIS CLEARINGHOUSE (NYGIS).
5. THE BATHYMETRY CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

W S N E

0 100 200 300 400
SCALE IN FEET

DRAFT

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

LOCATION PLAN - GEOTECHNICAL BORINGS AND TEST PITS

SCALE: AS SHOWN
JULY 2015

FIGURE 3.7A

TABLE 3.7A

SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM

1 RIVER STREET

HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
																											Corrected					Lab					
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d (pcf)	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)	OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	(pcf)
PD-GL-001	7	U-3	28	-21																																113.6
PD-GL-001	7	U-3	27.45	-20.45		42.6																														
PD-GL-001	7	U-3B	27.7	-20.7	CL	45.2	40	21	19.0	1.3		65		10	3.4												2	4000	0.21	0.015	9	1.7	3400	2.32			110.4	
PD-GL-001	7	U-3	28	-21		47.1																														
PD-GL-001	7	U-3C	28.25	-21.25	CL	44.3															44.3	76.2	1460	965	8.7	12.7								110		
PD-GL-001	7	U-4	36	-29																																116
PD-GL-001	7	U-4A	35.2	-28.2	CL	31.1															31.1	87.0	1040	694	6.3	14.7								114.1		
PD-GL-001	7	U-4B	35.6	-28.6	CH	55	60	30	30.0	0.8		87.7		19													2	4000	0.23	0.026	3	2	4000	1.98			105.3	
PD-GL-001	7	U-5	43	-36																																120.6
PD-GL-001	7	U-5	42.25	-35.25		39.8																														
PD-GL-001	7	U-5	42.8	-35.8		24.8																														
PD-GL-001	7	U-5	43.05	-36.05	SC	25.8															25.8	100.2	1580	1086	15	16.6								126		
PD-GL-001	7	U-5	43.35	-36.35		33.8																														
PD-GL-001	7	U-5C	43.6	-36.6	CL	36.2	43	23	20.0	0.7		69.4		18													1.7	3400	0.21	0.028	6	1.5	3000	1.41			108.2	
PD-GL-002	7	U-4	39	-32																																101.9
PD-GL-002	7	U-4	38.55	-31.55		50.8																														
PD-GL-002	7	U-4B	38.8	-31.8	CH	52.1	62	28	34.0	0.7		87		17	3												1.1	2200	0.21	0.019	7	1.1	2200	1.03			106.8	
PD-GL-002	7	U-4	39.1	-32.1		58.4																														
PD-GL-002	7	U-4	39.35	-32.35	CH	61.7															61.7	63.1	1010	661	12.7	15.8								102.1		
PD2-GR-001	-10.9	U-1	11.5	-22.4																																91.9
PD2-GR-001	-10.9	U-1	10.75	-21.65		67.1																														
PD2-GR-001	-10.9	U-1A	11	-21.9	MH	80.8															80.8	50.2	180	111	8.7	3.0								90.7		
PD2-GR-001	-10.9	U-1	11.3	-22.2		71.5																														
PD2-GR-001	-10.9	U-1B	11.55	-22.45	MH	70.8	66	37	29.0	1.2	0.8	93.2		26													0.7	1400	0.31	0.027	4	0.4	800	1.27			94	
PD2-GR-001	-10.9	U-3	26.5	-37.4																																99
PD2-GR-001	-10.9	U-3	25.8	-36.7		67.4																														
PD2-GR-001	-10.9	U-3A	26.05	-36.95	ML	60.3										60.3	62.6	1500	500	0.33														100.4			
PD2-GR-001	-10.9	U-3	26.35	-37.25		58.4																														
PD2-GR-001	-10.9	U-3B	26.6	-37.5	ML	65.3															65.3	60.4	540	357	5.3	6.9								99.9		
PD2-GR-001	-10.9	U-3	26.9	-37.8		67.5																														
PD2-GR-001	-10.9	U-3C	27.15	-38.05	ML	57.4	44	27	17.0	1.8	1.0	92.8		17													0.7	1400	0.22	0.014	4	0.7	1400	0.86			103.5	
PD2-GR-001	-10.9	U-4	36.5	-47.4																																105
PD2-GR-001	-10.9	U-4	35.7	-46.6		50.1																														
PD2-GR-001	-10.9	U-4	36.25	-47.15		54.3																														
PD2-GR-001	-10.9	U-4B	36.5	-47.4	CH	60															60	63.1	870	578	13.1	9.5								100.9		
PD2-GR-001	-10.9	U-4	36.8	-47.7		54.2																														
PD2-GR-001	-10.9	U-4C	37.05	-47.95	CH	66.4	50	23	27.0	1.6		66.9		13													1.2	2400	0.42	0.016	3	0.8	1600	1.23			99.4	
PD2-GR-001	-10.9	U-5	46.5	-57.4																																115.5
PD2-GR-001	-10.9	U-5	45.75	-56.65		61.1																														
PD2-GR-001	-10.9	U-5A	46	-56.9	CL	54.4	47	23	24.0	1.3		66.9		17													1.5	3000	0.23	0.017	9	0.9	1800	1.25			105.1	
PD2-GR-001	-10.9	U-5	46.3	-57.2		31.7																														
PD2-GR-001	-10.9	U-5B	46.55	-57.45	SM	32.4															32.4	87.5	1800	1281	15	12.1								115.9		
PD2-GR-001	-10.9	U-5	46.85	-57.75		31.8																														
PD2-GR-002A	-24.3	U-5	37	-61.3																																90.4
PD2-GR-002A	-24.3	U-5	36.5	-60.8	CL	58.7															58.7	65.0	640	428	4.1	9.7								103.1		
PD2-GR-002A	-24.3	U-5	36.8	-61.1		65.1																														
PD2-GR-002A	-24.3	U-5	37.05	-61.35	CL	53.8										53.8	67.0	2090	520	0.25														103.1			
PD2-GR-002A	-24.3	U-5	37.35	-61.65		60																														
PD2-GR-002A	-24.3	U-5	37.6	-61.9	CL	56.7	30	18	12	3.2		70.6		21													0.7	1400	0.2	0.015	8	0.7	1400	0.88			106.2	
PD2-GR-002A	-24.3	U-7	57	-81.3																																117.8
PD2-GR-002A	-24.3	U-7	56.35	-80.65		29.7																														
PD2-GR-002A	-24.3	U-7	56.9	-81.2		25.6																														
PD2-GR-002A	-24.3	U-7	57.15	-81.45	CL	27.8															27.8	94.6	880	637	4.5	14.9								120.9		
PD2-GR-002A	-24.3	U-7	57.45	-81.75		29.9																														
PD2-GR-002A	-24.3	U-7	57.7	-82	CL	33.4	44	19	25	0.6	0.8	63.6		20													1.7	3400	0.2	0.007	4	1.4	2800	1.11			117.3	
PD2-GR-003	-27.7	U-2	13.5	-41.2																																105.3
PD2-GR-003	-27.7	U-2	12.85	-40.55		59.2																														
PD2-GR-003	-27.7	U-2B	13.1	-40.8	OH	44.1															44.4	79.1	220	155	9.3	3.5								114.2		
PD2-GR-003	-27.7	U-2	13.4	-41.1		68.7																														
PD2-GR-003	-27.7	U-2C	13.65	-41.35	OH	76.7	53	26	27.0	1.9	0.7	68.7		10													0.7	1400	0.3	0.033	4	0.6	1200	3.32			94.9	
PD2-GR-003	-27.7	U-3	23.5	-51.2																																101.1
PD2-GR-003	-27.7	U-3	22.8	-50.5		59.6																														
PD2-GR-003	-27.7	U-3B	23.05	-50.75	CH	57.5															57.5	64.4	400	266	6.2	6.1								101.4		
PD2-GR-003	-27.7	U-3	23.35	-51.05		39.4																														
PD2-GR-003	-27.7	U-3	23.45	-51.15	CH	66.9										66.9	58.8	1330	360	0.27														98.2			
PD2-GR-003	-27.7	U-3C	23.6	-51.3	CH	57.9	54	23	31.0	1.1	0.8	82.8		16													0.75	1500	0.28	0.023	5	0.8	1600	1.61			103.6	
PD2-GR-003	-27.7	U-5	48.5	-76.2																																110.6
PD2-GR-003	-27.7	U-5	48.05	-75.75		52.7																														
PD2-GR-003	-27.7	U-5B	48.3	-76	ML	47.2	41	26	15.0	1.4	0.8										47.2	72.5	820	560	11.4	12.7								106.7		
PD2-GR-003	-27.7	U-5	48.6	-76.3		25.2																														
PD2-GR-003	-27.7	U-5C	48.85	-76.55	ML	40.6						57.3		13													1.5	3000	0.17	0.010	6	1.2	2400	1.30			111.4	
PD2-GR-004	-9.8	U-1	9	-18.8																																92.2
PD2-GR-004	-9.8	U-1	8.2	-18		79.7																														
PD2-GR-004	-9.8	U-1	8.45	-18.25	CH	88.1										88.1	48.3	510	180	0.35														90.9			
PD2-GR-004	-9.8	U-1	8.7	-18.5		83.7																														
PD2-GR-004	-9.8	U-1	8.95	-18.75	CH	77.7															77.7	53.5	250	160	9.8	2.4								95		
PD2-GR-004	-9.8	U-1	9.3	-19.1		70.1																														
PD2-GR-004	-9.8	U-1	9.55	-19.35	CH	75.9	85	33	52	0.8	0.78	95.8		23													0.4	800	0.25	0.023	4	0.5	1000	2.88			93.1	
PD2-GR-004	-9.8	U-2	19	-28.8																																95
PD2-GR-004	-9.8	U-2	18.4	-28.2		79.8																														
PD2-GR-004	-9.8	U-2	18.65	-28.45	CH	82										82	51.2	1090	360	0.33														93.1			
PD2-GR-004	-9.8	U-2	18.95	-28.75		84.3																														
PD2-GR-004	-9.8	U-2	19.2	-29	CH	78.2															78.2	53.0	390	250	7	4.9								94.4		
PD2-GR-004	-9.8	U-2	19.5	-29.3		65.6																														
PD2-GR-004	-9.8	U-2	19.75	-29.55	CH	65.1	57	28	29	1.3	0.81	85.2		14													0.45	900	0.25	0.014	4	0.6	1200	1.27			100	
PD2-GR-004	-9.8	U-3	30	-39.8																																98.5
PD2-GR-004	-9.8	U-3	28.25	-38.05		66.6																														
PD2-GR-004	-9.8	U-3	28.8	-38.6		58.8																														
PD2-GR-004	-9.8	U-3	29.05	-38.85	CH	63.8	56	29	27	1.3		78.3		15																							
PD2-GR-004	-9.8	U-3	29.35	-39.15		72.4																														
PD2-GR-004	-9.8	U-5	44	-53.8																																120.3
PD2-GR-004	-9.8	U-5	43.2	-53		39.3																														
PD2-GR-004	-9.8	U-5	43.75	-53.55		33.1																														
PD2-GR-004	-9.8	U-5	44	-53.8	SP-SC	49.4	25	17	8	4.1		10.8		1																							
PD2-GR-004	-9.8	U-6	54	-63.8																																102.2
PD2-GR-004	-9.8	U-6	53.35	-63.15		47.5																														
PD2-GR-004	-9.8	U-6	53.9	-63.7		53.1																														
PD2-GR-004	-9.8	U-6	54.15	-63.95	CL	51.1															51.1	70.2	800	546	4.5	14.1								106		

TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
																											Corrected					Lab					
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress	Su/p	w% initial	ρ_d initial	1/2 sdev (lab)	1/2 sdev (corrected)	% STRAIN	σ'con	Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)	OCR	DSS	CU TRX	Consol	
						(%)						(%)	(%)	(%)	(%)	initial	(pcf)		(psf)		initial	(pcf)	(psf)	(psf)		(psi)								(pcf)	(pcf)	(pcf)	(pcf)
PD2-GR-005	-22.4	U-1	8.75	-31.15		73.2																														
PD2-GR-005	-22.4	U-1	9	-31.4	OH	79.8															79.8	53.4	210	136	4.4	2.4								96.1		
PD2-GR-005	-22.4	U-1	9.3	-31.7		87.8																														
PD2-GR-005	-22.4	U-1	9.55	-31.95	OH	102.5	68	32	36	2.0	0.59	90		20												0.2	400	0.3	0.031	3	0.2	400	1.54			91.2	
PD2-GR-005	-22.4	U-2	20	-42.4																																107.4
PD2-GR-005	-22.4	U-2	19.6	-42		57.2																														
PD2-GR-005	-22.4	U-2	20.15	-42.55		58.1																														
PD2-GR-005	-22.4	U-2	20.4	-42.8	CL	57.1	40	21	19	1.9	1.03	92.3		17																						
PD2-GR-005	-22.4	U-3	30	-52.4																																102.1
PD2-GR-005	-22.4	U-3	29.3	-51.7		62.7																														
PD2-GR-005	-22.4	U-3	29.85	-52.25		66.2																														
PD2-GR-005	-22.4	U-3	30.4	-52.8		50.3																														
PD2-GR-005	-22.4	U-3	30.65	-53.05	CH	81.7	60	27	33	1.7		95.1		23																						
PD2-GR-005	-22.4	U-4	40	-62.4																																
PD2-GR-005	-22.4	U-4	39.25	-61.65		21																														121.8
PD2-GR-005	-22.4	U-4	39.5	-61.9	SC	26.7															26.7	97.7	2335	1705	15	10.4								123.8		
PD2-GR-005	-22.4	U-4	39.8	-62.2		21.4																														
PD2-GR-005	-22.4	U-4	40.05	-62.45	CL	36.1	35	16	19	1.1		55.9		7												1.3	2600	0.12	0.005	4	1	2000	1.32			113.1	
PD2-GR-005	-22.4	U-5	50	-72.4																																102.3
PD2-GR-005	-22.4	U-5	49.55	-71.95		59.8																														
PD2-GR-005	-22.4	U-5	50.1	-72.5		53.2																														
PD2-GR-005	-22.4	U-5	50.35	-72.75	CH	45.3	53	27	26	0.7		92.4		29																						
PD2-GR-006	-4.9	U-1	8	-12.9																																92.9
PD2-GR-006	-4.9	U-1	7.6	-12.5		85.9																														
PD2-GR-006	-4.9	U-1	7.85	-12.75	MH	82.1															82.1	50.7	210	132	7.1	2.1								92.3		
PD2-GR-006	-4.9	U-1	8.15	-13.05		89.3																														
PD2-GR-006	-4.9	U-1	8.3	-13.2	MH	93.3										93.3	46.5	450	160	0.36														89.9			
PD2-GR-006	-4.9	U-1	8.5	-13.4	MH	93.8	80	40	40	1.3	0.78	92		28												0.23	460	0.27	0.043	2	0.4	800	2.08			90	
PD2-GR-006	-4.9	U-2	18	-22.9																																90.6
PD2-GR-006	-4.9	U-2	17.65	-22.55		78																														
PD2-GR-006	-4.9	U-2	17.9	-22.8	CH	84.2	89	33	56	0.9		95.9		27																						
PD2-GR-006	-4.9	U-3	28	-32.9																																99.2
PD2-GR-006	-4.9	U-3	27.4	-32.3		68.3																														
PD2-GR-006	-4.9	U-3	27.65	-32.55	MH	66															66	60.2	500	330	15	7.3								99.9		
PD2-GR-006	-4.9	U-3	27.95	-32.85		50.8																														
PD2-GR-006	-4.9	U-3	28.2	-33.1	MH	66.5	56	30	26	1.4	0.79	93.1		17												0.7	1400	0.29	0.018	4	0.7	1400	1.37			100.3	
PD2-GR-006	-4.9	U-3	28.5	-33.4		67.2																														
PD2-GR-006	-4.9	U-3	28.75	-33.65	MH	65.3										65.3	59.8	1580	470	0.30														98.8			
PD2-GR-006	-4.9	U-5	43	-47.9																																104.9
PD2-GR-006	-4.9	U-5	42.35	-47.25		44.2																														
PD2-GR-006	-4.9	U-5	42.6	-47.5	CL	54															54	69.1	710	484	10	11.2								106.4		
PD2-GR-006	-4.9	U-5	42.9	-47.8		68.3																														
PD2-GR-006	-4.9	U-5	43	-47.9	CL	55.8										55.8	66.1	2430	680	0.28														103			
PD2-GR-006	-4.9	U-5	43.2	-48.1	CL	50.1	48	27	21	1.1		90.1		18												0.95	1900	0.23	0.007	6	0.8	1600	1.04		106.3		
PD2-GR-006	-4.9	U-6	53	-57.9																																112.1
PD2-GR-006	-4.9	U-6	52.7	-57.6		32.5																														
PD2-GR-006	-4.9	U-6	52.95	-57.85	SC	28.9										28.9	95.0	2990	970	0.32														122.5			
PD2-GR-006	-4.9	U-6	53.25	-58.15		28																														
PD2-GR-006	-4.9	U-6	53.5	-58.4	SC	34.9	32	21	11	1.3		30.6		6												1.7	3400	0.17	0.003	6	1.6	3200	1.19			117.6	
PD2-GR-006	-4.9	U-7	63	-67.9																																107.7
PD2-GR-006	-4.9	U-7	62.3	-67.2		55.4																														
PD2-GR-006	-4.9	U-7	62.55	-67.45	CL	54.9										54.9	67.1	3540	810	0.23														104			
PD2-GR-006	-4.9	U-7	62.85	-67.75		44.8																														
PD2-GR-006	-4.9	U-7	63.1	-68	CL	49.6															49.6	72.6	990	683	5.6	16.5								108.6		
PD2-GR-006	-4.9	U-7	63.4	-68.3		50.7																														
PD2-GR-006	-4.9	U-7	63.65	-68.55	CL	43.8	41	22	19	1.1		87.8		18												2	4000	0.18	0.010	5	1.7	3400	1.36			110.2	
PD2-GR-007	-22.8	U-1	9	-31.8																																102.1
PD2-GR-007	-22.8	U-1	8.2	-31		74																														
PD2-GR-007	-22.8	U-1A	8.45	-31.25	CH	55.3										55.3	66.1	420	200	0.48														102.6			
PD2-GR-007	-22.8	U-1	8.75	-31.55		76.3																														
PD2-GR-007	-22.8	U-1	8.95	-31.75	CH	65.6	51	25	26.0	1.6	0.8	93.8		14												0.23	460	0.22	0.023	4	0.3	600	1.53			97.6	
PD2-GR-007	-22.8	U-2	19	-41.8																																101
PD2-GR-007	-22.8	U-2	18.2	-41		87.9																														
PD2-GR-007	-22.8	U-2	18.7	-41.5		66.5																														
PD2-GR-007	-22.8	U-2	19.25	-42.05		79.8																														
PD2-GR-007	-22.8	U-2C	19.55	-42.35	OH		61	30	31.0		0.6	86.5		12																						
PD2-GR-007	-22.8	U-3	29	-51.8																																105.5
PD2-GR-007	-22.8	U-3A	28.25	-51.05	OH	69.2	65	30	35.0	1.1	0.7	98.9		79																						
PD2-GR-007	-22.8	U-3	28.55	-51.35		74.5																														
PD2-GR-007	-22.8	U-3B	28.8	-51.6	OH	63.5																				0.7	1400	0.27	0.017	6	0.7	1400	1.36			99.8	
PD2-GR-007	-22.8	U-3	29.1	-51.9		41																														
PD2-GR-007	-22.8	U-3C	29.35	-52.15	SP-SM/OH	34.1															34.1	81.0	700	484	15	7.6								108.6		
PD2-GR-007	-22.8	U-4	38.85	-61.65		55.3																														
PD2-GR-007	-22.8	U-4B	39.1	-61.9	CL	55.6										55.6	66.1	2200	550	0.25														102.9			
PD2-GR-007	-22.8	U-4	39.4	-62.2		47.9																														
PD2-GR-007	-22.8	U-4	39.65	-62.45	CL	75.5	42	23	19.0	2.8	1.0	78.6		20												0.8	1600	0.31	0.030	4	0.7	1400	1.23			96.7	
PD2-GR-008	-19.3	U-1	8	-27.3																																91.7
PD2-GR-008	-19.3	U-1	7.15	-26.45		83.6																														
PD2-GR-008	-19.3	U-1A	7.4	-26.7	OH	76.6	82	33	49.0	0.9	0.6	84.6		12												0.3	600	0.26	0.015	7	0.2	400	2.53			96.1	
PD2-GR-008	-19.3	U-1	7.7	-27		88.5																														
PD2-GR-008	-19.3	U-1B	7.95	-27.25	OH	84.9															84.9	50.0	160	101	5.5	2.1								92.4		
PD2-GR-008	-19.3	U-1	8.25	-27.55		91.9																														
PD2-GR-008	-19.3	U-1C	8.5	-27.8	OH	86.7										86.7	49.2	450	140	0.31														91.8			
PD2-GR-008	-19.3	U-2	18	-37.3																																97.6
PD2-GR-008	-19.3	U-2	17.7	-37		81.2																														
PD2-GR-008	-19.3	U-2B	17.95	-37.25	OH	89.3										89.3	48.1	1010	280	0.28														91.1			
PD2-GR-008	-19.3	U-2	18.25	-37.55		61.8																														
PD2-GR-008	-19.3	U-2	18.55	-37.85	OL	36.2	46	26	20.0	0.5	0.7	88.3		19												2	4000	0.13	0.008	1	3.4	6800	4.30			114.1	
PD2-GR-008	-19.3	U-3	28	-47.3																																105.1
PD2-GR-008	-19.3	U-3	27.4	-46.7		69.5																														
PD2-GR-008	-19.3	U-3	27.95	-47.25		55.5																														
PD2-GR-008	-19.3	U-3	28.2	-47.5	CL	51.8										51.8	69.4	1580	350	0.22														105.3			
PD2-GR-008	-19.3	U-3	28.5	-47.8		67.1																														
PD2-GR-008	-19.3	U-3	28.8	-48.1	CL	64.5	49	23	26	1.6		92.8		16												0.6	1200	0.25	0.017	3	0.6	1200	1.11			101.5	
PD2-GR-008	-19.3	U-4	38	-57.3																																101.7
PD2-GR-008	-19.3	U-4	37.2	-56.5		61.4																														
PD2-GR-008	-19.3	U-4	37.75	-57.05		45.5																														
PD2-GR-008	-19.3	U-4	38.3	-57.6		52.3																														

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TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

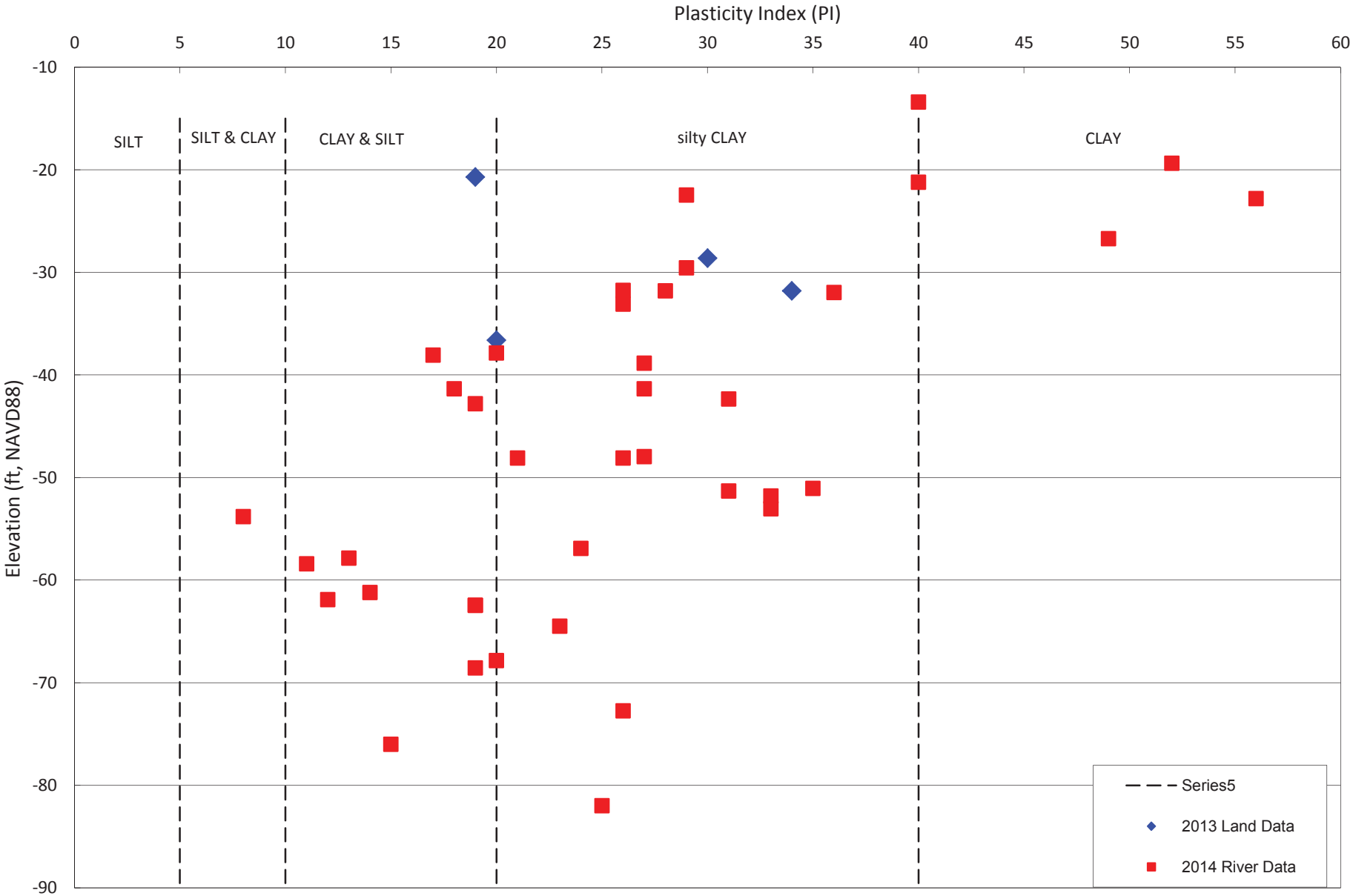
BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Corrected					Lab		OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	
																	(pcf)										Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)					
						(%)						(%)	(%)	(%)	(%)																						
PD2-GR-008	-19.3	U-5	48.3	-67.6		58.5																														
PD2-GR-008	-19.3	U-5C	48.55	-67.85	ML	57.7	49	29	20	1.4		94		23																						
PD2-GR-009	-14.2	U-1	7	-21.2																																93.3
PD2-GR-009	-14.2	U-1A	6.45	-20.65	OH	74.8															74.8	53.8	130	82	12.3	1.8									94.1		
PD2-GR-009	-14.2	U-1	6.75	-20.95		76.8																														
PD2-GR-009	-14.2	U-1B	7	-21.2	OH	76.2	72	32	40	1.1	0.74	95.4		27													0.55	1100	0.29	0.035	2	0.5	1000	5.19			94.3	
PD2-GR-009	-14.2	U-1	7.25	-21.45		68.3																														
PD2-GR-009	-14.2	U-1C	7.5	-21.7	OH	77.8										77.8	52.2	400	170	0.43														92.8			
PD2-GR-009	-14.2	U-2	17	-31.2																																100.1
PD2-GR-009	-14.2	U-2	16.25	-30.45		49.3																														
PD2-GR-010	-14.2	U-3	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	17.35	-31.55		64.1																														
PD2-GR-009	-14.2	U-2C	17.6	-31.8	OH	63.3	66	38	28	0.9	0.67	81.9		4																						
PD2-GR-009	-14.2	U-3	27	-41.2																																105.1
PD2-GR-009	-14.2	U-3	26.35	-40.55		68																														
PD2-GR-009	-14.2	U-3	26.9	-41.1		51.4																														
PD2-GR-009	-14.2	U-3	27.15	-41.35	CL	60.3	39	21	18	2.2	0.9	94.8		15		60.3	62.6	1520	420	0.28														100.4			
PD2-GR-009	-14.2	U-3	27.3	-41.5	CL	57.5																					0.7	1400	0.23	0.023	4	0.7	1400	1.41		100.3	
PD2-GR-009	-14.2	U-3	27.45	-41.65		48.8																														
PD2-GR-009	-14.2	U-3C	27.7	-41.9	CL	41.4															41.4	81.7	500	356	7.9	7.1									115.5		
PD2-GR-009	-14.2	U-4	37	-51.2																																103.4
PD2-GR-009	-14.2	U-4	36.25	-50.45		65																														
PD2-GR-009	-14.2	U-4	36.8	-51		57.7																														
PD2-GR-009	-14.2	U-4	37.05	-51.25	CH	57.3										57.3	64.5	2090	540	0.26														101.4			
PD2-GR-009	-14.2	U-4	37.35	-51.55		49																														
PD2-GR-009	-14.2	U-4C	37.6	-51.8	CH	70.1	65	32	33	1.2		83.4		14													1.2	2400	0.35	0.027	3	1	2000	1.84		98.6	
PD2-GR-009	-14.2	U-5	47	-61.2																																109.8
PD2-GR-009	-14.2	U-5	46.2	-60.4		28.4																														
PD2-GR-009	-14.2	U-5	46.75	-60.95		45.4																														
PD2-GR-009	-14.2	U-5	47	-61.2	CL		38	24	14																											
PD2-GR-009	-14.2	U-5	47.55	-61.75		43.4																														
PD2-GR-009	-14.2	U-5B	48	-62.2	CL	49.1						83.1		14																						

Notes:
1. Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88).

Legend:
LL_{oven} = liquid limit by oven-dried method
LL_{air} = liquid limit by air-dried method
σ_{dev} = deviator stress at failure
$\sigma'_{confined}$ = effective confining stress
CU TRX = consolidated undrained triaxial test
ε_{vo} - strain at in-situ effective stress
CR = compression ratio (strain per log cycle stress)
RR = recompression ratio (strain per log cycle stress)
Pp = preconsolidation pressure

1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7D
PLASTICITY INDEX VERSUS ELEVATION IN MARINE SILT STRATUM
and CORRESPONDING BURMISTER CLASSIFICATION



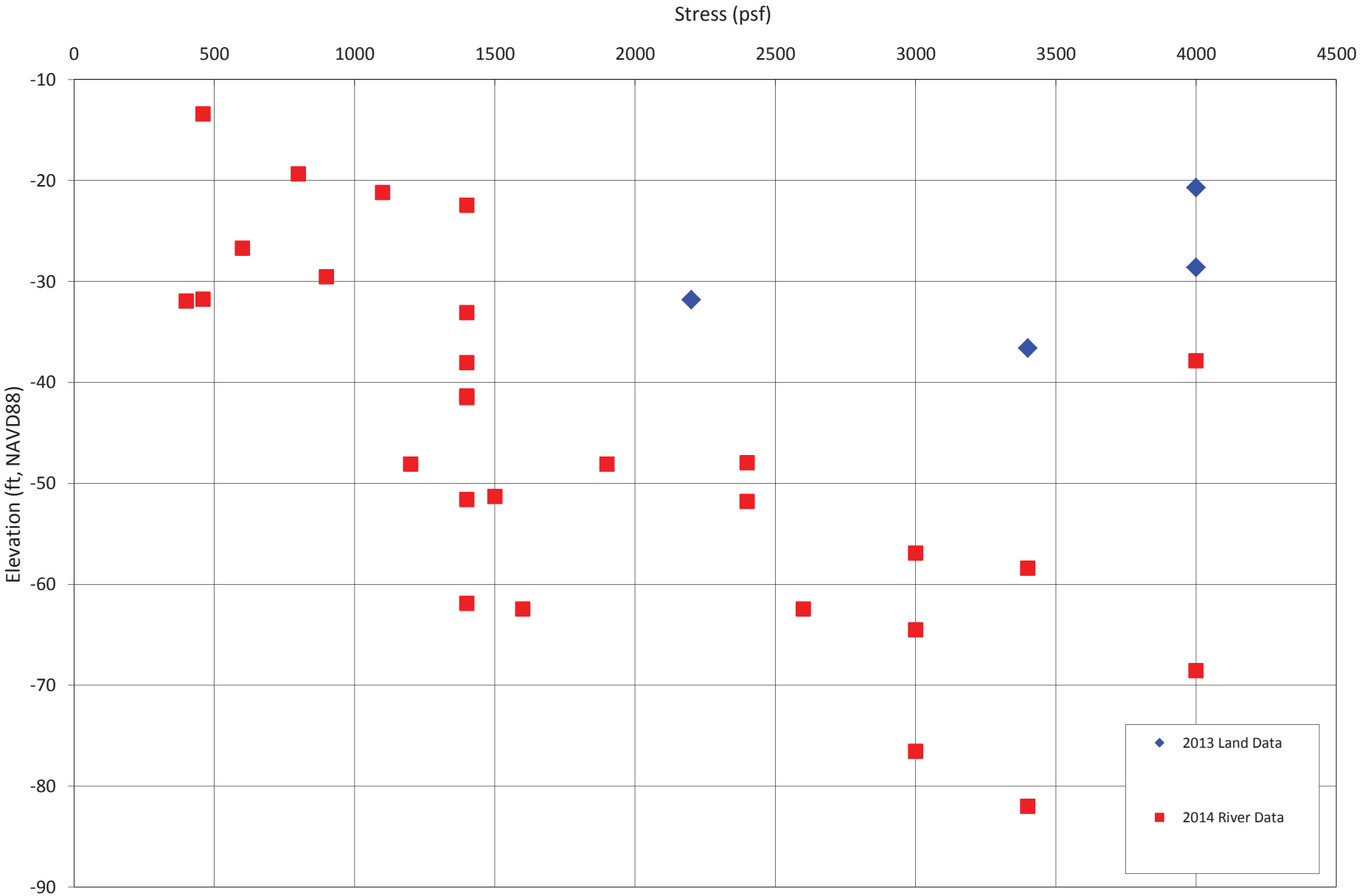
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Prepared by Haley & Aldrich

Printed on 8/7/2015

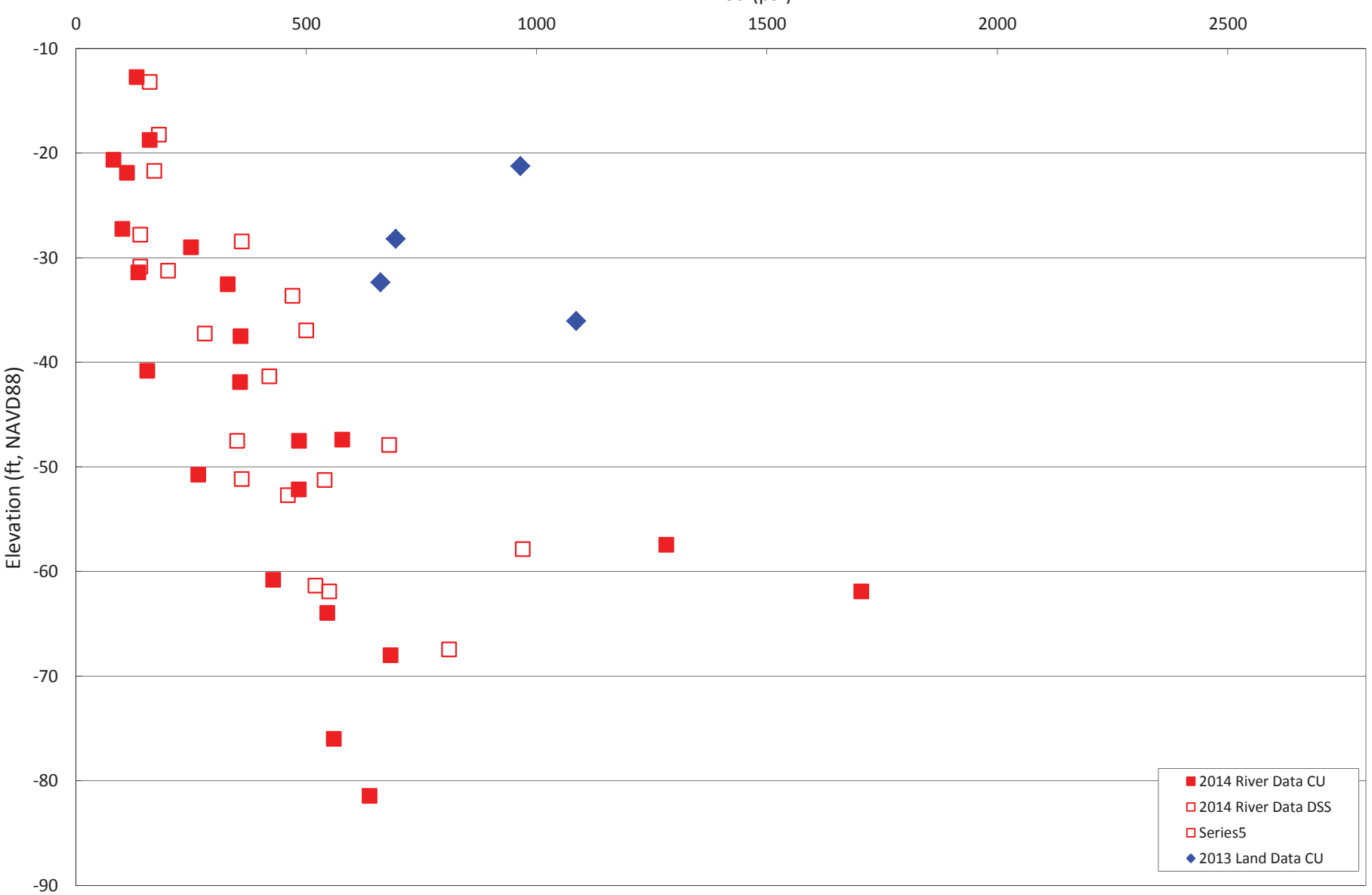
1 River Street
Hastings-on-Hudson, New York

FIGURE 3.7G
PRECONSOLIDATION PRESSURE VERSUS ELEVATION IN MARINE SILT STRATUM



G:\28612\329 - 2014 PD2-GR borings\Lab Test Data\For 2015 PDI Data Report\2015-0701-HAI-Hastings-Geotechnical Laboratory Testing Results Plots from 2013-2014 Explorations-D4.xls
.
Prepared by Haley & Aldrich
Printed on 8/7/2015

FIGURE 3.7J
UNDRAINED SHEAR STRENGTH VERSUS ELEVATION IN MARINE SILT STRATUM
FROM TRIAXIAL CONSOLIDATED UNDRAINED (CU) OR DIRECT SIMPLE SHEAR (DSS)



G:\28612\329 - 2014 PD2-GR borings\Lab Test Data\For 2015 PDI Data Report\2015-0701-HAI-Hastings-Geotechnical Laboratory Testing Results Plots from 2013-2014 Explorations-D4.xls

Prepared by Haley & Aldrich

Printed on 8/7/2015

Attachment B

Soil Profile Evaluation

Locations

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

FORMER BLDG #15

MOBIL OIL CORPORATION
(formerly of Zinsser & Company, Inc.)

N/F UHLICH COLOR COMPANY, INC.

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

MATCHLINE - SEE FIGURE 5.4B

#22A #79A #19 #18 #17 #23 #22 #22C

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A▲▲A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1A

28612-116 D092
J:\GRAPHICS\28612\28612-116-D092.DWG

LED: "BOUNDARY AND
& 94, AR/AERL, VILLAGE OF
OUNTY, NEW YORK, SHEETS
INEERING, 330 PHILLIPS
ND REVISED ON 05/23/2005.
POINTS, CONCRETE SLABS,
G THE MONTHS OF OCTOBER

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

MATCHLINE - SEE FIGURE 5.1A

#22A #22B #22C #22 #22 #79A #57 #51 #51A #72A #72 #52

FORMER BLDG #52B FORMER BLDG #52A FORMER BLDG #53 FORMER BLDG #54

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

N/F THE HARBOR AT HASTINGS ASSOCIATES
100 River Street

LEGEND:

PDGEO–02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION

PDMW–06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION

PDTP–06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION

GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.

A A A A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
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5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

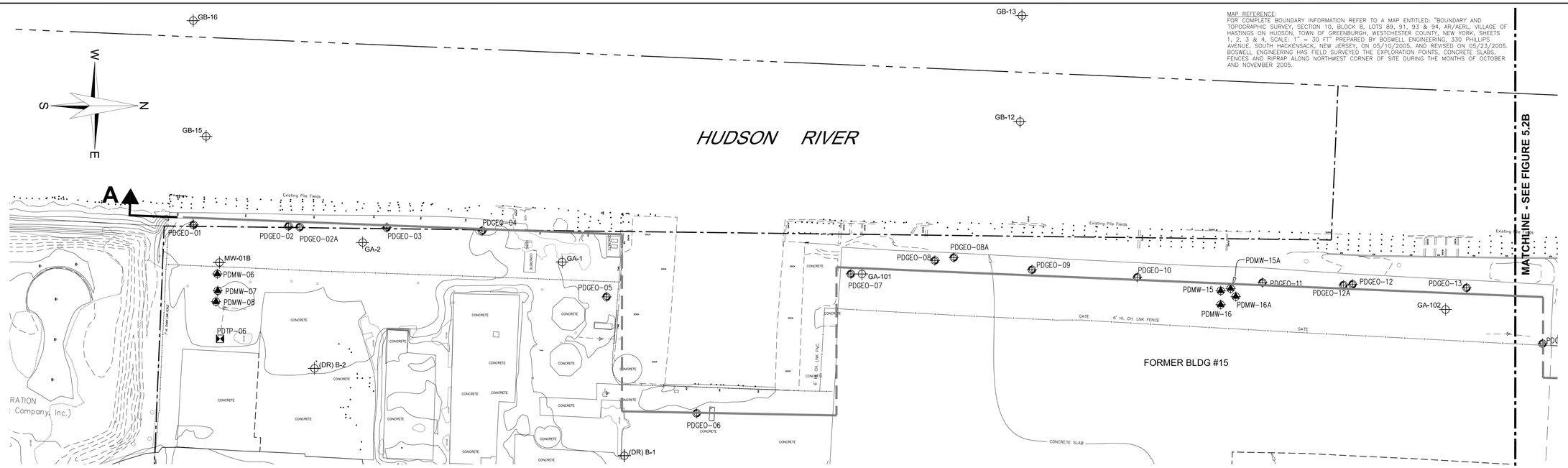
SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

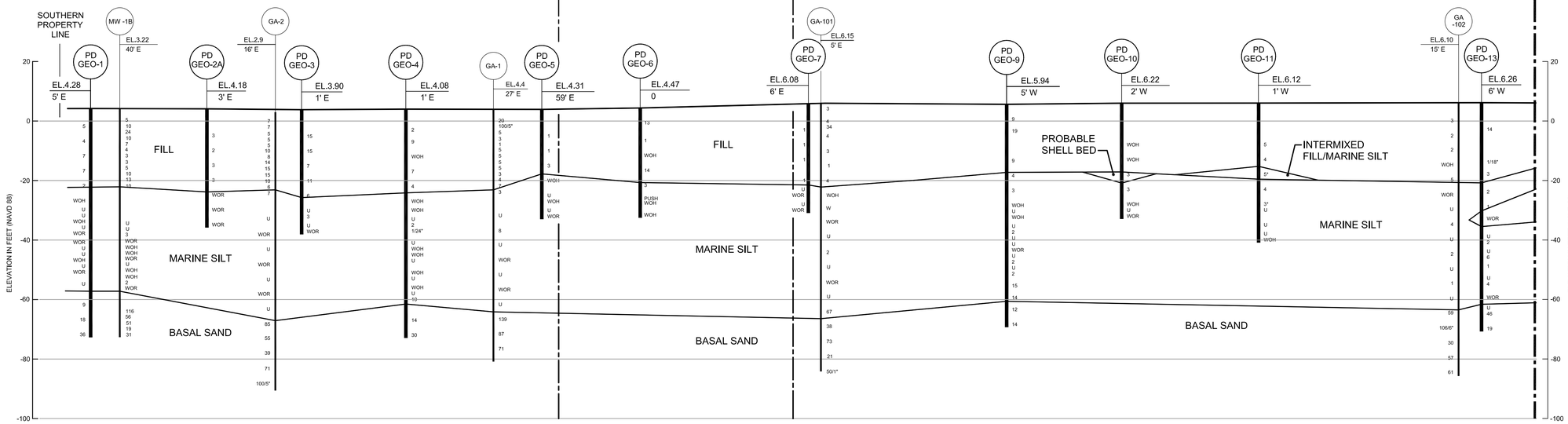
SCALE: AS SHOWN
JULY 2006

FIGURE D5.1B

28612-116 D093 (D092)
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MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.





PROFILE A-A

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

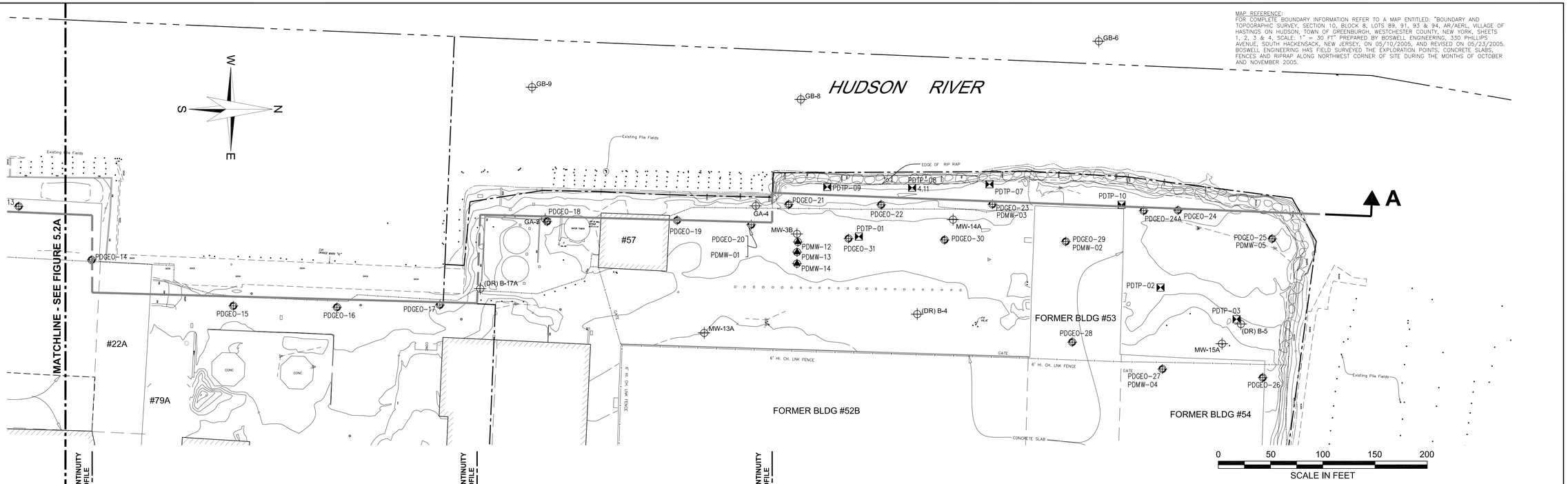
SITE PLAN AND GEOTECHNICAL SUBSURFACE PROFILE A-A

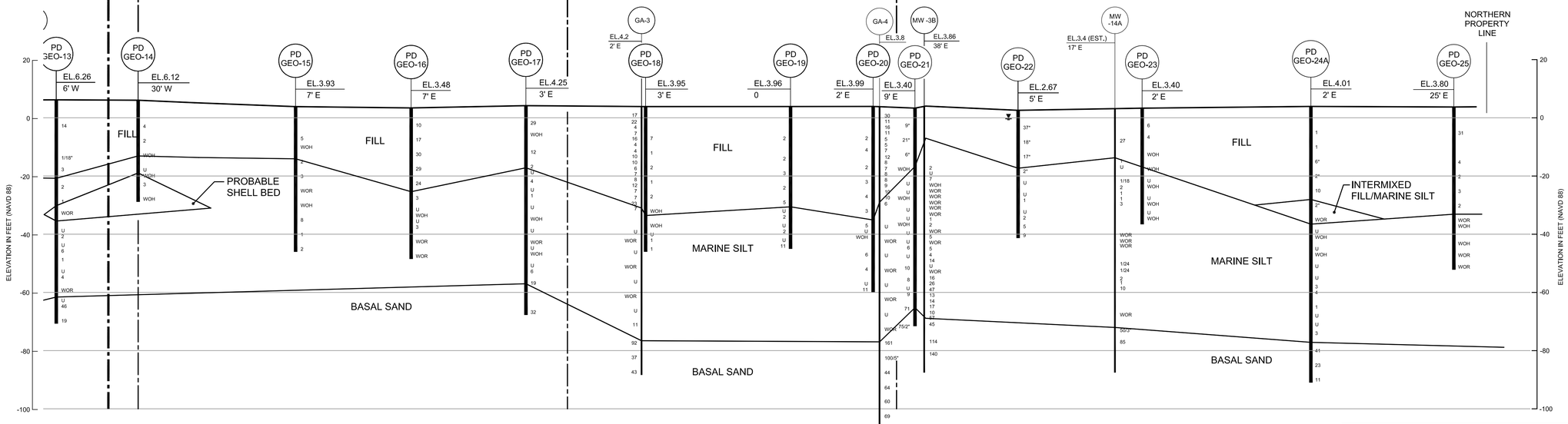
SCALE: AS SHOWN
JULY 2006

FIGURE D5.2A

28612-116 D094 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.





PROFILE A-A

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY & ALDRICH
ENSR | AECOM

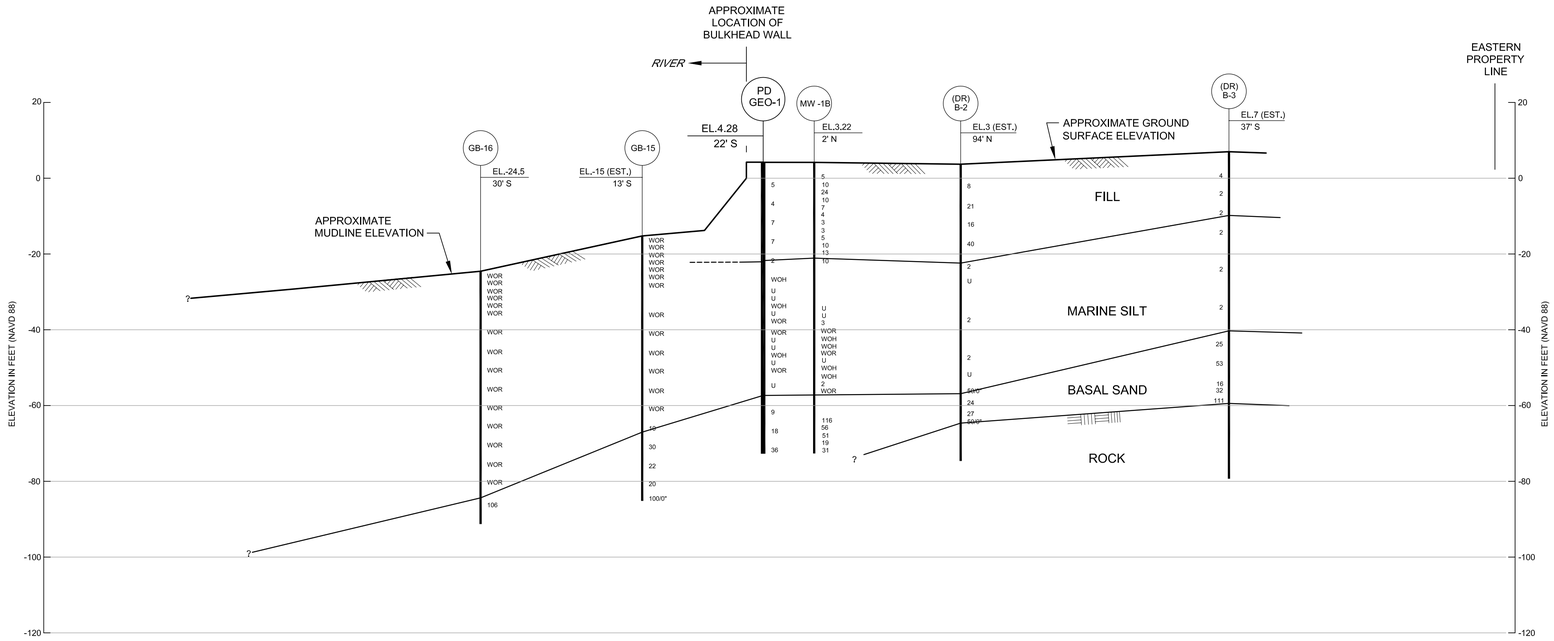
OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE PLAN AND GEOTECHNICAL SUBSURFACE PROFILE A-A

SCALE: AS SHOWN
JULY 2006

FIGURE D5.2B

28612-116 D095 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

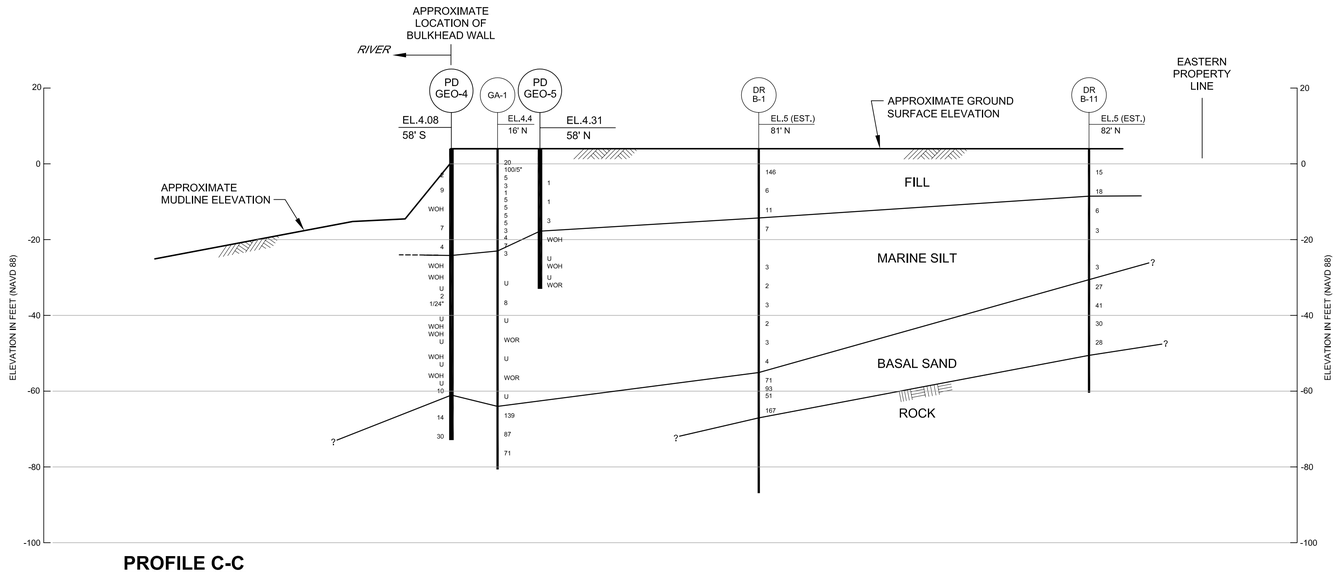


PROFILE B-B

HORIZ. 0 50 100

VERT. 0 20 40

SCALE IN FEET



PROFILE C-C

HORIZ. 0 50 100

VERT. 0 20 40

SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY& ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

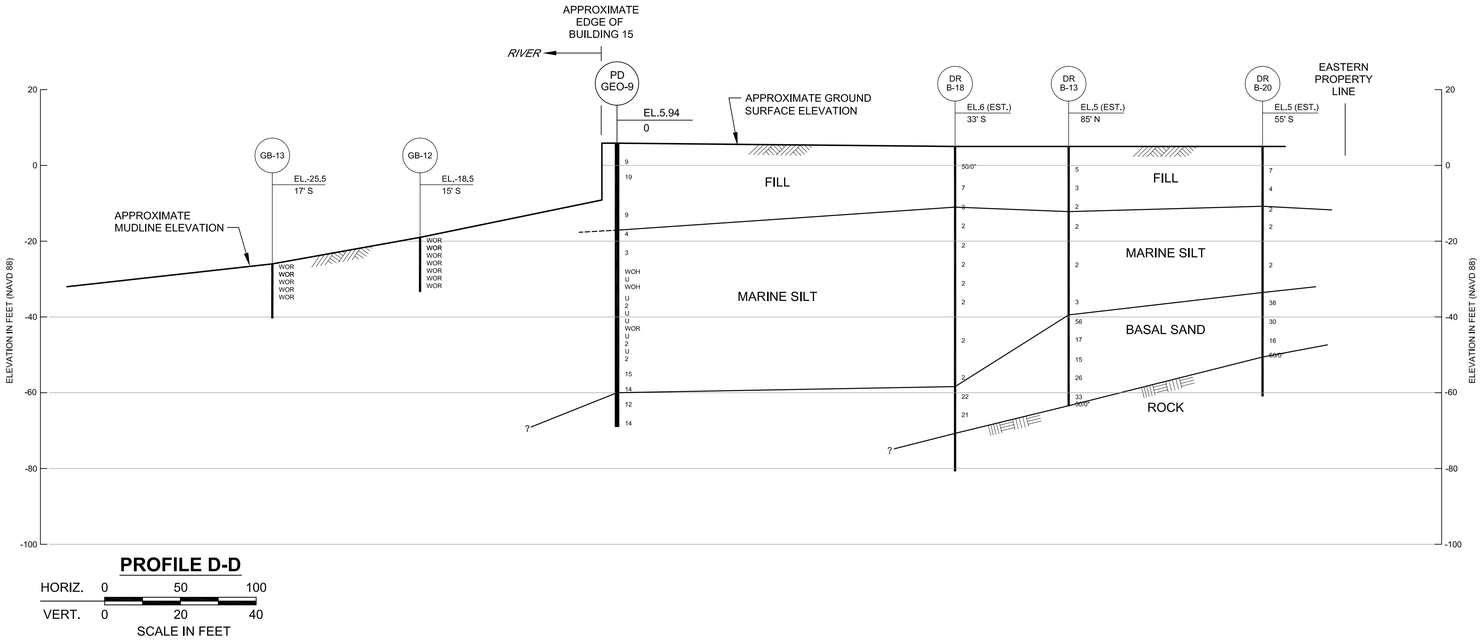
ENSR | AECOM

GEOTECHNICAL SUBSURFACE PROFILES B-B AND C-C

SCALE: AS SHOWN
JULY 2006

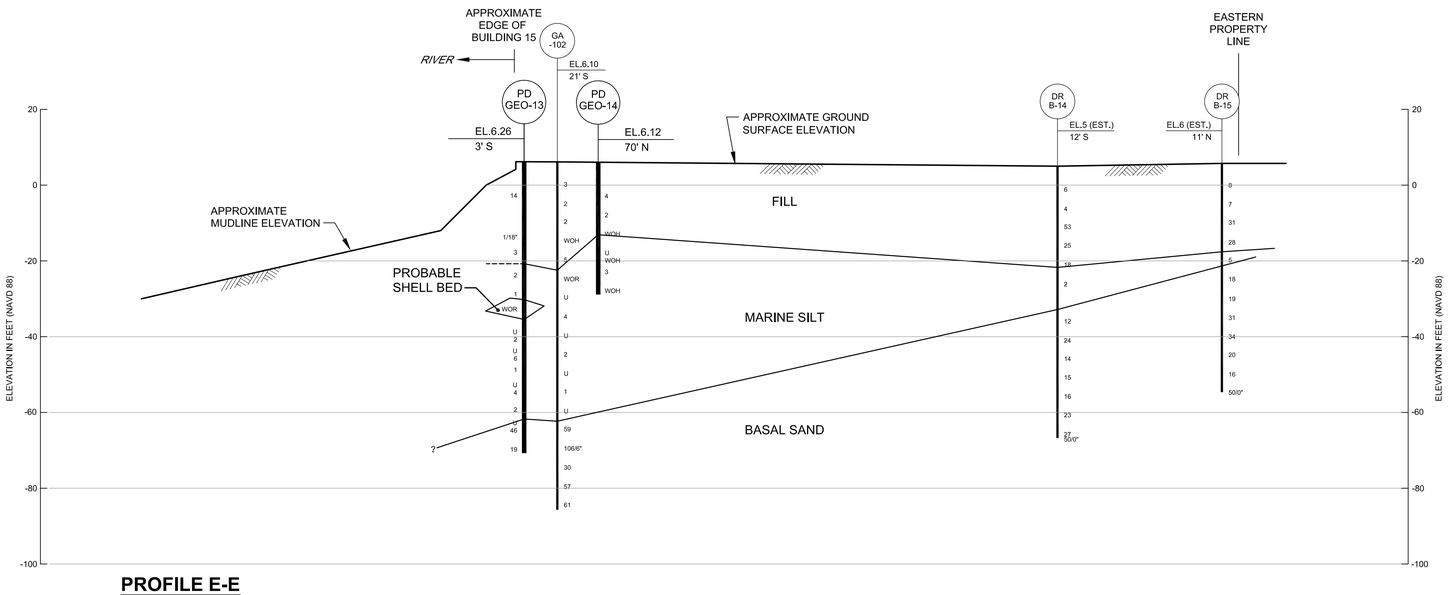
FIGURE D5.3

28612-116 D096 (D092)
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PROFILE D-D

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET



PROFILE E-E

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY& ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

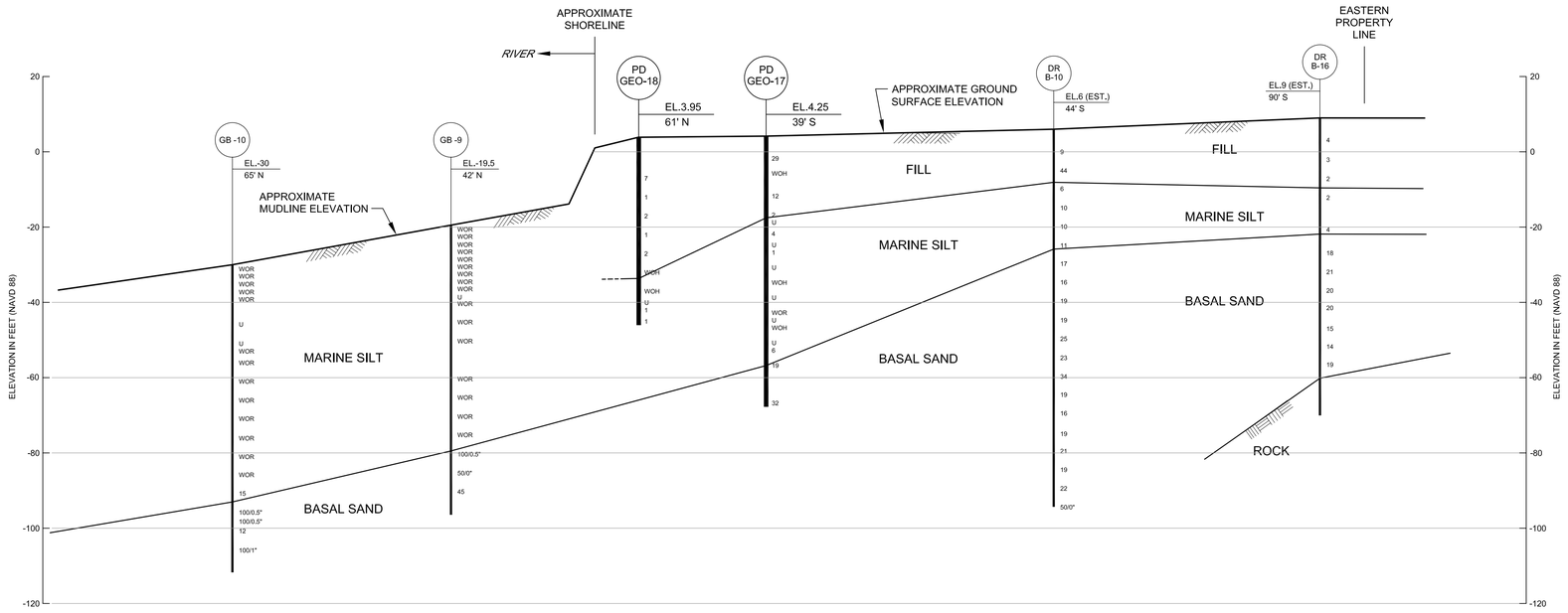
ENSR | AECOM

GEOTECHNICAL SUBSURFACE PROFILES D-D AND E-E

SCALE: AS SHOWN
JULY 2006

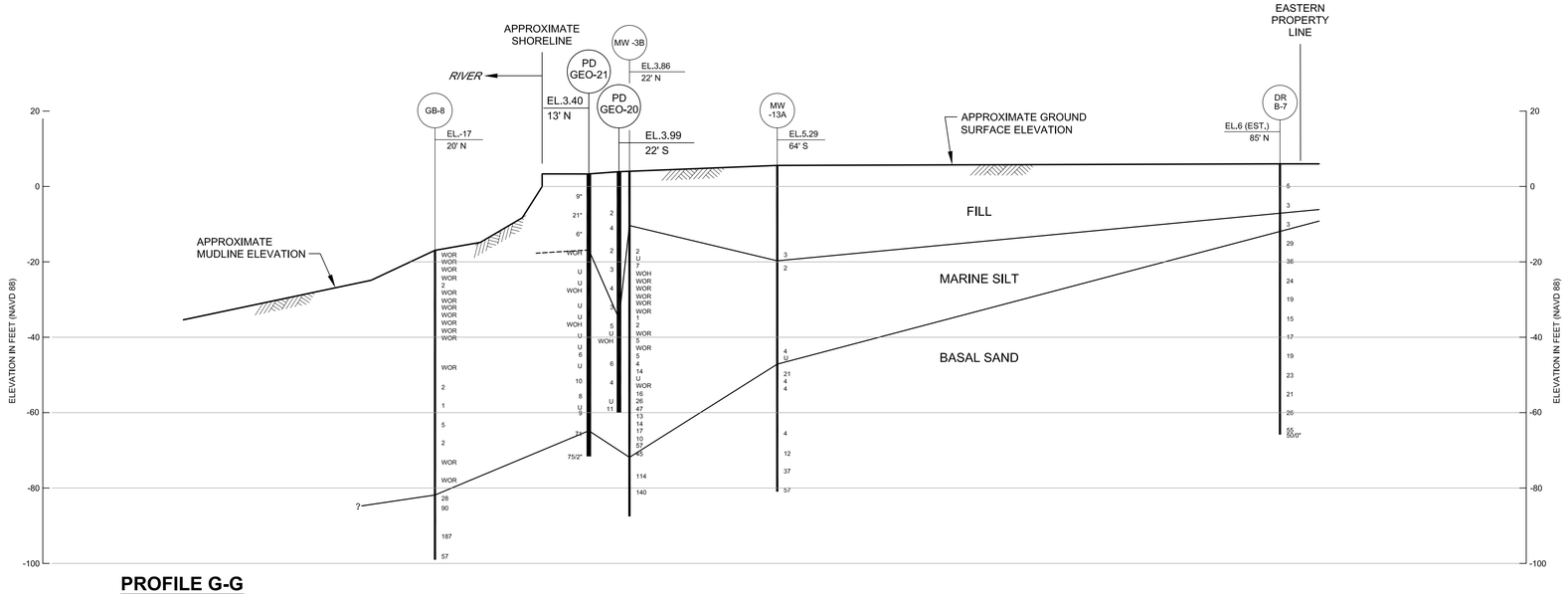
FIGURE D5.4

28612-116 D097 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG



PROFILE F-F

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET



PROFILE G-G

HORIZ. 0 50 100
VERT. 0 20 40
SCALE IN FEET

NOTE:

1. REFER TO FIGURE 5.6 FOR NOTES AND LEGEND.

HALEY& ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

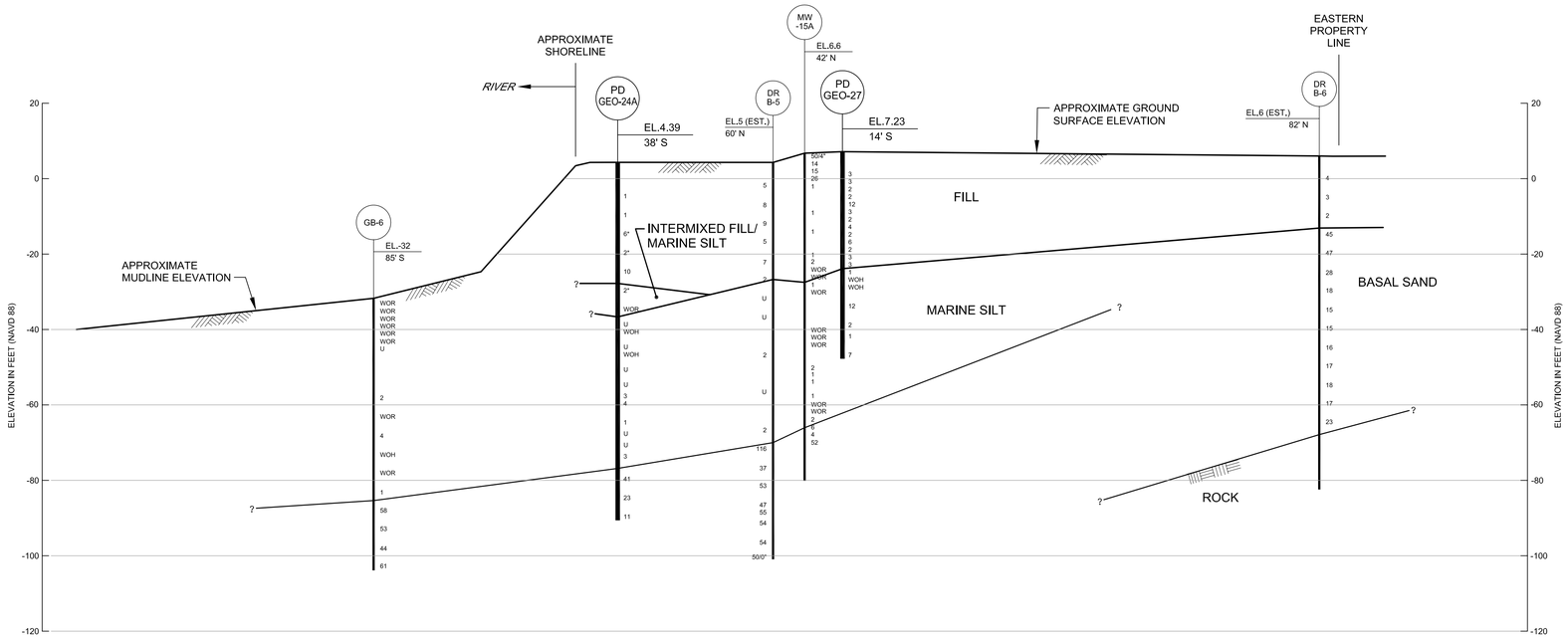
ENSR | AECOM

GEOTECHNICAL SUBSURFACE PROFILES F-F AND G-G

SCALE: AS SHOWN
JULY 2006

FIGURE D5.5

28612-116 D098 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG



PROFILE H-H

HORIZ. 0 50 100

VERT. 0 20 40

SCALE IN FEET

LEGEND:

PD GEO-1 — EXPLORATION DESIGNATION

EL.4.28 / 25' S — APPROXIMATE GROUND SURFACE ELEVATION (FEET) AT EXPLORATION; APPROXIMATE OFFSET FROM PROFILE BASELINE IN FEET

MAJOR STRATUM BOUNDARY BETWEEN DIFFERENT SOIL TYPES

20 — SAMPLE LOCATION AND INTERVAL

U — LOCATION OF SHELBY TUBE SAMPLE

** DENOTES 3-IN. SPLIT SPOON USED FOR SPT.

NOTES:

1. REFER TO FIGURE 5.1 FOR LOCATION AND ORIENTATION OF THE SUBSURFACE PROFILES.
2. ELEVATIONS REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. THE STRATIFICATION LINES SHOWN ON THE GRAPHIC REPRESENTATION OF THE TEST BORINGS REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. THE TRANSITION BEWEEN MATERIALS IS APPROXIMATE AND MAY BE GRADUAL.
4. THESE PROFILES WERE DEVELOPED BY INTERPOLATION BETWEEN WIDELY SPACED BORINGS. ONLY AT THE BORING LOCATIONS SHOULD IT BE CONSIDERED AS AN APPROXIMATELY ACCURATE REPRESENTATION AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS.
5. FOR SOME OF THE HISTORICAL BORINGS, THE BASAL SAND BOUNDARY WAS RE-INTERPRETED TO BE CONSISTENT WITH THE INTERPRETATION ADOPTED DURING THE PDI. REFER TO INDIVIDUAL LOGS FOR DETAILS.
6. BUILDING LIMITS ARE NOT SHOWN ON THESE PROFILES.

HALEY & ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

GEOTECHNICAL SUBSURFACE PROFILE H-H

SCALE: AS SHOWN
JULY 2006

FIGURE D5.6

28612-116 D099 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

ARCADIS Design & Consultancy for natural and built assets

Attachment C

Consolidation Settlement

Calculations

Table 1
Summary of Upland Area Geotechnical Data

Preliminary Design
Former Anaconda Wire and Cable Plant Site

						Unit Weight						Consolidation Parameters (corrected)														
Data Report Year	Boring No.	Ground Surface Elevation	Sample No.	Depth	σ'v	TRX	K	Average	Elev.	Classification USCS	Water Content	Pp	Pp	Cv	Cv	Ca	t50	t90	t95	t99	CR	RR	ε_{vo}	OCR	Lab Pp	Lab Pp
	Units			(ft)	(psf)	pcf			ft NAVD88		(%)	(tsf)	(psf)	(in^2/min)	(ft^2/sec)		YR	YR	YR	YR					(tsf)	(psf)
2006	PDGEO-31	3.42	U-1	21	894.6	105.4	93.1	99.25	-17.58	MH	78.1	0.35	700	0.0168	1.94444E-06	0.0161	2.9	12.4	16.6	26.1	0.35	0.12	15	0.6	0.48	960
2006	PDGEO-23	3.4	U-1	25	1065	105.5	96.5	101	-21.6	MH	63.8	0.55	1100	0.0056	6.48148E-07	0.0107	8.7	37.3	49.7	78.4	0.25	0.09	8.5	0.9	0.41	820
2006	PDGEO-21	3.4	U-2	29	1235.4	96.2		96.2	-25.6		68.7	0.81	1620	0.004	4.62963E-07	0.0115	12.1	52.3	69.6	109.8	0.29	0.07	10.5	1.07	0.72	1440
2006	PDGEO-31	3.42	U-3	31	1320.6	105.5	103.4	104.45	-27.58	CL	69.3	0.4	800	0.0172	1.99074E-06	0.0088	2.8	12.2	16.2	25.5	0.24	0.08	15.5	0.5	0.43	860
2006	PDGEO-23	3.4	U-2	31	1320.6				-27.6		80.3	0.63	1260	0.004	4.62963E-07	0.0089	12.1	52.3	69.6	109.8	0.21	0.1	16.5	0.85	0.45	900
2006	PDGEO-30	3.28	U-1	33	1405.8	101.9	105	103.45	-29.72	CL	63.5	0.61	1220	0.0521	6.03009E-06	0.00758	0.9	4.0	5.3	8.4	0.2	0.08	9	0.7	1.2	2400
2006	PDGEO-28	6.96	U-1	38	1618.8	106		106	-31.04	CL	58.2	0.62	1240	0.0412	4.76852E-06	0.00946	1.2	5.1	6.8	10.7	0.24	0.05	9.5	0.7	0.86	1720
2006	PDGEO-19	3.96	U-1	36	1533.6	107.5	110.5	109	-32.04	CL	58.9	0.65	1300	0.0086	9.9537E-07	0.0102	5.6	24.3	32.4	51.1	0.27	0.05	7	0.7	1.1	2200
2006	PDGEO-22	2.67	U-2	35	1491	105.2	103.7	104.45	-32.33	MH	61.8	0.79	1580	0.003	3.47222E-07	0.0152	16.2	69.7	92.8	146.4	0.27	0.09	13	0.94	0.62	1240
2006	PDGEO-21	3.4	U-4	38	1618.8	99.9		99.9	-34.6		58.6	0.3	600	0.0197	2.28009E-06	0.0095	2.5	10.6	14.1	22.3	0.21	0.04	9	0.32	0.28	560
2006	PDGEO-28	6.96	U-2	42	1789.2	105.5	107.1	106.3	-35.04		57.7	1.4	2800	0.0134	1.55093E-06	0.0042	3.6	15.6	20.8	32.8	0.32	0.09	17	1.4	1.1	2200
2006	PDGEO-29	6.8	U-1	43	1831.8	101.9		101.9	-36.2		49.2	0.98	1960	0.0119	1.37731E-06	0.0079	4.1	17.6	23.4	36.9	0.46	0.11	19	0.93	1.1	2200
2006	PDGEO-21	3.4	U-5	43	1831.8	107.3		107.3	-39.6	CL	36.9	0.68	1360	0.0119	1.37731E-06	0.0057	4.1	17.6	23.4	36.9	0.25	0.1	0.17	0.64	0.41	820
2006	PDGEO-19	3.96	U-3	46	1959.6	115.5	108.7	112.1	-42.04	CL	51.7	0.9	1800	0.0032	3.7037E-07	0.0212	15.2	65.3	87.0	137.2	0.31	0.08	14.5	0.8	0.91	1820
2006	PDGEO-28	6.96	U-3	51	2172.6	116	114	115	-44.04	CL	34.6	0.6	1200	0.0759	8.78472E-06	0.00648	0.6	2.8	3.7	5.8	0.17	0.09	12	0.5	0.43	860
2006	PDGEO-24A	4.39	U-2	49	2087.4	110.2		110.2	-44.61		47.6	0.81	1620	0.012	1.38889E-06	0.0103	4.0	17.4	23.2	36.6	0.27	0.06	10	0.68	0.87	1740
2006	PDGEO-17	4.25	U-2	49	2087.4	103		103	-44.75		39.5	0.34	680	1.78E-02	2.06019E-06	1.04E-02	2.7	11.7	15.6	24.7	0.23	0.05	14.5	0.3	0.47	940
2006	PDGEO-28	6.96	U-4	58	2470.8	105.4		105.4	-51.04		46.4	0.83	1660	0.0237	2.74306E-06	0.005	2.0	8.8	11.7	18.5	0.16	0.04	7	0.6	1.43	2860
2006	PDGEO-24A	4.39	U-4	72	3067.2	125.2		125.2	-67.61		31.5	0.8	1600	0.0174	2.01389E-06	0.0032	2.8	12.0	16.0	25.2	0.11	0.07	9	0.48	0.55	1100
							Averages =	106.1167			55.59474				2.18933E-06		5.5	23.6	31.5	49.6	0.253158	0.076842		1[1]		

Notes:
1. Assumed Normally Consolidated value due to sample disturbance.

Client: Atlantic Richfield Company
Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Cap Material at PDGEO18
Analysis for Low End Compressibility

Average Depth to Water = 2.4 ft bgs
γ_w = 62.4 pcf

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	Assumed OCR profile OCR	Assumed OCR profile p'_c (psf)
0	FILL	125	0.0	0.0	0.0		0.0
0.5	FILL	125	62.5	0.0	62.5	1	62.5
1	FILL	125	125.0	0.0	125.0	1	125.0
1.5	FILL	125	187.5	0.0	187.5	1	187.5
2	FILL	125	250.0	0.0	250.0	1	250.0
2.5	FILL	125	312.5	6.2	306.3	1	306.3
3	FILL	125	375.0	37.4	337.6	1	337.6
3.5	FILL	125	437.5	68.6	368.9	1	368.9
4	FILL	125	500.0	99.8	400.2	1	400.2
4.5	FILL	125	562.5	131.0	431.5	1	431.5
5	FILL	125	625.0	162.2	462.8	1	462.8
5.5	FILL	125	687.5	193.4	494.1	1	494.1
6	FILL	125	750.0	224.6	525.4	1	525.4
6.5	FILL	125	812.5	255.8	556.7	1	556.7
7	FILL	125	875.0	287.0	588.0	1	588.0
7.5	FILL	125	937.5	318.2	619.3	1	619.3
8	FILL	125	1000.0	349.4	650.6	1	650.6
8.5	FILL	125	1062.5	380.6	681.9	1	681.9
9	FILL	125	1125.0	411.8	713.2	1	713.2
9.5	FILL	125	1187.5	443.0	744.5	1	744.5
10	FILL	125	1250.0	474.2	775.8	1	775.8
10.5	FILL	125	1312.5	505.4	807.1	1	807.1
11	FILL	125	1375.0	536.6	838.4	1	838.4
11.5	FILL	125	1437.5	567.8	869.7	1	869.7
12	FILL	125	1500.0	599.0	901.0	1	901.0
12.5	FILL	125	1562.5	630.2	932.3	1	932.3
13	FILL	125	1625.0	661.4	963.6	1	963.6
13.5	FILL	125	1687.5	692.6	994.9	1	994.9
14	FILL	125	1750.0	723.8	1026.2	1	1026.2
14.5	FILL	125	1812.5	755.0	1057.5	1	1057.5
15	FILL	125	1875.0	786.2	1088.8	1	1088.8
15.5	FILL	125	1937.5	817.4	1120.1	1	1120.1
16	FILL	125	2000.0	848.6	1151.4	1	1151.4
16.5	FILL	125	2062.5	879.8	1182.7	1	1182.7
17	FILL	125	2125.0	911.0	1214.0	1	1214.0
17.5	FILL	125	2187.5	942.2	1245.3	1	1245.3
18	FILL	125	2250.0	973.4	1276.6	1	1276.6
18.5	FILL	125	2312.5	1004.6	1307.9	1	1307.9
19	FILL	125	2375.0	1035.8	1339.2	1	1339.2
19.5	FILL	125	2437.5	1067.0	1370.5	1	1370.5
20	FILL	125	2500.0	1098.2	1401.8	1	1401.8
20.5	FILL	125	2562.5	1129.4	1433.1	1	1433.1
21	FILL	125	2625.0	1160.6	1464.4	1	1464.4
21.5	FILL	125	2687.5	1191.8	1495.7	1	1495.7
22	FILL	125	2750.0	1223.0	1527.0	1	1527.0

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
22.5	FILL	125	2812.5	1254.2	1558.3	1	1558.3
23	FILL	125	2875.0	1285.4	1589.6	1	1589.6
23.5	FILL	125	2937.5	1316.6	1620.9	1	1620.9
24	FILL	125	3000.0	1347.8	1652.2	1	1652.2
24.5	FILL	125	3062.5	1379.0	1683.5	1	1683.5
25	FILL	125	3125.0	1410.2	1714.8	1	1714.8
25.5	FILL	125	3187.5	1441.4	1746.1	1	1746.1
26	FILL	125	3250.0	1472.6	1777.4	1	1777.4
26.5	FILL	125	3312.5	1503.8	1808.7	1	1808.7
27	FILL	125	3375.0	1535.0	1840.0	1	1840.0
27.5	FILL	125	3437.5	1566.2	1871.3	1	1871.3
28	FILL	125	3500.0	1597.4	1902.6	1	1902.6
28.5	FILL	125	3562.5	1628.6	1933.9	1	1933.9
29	FILL	125	3625.0	1659.8	1965.2	1	1965.2
29.5	FILL	125	3687.5	1691.0	1996.5	1	1996.5
30	FILL	125	3750.0	1722.2	2027.8	1	2027.8
30.5	FILL	125	3812.5	1753.4	2059.1	1	2059.1
31	FILL	125	3875.0	1784.6	2090.4	1	2090.4
31.5	FILL	125	3937.5	1815.8	2121.7	1	2121.7
32	FILL	125	4000.0	1847.0	2153.0	1	2153.0
32.5	FILL	125	4062.5	1878.2	2184.3	1	2184.3
33	FILL	125	4125.0	1909.4	2215.6	1	2215.6
33.5	FILL	125	4187.5	1940.6	2246.9	1	2246.9
34	FILL	125	4250.0	1971.8	2278.2	1	2278.2
34.5	FILL	125	4312.5	2003.0	2309.5	1	2309.5
35	FILL	125	4375.0	2034.2	2340.8	1	2340.8
35.5	FILL	125	4437.5	2065.4	2372.1	1	2372.1
36	FILL	125	4500.0	2096.6	2403.4	1	2403.4
36.5	FILL	125	4562.5	2127.8	2434.7	1	2434.7
37	FILL	125	4625.0	2159.0	2466.0	1	2466.0
37.5	FILL	125	4687.5	2190.2	2497.3	1	2497.3
38	MS	106	4745.3	2221.4	2523.8	1	2523.8
38.5	MS	106	4798.3	2252.6	2545.7	1	2545.7
39	MS	106	4851.4	2283.8	2567.6	1	2567.6
39.5	MS	106	4904.5	2315.0	2589.4	1	2589.4
40	MS	106	4957.5	2346.2	2611.3	1	2611.3
40.5	MS	106	5010.6	2377.4	2633.1	1	2633.1
41	MS	106	5063.6	2408.6	2655.0	1	2655.0
41.5	MS	106	5116.7	2439.8	2676.8	1	2676.8
42	MS	106	5169.7	2471.0	2698.7	1	2698.7
42.5	MS	106	5222.8	2502.2	2720.6	1	2720.6
43	MS	106	5275.9	2533.4	2742.4	1	2742.4
43.5	MS	106	5328.9	2564.6	2764.3	1	2764.3
44	MS	106	5382.0	2595.8	2786.1	1	2786.1
44.5	MS	106	5435.0	2627.0	2808.0	1	2808.0
45	MS	106	5488.1	2658.2	2829.9	1	2829.9
45.5	MS	106	5541.2	2689.4	2851.7	1	2851.7
46	MS	106	5594.2	2720.6	2873.6	1	2873.6
46.5	MS	106	5647.3	2751.8	2895.4	1	2895.4
47	MS	106	5700.3	2783.0	2917.3	1	2917.3
47.5	MS	106	5753.4	2814.2	2939.1	1	2939.1
48	MS	106	5806.4	2845.4	2961.0	1	2961.0
48.5	MS	106	5859.5	2876.6	2982.9	1	2982.9
49	MS	106	5912.6	2907.8	3004.7	1	3004.7
49.5	MS	106	5965.6	2939.0	3026.6	1	3026.6
50	MS	106	6018.7	2970.2	3048.4	1	3048.4
50.5	MS	106	6071.7	3001.4	3070.3	1	3070.3
51	MS	106	6124.8	3032.6	3092.2	1	3092.2
51.5	MS	106	6177.9	3063.8	3114.0	1	3114.0
52	MS	106	6230.9	3095.0	3135.9	1	3135.9
52.5	MS	106	6284.0	3126.2	3157.7	1	3157.7
53	MS	106	6337.0	3157.4	3179.6	1	3179.6

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
53.5	MS	106	6390.1	3188.6	3201.4	1	3201.4
54	MS	106	6443.1	3219.8	3223.3	1	3223.3
54.5	MS	106	6496.2	3251.0	3245.2	1	3245.2
55	MS	106	6549.3	3282.2	3267.0	1	3267.0
55.5	MS	106	6602.3	3313.4	3288.9	1	3288.9
56	MS	106	6655.4	3344.6	3310.7	1	3310.7
56.5	MS	106	6708.4	3375.8	3332.6	1	3332.6
57	MS	106	6761.5	3407.0	3354.5	1	3354.5
57.5	MS	106	6814.6	3438.2	3376.3	1	3376.3
58	MS	106	6867.6	3469.4	3398.2	1	3398.2
58.5	MS	106	6920.7	3500.6	3420.0	1	3420.0
59	MS	106	6973.7	3531.8	3441.9	1	3441.9
59.5	MS	106	7026.8	3563.0	3463.7	1	3463.7
60	MS	106	7079.8	3594.2	3485.6	1	3485.6
60.5	MS	106	7132.9	3625.4	3507.5	1	3507.5
61	MS	106	7186.0	3656.6	3529.3	1	3529.3
61.5	MS	106	7239.0	3687.8	3551.2	1	3551.2
62	MS	106	7292.1	3719.0	3573.0	1	3573.0
62.5	MS	106	7345.1	3750.2	3594.9	1	3594.9
63	MS	106	7398.2	3781.4	3616.8	1	3616.8
63.5	MS	106	7451.3	3812.6	3638.6	1	3638.6
64	MS	106	7504.3	3843.8	3660.5	1	3660.5
64.5	MS	106	7557.4	3875.0	3682.3	1	3682.3
65	MS	106	7610.4	3906.2	3704.2	1	3704.2
65.5	MS	106	7663.5	3937.4	3726.0	1	3726.0
66	MS	106	7716.5	3968.6	3747.9	1	3747.9
66.5	MS	106	7769.6	3999.8	3769.8	1	3769.8
67	MS	106	7822.7	4031.0	3791.6	1	3791.6
67.5	MS	106	7875.7	4062.2	3813.5	1	3813.5
68	MS	106	7928.8	4093.4	3835.3	1	3835.3
68.5	MS	106	7981.8	4124.6	3857.2	1	3857.2
69	MS	106	8034.9	4155.8	3879.1	1	3879.1
69.5	MS	106	8088.0	4187.0	3900.9	1	3900.9
70	MS	106	8141.0	4218.2	3922.8	1	3922.8
70.5	MS	106	8194.1	4249.4	3944.6	1	3944.6
71	BASAL SAND	125	8251.9	4280.6	3971.2	1	3971.2
71.5	BASAL SAND	125	8314.4	4311.8	4002.5	1	4002.5
72	BASAL SAND	125	8376.9	4343.0	4033.8	1	4033.8

ft bgs = feet below ground surface
z = depth
γ_w = unit weight of water; γ = unit weight of soil
γ = unit weight of soil
σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress
OCR = overconsolidation ratio (assumed)
p'_c = preconsolidation stress (aka maximum past effective stress)
$s_{u,UU,est.}$ = undrained shear strength assuming unconsolidated, undrained (UU) test conditions estimated based on assumed OCR

Atlantic Richfield Company

Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for PDGEO18
Analysis for 2.4 ft Fill

top elev = 4 ft NAVD88
h_{cap} = 4.7 ft
$h_{effective,\ post\ settlement}$ = 4.0 ft
$\gamma_{bulk,cap}$ = 120 pcf
Δp = 564 psf
t = 100 yrs
t_p = 9.3 yrs

Secondary Compression

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression in in.*	Cumulative Secondary Compression in in.
38.0	-34.0	MS	106	1589.6	564	2154	1.00	1590	0.253	0.077	0.000	0.00				
38.5	-34.5	MS	106	1620.9	564	2185	1.00	1621	0.253	0.077	0.017	0.20	1.348	0.0127	0.08	0.08
39.0	-35.0	MS	106	1652.2	564	2216	1.00	1652	0.253	0.077	0.016	0.39	1.341	0.0127	0.08	0.16
39.5	-35.5	MS	106	1683.5	564	2247	1.00	1683	0.253	0.077	0.016	0.59	1.335	0.0127	0.08	0.24
40.0	-36.0	MS	106	1714.8	564	2279	1.00	1715	0.253	0.077	0.016	0.78	1.329	0.0127	0.08	0.31
40.5	-36.5	MS	106	1746.1	564	2310	1.00	1746	0.253	0.077	0.016	0.96	1.323	0.0127	0.08	0.39
41.0	-37.0	MS	106	1777.4	564	2341	1.00	1777	0.253	0.077	0.015	1.14	1.317	0.0127	0.08	0.47
41.5	-37.5	MS	106	1808.7	564	2373	1.00	1809	0.253	0.077	0.015	1.32	1.312	0.0127	0.08	0.55
42.0	-38.0	MS	106	1840.0	564	2404	1.00	1840	0.253	0.077	0.015	1.50	1.307	0.0127	0.08	0.63
42.5	-38.5	MS	106	1871.3	564	2435	1.00	1871	0.253	0.077	0.015	1.68	1.301	0.0127	0.08	0.71
43.0	-39.0	MS	106	1902.6	564	2467	1.00	1903	0.253	0.077	0.014	1.85	1.296	0.0127	0.08	0.78
43.5	-39.5	MS	106	1933.9	564	2498	1.00	1934	0.253	0.077	0.014	2.02	1.292	0.0127	0.08	0.86
44.0	-40.0	MS	106	1965.2	564	2529	1.00	1965	0.253	0.077	0.014	2.19	1.287	0.0127	0.08	0.94
44.5	-40.5	MS	106	1996.5	564	2560	1.00	1996	0.253	0.077	0.014	2.35	1.283	0.0127	0.08	1.02
45.0	-41.0	MS	106	2027.8	564	2592	1.00	2028	0.253	0.077	0.014	2.52	1.278	0.0127	0.08	1.10
45.5	-41.5	MS	106	2059.1	564	2623	1.00	2059	0.253	0.077	0.013	2.68	1.274	0.0127	0.08	1.18
46.0	-42.0	MS	106	2090.4	564	2654	1.00	2090	0.253	0.077	0.013	2.84	1.270	0.0127	0.08	1.25
46.5	-42.5	MS	106	2121.7	564	2686	1.00	2122	0.253	0.077	0.013	2.99	1.266	0.0127	0.08	1.33
47.0	-43.0	MS	106	2153.0	564	2717	1.00	2153	0.253	0.077	0.013	3.15	1.262	0.0127	0.08	1.41
47.5	-43.5	MS	106	2184.3	564	2748	1.00	2184	0.253	0.077	0.013	3.30	1.258	0.0127	0.08	1.49
48.0	-44.0	MS	106	2215.6	564	2780	1.00	2216	0.253	0.077	0.013	3.45	1.255	0.0127	0.08	1.57
48.5	-44.5	MS	106	2246.9	564	2811	1.00	2247	0.253	0.077	0.012	3.60	1.251	0.0127	0.08	1.65
49.0	-45.0	MS	106	2278.2	564	2842	1.00	2278	0.253	0.077	0.012	3.75	1.248	0.0127	0.08	1.72
49.5	-45.5	MS	106	2309.5	564	2873	1.00	2309	0.253	0.077	0.012	3.89	1.244	0.0127	0.08	1.80
50.0	-46.0	MS	106	2340.8	564	2905	1.00	2341	0.253	0.077	0.012	4.03	1.241	0.0127	0.08	1.88
50.5	-46.5	MS	106	2372.1	564	2936	1.00	2372	0.253	0.077	0.012	4.18	1.238	0.0127	0.08	1.96
51.0	-47.0	MS	106	2403.4	564	2967	1.00	2403	0.253	0.077	0.012	4.31	1.235	0.0127	0.08	2.04
51.5	-47.5	MS	106	2434.7	564	2999	1.00	2435	0.253	0.077	0.012	4.45	1.232	0.0127	0.08	2.12
52.0	-48.0	MS	106	2466.0	564	3030	1.00	2466	0.253	0.077	0.011	4.59	1.229	0.0127	0.08	2.19
52.5	-48.5	MS	106	2497.3	564	3061	1.00	2497	0.253	0.077	0.011	4.72	1.226	0.0127	0.08	2.27
53.0	-49.0	MS	106	2523.8	564	3088	1.00	2524	0.253	0.077	0.011	4.86	1.223	0.0127	0.08	2.35
53.5	-49.5	MS	106	2545.7	564	3110	1.00	2546	0.253	0.077	0.011	4.99	1.222	0.0127	0.08	2.43
54.0	-50.0	MS	106	2567.6	564	3132	1.00	2568	0.253	0.077	0.011	5.12	1.220	0.0127	0.08	2.51
54.5	-50.5	MS	106	2589.4	564	3153	1.00	2589	0.253	0.077	0.011	5.25	1.218	0.0127	0.08	2.59
55.0	-51.0	MS	106	2611.3	564	3175	1.00	2611	0.253	0.077	0.011	5.38	1.216	0.0127	0.08	2.66
55.5	-51.5	MS	106	2633.1	564	3197	1.00	2633	0.253	0.077	0.011	5.51	1.214	0.0127	0.08	2.74

56.0	-52.0	MS	106	2655.0	564	3219	1.00	2655	0.253	0.077	0.011	5.64	1.212	0.0127	0.08	2.82
56.5	-52.5	MS	106	2676.8	564	3241	1.00	2677	0.253	0.077	0.011	5.77	1.211	0.0127	0.08	2.90
57.0	-53.0	MS	106	2698.7	564	3263	1.00	2699	0.253	0.077	0.010	5.89	1.209	0.0127	0.08	2.98
57.5	-53.5	MS	106	2720.6	564	3285	1.00	2721	0.253	0.077	0.010	6.02	1.207	0.0127	0.08	3.06
58.0	-54.0	MS	106	2742.4	564	3306	1.00	2742	0.253	0.077	0.010	6.14	1.206	0.0127	0.08	3.13
58.5	-54.5	MS	106	2764.3	564	3328	1.00	2764	0.253	0.077	0.010	6.26	1.204	0.0127	0.08	3.21
59.0	-55.0	MS	106	2786.1	564	3350	1.00	2786	0.253	0.077	0.010	6.38	1.202	0.0127	0.08	3.29
59.5	-55.5	MS	106	2808.0	564	3372	1.00	2808	0.253	0.077	0.010	6.51	1.201	0.0127	0.08	3.37
60.0	-56.0	MS	106	2829.9	564	3394	1.00	2830	0.253	0.077	0.010	6.63	1.199	0.0127	0.08	3.45
60.5	-56.5	MS	106	2851.7	564	3416	1.00	2852	0.253	0.077	0.010	6.75	1.198	0.0127	0.08	3.53
61.0	-57.0	MS	106	2873.6	564	3438	1.00	2874	0.253	0.077	0.010	6.86	1.196	0.0127	0.08	3.60
61.5	-57.5	MS	106	2895.4	564	3459	1.00	2895	0.253	0.077	0.010	6.98	1.195	0.0127	0.08	3.68
62.0	-58.0	MS	106	2917.3	564	3481	1.00	2917	0.253	0.077	0.010	7.10	1.193	0.0127	0.08	3.76
62.5	-58.5	MS	106	2939.1	564	3503	1.00	2939	0.253	0.077	0.010	7.22	1.192	0.0127	0.08	3.84
63.0	-59.0	MS	106	2961.0	564	3525	1.00	2961	0.253	0.077	0.010	7.33	1.190	0.0127	0.08	3.92
63.5	-59.5	MS	106	2982.9	564	3547	1.00	2983	0.253	0.077	0.010	7.45	1.189	0.0127	0.08	4.00
64.0	-60.0	MS	106	3004.7	564	3569	1.00	3005	0.253	0.077	0.009	7.56	1.188	0.0127	0.08	4.07
64.5	-60.5	MS	106	3026.6	564	3591	1.00	3027	0.253	0.077	0.009	7.67	1.186	0.0127	0.08	4.15
65.0	-61.0	MS	106	3048.4	564	3612	1.00	3048	0.253	0.077	0.009	7.78	1.185	0.0127	0.08	4.23
65.5	-61.5	MS	106	3070.3	564	3634	1.00	3070	0.253	0.077	0.009	7.90	1.184	0.0127	0.08	4.31
66.0	-62.0	MS	106	3092.2	564	3656	1.00	3092	0.253	0.077	0.009	8.01	1.182	0.0127	0.08	4.39
66.5	-62.5	MS	106	3114.0	564	3678	1.00	3114	0.253	0.077	0.009	8.12	1.181	0.0127	0.08	4.47
67.0	-63.0	MS	106	3135.9	564	3700	1.00	3136	0.253	0.077	0.009	8.23	1.180	0.0127	0.08	4.54
67.5	-63.5	MS	106	3157.7	564	3722	1.00	3158	0.253	0.077	0.009	8.34	1.179	0.0127	0.08	4.62
68.0	-64.0	MS	106	3179.6	564	3744	1.00	3180	0.253	0.077	0.009	8.44	1.177	0.0127	0.08	4.70
68.5	-64.5	MS	106	3201.4	564	3765	1.00	3201	0.253	0.077	0.009	8.55	1.176	0.0127	0.08	4.78
69.0	-65.0	MS	106	3223.3	564	3787	1.00	3223	0.253	0.077	0.009	8.66	1.175	0.0127	0.08	4.86
69.5	-65.5	MS	106	3245.2	564	3809	1.00	3245	0.253	0.077	0.009	8.76	1.174	0.0127	0.08	4.94
70.0	-66.0	MS	106	3267.0	564	3831	1.00	3267	0.253	0.077	0.009	8.87	1.173	0.0127	0.08	5.01
70.5	-66.5	MS	106	3288.9	564	3853	1.00	3289	0.253	0.077	0.009	8.97	1.171	0.0127	0.08	5.09
			average	2514.1							total settlement (ft.) =	0.748			total settlement (ft.) =	0.424

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)

c_{cc} = modified compression index (aka compression ratio) of cohesive soil

c_{rc} = modified recompression index (aka recompression ratio) of cohesive soil

E_s = Young's modulus of upper granular soil

ν = Poisson's ratio of upper granular soil

ft bgs = feet below ground surface

z = depth

γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

Δp = stress increase below load

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

Client:

Client: Atlantic Richfield Company
Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Cap Material at PDGEO17
Analysis for Low End Compressibility

Average Depth to Water = 2.6 ft bgs
γ_w = 62.4 pcf

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	Assumed OCR profile OCR	Assumed OCR profile p'_c (psf)
0	FILL	125	0.0	0.0	0.0		0.0
0.5	FILL	125	62.5	0.0	62.5	1	62.5
1	FILL	125	125.0	0.0	125.0	1	125.0
1.5	FILL	125	187.5	0.0	187.5	1	187.5
2	FILL	125	250.0	0.0	250.0	1	250.0
2.5	FILL	125	312.5	0.0	312.5	1	312.5
3	FILL	125	375.0	25.0	350.0	1	350.0
3.5	FILL	125	437.5	56.2	381.3	1	381.3
4	FILL	125	500.0	87.4	412.6	1	412.6
4.5	FILL	125	562.5	118.6	443.9	1	443.9
5	FILL	125	625.0	149.8	475.2	1	475.2
5.5	FILL	125	687.5	181.0	506.5	1	506.5
6	FILL	125	750.0	212.2	537.8	1	537.8
6.5	FILL	125	812.5	243.4	569.1	1	569.1
7	FILL	125	875.0	274.6	600.4	1	600.4
7.5	FILL	125	937.5	305.8	631.7	1	631.7
8	FILL	125	1000.0	337.0	663.0	1	663.0
8.5	FILL	125	1062.5	368.2	694.3	1	694.3
9	FILL	125	1125.0	399.4	725.6	1	725.6
9.5	FILL	125	1187.5	430.6	756.9	1	756.9
10	FILL	125	1250.0	461.8	788.2	1	788.2
10.5	FILL	125	1312.5	493.0	819.5	1	819.5
11	FILL	125	1375.0	524.2	850.8	1	850.8
11.5	FILL	125	1437.5	555.4	882.1	1	882.1
12	FILL	125	1500.0	586.6	913.4	1	913.4
12.5	FILL	125	1562.5	617.8	944.7	1	944.7
13	FILL	125	1625.0	649.0	976.0	1	976.0
13.5	FILL	125	1687.5	680.2	1007.3	1	1007.3
14	FILL	125	1750.0	711.4	1038.6	1	1038.6
14.5	FILL	125	1812.5	742.6	1069.9	1	1069.9
15	FILL	125	1875.0	773.8	1101.2	1	1101.2
15.5	FILL	125	1937.5	805.0	1132.5	1	1132.5
16	FILL	125	2000.0	836.2	1163.8	1	1163.8
16.5	FILL	125	2062.5	867.4	1195.1	1	1195.1
17	FILL	125	2125.0	898.6	1226.4	1	1226.4
17.5	FILL	125	2187.5	929.8	1257.7	1	1257.7
18	FILL	125	2250.0	961.0	1289.0	1	1289.0
18.5	FILL	125	2312.5	992.2	1320.3	1	1320.3
19	FILL	125	2375.0	1023.4	1351.6	1	1351.6
19.5	FILL	125	2437.5	1054.6	1382.9	1	1382.9
20	FILL	125	2500.0	1085.8	1414.2	1	1414.2
20.5	FILL	125	2562.5	1117.0	1445.5	1	1445.5
21	FILL	125	2625.0	1148.2	1476.8	1	1476.8
21.5	FILL	125	2687.5	1179.4	1508.1	1	1508.1

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
22	MS	106	2745.3	1210.6	1534.7	1	1534.7
22.5	MS	106	2798.3	1241.8	1556.6	1	1556.6
23	MS	106	2851.4	1273.0	1578.4	1	1578.4
23.5	MS	106	2904.5	1304.2	1600.3	1	1600.3
24	MS	106	2957.5	1335.4	1622.2	1	1622.2
24.5	MS	106	3010.6	1366.6	1644.0	1	1644.0
25	MS	106	3063.6	1397.8	1665.9	1	1665.9
25.5	MS	106	3116.7	1429.0	1687.7	1	1687.7
26	MS	106	3169.7	1460.2	1709.6	1	1709.6
26.5	MS	106	3222.8	1491.4	1731.4	1	1731.4
27	MS	106	3275.9	1522.6	1753.3	1	1753.3
27.5	MS	106	3328.9	1553.8	1775.2	1	1775.2
28	MS	106	3382.0	1585.0	1797.0	1	1797.0
28.5	MS	106	3435.0	1616.2	1818.9	1	1818.9
29	MS	106	3488.1	1647.4	1840.7	1	1840.7
29.5	MS	106	3541.2	1678.6	1862.6	1	1862.6
30	MS	106	3594.2	1709.8	1884.5	1	1884.5
30.5	MS	106	3647.3	1741.0	1906.3	1	1906.3
31	MS	106	3700.3	1772.2	1928.2	1	1928.2
31.5	MS	106	3753.4	1803.4	1950.0	1	1950.0
32	MS	106	3806.4	1834.6	1971.9	1	1971.9
32.5	MS	106	3859.5	1865.8	1993.7	1	1993.7
33	MS	106	3912.6	1897.0	2015.6	1	2015.6
33.5	MS	106	3965.6	1928.2	2037.5	1	2037.5
34	MS	106	4018.7	1959.4	2059.3	1	2059.3
34.5	MS	106	4071.7	1990.6	2081.2	1	2081.2
35	MS	106	4124.8	2021.8	2103.0	1	2103.0
35.5	MS	106	4177.9	2053.0	2124.9	1	2124.9
36	MS	106	4230.9	2084.2	2146.8	1	2146.8
36.5	MS	106	4284.0	2115.4	2168.6	1	2168.6
37	MS	106	4337.0	2146.6	2190.5	1	2190.5
37.5	MS	106	4390.1	2177.8	2212.3	1	2212.3
38	MS	106	4443.1	2209.0	2234.2	1	2234.2
38.5	MS	106	4496.2	2240.2	2256.0	1	2256.0
39	MS	106	4549.3	2271.4	2277.9	1	2277.9
39.5	MS	106	4602.3	2302.6	2299.8	1	2299.8
40	MS	106	4655.4	2333.8	2321.6	1	2321.6
40.5	MS	106	4708.4	2365.0	2343.5	1	2343.5
41	MS	106	4761.5	2396.2	2365.3	1	2365.3
41.5	MS	106	4814.6	2427.4	2387.2	1	2387.2
42	MS	106	4867.6	2458.6	2409.1	1	2409.1
42.5	MS	106	4920.7	2489.8	2430.9	1	2430.9
43	MS	106	4973.7	2521.0	2452.8	1	2452.8
43.5	MS	106	5026.8	2552.2	2474.6	1	2474.6
44	MS	106	5079.8	2583.4	2496.5	1	2496.5
44.5	MS	106	5132.9	2614.6	2518.3	1	2518.3
45	MS	106	5186.0	2645.8	2540.2	1	2540.2
45.5	MS	106	5239.0	2677.0	2562.1	1	2562.1

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
46	MS	106	5292.1	2708.2	2583.9	1	2583.9
46.5	MS	106	5345.1	2739.4	2605.8	1	2605.8
47	MS	106	5398.2	2770.6	2627.6	1	2627.6
47.5	MS	106	5451.3	2801.8	2649.5	1	2649.5
48	MS	106	5504.3	2833.0	2671.4	1	2671.4
48.5	MS	106	5557.4	2864.2	2693.2	1	2693.2
49	MS	106	5610.4	2895.4	2715.1	1	2715.1
49.5	MS	106	5663.5	2926.6	2736.9	1	2736.9
50	MS	106	5716.5	2957.8	2758.8	1	2758.8
50.5	MS	106	5769.6	2989.0	2780.6	1	2780.6
51	MS	106	5822.7	3020.2	2802.5	1	2802.5
51.5	MS	106	5875.7	3051.4	2824.4	1	2824.4
52	MS	106	5928.8	3082.6	2846.2	1	2846.2
52.5	MS	106	5981.8	3113.8	2868.1	1	2868.1
53	MS	106	6034.9	3145.0	2889.9	1	2889.9
53.5	MS	106	6088.0	3176.2	2911.8	1	2911.8
54	MS	106	6141.0	3207.4	2933.7	1	2933.7
54.5	MS	106	6194.1	3238.6	2955.5	1	2955.5
55	MS	106	6247.1	3269.8	2977.4	1	2977.4
55.5	MS	106	6300.2	3301.0	2999.2	1	2999.2
56	MS	106	6353.2	3332.2	3021.1	1	3021.1
56.5	MS	106	6406.3	3363.4	3042.9	1	3042.9
57	MS	106	6459.4	3394.6	3064.8	1	3064.8
57.5	MS	106	6512.4	3425.8	3086.7	1	3086.7
58	MS	106	6565.5	3457.0	3108.5	1	3108.5
58.5	MS	106	6618.5	3488.2	3130.4	1	3130.4
59	MS	106	6671.6	3519.4	3152.2	1	3152.2
59.5	BASAL SAND	125	6729.4	3550.6	3178.8	1	3178.8
60	BASAL SAND	125	6791.9	3581.8	3210.1	1	3210.1
60.5	BASAL SAND	125	6854.4	3613.0	3241.4	1	3241.4

ft bgs = feet below ground surface
z = depth
γ_w = unit weight of water; γ = unit weight of soil
γ = unit weight of soil
σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress
OCR = overconsolidation ratio (assumed)
p'_c = preconsolidation stress (aka maximum past effective stress)
$s_{u,UU,est.}$ = undrained shear strength assuming unconsolidated, undrained (UU) test conditions estimated based on assumed OCR

Client:	Atlantic Richfield Company		
Prepared by:	L. Selleck	Date:	10.14.17
Checked by:	R. Kilkenny	Date:	10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for PDGEO17
Analysis for 5.1 ft Fill

top elev =	4	ft NAVD88
h_{cap} =	5.1	ft
$h_{effective,\ post\ settlement}$ =	4.0	ft
$\gamma_{bulk,cap}$ =	120	pcf
Δp =	612	psf
t =	100	yrs
t_p =	9.3	yrs

														Secondary Compression			
Depth,z (ft bgs)	**Elevation (ft)**	**Soil Type**	**γ (pcf)**	**σ'v0 (psf)**	**Δp (psf)**	**σ'v0 + Δp (psf)**	**OCR**	**pc' (psf)**	**Ccε**	**Crε**	**Consolidation Settlement (ft)**	**Cumulative Consolidation Settlement (in.)**	**σ'v / σ'p**	**Cαε**	**Secondary Compression in in.***	**Cumulative Secondary Compression in in.**
22.0	-17.7	MS	106	1195.1	612	1807	1.00	1195	0.253	0.077	0.000	0.00				
22.5	-18.2	MS	106	1226.4	612	1838	1.00	1226	0.253	0.077	0.022	0.27	1.499	0.0127	0.08	0.08
23.0	-18.7	MS	106	1257.7	612	1870	1.00	1258	0.253	0.077	0.022	0.53	1.487	0.0127	0.08	0.16
23.5	-19.2	MS	106	1289.0	612	1901	1.00	1289	0.253	0.077	0.022	0.79	1.475	0.0127	0.08	0.24
24.0	-19.7	MS	106	1320.3	612	1932	1.00	1320	0.253	0.077	0.021	1.05	1.464	0.0127	0.08	0.31
24.5	-20.2	MS	106	1351.6	612	1964	1.00	1352	0.253	0.077	0.021	1.30	1.453	0.0127	0.08	0.39
25.0	-20.7	MS	106	1382.9	612	1995	1.00	1383	0.253	0.077	0.020	1.54	1.443	0.0127	0.08	0.47
25.5	-21.2	MS	106	1414.2	612	2026	1.00	1414	0.253	0.077	0.020	1.78	1.433	0.0127	0.08	0.55
26.0	-21.7	MS	106	1445.5	612	2058	1.00	1446	0.253	0.077	0.020	2.01	1.423	0.0127	0.08	0.63
26.5	-22.2	MS	106	1476.8	612	2089	1.00	1477	0.253	0.077	0.019	2.24	1.414	0.0127	0.08	0.71
27.0	-22.7	MS	106	1508.1	612	2120	1.00	1508	0.253	0.077	0.019	2.47	1.406	0.0127	0.08	0.78
27.5	-23.2	MS	106	1534.7	612	2147	1.00	1535	0.253	0.077	0.019	2.69	1.399	0.0127	0.08	0.86
28.0	-23.7	MS	106	1556.6	612	2169	1.00	1557	0.253	0.077	0.018	2.91	1.393	0.0127	0.08	0.94
28.5	-24.2	MS	106	1578.4	612	2190	1.00	1578	0.253	0.077	0.018	3.13	1.388	0.0127	0.08	1.02
29.0	-24.7	MS	106	1600.3	612	2212	1.00	1600	0.253	0.077	0.018	3.35	1.382	0.0127	0.08	1.10
29.5	-25.2	MS	106	1622.2	612	2234	1.00	1622	0.253	0.077	0.018	3.56	1.377	0.0127	0.08	1.18
30.0	-25.7	MS	106	1644.0	612	2256	1.00	1644	0.253	0.077	0.017	3.77	1.372	0.0127	0.08	1.25
30.5	-26.2	MS	106	1665.9	612	2278	1.00	1666	0.253	0.077	0.017	3.98	1.367	0.0127	0.08	1.33
31.0	-26.7	MS	106	1687.7	612	2300	1.00	1688	0.253	0.077	0.017	4.18	1.363	0.0127	0.08	1.41
31.5	-27.2	MS	106	1709.6	612	2322	1.00	1710	0.253	0.077	0.017	4.39	1.358	0.0127	0.08	1.49
32.0	-27.7	MS	106	1731.4	612	2343	1.00	1731	0.253	0.077	0.017	4.59	1.353	0.0127	0.08	1.57
32.5	-28.2	MS	106	1753.3	612	2365	1.00	1753	0.253	0.077	0.017	4.78	1.349	0.0127	0.08	1.65
33.0	-28.7	MS	106	1775.2	612	2387	1.00	1775	0.253	0.077	0.016	4.98	1.345	0.0127	0.08	1.72
33.5	-29.2	MS	106	1797.0	612	2409	1.00	1797	0.253	0.077	0.016	5.18	1.341	0.0127	0.08	1.80
34.0	-29.7	MS	106	1818.9	612	2431	1.00	1819	0.253	0.077	0.016	5.37	1.336	0.0127	0.08	1.88
34.5	-30.2	MS	106	1840.7	612	2453	1.00	1841	0.253	0.077	0.016	5.56	1.332	0.0127	0.08	1.96
35.0	-30.7	MS	106	1862.6	612	2475	1.00	1863	0.253	0.077	0.016	5.75	1.329	0.0127	0.08	2.04
35.5	-31.2	MS	106	1884.5	612	2496	1.00	1884	0.253	0.077	0.016	5.93	1.325	0.0127	0.08	2.12
36.0	-31.7	MS	106	1906.3	612	2518	1.00	1906	0.253	0.077	0.015	6.12	1.321	0.0127	0.08	2.19
36.5	-32.2	MS	106	1928.2	612	2540	1.00	1928	0.253	0.077	0.015	6.30	1.317	0.0127	0.08	2.27
37.0	-32.7	MS	106	1950.0	612	2562	1.00	1950	0.253	0.077	0.015	6.48	1.314	0.0127	0.08	2.35
37.5	-33.2	MS	106	1971.9	612	2584	1.00	1972	0.253	0.077	0.015	6.66	1.310	0.0127	0.08	2.43
38.0	-33.7	MS	106	1993.7	612	2606	1.00	1994	0.253	0.077	0.015	6.84	1.307	0.0127	0.08	2.51
38.5	-34.2	MS	106	2015.6	612	2628	1.00	2016	0.253	0.077	0.015	7.01	1.304	0.0127	0.08	2.59
39.0	-34.7	MS	106	2037.5	612	2649	1.00	2037	0.253	0.077	0.015	7.19	1.300	0.0127	0.08	2.66
39.5	-35.2	MS	106	2059.3	612	2671	1.00	2059	0.253	0.077	0.014	7.36	1.297	0.0127	0.08	2.74
40.0	-35.7	MS	106	2081.2	612	2693	1.00	2081	0.253	0.077	0.014	7.53	1.294	0.0127	0.08	2.82
40.5	-36.2	MS	106	2103.0	612	2715	1.00	2103	0.253	0.077	0.014	7.70	1.291	0.0127	0.08	2.90

41.0	-36.7	MS	106	2124.9	612	2737	1.00	2125	0.253	0.077	0.014	7.87	1.288	0.0127	0.08	2.98
41.5	-37.2	MS	106	2146.8	612	2759	1.00	2147	0.253	0.077	0.014	8.03	1.285	0.0127	0.08	3.06
42.0	-37.7	MS	106	2168.6	612	2781	1.00	2169	0.253	0.077	0.014	8.20	1.282	0.0127	0.08	3.13
42.5	-38.2	MS	106	2190.5	612	2802	1.00	2190	0.253	0.077	0.014	8.36	1.279	0.0127	0.08	3.21
43.0	-38.7	MS	106	2212.3	612	2824	1.00	2212	0.253	0.077	0.013	8.52	1.277	0.0127	0.08	3.29
43.5	-39.2	MS	106	2234.2	612	2846	1.00	2234	0.253	0.077	0.013	8.68	1.274	0.0127	0.08	3.37
44.0	-39.7	MS	106	2256.0	612	2868	1.00	2256	0.253	0.077	0.013	8.84	1.271	0.0127	0.08	3.45
44.5	-40.2	MS	106	2277.9	612	2890	1.00	2278	0.253	0.077	0.013	9.00	1.269	0.0127	0.08	3.53
45.0	-40.7	MS	106	2299.8	612	2912	1.00	2300	0.253	0.077	0.013	9.16	1.266	0.0127	0.08	3.60
45.5	-41.2	MS	106	2321.6	612	2934	1.00	2322	0.253	0.077	0.013	9.31	1.264	0.0127	0.08	3.68
46.0	-41.7	MS	106	2343.5	612	2955	1.00	2343	0.253	0.077	0.013	9.47	1.261	0.0127	0.08	3.76
46.5	-42.2	MS	106	2365.3	612	2977	1.00	2365	0.253	0.077	0.013	9.62	1.259	0.0127	0.08	3.84
47.0	-42.7	MS	106	2387.2	612	2999	1.00	2387	0.253	0.077	0.013	9.77	1.256	0.0127	0.08	3.92
47.5	-43.2	MS	106	2409.1	612	3021	1.00	2409	0.253	0.077	0.012	9.92	1.254	0.0127	0.08	4.00
48.0	-43.7	MS	106	2430.9	612	3043	1.00	2431	0.253	0.077	0.012	10.07	1.252	0.0127	0.08	4.07
48.5	-44.2	MS	106	2452.8	612	3065	1.00	2453	0.253	0.077	0.012	10.22	1.250	0.0127	0.08	4.15
49.0	-44.7	MS	106	2474.6	612	3087	1.00	2475	0.253	0.077	0.012	10.36	1.247	0.0127	0.08	4.23
49.5	-45.2	MS	106	2496.5	612	3108	1.00	2496	0.253	0.077	0.012	10.51	1.245	0.0127	0.08	4.31
50.0	-45.7	MS	106	2518.3	612	3130	1.00	2518	0.253	0.077	0.012	10.65	1.243	0.0127	0.08	4.39
50.5	-46.2	MS	106	2540.2	612	3152	1.00	2540	0.253	0.077	0.012	10.79	1.241	0.0127	0.08	4.47
51.0	-46.7	MS	106	2562.1	612	3174	1.00	2562	0.253	0.077	0.012	10.94	1.239	0.0127	0.08	4.54
51.5	-47.2	MS	106	2583.9	612	3196	1.00	2584	0.253	0.077	0.012	11.08	1.237	0.0127	0.08	4.62
52.0	-47.7	MS	106	2605.8	612	3218	1.00	2606	0.253	0.077	0.012	11.22	1.235	0.0127	0.08	4.70
52.5	-48.2	MS	106	2627.6	612	3240	1.00	2628	0.253	0.077	0.012	11.36	1.233	0.0127	0.08	4.78
53.0	-48.7	MS	106	2649.5	612	3261	1.00	2649	0.253	0.077	0.011	11.49	1.231	0.0127	0.08	4.86
53.5	-49.2	MS	106	2671.4	612	3283	1.00	2671	0.253	0.077	0.011	11.63	1.229	0.0127	0.08	4.94
54.0	-49.7	MS	106	2693.2	612	3305	1.00	2693	0.253	0.077	0.011	11.76	1.227	0.0127	0.08	5.01
54.5	-50.2	MS	106	2715.1	612	3327	1.00	2715	0.253	0.077	0.011	11.90	1.225	0.0127	0.08	5.09
55.0	-50.7	MS	106	2736.9	612	3349	1.00	2737	0.253	0.077	0.011	12.03	1.224	0.0127	0.08	5.17
55.5	-51.2	MS	106	2758.8	612	3371	1.00	2759	0.253	0.077	0.011	12.17	1.222	0.0127	0.08	5.25
56.0	-51.7	MS	106	2780.6	612	3393	1.00	2781	0.253	0.077	0.011	12.30	1.220	0.0127	0.08	5.33
56.5	-52.2	MS	106	2802.5	612	3415	1.00	2803	0.253	0.077	0.011	12.43	1.218	0.0127	0.08	5.41
57.0	-52.7	MS	106	2824.4	612	3436	1.00	2824	0.253	0.077	0.011	12.56	1.217	0.0127	0.08	5.48
57.5	-53.2	MS	106	2846.2	612	3458	1.00	2846	0.253	0.077	0.011	12.69	1.215	0.0127	0.08	5.56
58.0	-53.7	MS	106	2868.1	612	3480	1.00	2868	0.253	0.077	0.011	12.81	1.213	0.0127	0.08	5.64
58.5	-54.2	MS	106	2889.9	612	3502	1.00	2890	0.253	0.077	0.011	12.94	1.212	0.0127	0.08	5.72
59.0	-54.7	MS	106	2911.8	612	3524	1.00	2912	0.253	0.077	0.011	13.07	1.210	0.0127	0.08	5.80
			average	2095.4							total settlement (ft.) =	1.09			total settlement (ft.) =	0.48

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)

c_{cc} = modified compression index (aka compression ratio) of cohesive soil

c_{rc} = modified recompression index (aka recompression ratio) of cohesive soil

E_s = Young's modulus of upper granular soil

ν = Poisson's ratio of upper granular soil

ft bgs = feet below ground surface

z = depth

γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

Δp = stress increase below load

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

Client: Atlantic Richfield Company
Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Cap Material at DRB10
Analysis for Low End Compressibility

Average Depth to Water = 3.7 ft bgs
γ_w = 62.4 pcf

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	Assumed OCR profile OCR	Assumed OCR profile p'_c (psf)
0	FILL	125	0.0	0.0	0.0		0.0
0.5	FILL	125	62.5	0.0	62.5	1	62.5
1	FILL	125	125.0	0.0	125.0	1	125.0
1.5	FILL	125	187.5	0.0	187.5	1	187.5
2	FILL	125	250.0	0.0	250.0	1	250.0
2.5	FILL	125	312.5	0.0	312.5	1	312.5
3	FILL	125	375.0	0.0	375.0	1	375.0
3.5	FILL	125	437.5	0.0	437.5	1	437.5
4	FILL	125	500.0	18.7	481.3	1	481.3
4.5	FILL	125	562.5	49.9	512.6	1	512.6
5	FILL	125	625.0	81.1	543.9	1	543.9
5.5	FILL	125	687.5	112.3	575.2	1	575.2
6	FILL	125	750.0	143.5	606.5	1	606.5
6.5	FILL	125	812.5	174.7	637.8	1	637.8
7	FILL	125	875.0	205.9	669.1	1	669.1
7.5	FILL	125	937.5	237.1	700.4	1	700.4
8	FILL	125	1000.0	268.3	731.7	1	731.7
8.5	FILL	125	1062.5	299.5	763.0	1	763.0
9	FILL	125	1125.0	330.7	794.3	1	794.3
9.5	FILL	125	1187.5	361.9	825.6	1	825.6
10	FILL	125	1250.0	393.1	856.9	1	856.9
10.5	FILL	125	1312.5	424.3	888.2	1	888.2
11	FILL	125	1375.0	455.5	919.5	1	919.5
11.5	FILL	125	1437.5	486.7	950.8	1	950.8
12	FILL	125	1500.0	517.9	982.1	1	982.1
12.5	FILL	125	1562.5	549.1	1013.4	1	1013.4
13	FILL	125	1625.0	580.3	1044.7	1	1044.7
13.5	FILL	125	1687.5	611.5	1076.0	1	1076.0
14	FILL	125	1750.0	642.7	1107.3	1	1107.3
14.5	FILL	125	1812.5	673.9	1138.6	1	1138.6
15	MS	106	1870.3	705.1	1165.2	1	1165.2
15.5	MS	106	1923.3	736.3	1187.0	1	1187.0
16	MS	106	1976.4	767.5	1208.9	1	1208.9
16.5	MS	106	2029.5	798.7	1230.7	1	1230.7
17	MS	106	2082.5	829.9	1252.6	1	1252.6
17.5	MS	106	2135.6	861.1	1274.5	1	1274.5
18	MS	106	2188.6	892.3	1296.3	1	1296.3
18.5	MS	106	2241.7	923.5	1318.2	1	1318.2
19	MS	106	2294.7	954.7	1340.0	1	1340.0

Depth, z (ft bgs)	Soil Type	g (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
19.5	MS	106	2347.8	985.9	1361.9	1	1361.9
20	MS	106	2400.9	1017.1	1383.7	1	1383.7
20.5	MS	106	2453.9	1048.3	1405.6	1	1405.6
21	MS	106	2507.0	1079.5	1427.5	1	1427.5
21.5	MS	106	2560.0	1110.7	1449.3	1	1449.3
22	MS	106	2613.1	1141.9	1471.2	1	1471.2
22.5	MS	106	2666.2	1173.1	1493.0	1	1493.0
23	MS	106	2719.2	1204.3	1514.9	1	1514.9
23.5	MS	106	2772.3	1235.5	1536.8	1	1536.8
24	MS	106	2825.3	1266.7	1558.6	1	1558.6
24.5	MS	106	2878.4	1297.9	1580.5	1	1580.5
25	MS	106	2931.4	1329.1	1602.3	1	1602.3
25.5	MS	106	2984.5	1360.3	1624.2	1	1624.2
26	MS	106	3037.6	1391.5	1646.0	1	1646.0
26.5	MS	106	3090.6	1422.7	1667.9	1	1667.9
27	MS	106	3143.7	1453.9	1689.8	1	1689.8
27.5	MS	106	3196.7	1485.1	1711.6	1	1711.6
28	MS	106	3249.8	1516.3	1733.5	1	1733.5
28.5	MS	106	3302.9	1547.5	1755.3	1	1755.3
29	MS	106	3355.9	1578.7	1777.2	1	1777.2
29.5	MS	106	3409.0	1609.9	1799.1	1	1799.1
30	MS	106	3462.0	1641.1	1820.9	1	1820.9
30.5	MS	106	3515.1	1672.3	1842.8	1	1842.8
31	MS	106	3568.1	1703.5	1864.6	1	1864.6
31.5	MS	106	3621.2	1734.7	1886.5	1	1886.5
32	BASAL SAND	125	3679.0	1765.9	1913.1	1	1913.1
32.5	BASAL SAND	125	3741.5	1797.1	1944.4	1	1944.4
33	BASAL SAND	125	3804.0	1828.3	1975.7	1	1975.7
33.5	BASAL SAND	125	3866.5	1859.5	2007.0	1	2007.0
34	BASAL SAND	125	3929.0	1890.7	2038.3	1	2038.3

ft bgs = feet below ground surface
z = depth
γ_w = unit weight of water; γ = unit weight of soil
γ = unit weight of soil
σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress
OCR = overconsolidation ratio (assumed)
p'_c = preconsolidation stress (aka maximum past effective stress)
$s_{u,UU,est.}$ = undrained shear strength assuming unconsolidated, undrained (UU) test conditions estimated based on assumed OCR

Client: Atlantic Richfield Company
Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for DRB10 (+11 ft NAVD88)
Analysis for 5.8 ft Fill

top elev =	6	ft NAVD88
h_{cap} =	5.8	ft
$h_{effective,\ post\ settlement}$ =	5	ft
$\gamma_{bulk,cap}$ =	120	pcf
Δp =	696	psf
t =	100	yrs
t_p =	9.3	yrs

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	C_{c_c}	C_{r_c}	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression in in.*	Cumulative Secondary Compression in in.
														Secondary Compression		
15.0	-9.0	MS	106	919.5	696	1615	1.00	919	0.253	0.077	0.000	0.00	1.757			
15.5	-9.5	MS	106	950.8	696	1647	1.00	951	0.253	0.077	0.031	0.37	1.732	0.0127	0.08	0.08
16.0	-10.0	MS	106	982.1	696	1678	1.00	982	0.253	0.077	0.030	0.72	1.709	0.0127	0.08	0.16
16.5	-10.5	MS	106	1013.4	696	1709	1.00	1013	0.253	0.077	0.029	1.07	1.687	0.0127	0.08	0.24
17.0	-11.0	MS	106	1044.7	696	1741	1.00	1045	0.253	0.077	0.028	1.41	1.666	0.0127	0.08	0.31
17.5	-11.5	MS	106	1076.0	696	1772	1.00	1076	0.253	0.077	0.028	1.75	1.647	0.0127	0.08	0.39
18.0	-12.0	MS	106	1107.3	696	1803	1.00	1107	0.253	0.077	0.027	2.07	1.629	0.0127	0.08	0.47
18.5	-12.5	MS	106	1138.6	696	1835	1.00	1139	0.253	0.077	0.027	2.39	1.611	0.0127	0.08	0.55
19.0	-13.0	MS	106	1165.2	696	1861	1.00	1165	0.253	0.077	0.026	2.70	1.597	0.0127	0.08	0.63
19.5	-13.5	MS	106	1187.0	696	1883	1.00	1187	0.253	0.077	0.026	3.01	1.586	0.0127	0.08	0.71
20.0	-14.0	MS	106	1208.9	696	1905	1.00	1209	0.253	0.077	0.025	3.31	1.576	0.0127	0.08	0.78
20.5	-14.5	MS	106	1230.7	696	1927	1.00	1231	0.253	0.077	0.025	3.61	1.566	0.0127	0.08	0.86
21.0	-15.0	MS	106	1252.6	696	1949	1.00	1253	0.253	0.077	0.024	3.90	1.556	0.0127	0.08	0.94
21.5	-15.5	MS	106	1274.5	696	1970	1.00	1274	0.253	0.077	0.024	4.19	1.546	0.0127	0.08	1.02
22.0	-16.0	MS	106	1296.3	696	1992	1.00	1296	0.253	0.077	0.024	4.48	1.537	0.0127	0.08	1.10
22.5	-16.5	MS	106	1318.2	696	2014	1.00	1318	0.253	0.077	0.023	4.76	1.528	0.0127	0.08	1.18
23.0	-17.0	MS	106	1340.0	696	2036	1.00	1340	0.253	0.077	0.023	5.04	1.519	0.0127	0.08	1.25
23.5	-17.5	MS	106	1361.9	696	2058	1.00	1362	0.253	0.077	0.023	5.31	1.511	0.0127	0.08	1.33
24.0	-18.0	MS	106	1383.7	696	2080	1.00	1384	0.253	0.077	0.023	5.58	1.503	0.0127	0.08	1.41
24.5	-18.5	MS	106	1405.6	696	2102	1.00	1406	0.253	0.077	0.022	5.85	1.495	0.0127	0.08	1.49
25.0	-19.0	MS	106	1427.5	696	2123	1.00	1427	0.253	0.077	0.022	6.11	1.488	0.0127	0.08	1.57
25.5	-19.5	MS	106	1449.3	696	2145	1.00	1449	0.253	0.077	0.022	6.37	1.480	0.0127	0.08	1.65
26.0	-20.0	MS	106	1471.2	696	2167	1.00	1471	0.253	0.077	0.021	6.63	1.473	0.0127	0.08	1.72
26.5	-20.5	MS	106	1493.0	696	2189	1.00	1493	0.253	0.077	0.021	6.88	1.466	0.0127	0.08	1.80
27.0	-21.0	MS	106	1514.9	696	2211	1.00	1515	0.253	0.077	0.021	7.14	1.459	0.0127	0.08	1.88
27.5	-21.5	MS	106	1536.8	696	2233	1.00	1537	0.253	0.077	0.021	7.38	1.453	0.0127	0.08	1.96
28.0	-22.0	MS	106	1558.6	696	2255	1.00	1559	0.253	0.077	0.020	7.63	1.447	0.0127	0.08	2.04
28.5	-22.5	MS	106	1580.5	696	2276	1.00	1580	0.253	0.077	0.020	7.87	1.440	0.0127	0.08	2.12
29.0	-23.0	MS	106	1602.3	696	2298	1.00	1602	0.253	0.077	0.020	8.11	1.434	0.0127	0.08	2.19
29.5	-23.5	MS	106	1624.2	696	2320	1.00	1624	0.253	0.077	0.020	8.35	1.429	0.0127	0.08	2.27
30.0	-24.0	MS	106	1646.0	696	2342	1.00	1646	0.253	0.077	0.019	8.58	1.423	0.0127	0.08	2.35
30.5	-24.5	MS	106	1667.9	696	2364	1.00	1668	0.253	0.077	0.019	8.81	1.417	0.0127	0.08	2.43
31.0	-25.0	MS	106	1689.8	696	2386	1.00	1690	0.253	0.077	0.019	9.04	1.412	0.0127	0.08	2.51
31.5	-25.5	MS	106	1711.6	696	2408	1.00	1712	0.253	0.077	0.019	9.27	1.407	0.0127	0.08	2.59
			average	1342.1							total settlement (ft.) =	0.77			total settlement (ft.) =	0.22

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)
c_{c_c} = modified compression index (aka compression ratio) of cohesive soil
c_{r_c} = modified recompression index (aka recompression ratio) of cohesive soil
E_s = Young's modulus of upper granular soil
ν = Poisson's ratio of upper granular soil
ft bgs = feet below ground surface
z = depth
γ = unit weight of soil
γ = unit weight of soil
σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress
Δp = stress increase below load
OCR = overconsolidation ratio (assumed)
p'_c = preconsolidation stress (aka maximum past effective stress)

DRAFT PRELIMINARY

Client: Atlantic Richfield Company
Prepared by: L. Selleck Date: 10.14.17
Checked by: R. Kilkenny Date: 10.15.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for DRB10 (+14 ft NAVD88)
Analysis for 9.1 ft Fill

top elev = 6 ft NAVD88
h_{cap} = 9.1 ft
$h_{effective,\ post\ settlement}$ = 8 ft
$\gamma_{bulk,cap}$ = 120 pcf
Δp = 1,092 psf
t = 100 yrs
t_p = 9.3 yrs

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	C_{cs}	C_{rs}	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	C_{as}	Secondary Compression in in.*	Cumulative Secondary Compression in in.
														Secondary Compression		
15.0	-9.0	MS	106	919.5	1092	2011	1.00	919	0.253	0.077	0.000	0.00	2.188			
15.5	-9.5	MS	106	950.8	1092	2043	1.00	951	0.253	0.077	0.043	0.51	2.149	0.0127	0.08	0.08
16.0	-10.0	MS	106	982.1	1092	2074	1.00	982	0.253	0.077	0.042	1.01	2.112	0.0127	0.08	0.16
16.5	-10.5	MS	106	1013.4	1092	2105	1.00	1013	0.253	0.077	0.041	1.50	2.078	0.0127	0.08	0.24
17.0	-11.0	MS	106	1044.7	1092	2137	1.00	1045	0.253	0.077	0.040	1.97	2.045	0.0127	0.08	0.31
17.5	-11.5	MS	106	1076.0	1092	2168	1.00	1076	0.253	0.077	0.039	2.44	2.015	0.0127	0.08	0.39
18.0	-12.0	MS	106	1107.3	1092	2199	1.00	1107	0.253	0.077	0.038	2.90	1.986	0.0127	0.08	0.47
18.5	-12.5	MS	106	1138.6	1092	2231	1.00	1139	0.253	0.077	0.037	3.35	1.959	0.0127	0.08	0.55
19.0	-13.0	MS	106	1165.2	1092	2257	1.00	1165	0.253	0.077	0.037	3.79	1.937	0.0127	0.08	0.63
19.5	-13.5	MS	106	1187.0	1092	2279	1.00	1187	0.253	0.077	0.036	4.22	1.920	0.0127	0.08	0.71
20.0	-14.0	MS	106	1208.9	1092	2301	1.00	1209	0.253	0.077	0.036	4.65	1.903	0.0127	0.08	0.78
20.5	-14.5	MS	106	1230.7	1092	2323	1.00	1231	0.253	0.077	0.035	5.07	1.887	0.0127	0.08	0.86
21.0	-15.0	MS	106	1252.6	1092	2345	1.00	1253	0.253	0.077	0.035	5.48	1.872	0.0127	0.08	0.94
21.5	-15.5	MS	106	1274.5	1092	2366	1.00	1274	0.253	0.077	0.034	5.90	1.857	0.0127	0.08	1.02
22.0	-16.0	MS	106	1296.3	1092	2388	1.00	1296	0.253	0.077	0.034	6.30	1.842	0.0127	0.08	1.10
22.5	-16.5	MS	106	1318.2	1092	2410	1.00	1318	0.253	0.077	0.033	6.70	1.828	0.0127	0.08	1.18
23.0	-17.0	MS	106	1340.0	1092	2432	1.00	1340	0.253	0.077	0.033	7.10	1.815	0.0127	0.08	1.25
23.5	-17.5	MS	106	1361.9	1092	2454	1.00	1362	0.253	0.077	0.033	7.49	1.802	0.0127	0.08	1.33
24.0	-18.0	MS	106	1383.7	1092	2476	1.00	1384	0.253	0.077	0.032	7.87	1.789	0.0127	0.08	1.41
24.5	-18.5	MS	106	1405.6	1092	2498	1.00	1406	0.253	0.077	0.032	8.26	1.777	0.0127	0.08	1.49
25.0	-19.0	MS	106	1427.5	1092	2519	1.00	1427	0.253	0.077	0.031	8.63	1.765	0.0127	0.08	1.57
25.5	-19.5	MS	106	1449.3	1092	2541	1.00	1449	0.253	0.077	0.031	9.01	1.753	0.0127	0.08	1.65
26.0	-20.0	MS	106	1471.2	1092	2563	1.00	1471	0.253	0.077	0.031	9.37	1.742	0.0127	0.08	1.72
26.5	-20.5	MS	106	1493.0	1092	2585	1.00	1493	0.253	0.077	0.030	9.74	1.731	0.0127	0.08	1.80
27.0	-21.0	MS	106	1514.9	1092	2607	1.00	1515	0.253	0.077	0.030	10.10	1.721	0.0127	0.08	1.88
27.5	-21.5	MS	106	1536.8	1092	2629	1.00	1537	0.253	0.077	0.030	10.45	1.711	0.0127	0.08	1.96
28.0	-22.0	MS	106	1558.6	1092	2651	1.00	1559	0.253	0.077	0.029	10.81	1.701	0.0127	0.08	2.04
28.5	-22.5	MS	106	1580.5	1092	2672	1.00	1580	0.253	0.077	0.029	11.15	1.691	0.0127	0.08	2.12
29.0	-23.0	MS	106	1602.3	1092	2694	1.00	1602	0.253	0.077	0.029	11.50	1.682	0.0127	0.08	2.19
29.5	-23.5	MS	106	1624.2	1092	2716	1.00	1624	0.253	0.077	0.028	11.84	1.672	0.0127	0.08	2.27
30.0	-24.0	MS	106	1646.0	1092	2738	1.00	1646	0.253	0.077	0.028	12.18	1.663	0.0127	0.08	2.35
30.5	-24.5	MS	106	1667.9	1092	2760	1.00	1668	0.253	0.077	0.028	12.51	1.655	0.0127	0.08	2.43
31.0	-25.0	MS	106	1689.8	1092	2782	1.00	1690	0.253	0.077	0.028	12.84	1.646	0.0127	0.08	2.51
31.5	-25.5	MS	106	1711.6	1092	2804	1.00	1712	0.253	0.077	0.027	13.17	1.638	0.0127	0.08	2.59
			average	1342.1							total settlement (ft.) =	1.10			total settlement (ft.) =	0.22

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)
c_{cc} = modified compression index (aka compression ratio) of cohesive soil
c_{rc} = modified recompression index (aka recompression ratio) of cohesive soil
E_s = Young's modulus of upper granular soil
ν = Poisson's ratio of upper granular soil
ft bgs = feet below ground surface
z = depth
γ = unit weight of soil
γ = unit weight of soil
σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress
Δp = stress increase below load
OCR = overconsolidation ratio (assumed)
p'_c = preconsolidation stress (aka maximum past effective stress)

DRAFT PRELIMINARY

Client:	BP			Hastings-On-Hudson
Prepared by:	A. Baird	Date:	10.14.17	Preliminary Design
Checked by:	R. Kilkenny	Date:	10.15.17	NW Extension Settlement Analysis
				October 2017
				Revision 0

Subject: Time-Rate of Consolidation with Pre-Compression Load

Magnitude of Expected Consolidation

Analysis Section	Existing Ground Surface (ft NAVD88)	Design Final Ground Surface (ft NAVD88)	Total Expected Primary Consolidatio	Total Fill Required (ft)
PDGEO18 (sloped shoreline)	4	8	0.7	4.7
PDGEO17 (open space)	4	8	1.1	5.1
DRB10 (to +11 ft NAVD88)	6	11	0.8	5.8
DRB10 (to +14 ft NAVD88)	6	14	1.1	9.1

$$t = \frac{T_v * {H_{dr}}^2}{C_v}$$

Time to Consolidate without Surcharge

Analysis Section	Cv (ft^2/sec)	Consolidation Time			
		t_{50}	t_{90}	t_{95}	t_{99}
PDGEO18 (sloped shoreline)	2.18933E-06	0.8	3.4	4.6	7.2
PDGEO17 (open space)	2.18933E-06	1.0	4.4	5.8	9.2
DRB10 (to +11 ft NAVD88)	2.18933E-06	0.2	0.9	1.2	1.9
DRB10 (to +14 ft NAVD88)	2.18933E-06	0.2	0.9	1.2	1.9

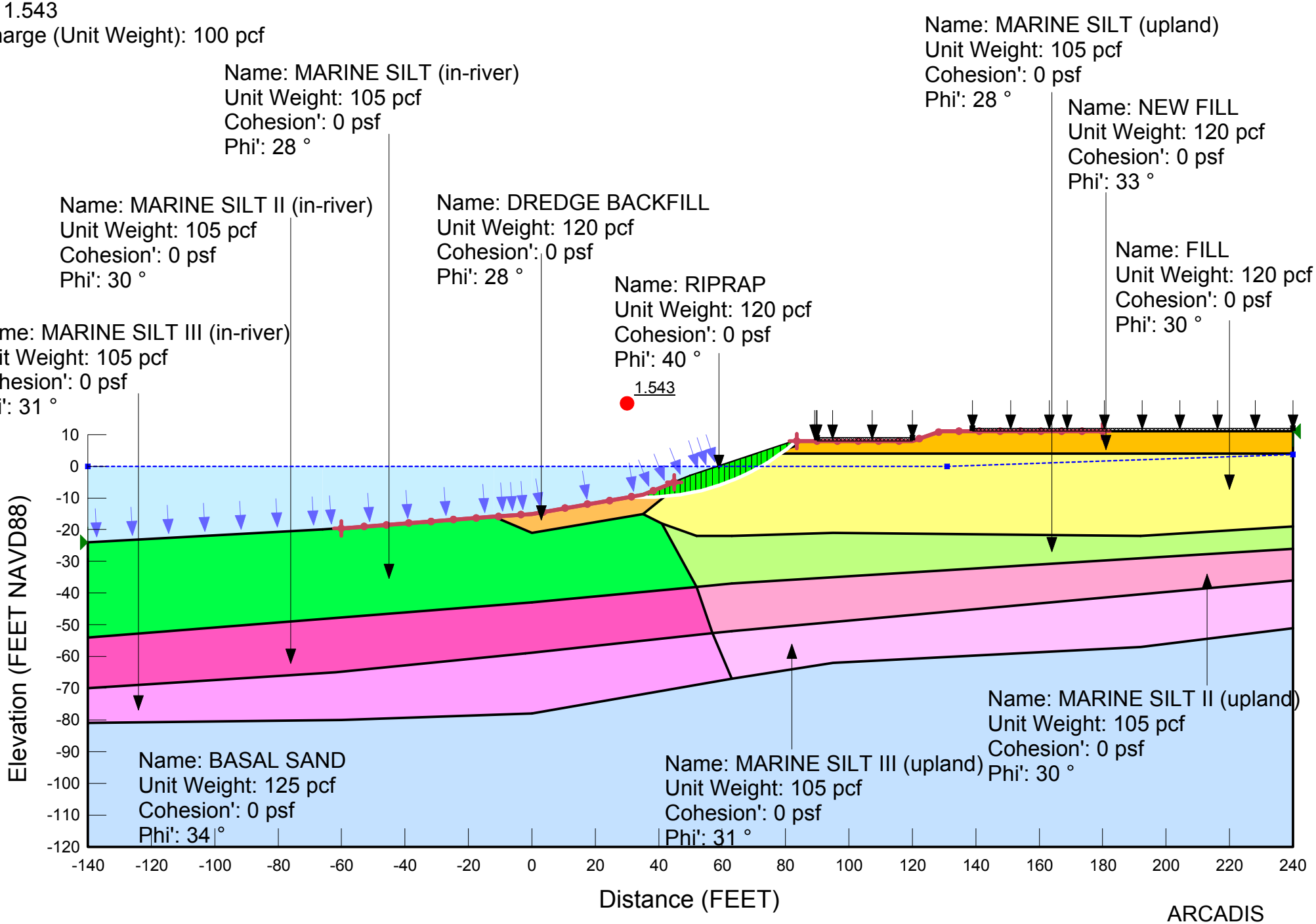
Precompression Load Calculation

Design Section	PDGEO18 (sloped shoreline)	PDGEO17 (open space)	DRB10 (to +11 ft NAVD88)	DRB10 (to +14 ft NAVD88)	
Additional Design Load (σ_p) (psf)	564	612	696	1,092	
Average effective overburden (σ_0) (psf)	2,514	2,095	1,342	1,342	
Cv (ft^2/year)	69	69	69	69	
Drainage Height H_{dr} (ft)	*35.5*	*29.65*	*16*	*16*	
Surcharge Fill Height (ft)	*6*	*6*	*6*	*6*	Input
Preload (σ_f) (psf)	720	720	720	720	
σ_p/σ_0	0.22	0.29	0.52	0.81	
σ_f/σ_p	1.28	1.18	1.03	0.66	
U (%)	49.1	52.1	58.0	69.7	
Tv (Table 10.6)	0.0803	0.221	0.267	0.403	Must be Manually Updated After Every Change
Time to Settlement of Final Design Load (t_2) (years)	1.5	2.8	1.0	1.5	

Attachment D

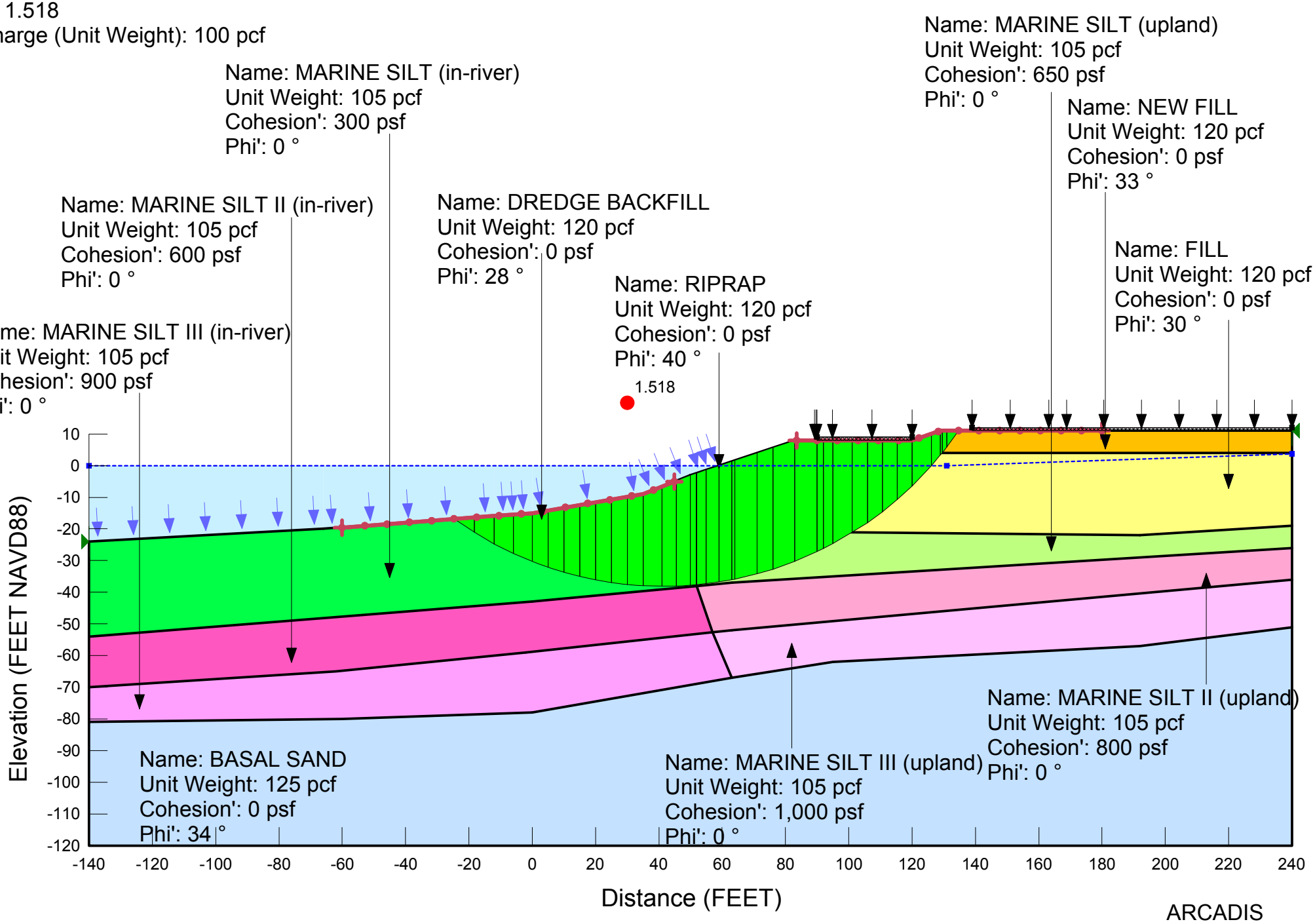
Slope/W Results

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Date: 11/4/2017
Method: Spencer
FOS: 1.543
Surcharge (Unit Weight): 100 pcf



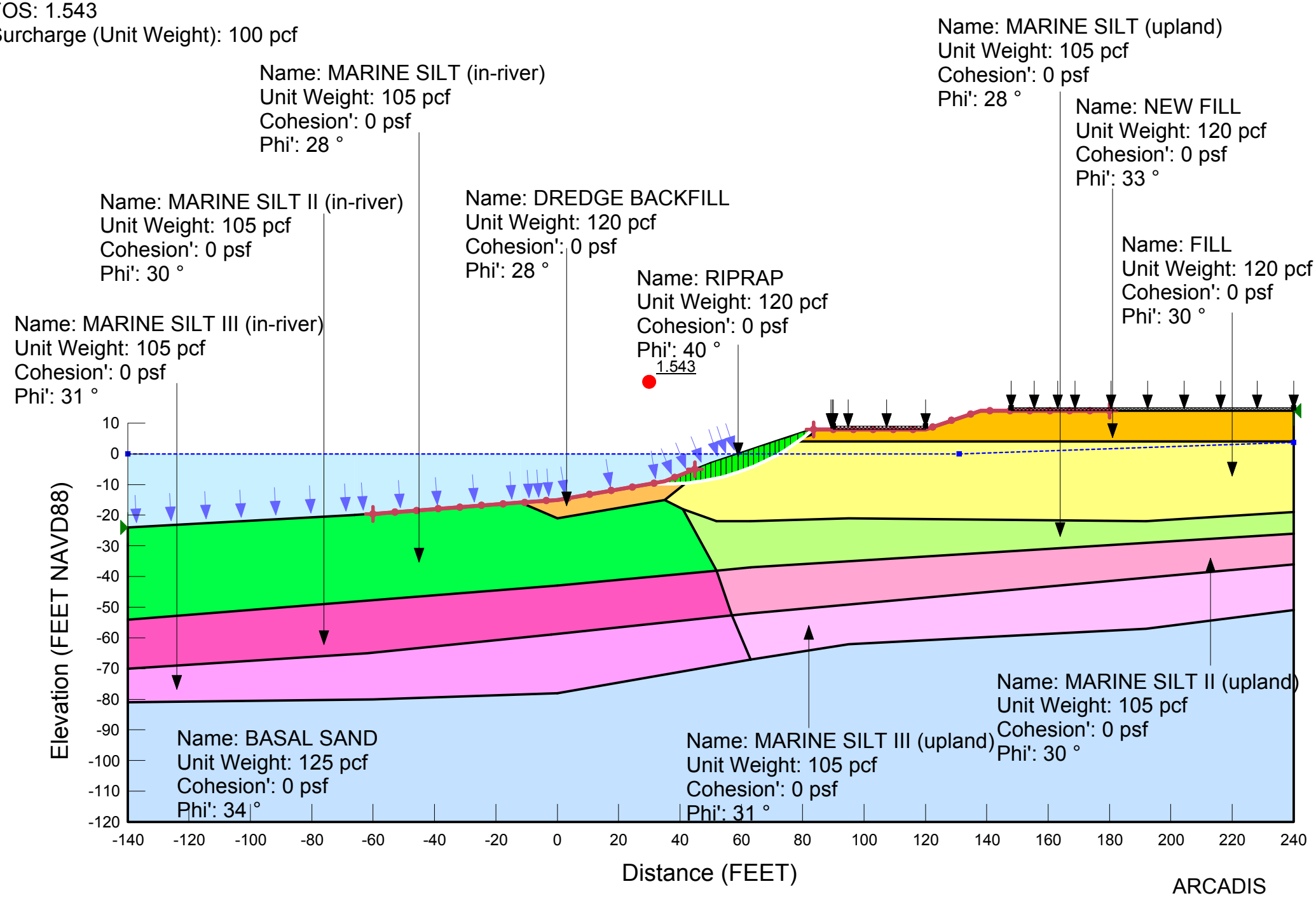
ARCADIS

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Date: 11/4/2017
Method: Spencer
FOS: 1.518
Surcharge (Unit Weight): 100 pcf



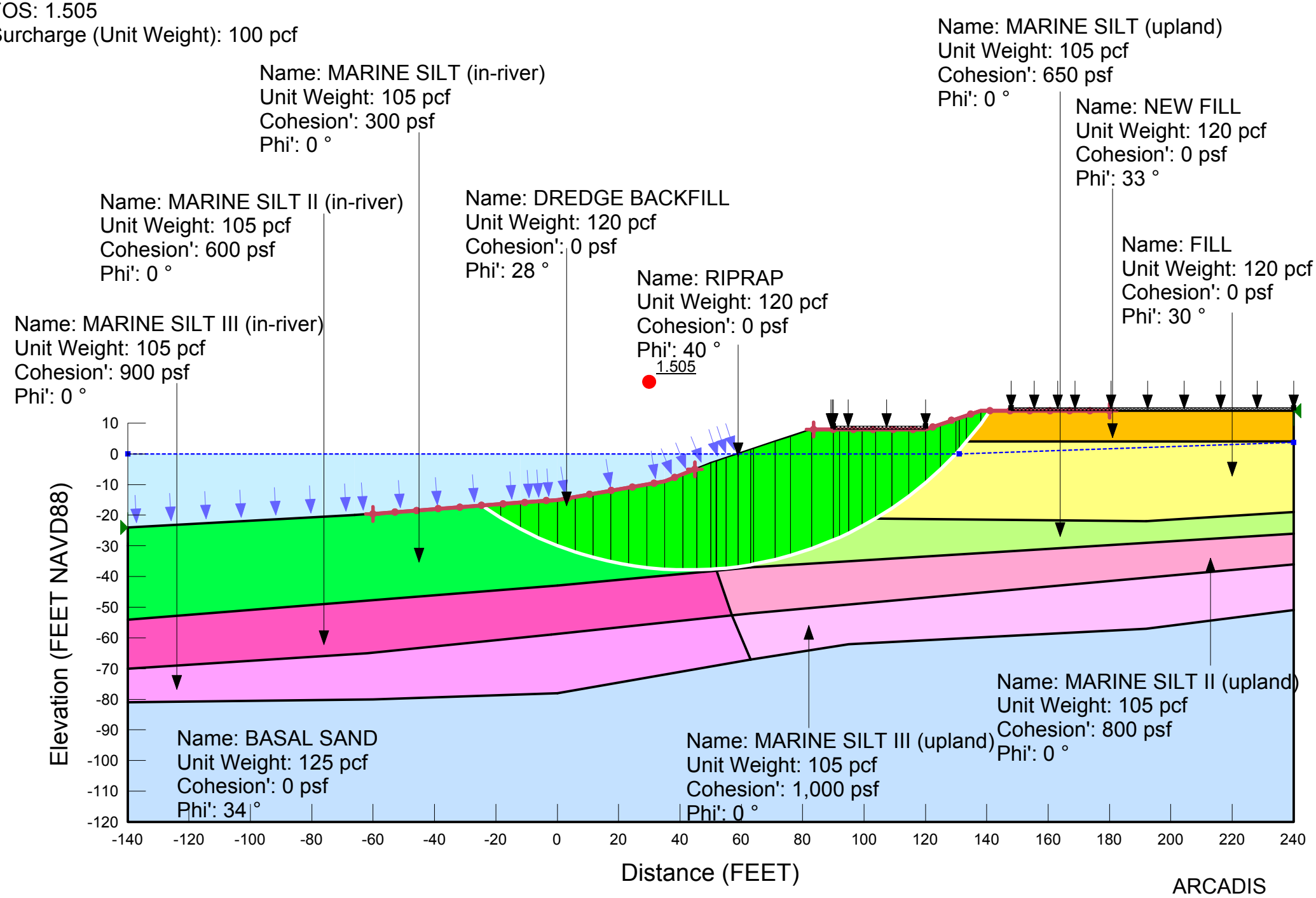
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Date: 11/4/2017
Method: Spencer
FOS: 1.543
Surcharge (Unit Weight): 100 pcf



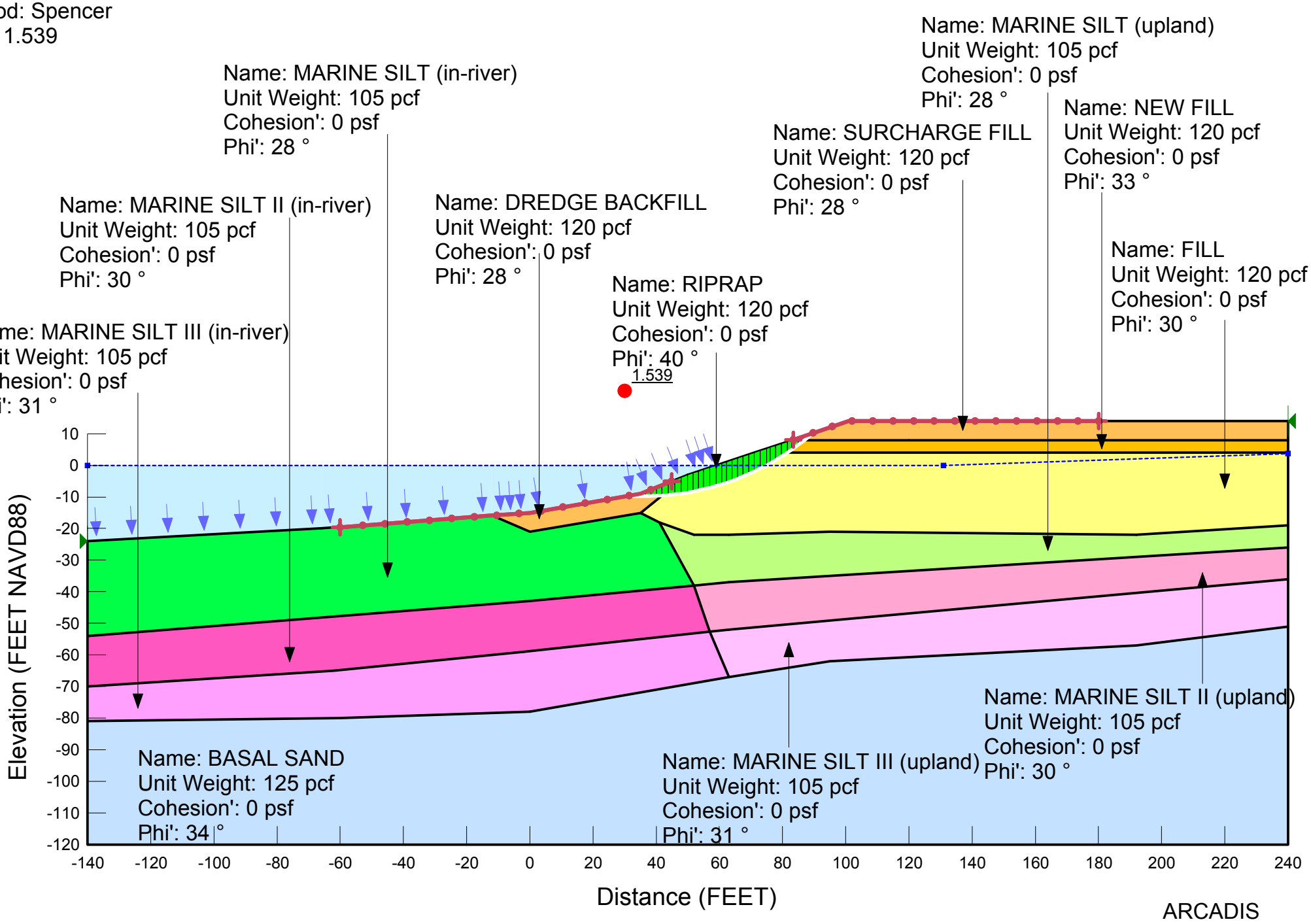
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Date: 11/4/2017
Method: Spencer
FOS: 1.505
Surcharge (Unit Weight): 100 pcf



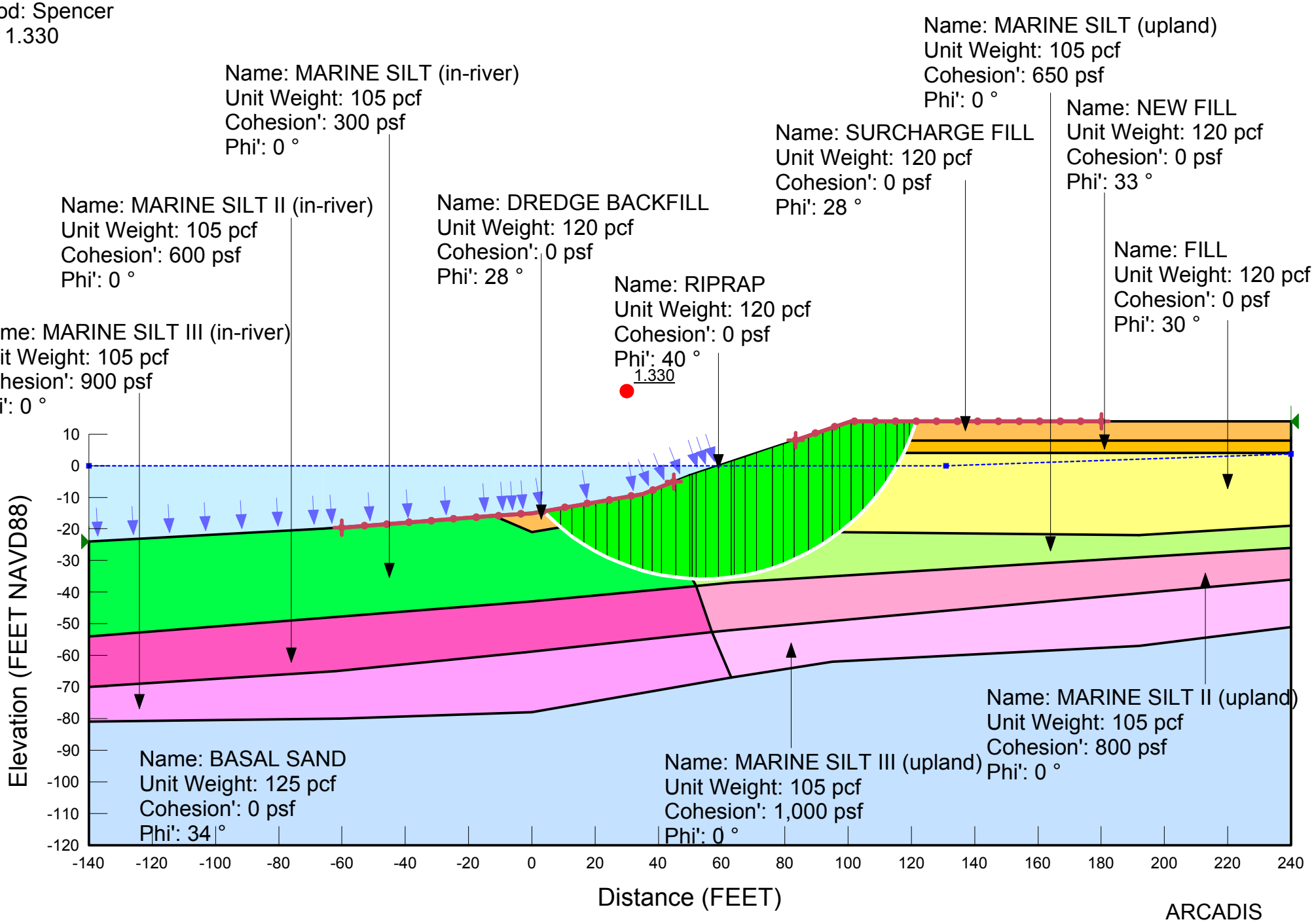
ARCADIS

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Date: 11/4/2017
Method: Spencer
FOS: 1.539



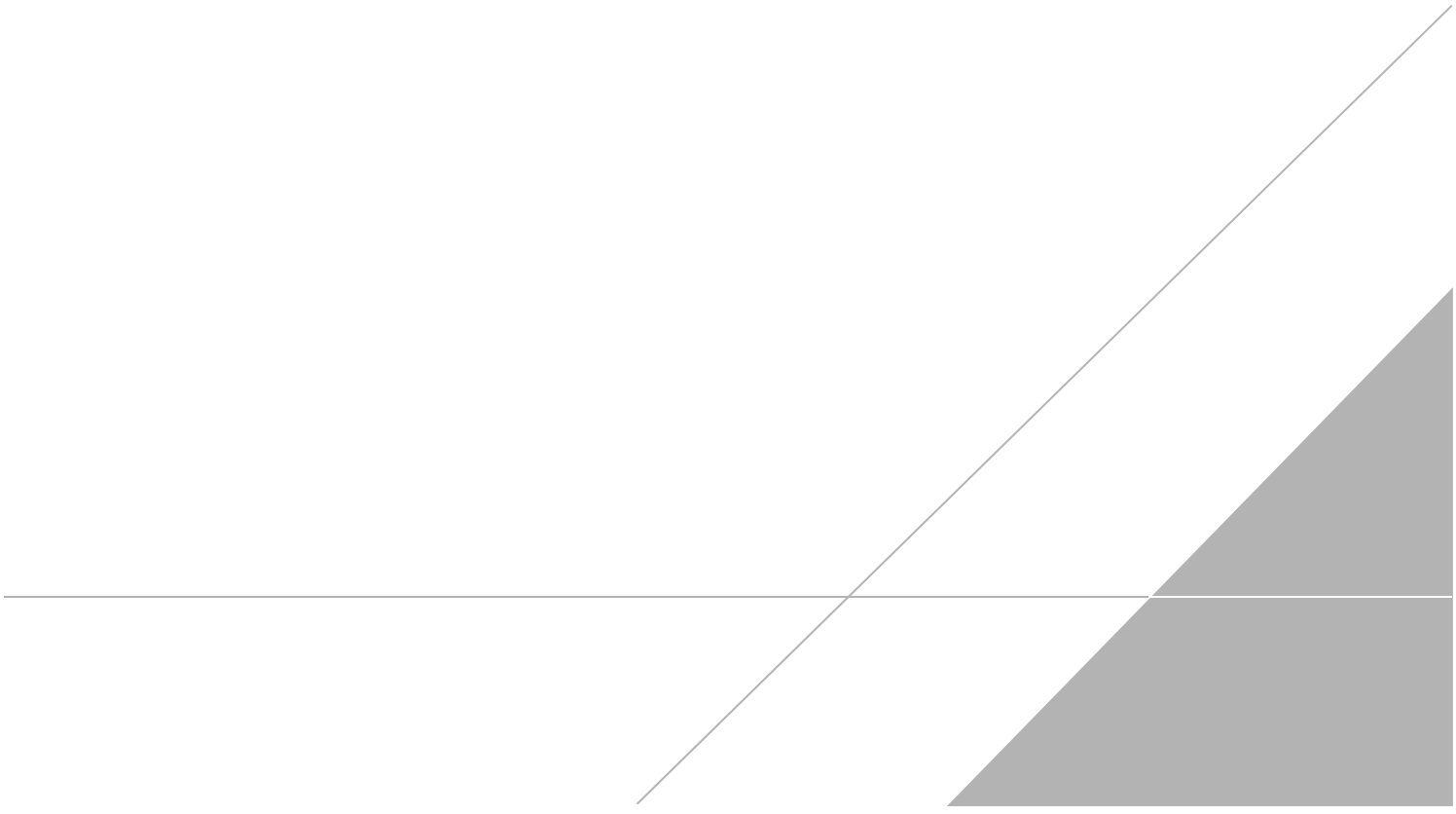
ARCADIS

File Name: 1 Final_undrained_precompression.gsz
Created By: Matthews, Tyler
Date: 11/4/2017
Method: Spencer
FOS: 1.330



ARCADIS

In-Water Consolidation
Preliminary Design



Client: Atlantic Richfield Company **Project:** B0001701.0000

Prepared by: L. Selleck and A. Baird **Date:** 10/31/2017

Title: In-Water Consolidation Preliminary Design – Harbor at Hastings

Reviewed By: R. Kilkenny **Date:** 11/01/2017
A. Chwalibog **Date:** 11/28/2017

SUBJECT

Calculations for the installation and fill behind new bulkhead alignment at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

OBJECTIVE

Determine assumptions and requirements to:

- Calculate total settlement of three soil profiles within the new bulkhead alignment after filling to +6 ft. NAVD 88.
- Accelerate total consolidation time and minimize potential risk to anchored tieback bulkhead supports utilizing applied surcharge loads and possibly wick drains.

ATTACHMENTS

A. Geotechnical Laboratory Data Summary

B. Consolidation Settlement Calculations

ABBREVIATIONS

ARC	Atlantic Richfield Company
Arcadis	Arcadis U.S., Inc.
bss	below sediment surface
$C_{c\varepsilon}$	modified compression index
$C_{r\varepsilon}$	modified recompression index
DNAPL	dense non-aqueous phase liquid
ft.	feet
H&A	Haley & Aldrich of New York
MS	Marine Silt
NAVD 88	North American Vertical Datum of 1988
NEA	Northwest Extension Area
OCR	Overconsolidation ratio

OU	Operable Unit
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
psf	pound per square foot

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Wendel Architecture, Engineering, Surveying and Landscape Architecture, PC. Topographic Survey Dated: May 2013 and June 2014. Drawing Dated: 22 July 2014.

ENGINEERED REMEDY – GENERAL

The Site is located at 1 River Street, Hastings-on-Hudson, New York. The installation of a sheet pile wall within the Hudson River will provide containment and allow for the recovery of liquid PCB DNAPL offshore of the northwest corner of the site. After wall construction, fill will be added to the Northwest Extension Area (NEA) portion of the site. Consolidation settlement is calculated to anticipate and accelerate consolidation times and therefore minimize potential risk to tieback anchors. This report summarizes the calculations for consolidation settlement in the proposed NEA that will be created by the new sheet pile wall.

ASSUMPTIONS

General Assumptions

1. Vertical coordinates are North American Vertical Datum of 1988. Horizontal coordinates (northing and easting) are U.S. State Plane coordinates in U.S. survey feet and are referenced to the North American Datum of 1983, New York State East Zone. Topographic and surface features were surveyed by Wendel Architecture, Engineering, Surveying & Landscape Architecture, PC (2013 and 2014). Bathymetry surface was surveyed by Ocean Surveys, Inc. (Ocean Surveys, Inc. 2012). Current surface features may have varied since the time of the surveys.

Imported Backfill Assumptions

1. Engineered fill will be used to raise ground elevation to the proposed level and as a surcharge load to accelerate consolidation time. For design, Norlite Corporation expanded shale aggregate was referenced with typical lightweight fill aggregate properties. The fill properties used for analysis are included in Table 1.

Construction Sequencing Assumptions

Due to the potential for large settlements given the thick Marine Silt layer and its compression parameters, the installation of tie rods will need to be delayed until most of the consolidation in the NEA has occurred. This is done to prevent differential settlement between the bulkhead and anchor wall which can cause increased stress at the connections and potentially result in failure of the anchored system. Methods to speed up consolidation of the Marine Silt are presented below for wick drains and/or precompression loading.

The construction sequencing of the NEA bulkhead installation is assumed to proceed with:

1. Install upland isolation slurry wall.
2. Install cantilever steel sheets pile wall along the bulkhead alignment, except for those areas left uninstalled to allow water to freely travel on either side of the bulkhead.
3. Dredge down to 6 ft. bss in areas with impacted sediment on the riverside of the bulkhead.
4. Backfill dredged areas.
5. Install remaining sheet piles to isolate NEA from the Hudson River.

6. Fill behind sheet pile wall with lightweight aggregate to elevation +0 ft. for consolidation management through either:

    a. Applying additional surcharge loads to accelerate consolidation with water management to maintain wall stability;
    b. Installing wick drains with subsequent water management.

7. Add additional fill to account for settlements and to reach elevations to facilitate tieback installation.

8. Install tie-rods connected to anchor wall on existing upland portion of the site.

9. Fill behind bulkhead to proposed final elevation with lightweight aggregate.

Soil Profile Assumptions

1. The geotechnical design sections were interpreted using topographic survey data (Wendel 2014), bathymetry data (Ocean Surveys 2012) and soil boring data from H&A (H&A 2006, 2011, and 2015). Laboratory geotechnical data from H&A reports are included in Attachment A and summary of this data used in the analysis is included in Attachment B – Consolidation Settlement Calculations.

2. Table 1 below summarizes the soil strengths used in the design. Marine silt and basal sand parameters are based on H&A boring log data (H&A 2006, 2011, 2015). Due to high layer thicknesses and linear nature of soil strengths measured in shear vane tests (H&A 2011), the marine silt (MS) is separated into three layers to reflect similar soil parameters of sublayer soil strength and consolidation properties.

Table 1: Soil Properties

Soil Parameter	Additional Fill	Lightweight Fill	MS (1)	MS (2)	MS (3)	Basal Sand
OCR	--	--	1.8	1.3	1.2	--
Modified compression index, $C_{c\varepsilon}$	--	--	0.270	0.272	0.174	--
Modified recompression index, $C_{r\varepsilon}$	--	--	0.0240	0.0165	0.0094	--
Moist Unit Weight, γ_m (pcf)	120	60	--	--	--	--
Saturated Unit Weight, γ_{sat} (pcf)	125	90	100	105	111	125
Submerged Unit Weight, γ_{sub} (pcf)	62.6	27.6	37.9	42.4	49.0	62.6
C_v (in^2/min)	--	--	1.611E-02	2.652E-02	6.051E-02	--

3. Settlement is analyzed for three (3) sections along the extension bulkhead alignment corresponding with various retained fill heights and subsurface layer thicknesses. Sections are summarized in Table 2 below and are shown in plan view in the Preliminary Design Report Appendix A.

Table 2: Bulkhead Barrier Wall Design Sections

Bulkhead Design ID	Drawing Section ID	Wall Alignment Control Points
01	B	CP-02 TO CP-03, CP-07 TO CP-08
02	A	CP-03 TO CP-07
03	C	CP-01 TO CP 02, CP-08 TO CP-10

4. The ground surface is assumed to have a final elevation of +6 ft. NAVD 88. The soil profiles and layer elevations are summarized in Table 3:

Table 3: Settlement Evaluation Scenarios

Fill Name	Layer Top Elevations (ft. NAVD 88)		
	01	02	03
Lightweight Fill	6	6	6
MS (1)	-20	-27	-5
MS (2)	-40	-40	-25
MS (3)	-60	-60	-45
Basal Sand	-80	-80	-75

CALCULATIONS

All calculations and outputs are included in Attachment B. Consolidation calculations are based on Terzaghi one-dimensional consolidation equations (Terzaghi 1996). Precompression to accelerate consolidation settlement is based on equations presented in Das (Das 2006). Wick drain consolidation calculations are based on Yeung design curve equations presented in Das (Das 2007).

Initial Stress

Initial stress profile for the existing site conditions are produced based on total stress which is calculated at incremental depths from the top of the soil surface (Das, 2006):

$$\sigma_{vo} = h\gamma$$

Where:

σ_{v0} = total stress at point A (psf)
h = height from top of the soil column to point A (ft.)
γ = saturated unit weight of soil (pcf)

Porewater pressure is calculated for soil depths beneath the groundwater surface (Das, 2006):

$$u = h_a \gamma_w$$

Where:

u = porewater pressure at point A (psf)
h_a = distance between point A and the groundwater surface (ft.)
γ_w = unit weight of water (pcf)

Porewater pressure is then subtracted from total stress for values beneath the water table to calculate effective stress (σ'_{vo}). This value accounts for the buoyant forces of groundwater (Das, 2006):

$$\sigma'_{vo} = \sigma_{vo} - u$$

The initial stresses in the compressible layer, i.e. Marine Silt, are used to relate pressure increases due to filling and the resulting time-dependent consolidation of the layer due to drainage of excess pore water pressures.

Primary Consolidation

Primary consolidation is calculated for the Marine Silt layers based on the effective stresses, preconsolidation pressure, and change in pressure due to added cap material. Preconsolidation pressure is calculated using the overconsolidation ratio (OCR) (Das, 2006):

$$p'_c = \sigma'_{v0} \; x \; OCR$$

Cap unit weights of 60 (moist) and 90 (saturated) pcf are assumed. Fill height is the amount needed to reach +6 ft. NAVD 88. Change in pressure due to additional fill is calculated using the following equation:

$$\Delta p = h_{cap} \gamma_{bulk,cap}$$

Consolidation settlement is calculated at each half-foot increment, and cumulative consolidation is determined using the following set of primary settlement equations (Das, 2006 and Holtz, 1981):

When OCR=1 (normally consolidated clays):

$$S_c = C_{c\varepsilon} h \log\left(\frac{\sigma'_{v0} + \Delta p}{\sigma'_{v0}}\right)$$

When OCR>1 (overconsolidated clays) and $\sigma_0' + \Delta p \leq p'_c$:

$$S_c = C_{r\varepsilon} h \log\left(\frac{\sigma_{v0}' + \Delta p}{\sigma'_{v0}}\right)$$

When OCR>1 and $\sigma_0' + \Delta p > p'_c$:

$$S_c = C_{r\varepsilon} h \log\left(\frac{p_c'}{\sigma_0'}\right) + C_{c\varepsilon} h \log\left(\frac{\sigma_{v0}{}' + \Delta p}{p_c'}\right)$$

Where:

S_c = primary settlement (feet)
$C_{c\varepsilon}$ = modified compression index
$C_{r\varepsilon}$ = modified recompression index
h = change in height (feet)
σ_{v0}' = average effective overburden pressure (psf)
Δp = increase in effective pressure (psf)
p'_c = preconsolidation pressure (psf)

Table 4 summarizes the expected magnitude of primary consolidation for each scenario profile.

Table 4: Magnitude of Expected Consolidation

Bulkhead Design ID	Total Expected Primary Consolidation (ft.)
01	3.5
02	4.1
03	1.9

Secondary Consolidation

The magnitude of secondary consolidation is determined using the following equation (Das, 2006):

$$S_s = C_{\alpha\varepsilon} h \log\left(\frac{t}{t_p}\right)$$

Where:

S_s = secondary settlement (feet)
h = change in height (feet)
$C_{\alpha\varepsilon}$ = modified secondary compression index
t = design life (years)
t_p = time to end of primary consolidation (years)

The design life for the bulkhead is considered for 100 years and therefore the total magnitude of secondary compression calculated for that time period. Table 5 summarizes the estimated magnitude of secondary consolidation for each scenario profile.

Table 5: Magnitude of Estimated Secondary Consolidation

Bulkhead Design ID	Total Expected Primary Consolidation (ft.)
01	0.71
02	0.66
03	0.71

Consolidation Time

Using an average coefficient of consolidation obtained from lab results (H&A, 2006, 2011, and 2015), consolidation times are calculated using the following equation (Das, 2006):

$$t = \frac{T_v H_{dr}^2}{C_v}$$

Where:

T_v = dimensionless time factor based off percent consolidation

H_{dr} = length of drainage path (half the distance of marine silt layer thickness for two-way drainage) (ft.)

C_v = coefficient of consolidation

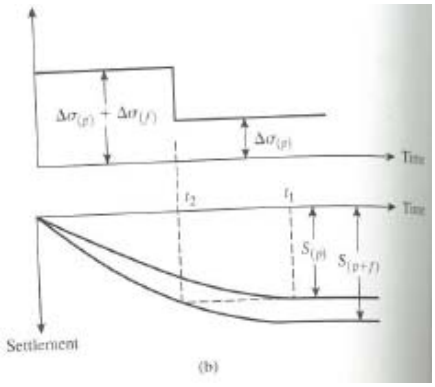
Weighted average C_v values and consolidation times for each scenario profile are summarized in Table 5. The variable t_n denotes the time it takes for the soil to reach n% of its total consolidation settlement.

Table 5: Time to Consolidation (without wick drains or surcharge loading)

Bulkhead Design ID	C_v, Weighted Average (ft^2/sec)	Consolidation Time (years)			
		t_{50}	t_{90}	t_{95}	t_{99}
01	3.97908E-06	1.4	6.1	8.1	12.8
02	4.25839E-06	1.0	4.4	5.9	9.3
03	4.41113E-06	1.7	7.5	9.9	15.7

Precompression Surcharge

To accelerate consolidation times, surcharge loads are applied to each scenario profile. With surcharge loads, less time is needed to reach the final design settlement.



Since the bulkhead acts as a cantilever during any planned consolidation acceleration, additional filling above +0 ft. NAVD88 would cause greater stress and deflections than the current designed AZ sheet pile wall system would allow. However, given the fact that the NEA will be hydraulically isolated within the new sheet piles and slurry wall installed for upland excavation, drawing down water within the NEA would both reduced the resultant outward force and result in an increase in effective pressure on the Marine Silt. This would produce additional surcharge to speed up consolidation without increasing loading on the bulkhead. With greater water drawdown, filling to higher elevations would be possible as long as the water differential is greater than the resulting additional earth pressure from the fill.

Preload stress, which in this case is the additional stress induced by the increased effective stress load and any further fill height, is calculated based on the difference between the submerged buoyant unit weight and the moist unit weight of the soil above the water drawdown elevation. The equivalent total preload pressure would be:

$$\sigma_f = (h_{LW\ fill} - h_{drawdown})\gamma_{submerged,LW\ aggregate} + h_{drawdown}\gamma_{moist,LW\ aggregate} + h_{fill}\gamma_{moist,additional\ fill}$$

Percent consolidation required to reach the design settlement is calculated using the preload stress, initial design change in pressure, and the average effective overburden stress, which is taken from the initial stress profile (Das, 2006):

$$U = \frac{\log[1 + \frac{\Delta p}{\sigma'_{vo}}]}{\log\left[1 + \frac{\Delta p}{\sigma'_{vo}}\left[1 + \frac{\sigma_f}{\Delta p}\right]\right]}$$

Where:

U = percent consolidation
Δp' = change in pressure due to design fill load (psf)
σ_{v0}' = average effective overburden pressure (psf)
σ_f' = preload pressure (psf)

A time factor is determined based on the required percent consolidation and time to settlement of final design load can be calculated. Times to consolidation using surcharge are shown in Table 6.

Table 6: Time to Consolidation (with surcharge loading)

Bulkhead Design ID	Surcharge Water Drawdown (ft.)	Surcharge Additional Fill (ft.)	Time to Settlement of Final Design Load (years)
01	10	6	1.4
02	10	6	1.2
03	5	6	1.2

Prefabricated Vertical Drains (Wick Drains)

Prefabricated vertical drains (PVDs), also referred as wick or strip drains, were developed as an alternative to sand drain columns and consist of synthetic polymer shaped into corrugated or channeled synthetic cores which are enclosed by a geotextile filter material. They can be driven into the ground by mandrel at high installation rates and work under the same principle as sand drains. They decrease consolidation times by taking advantage of radial drainage and the shorter effective drainage paths to allow pore pressures to dissipate and consolidation to occur in a shorter time frame.

Yeung developed design curves for PVDs and the related simplified equations were used to estimate an appropriate wick drain spacing and the resulting reduced consolidation time. The general analysis profile and associated equation inputs include:

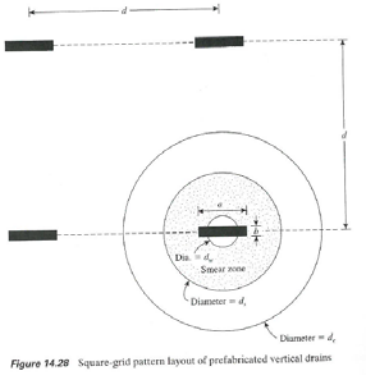


Figure 14.28 Square-grid pattern layout of prefabricated vertical drains

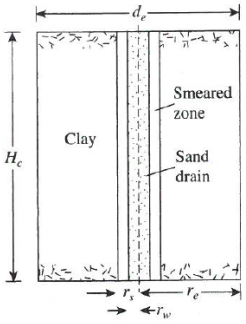


Figure 14.22 Schematic diagram of a sand drain

Where:

r_s = radial distance from center of sand drain to farthest point of smear zone
r_w = radius of sand drain
r_e = radius of effective zone of drainage
d_e = diameter of effective zone of drainage
H_c = Height of compressible material
k_h = hydraulic conductivity of clay in horizontal direction
k_s = hydraulic conductivity of clay in the smeared zone

a = drain width
b = drain height

The design of PVDs is similar to sand drains once an equivalent diameter, d_w, for the drains is calculated

and a pattern factor, d, is applied as follows:

a) $$d_w = \frac{2(a+b)}{\pi}$$

b) $$d = \frac{d_e}{1.05} \quad \text{(for triangular pattern)}$$

$$d = \frac{d_e}{1.128} \quad \text{(for square pattern)}$$

The associated time factor for percent consolidation is:

$$T_r' = -\frac{\alpha'}{8} \ln (1 - U_r)$$

Where:

a) $$\alpha' = n^2 m$$

b) $$n = \frac{d_e}{d_w}$$

And no-smear (negligible soil disturbance) is assumed, which is reasonable in most situations, provided that small mandrel cross-sections are used. Therefore $r_s = r_w$ and $k_h = k_s$, so $S = r_s/r_w = 1$ and:

$$m = \left(\frac{n^2}{n^2 - 1}\right) \ln (n) - \frac{3n^2 - 1}{4n^2}$$

Using this resulting time factor, T'_r, the corresponding percent consolidation is simply:

$$U_r = 1 - \exp\left(-\frac{8C_{vr}t}{d_w^2}\frac{d_w^2}{d_e^2 m}\right) = 1 - \exp\left(-\frac{8T_r'}{\alpha'}\right)$$

Times to consolidation using wick drains at an 8-foot spacing are shown in Table 7.

Table 7: Time to Consolidation (with wick drains)

Average Degree of Consolidation	Time to Reach % Consolidation (days)		
	Bulkhead Design ID		
	01	02	03
20%	17	16	15
40%	38	36	35
50%	52	49	47
70%	91	85	82
90%	173	162	156
95%	225	210	203
99%	346	324	312
Years to 99%	*0.95*	*0.89*	*0.86*

SUMMARY

Table 8 summarizes the consolidation settlements and times at the Atlantic Richfield Harbor at Hastings Site in Hastings-on-Hudson, New York.

Table 8: Consolidation Requirements

Bulkhead Design ID	Total Expected Primary Consolidation	Time to 99% Primary Consolidation		
		Without Surcharge or Wick Drains	With Surcharge (6 ft additional Fill + 5-10 ft of gw drawdown)	With Wick Drains (8-ft-spacing)
	ft.	years	years	years
01	3.5	12.8	1.4	0.95
02	4.1	9.3	1.2	0.89
03	1.9	15.7	1.2	0.86

Attachment A

Geotechnical Laboratory Data

Summary

Haley & Aldrich 2006—Pre-Design Investigation Report

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

FORMER BLDG #15

MOBIL OIL CORPORATION
(formerly of Zinsser & Company, Inc.)

N/F UHLICH COLOR COMPANY, INC.

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

MATCHLINE - SEE FIGURE 5.4B

#22A #79A #19 #18 #17 #23 #22 #22C

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A▲▲A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

ENSR | AECOM

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1A

28612-116 D092
J:\GRAPHICS\28612\28612-116-D092.DWG

LED: "BOUNDARY AND
& 94, AR/AERL, VILLAGE OF
OUNTY, NEW YORK, SHEETS
INEERING, 330 PHILLIPS
ND REVISED ON 05/23/2005.
POINTS, CONCRETE SLABS,
G THE MONTHS OF OCTOBER

MAP REFERENCE:
FOR COMPLETE BOUNDARY INFORMATION REFER TO A MAP ENTITLED: "BOUNDARY AND TOPOGRAPHIC SURVEY, SECTION 10, BLOCK 8, LOTS 89, 91, 93 & 94, AR/AERL, VILLAGE OF HASTINGS ON HUDSON, TOWN OF GREENBURGH, WESTCHESTER COUNTY, NEW YORK, SHEETS 1, 2, 3 & 4, SCALE: 1" = 30 FT" PREPARED BY BOSWELL ENGINEERING, 330 PHILLIPS AVENUE, SOUTH HACKENSACK, NEW JERSEY, ON 05/10/2005, AND REVISED ON 05/23/2005. BOSWELL ENGINEERING HAS FIELD SURVEYED THE EXPLORATION POINTS, CONCRETE SLABS, FENCES AND RIPRAP ALONG NORTHWEST CORNER OF SITE DURING THE MONTHS OF OCTOBER AND NOVEMBER 2005.

HUDSON RIVER

MATCHLINE - SEE FIGURE 5.1A

#57 #22A #79A #22B #22 #22 #22C #72A #72 #51 #51A #52

FORMER BLDG #53 FORMER BLDG #52B FORMER BLDG #54 FORMER BLDG #52A

RIVER STREET

PENN CENTRAL RAILROAD - HUDSON DIVISION
(formerly New York Central Railroad Company)

N/F THE HARBOR AT HASTINGS ASSOCIATES
100 River Street

LEGEND:

- PDGEO-02 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL BORING DRILLED DURING PRE-DESIGN INVESTIGATION
- PDMW-06 — DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELL INSTALLED DURING PRE-DESIGN INVESTIGATION
- PDTP-06 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION
- GA-1 — DESIGNATION AND APPROXIMATE LOCATION OF HISTORICAL BORING DRILLED PRIOR TO PRE-DESIGN INVESTIGATION. THE (DR) DESIGNATION WAS ADDED TO LABELS FOR BORINGS DRILLED BY DOLPH ROTFELD, TO DISTINGUISH THEM FROM OTHER B-SERIES BORINGS AT THE SITE.
- A A A A — DESIGNATION, APPROXIMATE LOCATION AND ORIENTATION OF SUBSURFACE PROFILE

NOTES:

1. BATHYMETRY INFORMATION IS BASED ON BATHYMETRIC SURVEY PERFORMED BY ALPINE OCEAN SEISMIC SURVEY, INC. OF NORWOOD, NEW JERSEY IN FEBRUARY, 1997.
2. ELEVATIONS INDICATED ON THIS DRAWING ARE IN FEET AND REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
3. TECHNICAL MONITORING OF PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WAS PERFORMED BY HALEY & ALDRICH OF NEW YORK.
4. AS-DRILLED OR AS-EXCAVATED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE PDGEO-SERIES BORINGS AND PDTP-SERIES TEST PITS WERE DETERMINED IN THE FIELD BY SURVEY.
5. LOCATIONS FOR THE HISTORICAL BORINGS WERE SCALED FROM HISTORICAL PLANS AND ARE APPROXIMATE. WHEN NOT KNOWN, ELEVATIONS FOR HISTORICAL BORINGS WERE ASSUMED TO CORRESPOND TO THE APPROXIMATE GROUND SURFACE ELEVATION AT THE TIME OF THE PDI.

0 50 100 150 200
SCALE IN FEET

HALEY & ALDRICH
ENSR | AECOM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE AND GEOTECHNICAL SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JULY 2006

FIGURE D5.1B

28612-116 D093 (D092)
J:\GRAPHICS\28612\28612-116-D092.DWG

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION		SPECIFIC GRAVITY	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	UU TRIAXIAL		CU TRIAXIAL					UNIT WEIGHT	
					BURMISTER	USCS			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					1/2 σdev	% STRAIN	1/2 σdev (lab)	1/2 σdev (corrected)	% STRAIN	σ'con	(TRX)	(K)
								(%)						(%)	(%)	(%)	(%)	(psf)		(psf)	(psf)		(psi)	(pcf)	(pcf)
JAR SAMPLES																									
PDGEO-04	4.08	S-9	47	-42.92				35.3						66.4	54.4	12									
PDGEO-09	5.94	S-12	61	-55.06				22.1						20.0	15.6	4.4									
PDGEO-13	6.26	S-5	52	-45.74				24.2						10.3	8.0	2.3									
PDGEO-15	3.93	S-6	34	-30.07				63.2						89.0	72.9	16.1									
PDGEO-15	3.93	S-7	39	-35.07				27.4						24.2	18.2	6.0									
PDGEO-18	3.95	S-7	46	-42.05				28.9						33.5	30.6	2.9									
PDGEO-20	3.99	S-10	63	-59.01				22.6						20.1	16.4	3.7									
PDGEO-24A	4.39	S-10	78	-73.61				38.1						72.3	54.6	17.7									
PDGEO-17	4.25	S-10	61	-56.75				13.3						8.2	7.2	1.0									
PDGEO-21	3.40	S-8	55	-51.6				22.2						17.1	14.7	2.4									
PDGEO-28	6.96	S-16	70	-63.04				21.4						16.2	12.5	3.7									
DIRECT PUSH TUBES																									
PDGEO-01	4.28	U-1	36	-31.72	SILT & CLAY or CLAY & SILT	CL	2.508	51.4	33	23	10	2.8		92.2	77.8	14.4	4.5	605	8.1					99	99.1
PDGEO-01	4.28	U-2	40	-35.72				50.8												734	512	12.3	10.9	102.4	
PDGEO-01	4.28	U-3	53	-48.72	SILT & CLAY	CL		47.5	27	18	9	3.3		78.8	63.6	15.2	3.0	727	15					106.7	107
PDGEO-04	4.08	U-1	37	-32.92	CLAY & SILT	CL		46.2	35	22	13	1.9		90.6	76.8	13.8	4.4			871	605	14.1	10.3	105.3	105.2
PDGEO-04	4.08	U-2	45	-40.92	SILT & CLAY	CL		37.4	26	18	8	2.4					2.3	569	15					113.4	118.1
PDGEO-05	4.31	U-1	29	-24.69	CLAY & SILT	ML		52.7	40	27	13	2.0		86.8	71.0	15.8	3.8	612	8.5					105.2	
PDGEO-05	4.31	U-2	34	-29.69				51.0												1188	832	10.7	9.9	105.5	100.2
PDGEO-07	6.08	U-1	29	-22.92	CLAY & SILT	ML		55.5	47	28	19	1.4						151	7					104.2	
PDGEO-07	6.08	U-2	34	-27.92				62.1						94.3	77.9	16.4	3.8			662	459	15	10.4	99.1	108
PDGEO-09	5.94	U-1	36	-30.06	silty CLAY	MH		58.9	51	29	22	1.4		89.9	68.9	21.0	5.3	274	9.1	828	579	15	10.1	103.8	
PDGEO-09	5.94	U-2	41	-35.06				55.4																	108.5
PDGEO-09	5.94	U-3	47	-41.06	CLAY & SILT	CL		44.0	36	22	14	1.6		84.1	68.0	16.1	3.3	619	15	1138	800	15	12.3	105.4	
PDGEO-09	5.94	U-4	51	-45.06				47.5																	
PDGEO-09	5.94	U-5	55	-49.06	SILT & CLAY	CL		37.5	29	21	8	2.1		82.7	70.2	12.5	2.5	202	11	1166	823	15	13.9	115.8	
PDGEO-16	3.48	U-1	39	-35.52	silty CLAY	MH		56.3	51	28	23	1.2		88.8	68.5	20.3	5.3	403	13					102.8	
PDGEO-17	4.25	U-1	43	-38.75	silty CLAY	MH		64.9	60	33	27	1.2		92.9	69.4	23.5	5.7			900	632	11.1	11.3	105.4	99.9
PDGEO-17	4.25	U-2	49	-44.75				39.5										104	4	1087	760	14	13	103.0	
PDGEO-17	4.25	U-3	55	-50.75	SILT & CLAY	CL-ML		52.1	28	21	7	4.4		56.9	45.2	11.7	2.6	1116	0.5					110.3	111.8
HYDRAULIC PISTON TUBES																									
PDGEO-06	4.47	U-1	30.5	-26.03	CLAY & SILT	ML		40.5	41	27	14	1.0		35.1	29.0	6.1				1015	702	15	9.1	105.5	
PDGEO-11	6.12	U-1	36	-29.88	CLAY & SILT	ML or MH		59.1	50	32	18	1.5		65.7	54.6	11.1	5.1			1174	816	15	10.2	109.2	
PDGEO-11	6.12	U-2	41	-34.88				57.5										706	8					98.3	
PDGEO-11	6.12	U-3	44	-37.88	CLAY & SILT	ML		59.2	46	29	17	1.8		92.6	78.4	14.2	4.7			1202	842	15	11.7	102.1	
PDGEO-13	6.26	U-1	45	-38.74	CLAY & SILT	CL		45.3	34	20	14	1.8		45.6	34.9	10.7	5.0	432	14					104.1	
PDGEO-13	6.26	U-2	50	-43.74				58.0												770	539	8	13.0	105.5	100.4
PDGEO-13	6.26	U-3	59	-52.74	CLAY & SILT	CL		46.9	34	20	14	1.9		54.2	39.2	15.0	1.5	835	4.8	1174	826	6	15.0		
PDGEO-19	3.96	U-1	36	-32.04	CLAY & SILT	CL		58.9	41	24	17	2.1						943	12					107.5	110.5
PDGEO-19	3.96	U-2	41	-37.04			2.514							90.1	73.9	16.2	3.8			929	642	8.8	11.8	105.5	104.5
PDGEO-19	3.96	U-3	46	-42.04	CLAY & SILT	CL		51.7	40	24	16	1.7						950	6					115.5	108.7
PDGEO-20	3.99	U-1	43	-39.01	CLAY & SILT	CL		58.0	43	24	19	1.8		89.2	67.2	22	4.6	835	5.2					105.8	106.4
PDGEO-21	3.40	U-1	26	-22.6	silty CLAY	CH		69.2	62	32	30	1.2		92.2	73.6	18.6	7.1	583	7					93.0	101.7
PDGEO-21	3.40	U-2	29	-25.6			2.346	68.7												821	573	6.1	8.4	96.2	
PDGEO-21	3.40	U-3	35	-31.6	CLAY & SILT	CL		60.8	34	23	11	3.4		92.3	74.1	18.2	2.9			979	686	15	9.6	103.1	104.4
PDGEO-21	3.40	U-4	38	-34.6				58.6										497	9					99.9	
PDGEO-21	3.40	U-5	43	-39.6	SILT & CLAY	CL		36.9	32	23	9	1.5		92.5	72.2	20.3	2.0			878	618	15	11.2	107.3	
PDGEO-21	3.40	U-6	46	-42.6				29.0																	
PDGEO-21	3.40	U-6	46	-42.6				60.1																	100.2
PDGEO-21	3.40	U-6	46	-42.6				39.1										526	5					108.4	
PDGEO-21	3.40	U-7	62	-58.6	CLAY & SILT	CL		51.6	38	21	17	1.8		89.5	69.3	20.2	1.0	1217	15						
PDGEO-22	2.67	U-1	29	-26.33				54.5										439	15					102.3	
PDGEO-22	2.67	U-2	35	-32.33	silty CLAY	MH		61.8	58	32	26	1.1		93.2	77.6	15.6	6.1			878	614	15	9.2	105.2	103.7
PDGEO-23	3.40	U-1	25	-21.6	silty CLAY	MH		63.8	70	42	28	0.8		92.8	75.2	17.6	8.1			655	454	10.8	7	105.5	96.5
PDGEO-23	3.40	U-2	31	-27.6				80.3																	

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION		SPECIFIC GRAVITY	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	UU TRIAXIAL		CU TRIAXIAL				UNIT WEIGHT	
					BURMISTER	USCS			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					1/2 σdev	% STRAIN	1/2 σdev (lab)	1/2 σdev (corrected)	% STRAIN	σ'con	(TRX)	(K)
								(%)						(%)	(%)	(%)	(%)	(psf)		(psf)	(psf)		(psi)	(pcf)	(pcf)
PDGEO-23	3.40	U-3	36	-32.6	CLAY & SILT	ML	2.566	64.7	48	30	18	1.9	0.83	94.1	80.3	13.8	4.7			821	575	5	9.2	105.5	103.9
PDGEO-24A	4.39	U-1	43	-38.61	SILT & CLAY	CL	2.610	56.7	30	21	9	4.0		85.7	72.4	13.3	3.6								103.0
PDGEO-24A	4.39	U-2	49	-44.61				47.6												1706	1178	15	13.8	110.2	
PDGEO-24A	4.39	U-3	55	-50.61	CLAY & SILT	CL		41.6	37	22	15	1.3		94.8	76.5	18.3	2.2	58	5.5					106.2	111.0
PDGEO-24A	4.39	U-4	72	-67.61				31.5												2988	2090	15	18.3	125.2	
PDGEO-24A	4.39	U-5	75	-70.61	SILT & CLAY	CL-ML		37.0	25	19	6	3.0		55.4	42.4	13	3.1	936	9	1519.2	1064	15	18.9		
PDGEO-28	6.96	U-1	38	-31.04	CLAY & SILT	CL		58.2	44	27	17	1.8		82.3	66.3	16	4.5	871	7					106	
PDGEO-28	6.96	U-2	42	-35.04				57.7												1051	728	14.1	11.9	105.5	107.1
PDGEO-28	6.96	U-3	51	-44.04	SILT & CLAY / CLAY & SILT	CL		34.6	30	20	10	1.5		75	57.0	18	2.5	504	15					116	114
PDGEO-28	6.96	U-4	58	-51.04				46.4												1872	1310	15	15.0	105.4	
PDGEO-29	6.80	U-1	43	-36.2				49.2												1066	734	13.2	12.5	101.9	
PDGEO-29	6.80	U-2	46	-39.2	CLAY & SILT	MH		65.1	52	38	14	1.9		79.1	66.4	12.7	4.8	778	12					100.0	
PDGEO-30	3.28	U-1	33	-29.72	CLAY & SILT	CL		63.5	36	22	14	3.0	1.06	55.7	44.1	11.6	4.8	900	3					101.9	105
PDGEO-30	3.28	U-2	40	-36.72				58.8										540	5	886	617	15	11.1	100.7	108.7
PDGEO-31	3.42	U-1	21	-17.58	silty CLAY	MH		78.1	64	36	28	1.5	0.84	94.8	78.6	16.2	7.2			3010	2087	12.5	6.7	105.4	93.1
PDGEO-31	3.42	U-2	26	-22.58				80.4										281	7					93.0	101.2
PDGEO-31	3.42	U-3	31	-27.58	CLAY & SILT	CL		69.3	45	27	18	2.4	0.91	93.2	77.6	15.6	4.4			634	444	15	8.7	105.5	103.4

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CONSOLIDATION PARAMETERS								HYDRAULIC CONDUCTIVITY	LABORATORY NOTES
					Corrected						Lab			
					Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	Pp (tsf)	Pp (psf)	(cm/sec)	
JAR SAMPLES														
PDGEO-04	4.08	S-9	47	-42.92										
PDGEO-09	5.94	S-12	61	-55.06										
PDGEO-13	6.26	S-5	52	-45.74										
PDGEO-15	3.93	S-6	34	-30.07										
PDGEO-15	3.93	S-7	39	-35.07										
PDGEO-18	3.95	S-7	46	-42.05										
PDGEO-20	3.99	S-10	63	-59.01										
PDGEO-24A	4.39	S-10	78	-73.61										
PDGEO-17	4.25	S-10	61	-56.75										
PDGEO-21	3.40	S-8	55	-51.6										
PDGEO-28	6.96	S-16	70	-63.04										
DIRECT PUSH TUBES														
PDGEO-01	4.28	U-1	36	-31.72									5.32E-08	
PDGEO-01	4.28	U-2	40	-35.72	1.1	2200	0.20	0.09	10.0	1.1	0.79	1580		SAMPLE CONTAINED 1 PIECE OF 7/8" GRAVEL.
PDGEO-01	4.28	U-3	53	-48.72									1.39E-07	
PDGEO-04	4.08	U-1	37	-32.92									3.26E-07	
PDGEO-04	4.08	U-2	45	-40.92	0.64	1280	0.21	0.06	11.0	0.6	1.08	2160	9.70E-05	SAMPLE HAD HIGH CONTENT OF M-F SAND AND SHELLS
PDGEO-05	4.31	U-1	29	-24.69	0.5	1000	0.245	0.04	9.5	0.6	0.45	900		SAMPLE CONTAINED LAYERS OF SMALL TO MEDIUM SIZE SHELLS; GSA COARSE FRACTION INCLUDED SAND, SHELL FRAGMENTS
PDGEO-05	4.31	U-2	34	-29.69									6.65E-07	SAMPLE HAD SHALLOW GROOVE ALONG 1 SIDE ENTIRE LENGTH, POSS. FROM SAMPLER PUSHING SHELL/STONE; WOOD CHIPS PRESENT IN CU SAMPLE
PDGEO-07	6.08	U-1	29	-22.92	0.61	1220	0.34	0.09	16.5	0.8	0.7	1400		SAMPLE CONTAINED GRAVEL, LARGE SHELLS, AND A 1/2" AIR VOID.
PDGEO-07	6.08	U-2	34	-27.92									3.87E-07	SAMPLE CONTAINED A FEW SMALL SHELLS
PDGEO-09	5.94	U-1	36	-30.06	0.81	1620	0.28	0.09	11.5	0.9	1	2000		UU SAMPLE HAD FEW LARGE SHELLS, STRESS-STRAIN CURVE ATYPICAL
PDGEO-09	5.94	U-2	41	-35.06	1.01	2020	0.22	0.06	11.0	1.0	1.1	2200	8.51E-08	
PDGEO-09	5.94	U-3	47	-41.06	2.1	4200	0.34	0.13	19.5	1.8	2.1	4200		
PDGEO-09	5.94	U-4	51	-45.06	0.21	420	0.22	0.07	15.0	0.2	1.1	2200		SAMPLE TOO WET FOR K TEST - SOIL IN "FLOWING" CONDITION
PDGEO-09	5.94	U-5	55	-49.06	1.4	2800	0.20	0.08	10.0	1.1	1.8	3600		
PDGEO-16	3.48	U-1	39	-35.52	0.9	1800	0.29	0.13	15.5	0.9	2.4	4800		CU TEST NOT PERFORMED DUE TO INSUFFICIENT QUANTITY OF ACCEPTABLE SAMPLE.
PDGEO-17	4.25	U-1	43	-38.75									2.11E-07	
PDGEO-17	4.25	U-2	49	-44.75	0.34	680	0.23	0.05	14.5	0.3	0.47	940		TRACE SHELL FRAGMENTS.
PDGEO-17	4.25	U-3	55	-50.75									5.82E-07	
HYDRAULIC PISTON TUBES														
PDGEO-06	4.47	U-1	30.5	-26.03	1.0	2000	0.26	0.07	15.5	1.3	0.53	1060		GSA COARSE PORTION INCLUDES SAND AND SHELL FRAGMENTS
PDGEO-11	6.12	U-1	36	-29.88										
PDGEO-11	6.12	U-2	41	-34.88										
PDGEO-11	6.12	U-3	44	-37.88										
PDGEO-13	6.26	U-1	45	-38.74										CONSOL TEST NOT PERFORMED DUE TO LARGE SHELL IN SAMPLE
PDGEO-13	6.26	U-2	50	-43.74									3.75E-07	SILTY, SOME FINE SHELL FRAGMENT LAYERS.
PDGEO-13	6.26	U-3	59	-52.74	0.46	920	0.42	0.05	16.5	0.3	0.67	1340		
PDGEO-19	3.96	U-1	36	-32.04	0.65	1300	0.27	0.05	7.0	0.7	1.1	2200	2.14E-07	
PDGEO-19	3.96	U-2	41	-37.04									2.18E-07	GSA COARSE FRACTION INCLUDES SAND AND SHELL FRAGMENTS
PDGEO-19	3.96	U-3	46	-42.04	0.9	1800	0.31	0.08	14.5	0.8	0.91	1820	4.35E-07	SAMPLE CONTAINED SOME SHELLS AND SMALL SANDY LENSES/LAYERS
PDGEO-20	3.99	U-1	43	-39.01									1.30E-07	
PDGEO-21	3.40	U-1	26	-22.6									2.30E-07	
PDGEO-21	3.40	U-2	29	-25.6	0.81	1620	0.29	0.07	10.5	1.07	0.72	1440		
PDGEO-21	3.40	U-3	35	-31.6									7.13E-07	
PDGEO-21	3.40	U-4	38	-34.6	0.3	600	0.21	0.04	9.0	0.32	0.28	560		
PDGEO-21	3.40	U-5	43	-39.6	0.68	1360	0.25	0.10	17.0	0.64	0.41	820		
PDGEO-21	3.40	U-6	46	-42.6										
PDGEO-21	3.40	U-6	46	-42.6									8.81E-07	
PDGEO-21	3.40	U-6	46	-42.6										
PDGEO-21	3.40	U-7	62	-58.6										CU TEST NOT PERFORMED; SAMPLE DEFORMED AS IT WAS EXTRACTED DUE TO VERY WET, SOFT, SOMEWHAT GRANULAR TEXTURE; CONSOL TEST NOT PERFORMED DUE TO SHELL IN SAMPLE
PDGEO-22	2.67	U-1	29	-26.33										UU TEST - HORIZONTAL SANDY LAYER NEAR CENTER OF SPECIMEN; INSUFFICIENT INTACT MATERIAL TO PERFORM K TEST
PDGEO-22	2.67	U-2	35	-32.33	0.79	1580	0.27	0.09	13.0	0.94	0.62	1240	1.43E-07	
PDGEO-23	3.40	U-1	25	-21.6	0.55	1100	0.25	0.09	8.5	0.90	0.41	820	1.69E-07	
PDGEO-23	3.40	U-2	31	-27.6	0.63	1260	0.21	0.10	16.5	0.85	0.45	900		UU TEST NOT PERFORMED; INSUFFICIENT TESTABLE SAMPLE RECOVERED

TABLE D5.2.
SUMMARY OF GEOTECHNICAL LABORATORY
TEST DATA ON SAMPLES FROM
MARINE SILT STRATUM

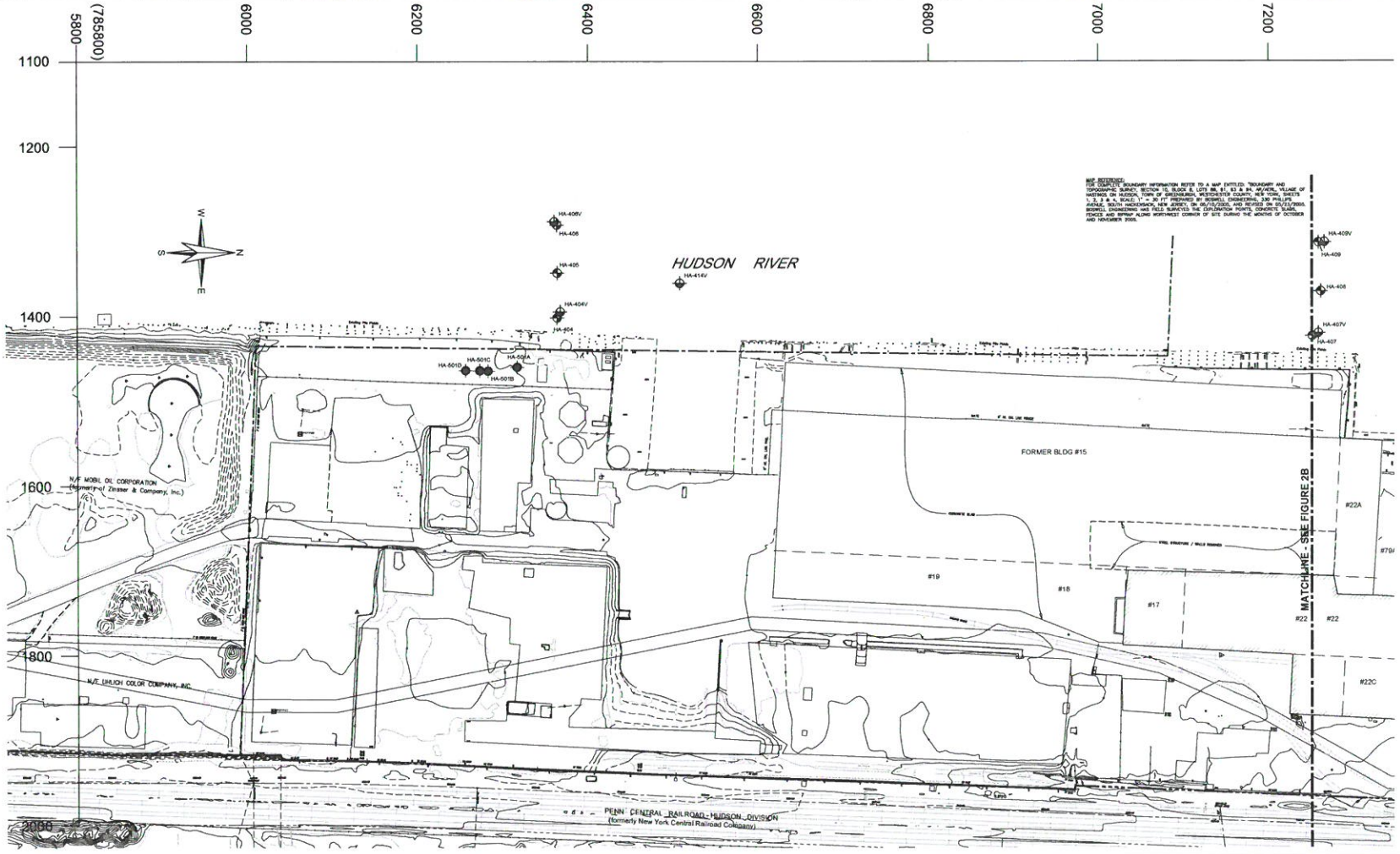
OU-1 REMEDIATION
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CONSOLIDATION PARAMETERS								HYDRAULIC CONDUCTIVITY	LABORATORY NOTES
					Corrected						Lab			
					Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	Pp (tsf)	Pp (psf)	(cm/sec)	
PDGEO-23	3.40	U-3	36	-32.6									8.35E-07	
PDGEO-24A	4.39	U-1	43	-38.61									2.77E-07	UU TEST NOT PERFORMED; SAMPLE CONSISTED OF INTERLAYERED SHELLS AND SILT; FELL APART UPON EXTRUSION/HANDLING
PDGEO-24A	4.39	U-2	49	-44.61	0.81	1620	0.27	0.06	10.0	0.68	0.87	1740		
PDGEO-24A	4.39	U-3	55	-50.61									3.42E-07	
PDGEO-24A	4.39	U-4	72	-67.61	0.8	1600	0.11	0.07	9.0	0.48	0.55	1100		
PDGEO-24A	4.39	U-5	75	-70.61										
PDGEO-28	6.96	U-1	38	-31.04	0.62	1240	0.24	0.05	9.5	0.7	0.86	1720		
PDGEO-28	6.96	U-2	42	-35.04	1.4	2800	0.32	0.09	17.0	1.4	1.1	2200	7.53E-06	
PDGEO-28	6.96	U-3	51	-44.04	0.6	1200	0.17	0.09	12.0	0.5	0.43	860	6.38E-07	
PDGEO-28	6.96	U-4	58	-51.04	0.83	1660	0.16	0.04	7.0	0.6	1.43	2860		SANDY SILT LAYES THROUGHOUT SAMPLE. ABUNDANT SHELL FRAGMENTS.
PDGEO-29	6.80	U-1	43	-36.2	0.98	1960	0.46	0.11	19.0	0.93	1.1	2200		
PDGEO-29	6.80	U-2	46	-39.2										K TEST NOT PERFORMED DUE TO INSUFFICIENT QUANTITY OF MATERIAL RECOVERED FROM TUBE
PDGEO-30	3.28	U-1	33	-29.72	0.61	1220	0.20	0.08	9.0	0.7	1.2	2400	2.73E-07	K SAMPLE CONTAINED A FEW LARGE SHELLS.; GSA COARSE PORTION INCLUDES SAND, SHELL FRAGMENTS
PDGEO-30	3.28	U-2	40	-36.72									4.37E-07	UU SAMPLE, LAYER OF SHELLS NEAR BOTTOM
PDGEO-31	3.42	U-1	21	-17.58	0.35	700	0.35	0.12	15.0	0.6	0.48	960	1.96E-07	
PDGEO-31	3.42	U-2	26	-22.58									1.04E-07	SAMPLE DARKER IN COLOR AND CONTAINED ABUNDANT SHELLS AND FINE GRAVEL IN BOTTOM THIRD.
PDGEO-31	3.42	U-3	31	-27.58	0.4	800	0.24	0.08	15.5	0.5	0.43	860	3.75E-07	

NOTES
1. Elevations are in feet and refer to the NAVD88 datum.
2. For CU data, "lab" designation indicates raw lab data; "corrected" indicates data corrected by Haley & Aldrich to account for in situ mean effective stress. See report text for details.
3. For consolidation data, "lab" designation indicates parameters determined by lab; "corrected" indicates parameters determined by Haley & Aldrich. See report text for details.

LEGEND
LLoven - liquid limit by oven-dried method
LLair - liquid limit by air-dried method
σdev - deviator stress at failure
σ'con - effective confining stress
TRX - triaxial test
K - hydraulic conductivity test
Pp - preconsolidation pressure
CR - compression ratio (strain per log cycle stress)
RR - recompression ratio (strain per log cycle stress)
εvo - strain at in situ effective stress

Haley & Aldrich 2011—Geotechnical Data Report



LEGEND:

HA-411 ◆ DESIGNATION AND APPROXIMATE LOCATION OF OFF-SHORE GEOTECHNICAL TEST BORING.

HA-411V ◆ DESIGNATION AND APPROXIMATE LOCATION OF FIELD VANE TEST.

HA-501A ◆ DESIGNATION AND APPROXIMATE LOCATION OF ON-SHORE GEOTECHNICAL TEST BORING FOR CROSSHOLE SEISMIC TEST.

NOTES:

1. TECHNICAL MONITORING OF HA-SERIES BORINGS WAS PERFORMED BY HALEY & ALDRICH.
2. AS-DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE HA-SERIES ON-SHORE BORINGS WERE DETERMINED IN THE FIELD BY SURVEY. AS-DRILLED LOCATIONS OF THE HA-SERIES OFF-SHORE BORINGS WERE DETERMINED BY GPS, AND MUDLINE ELEVATIONS WERE DETERMINED USING TIDE BOARDS INSTALLED ALONG THE SHORELINE.

0 60 120 180 240
SCALE IN FEET

HALEY & ALDRICH

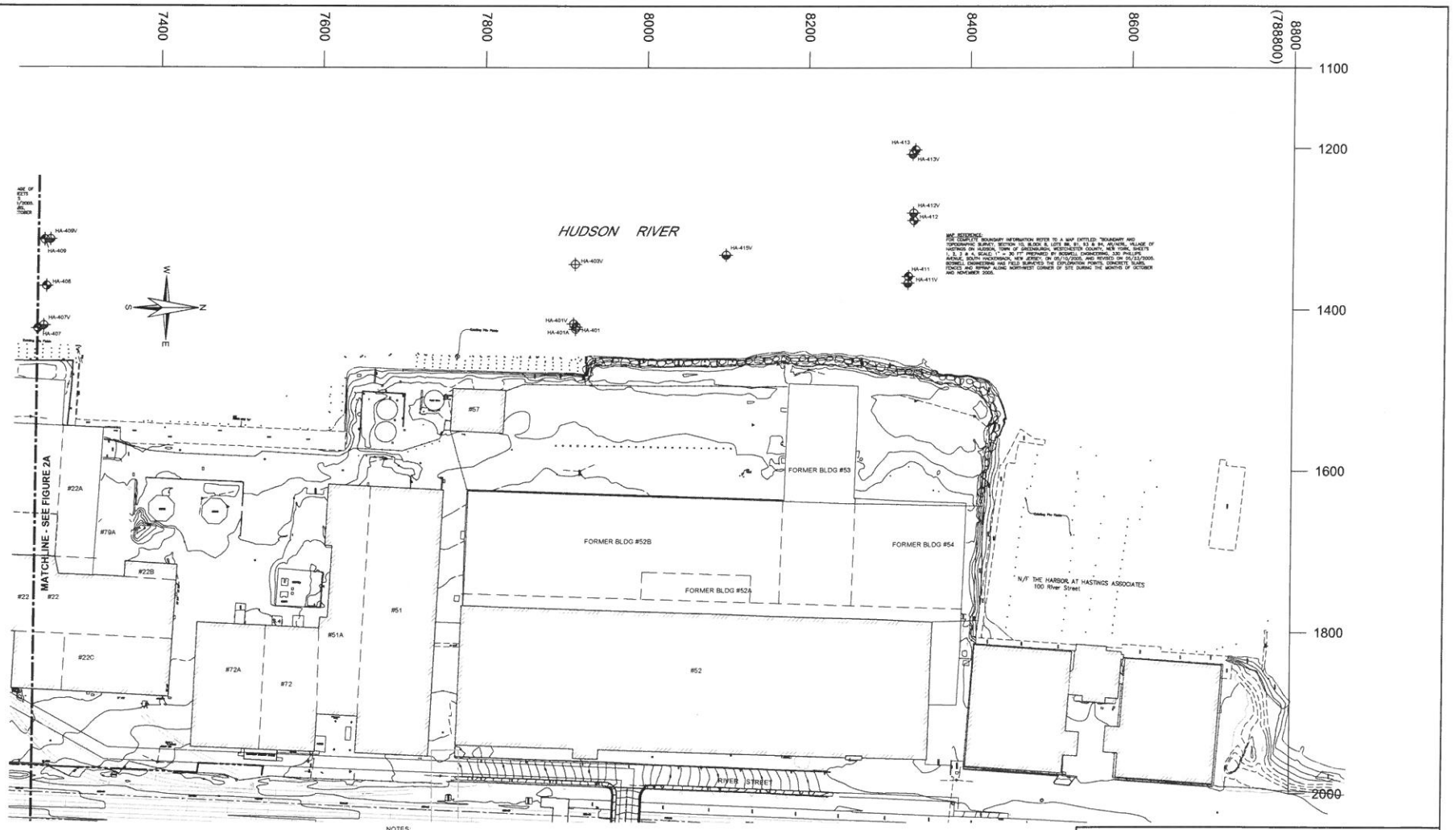
NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE PLAN SHOWING GEOTECHNICAL SUBSURFACE EXPLORATIONS PERFORMED IN 2007 AND 2008

SCALE: AS SHOWN
DECEMBER 2011

FIGURE 2A

G:\28612\231 - GEOTECH DATA REPORT\CAD\28612-224-D004-SITEGEO.DWG



LEGEND:

HA-411 — DESIGNATION AND APPROXIMATE LOCATION OF OFF-SHORE GEOTECHNICAL TEST BORING.

HA-411V — DESIGNATION AND APPROXIMATE LOCATION OF FIELD VANE TEST.

HA-501A — DESIGNATION AND APPROXIMATE LOCATION OF ON-SHORE GEOTECHNICAL TEST BORING FOR CROSSHOLE SEISMIC TEST.

NOTES:

1. TECHNICAL MONITORING OF HA-SERIES BORINGS WAS PERFORMED BY HALEY & ALDRICH.
2. AS-DRILLED LOCATIONS AND GROUND SURFACE ELEVATIONS FOR THE HA-SERIES ON-SHORE BORINGS WERE DETERMINED IN THE FIELD BY SURVEY. AS-DRILLED LOCATIONS OF THE HA-SERIES OFF-SHORE BORINGS WERE DETERMINED BY GPS, AND MUDLINE ELEVATIONS WERE DETERMINED USING TIDE BOARDS INSTALLED ALONG THE SHORELINE.

0 60 120 180 240
SCALE IN FEET

HALEY & ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

SITE PLAN SHOWING GEOTECHNICAL SUBSURFACE EXPLORATIONS PERFORMED IN 2007 AND 2008

SCALE: AS SHOWN
DECEMBER 2011

FIGURE 2B

28612-116 D093 (J0092)
G:\28612\231 - GEOTECH DATA REPORT\CAD\28612-224-D094-SITEGEO.DWG

TABLE I.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	CLASSIFICATION USCS	SPECIFIC GRAVITY	WATER CONTENT Atterberg (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair (1)	% PASSING NO. 200 SIEVE (%)	% SILT (%)	% CLAY (%)	ORGANIC CONTENT (%)	DSS: w% initial	γd (pcf)	p	peak sh stress (psf)	Su/p	CU TRIAXIAL: w% initial	γd initial (pcf)	1/2 σdev (lab) (psf)	1/2 σdev (corrected) (psf)	% STRAIN	σ'con (psi)	UNIT WEIGHT: (TRX) (pcf)	(K) (pcf)	(DSS) (pcf)	Drv Cylndr (pcf)	Drive Cylinder w%	UNIT WT AVG	CONSOLIDATION PARAMETERS Corrected: Pp (tsf)	Pp (psf)	CR	RR	εvo	OCR	LABORATORY NOTES
																											↓ or 100.1													
RIVER TUBES - DECEMBER 2007																																								
HA-401	-16.54	T-1	27	-43.54	OH		75	61	26	35	1.4	0.67	98	70.8	27	3	62	64.9	1320	480.6	0.364	74.8	54.89	407	270	12.8	6.115	95.9		105.1			100.5	0.6	1200	0.21	0.015	8	1.4	
HA-401A	-16.14	T-1	21	-37.14	OH		60	53	24	29	1.2	0.66	86	64.1	22	2.5	64	61.7	1027	253	0.246	51	65.16	335.5	226	8.6	4.756	98.4		101.2			99.8	0.44	880	0.19	0.019	7	1.2	
HA-401A	-16.14	T-2	31	-47.14	OL		70	47	21	26	1.9	0.72	89	62.5	26	2.9	70	61.4	1516	348	0.230	53.7	65.41	395	270	7.4	7.0	100.5		104.4			102.5	0.29	580	0.21	0.025	12	0.5	
RIVER TUBES - JUNE/JULY 2008																																								
HA-404	-12.94	U-1	9.25	-22.19	CH		82	94	35	59	0.8		95	77.5	17.5	6.6	85.1	50.1	527	157.9	0.300											92.7	87.3	79.1	90.0							
HA-404	-12.94	U-2	19.25	-32.19	MH or OH		65	59	35	24	1.3					2.3	66.7	60.9	1112	328	0.295											101.5	103.5	59.8	102.5							
HA-404	-12.94	U-3	34.25	-47.19			53.04						82	64.0	17.5		53.04	68.7	1989	453.8	0.228											105.1	104.2	48.5	104.7							
HA-404	-12.94	U-4	44.25	-57.19	CL		43	37	24	13	1.5					1.6	42.8	76.2	2574	645.3	0.251											108.8	109.3	47.1	109.1	1.05	2100	0.13	0.033	8	1.1	
HA-405	-16.54	U-1	11.3	-27.84													61.4	63.5	655	192.6	0.294											102.5	99.1	61.4	100.8	0.37	740	0.174	0.012	7	1.8	
HA-405	-16.54	U-2	19.3	-35.84													60.2	62.5	1112	462.3	0.416	57.1	64.2	357.9		5.8	5.146	100.9		100.1	100.6	57.1	100.5							
HA-405	-16.54	U-3	24.3	-40.84									80	57.6	22		52.4	70.1	1422	697.5	0.491											106.8	104.4	52.4	105.6							
HA-405	-16.54	U-4	34.5	-51.04	CL or OL		50	47	25	22	1.1					1.8	52	72.4	2001	849.6	0.425												102.7	52.0	102.7	0.8	1600	0.194	0.022	7	1.2	
HA-405	-16.54	U-6	45.2	-61.74													49.9	72.9	2627	1170	0.445												107.2	49.9	107.2	0.85	1700	0.163	0.02	6.5	0.9	
HA-406	-26.74	U-1	6.25	-32.99	OH		65	53	24	29	1.4	0.68	91	73.5	17.5	2.9	67.4	59.1	351	87.8	0.250	70.3	56.6	193.8		5.5	1.623	96.4		98.9	93.8	67.4	96.4	0.255	510	0.272	0.036	4	2.5	
HA-406	-26.74	U-2	15.25	-41.99		2.66	55.1										55.1	68.6	878	199.4	0.227											106.4	104.0	58.0	105.2	0.4525	905	0.211	0.012	7	1.4	
HA-406	-26.74	U-3	25.9	-52.64	CL		55	32	21	11	3.1					1	59.7	63.8	1492	403.8	0.271											101.9	101.5	63.5	101.7							
HA-406	-26.74	U-4	31	-57.74									84	65.4	19		50.6	73.5	2088	481.5	0.231											110.7	106.5	45.8	108.6							
HA-406	-26.74	U-5	45.75	-72.49			45.8						83	62.5	20		45.8	76.6	2662	682.6	0.256											111.7	106.2	47.6	108.9							
HA-407	-14.94	U-1	13.25	-28.19	CH		70	72	32	40	1.0		87	72.0	15	5.3																96.7	67.6	96.7							
HA-407	-14.94	U-2	19.25	-34.19			59										59	64.7	1112	282.5	0.254											102.9	103.5	67.0	103.2	1	2000	0.199	0.013	3	2.7	
HA-407	-14.94	U-3	29.65	-44.59			46						63	47.5	15		46	73.7	1720	478.6	0.278											107.6	103.1	46.7	105.4	1.2	2400	0.211	0.012	4.5	2.0	
HA-407	-14.94	U-4	39.4	-54.34	CL or OL	2.57	53	39	19	20	1.7					1.4	52.5	68.7	2293	620.2	0.270	60	62.7	641.3		4.28	10.62	100.3		104.8	103.3	53.3	102.8							
HA-407	-14.94	U-5	43.65	-58.59			42.6										42.6	78	2539	604.7	0.238											111.2	106.8	38.1	109.0	1.2	2400	0.177	0.023	5.5	1.2	
HA-407	-14.94	U-6	49.5	-64.44	CL or OL		32	40	19	21	0.6					3.5	39.3	73.5	2884	645.3	0.224	39.6	75.1	753.6		3	13.36	104.8		102.4	109.1	41.1	105.4							
HA-408	-18.04	U-1	10.1	-28.14	MH or OH		60	55	26	29	1.2					7.1	59.7	65.2	579	184.5	0.319											104.1	100.0	59.7	102.1	0.9	1800	0.266	0.012	9	4.7	
HA-408	-18.04	U-2	13.1	-31.14																		57.8	61.4	315.9		8	3.466	96.9			98.0	62.7	97.4							
HA-408	-18.04	U-3	23.1	-41.14									94	67.3	26.5		61.4	62.6	1334	384.3	0.288												100.2	61.4	100.2							
HA-408	-18.04	U-5	33.6	-51.64	MH or OH		29	52	31	21	-0.1					1.6	56.2	65.3	1948	501.6	0.257												102.8	29.3	102.8							
HA-408	-18.04	U-6	38.3	-56.34									59	46.1	13		41.8	81.7	2223	893.4	0.402												96.9	61.8	96.9	1	2000	0.215	0.025	3.8	1.6	
HA-409	-23.04	U-1	13.65	-36.89			86.2										86.2	51.7	784	158.2	0.202											96.3	97.0	85.1	96.6	0.85	1700	0.315	0.019	4	3.8	
HA-409	-23.04	U-2	28.3	-51.34	NP		24									0.3	62.4	65.5	1644	376.3	0.229											106.4	113.6	42.2	110.0							*Sample determined to be NONPLASTIC
HA-409	-23.04	U-4	52.4	-75.44	CL		60	47	24	23	1.6		86	63.4	22.5	2.4	52.4	68.6	3083	726.4	0.236	65.3	61.4	707.4		4.71	14.3	101.5		104.5	102.4	59.6	102.8	0.8	1600	0.216	0.033	7.5	0.8	
HA-411	-29.84	U-1	6.6	-36.44	MH or OH		65	53	28	25	1.5	0.62	65	51.1	14	1.8	55.3	68.2	369	190.1	0.515	74.4	52.6	141.5		10.1	1.7	91.7			99.7	71.0	95.7	0.31	620	0.216	0.028	9	3.0	
HA-411	-29.84	U-3	19.3	-49.14													61.6	63.1	1112	295.1	0.265												106.5	61.6	106.5							
HA-411	-29.84	U-4	29.3	-59.14	CL or OL		65	41	18	23	2.0					1.2	50.1	69	1697	390.5	0.230												103.2	48.0	103.2	0.7	1400	0.133	0.007	4.3	1.2	
HA-411	-29.84	U-5	40.45	-70.29													60.4	63.4	2352	578.9	0.246											101.7	94.1	60.4	97.9							
HA-411	-29.84	U-6	50.3	-80.14	CL	2.66	45	35	22	13	1.8		60	43.4	16.5	1.4	45.1	68.6	2925	1220	0.417												105.7	45.1	105.7	1.05	2100	0.189	0.006	5.5	1.0	
HA-412	-35.64	U-2	14.55	-50.19													66.8	60.2	837	362.4	0.433											100.4	99.1	66.8	99.8							
HA-412	-35.64	U-3	21.65	-57.29		2.75											35.1	85.4	1252	541.2	0.432	72.7	56.8	554.3		9.5	5.81	98.1			97.8	67.5	97.9	1.65	3300	0.097	0.009	2	4.5	
HA-412	-35.64	U-5	44.65	-80.29	OH or CH		48	67	28	39	0.5	0.54	98	58.4	40	10.6	55.1	68.4	2597	572.7	0.221												102.1	55.1	102.1							
HA-413	-38.94	U-1	11.25	-50.19	CH or OH	2.63	66	58	22	36	1.2					5	88.2	50.7	644	182.4	0.283												99.5	65.0	99.5	0.255	510	0.21	0.02	5.5	1.3	
HA-413	-38.94	U-2	16.25	-55.19																																				
HA-413	-38.94	U-3	21.75	-60.69	NP											1.5	34.4	82.6	1258	362.4	0.288											111.0	103.8	34.4	107.4							*Sample determined to be NONPLASTIC
HA-413	-38.94	U-4	39.25	-78.19	NP											1.3	38.9	79.1	2282	1087	0.476											109.9	114.6	38.9	112.2	0.7	1400	0.168	0.02	9	0.7	*Sample determined to be NONPLASTIC
HA-413	-38.94	U-5	44.3	-83.24																		55.6	65.7	771.7		8.3	11.92	102.2			102.0	55.6	102.1							
HA-413	-38.94	U-6	49.25	-88.19									97	62.6	34		53.5	65.7	2867	849.6	0.296											100.8	101.1	53.4	101.0	1.55	3100	0.245	0.031	6.5	1.7	

Notes:
1. If LLoven / LLair < 0.75, soil is classified as organic
2. For CU data, "lab" designation indicates raw lab data; "corrected" indicates data corrected by Haley & Aldrich to account for in situ mean effective stress. See report text for details.

LEGEND

LLoven - liquid limit by oven-dried method
LLair - liquid limit by air-dried method
w% - water content
γd - dry unit weight
σv' - vertical effective stress
Su/p - undrained shear strength divided by vertical effective stress
σdev - deviator stress at failure
σ'con - effective confining stress
TRX - triaxial test
K - hydraulic conductivity test
Pp - preconsolidation pressure
CR - compression ratio (strain per log cycle stress)
RR - recompression ratio (strain per log cycle stress)
εvo - strain at in situ effective stress

Haley & Aldrich 2015—Pre-Design Investigation Report



LEGEND

PD2-GR-009 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED IN THE RIVER DURING PRE-DESIGN INVESTIGATION IN 2014.

PD2-GL-001 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST BORING DRILLED ON LAND DURING PRE-DESIGN INVESTIGATION IN 2013.

PD2-TP-2 — DESIGNATION AND APPROXIMATE LOCATION OF GEOTECHNICAL TEST PIT EXCAVATED DURING PRE-DESIGN INVESTIGATION IN 2014.

PROPERTY LINE

RAIL ROAD

EXISTING STRUCTURES

CONCEPTUAL LOCATION OF NORTHWEST BULKHEAD EXTENSION WALL. ALIGNMENT SHOWN IS APPROXIMATE ONLY AND SUBJECT TO CHANGE.

NOTES

1. BASE PLAN BASED ON ELECTRONIC CAD FILE ENTITLED "TOPOGRAPHIC SURVEY" REVISED 22 JULY 2014 BY WENDEL WD ARCHITECTURE, ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE P.C. OF BUFFALO, NEW YORK.
2. RIP-RAP DESIGNATION IN THE RIVER IS BASED ON INTERPRETATION OF SIDE SCAN SONAR DATA PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
3. GRID SYSTEM IS THE NEW YORK STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAD 83, U.S. SURVEY FEET.
4. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND ARE BASED ON DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2009 AND OBTAINED FROM THE NEW YORK STATE GIS CLEARINGHOUSE (NYGIS).
5. THE BATHYMETRY CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10-16 DECEMBER 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.

W S N E

0 100 200 300 400

SCALE IN FEET

DRAFT

HALEY ALDRICH

NYSDEC SITE #3-60-022
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

LOCATION PLAN - GEOTECHNICAL BORINGS AND TEST PITS

SCALE: AS SHOWN
JULY 2015

FIGURE 3.7A

POSTOLOWSKI, KEVIN Printed: 7/20/2015 11:39 AM Layout: FIGURE 7-1
\\DTRCOMMON\28612 HASTINGS\286\CAD\28612-286_008 AS-DRILLED TEST PITS R6.DWG

TABLE 3.7A

SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM

1 RIVER STREET

HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
																											Corrected					Lab					
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d (pcf)	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)	OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	(pcf)
PD-GL-001	7	U-3	28	-21																																113.6
PD-GL-001	7	U-3	27.45	-20.45		42.6																														
PD-GL-001	7	U-3B	27.7	-20.7	CL	45.2	40	21	19.0	1.3		65		10	3.4												2	4000	0.21	0.015	9	1.7	3400	2.32			110.4	
PD-GL-001	7	U-3	28	-21		47.1																														
PD-GL-001	7	U-3C	28.25	-21.25	CL	44.3															44.3	76.2	1460	965	8.7	12.7								110		
PD-GL-001	7	U-4	36	-29																																116
PD-GL-001	7	U-4A	35.2	-28.2	CL	31.1															31.1	87.0	1040	694	6.3	14.7								114.1		
PD-GL-001	7	U-4B	35.6	-28.6	CH	55	60	30	30.0	0.8		87.7		19													2	4000	0.23	0.026	3	2	4000	1.98			105.3	
PD-GL-001	7	U-5	43	-36																																120.6
PD-GL-001	7	U-5	42.25	-35.25		39.8																														
PD-GL-001	7	U-5	42.8	-35.8		24.8																														
PD-GL-001	7	U-5	43.05	-36.05	SC	25.8															25.8	100.2	1580	1086	15	16.6								126		
PD-GL-001	7	U-5	43.35	-36.35		33.8																														
PD-GL-001	7	U-5C	43.6	-36.6	CL	36.2	43	23	20.0	0.7		69.4		18													1.7	3400	0.21	0.028	6	1.5	3000	1.41			108.2	
PD-GL-002	7	U-4	39	-32																																101.9
PD-GL-002	7	U-4	38.55	-31.55		50.8																														
PD-GL-002	7	U-4B	38.8	-31.8	CH	52.1	62	28	34.0	0.7		87		17	3												1.1	2200	0.21	0.019	7	1.1	2200	1.03			106.8	
PD-GL-002	7	U-4	39.1	-32.1		58.4																														
PD-GL-002	7	U-4	39.35	-32.35	CH	61.7															61.7	63.1	1010	661	12.7	15.8								102.1		
PD2-GR-001	-10.9	U-1	11.5	-22.4																																91.9
PD2-GR-001	-10.9	U-1	10.75	-21.65		67.1																														
PD2-GR-001	-10.9	U-1A	11	-21.9	MH	80.8															80.8	50.2	180	111	8.7	3.0								90.7		
PD2-GR-001	-10.9	U-1	11.3	-22.2		71.5																														
PD2-GR-001	-10.9	U-1B	11.55	-22.45	MH	70.8	66	37	29.0	1.2	0.8	93.2		26													0.7	1400	0.31	0.027	4	0.4	800	1.27			94	
PD2-GR-001	-10.9	U-3	26.5	-37.4																																99
PD2-GR-001	-10.9	U-3	25.8	-36.7		67.4																														
PD2-GR-001	-10.9	U-3A	26.05	-36.95	ML	60.3										60.3	62.6	1500	500	0.33														100.4			
PD2-GR-001	-10.9	U-3	26.35	-37.25		58.4																														
PD2-GR-001	-10.9	U-3B	26.6	-37.5	ML	65.3															65.3	60.4	540	357	5.3	6.9								99.9		
PD2-GR-001	-10.9	U-3	26.9	-37.8		67.5																														
PD2-GR-001	-10.9	U-3C	27.15	-38.05	ML	57.4	44	27	17.0	1.8	1.0	92.8		17													0.7	1400	0.22	0.014	4	0.7	1400	0.86			103.5	
PD2-GR-001	-10.9	U-4	36.5	-47.4																																105
PD2-GR-001	-10.9	U-4	35.7	-46.6		50.1																														
PD2-GR-001	-10.9	U-4	36.25	-47.15		54.3																														
PD2-GR-001	-10.9	U-4B	36.5	-47.4	CH	60															60	63.1	870	578	13.1	9.5								100.9		
PD2-GR-001	-10.9	U-4	36.8	-47.7		54.2																														
PD2-GR-001	-10.9	U-4C	37.05	-47.95	CH	66.4	50	23	27.0	1.6		66.9		13													1.2	2400	0.42	0.016	3	0.8	1600	1.23			99.4	
PD2-GR-001	-10.9	U-5	46.5	-57.4																																115.5
PD2-GR-001	-10.9	U-5	45.75	-56.65		61.1																														
PD2-GR-001	-10.9	U-5A	46	-56.9	CL	54.4	47	23	24.0	1.3		66.9		17													1.5	3000	0.23	0.017	9	0.9	1800	1.25			105.1	
PD2-GR-001	-10.9	U-5	46.3	-57.2		31.7																														
PD2-GR-001	-10.9	U-5B	46.55	-57.45	SM	32.4															32.4	87.5	1800	1281	15	12.1								115.9		
PD2-GR-001	-10.9	U-5	46.85	-57.75		31.8																														
PD2-GR-002A	-24.3	U-5	37	-61.3																																90.4
PD2-GR-002A	-24.3	U-5	36.5	-60.8	CL	58.7															58.7	65.0	640	428	4.1	9.7								103.1		
PD2-GR-002A	-24.3	U-5	36.8	-61.1		65.1																														
PD2-GR-002A	-24.3	U-5	37.05	-61.35	CL	53.8										53.8	67.0	2090	520	0.25														103.1			
PD2-GR-002A	-24.3	U-5	37.35	-61.65		60																														
PD2-GR-002A	-24.3	U-5	37.6	-61.9	CL	56.7	30	18	12	3.2		70.6		21													0.7	1400	0.2	0.015	8	0.7	1400	0.88			106.2	
PD2-GR-002A	-24.3	U-7	57	-81.3																																117.8
PD2-GR-002A	-24.3	U-7	56.35	-80.65		29.7																														
PD2-GR-002A	-24.3	U-7	56.9	-81.2		25.6																														
PD2-GR-002A	-24.3	U-7	57.15	-81.45	CL	27.8															27.8	94.6	880	637	4.5	14.9								120.9		
PD2-GR-002A	-24.3	U-7	57.45	-81.75		29.9																														
PD2-GR-002A	-24.3	U-7	57.7	-82	CL	33.4	44	19	25	0.6	0.8	63.6		20													1.7	3400	0.2	0.007	4	1.4	2800	1.11			117.3	
PD2-GR-003	-27.7	U-2	13.5	-41.2																																105.3
PD2-GR-003	-27.7	U-2	12.85	-40.55		59.2																														
PD2-GR-003	-27.7	U-2B	13.1	-40.8	OH	44.1															44.4	79.1	220	155	9.3	3.5								114.2		
PD2-GR-003	-27.7	U-2	13.4	-41.1		68.7																														
PD2-GR-003	-27.7	U-2C	13.65	-41.35	OH	76.7	53	26	27.0	1.9	0.7	68.7		10													0.7	1400	0.3	0.033	4	0.6	1200	3.32			94.9	
PD2-GR-003	-27.7	U-3	23.5	-51.2																																101.1
PD2-GR-003	-27.7	U-3	22.8	-50.5		59.6																														
PD2-GR-003	-27.7	U-3B	23.05	-50.75	CH	57.5															57.5	64.4	400	266	6.2	6.1								101.4		
PD2-GR-003	-27.7	U-3	23.35	-51.05		39.4																														
PD2-GR-003	-27.7	U-3	23.45	-51.15	CH	66.9										66.9	58.8	1330	360	0.27														98.2			
PD2-GR-003	-27.7	U-3C	23.6	-51.3	CH	57.9	54	23	31.0	1.1	0.8	82.8		16													0.75	1500	0.28	0.023	5	0.8	1600	1.61			103.6	
PD2-GR-003	-27.7	U-5	48.5	-76.2																																110.6
PD2-GR-003	-27.7	U-5	48.05	-75.75		52.7																														
PD2-GR-003	-27.7	U-5B	48.3	-76	ML	47.2	41	26	15.0	1.4	0.8										47.2	72.5	820	560	11.4	12.7								106.7		
PD2-GR-003	-27.7	U-5	48.6	-76.3		25.2																														
PD2-GR-003	-27.7	U-5C	48.85	-76.55	ML	40.6						57.3		13													1.5	3000	0.17	0.010	6	1.2	2400	1.30			111.4	
PD2-GR-004	-9.8	U-1	9	-18.8																																92.2
PD2-GR-004	-9.8	U-1	8.2	-18		79.7																														
PD2-GR-004	-9.8	U-1	8.45	-18.25	CH	88.1										88.1	48.3	510	180	0.35														90.9			
PD2-GR-004	-9.8	U-1	8.7	-18.5		83.7																														
PD2-GR-004	-9.8	U-1	8.95	-18.75	CH	77.7															77.7	53.5	250	160	9.8	2.4								95		
PD2-GR-004	-9.8	U-1	9.3	-19.1		70.1																														
PD2-GR-004	-9.8	U-1	9.55	-19.35	CH	75.9	85	33	52	0.8	0.78	95.8		23													0.4	800	0.25	0.023	4	0.5	1000	2.88			93.1	
PD2-GR-004	-9.8	U-2	19	-28.8																																95
PD2-GR-004	-9.8	U-2	18.4	-28.2		79.8																														
PD2-GR-004	-9.8	U-2	18.65	-28.45	CH	82										82	51.2	1090	360	0.33														93.1			
PD2-GR-004	-9.8	U-2	18.95	-28.75		84.3																														
PD2-GR-004	-9.8	U-2	19.2	-29	CH	78.2															78.2	53.0	390	250	7	4.9								94.4		
PD2-GR-004	-9.8	U-2	19.5	-29.3		65.6																														
PD2-GR-004	-9.8	U-2	19.75	-29.55	CH	65.1	57	28	29	1.3	0.81	85.2		14													0.45	900	0.25	0.014	4	0.6	1200	1.27			100	
PD2-GR-004	-9.8	U-3	30	-39.8																																98.5
PD2-GR-004	-9.8	U-3	28.25	-38.05		66.6																														
PD2-GR-004	-9.8	U-3	28.8	-38.6		58.8																														
PD2-GR-004	-9.8	U-3	29.05	-38.85	CH	63.8	56	29	27	1.3		78.3		15																							
PD2-GR-004	-9.8	U-3	29.35	-39.15		72.4																														
PD2-GR-004	-9.8	U-5	44	-53.8																																120.3
PD2-GR-004	-9.8	U-5	43.2	-53		39.3																														
PD2-GR-004	-9.8	U-5	43.75	-53.55		33.1																														
PD2-GR-004	-9.8	U-5	44	-53.8	SP-SC	49.4	25	17	8	4.1		10.8		1																							
PD2-GR-004	-9.8	U-6	54	-63.8																																102.2
PD2-GR-004	-9.8	U-6	53.35	-63.15		47.5																														
PD2-GR-004	-9.8	U-6	53.9	-63.7		53.1																														
PD2-GR-004	-9.8	U-6	54.15	-63.95	CL	51.1															51.1	70.2	800	546	4.5	14.1								106		

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TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress	Su/p	w% initial	ρ_d initial	1/2 sdev (lab)	1/2 sdev (corrected)	% STRAIN	σ'con	Corrected					Lab		OCR	DSS	CU TRX	Consol	
																	(pcf)										Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)		(pcf)	(pcf)	(pcf)	(pcf)
						(%)						(%)	(%)	(%)	(%)				(psf)			(pcf)	(psf)	(psf)		(psi)											
PD2-GR-005	-22.4	U-1	8.75	-31.15		73.2																														
PD2-GR-005	-22.4	U-1	9	-31.4	OH	79.8															79.8	53.4	210	136	4.4	2.4								96.1		
PD2-GR-005	-22.4	U-1	9.3	-31.7		87.8																														
PD2-GR-005	-22.4	U-1	9.55	-31.95	OH	102.5	68	32	36	2.0	0.59	90		20													0.2	400	0.3	0.031	3	0.2	400	1.54		91.2	
PD2-GR-005	-22.4	U-2	20	-42.4																																107.4
PD2-GR-005	-22.4	U-2	19.6	-42		57.2																														
PD2-GR-005	-22.4	U-2	20.15	-42.55		58.1																														
PD2-GR-005	-22.4	U-2	20.4	-42.8	CL	57.1	40	21	19	1.9	1.03	92.3		17																						
PD2-GR-005	-22.4	U-3	30	-52.4																																102.1
PD2-GR-005	-22.4	U-3	29.3	-51.7		62.7																														
PD2-GR-005	-22.4	U-3	29.85	-52.25		66.2																														
PD2-GR-005	-22.4	U-3	30.4	-52.8		50.3																														
PD2-GR-005	-22.4	U-3	30.65	-53.05	CH	81.7	60	27	33	1.7		95.1		23																						
PD2-GR-005	-22.4	U-4	40	-62.4																																
PD2-GR-005	-22.4	U-4	39.25	-61.65		21																														121.8
PD2-GR-005	-22.4	U-4	39.5	-61.9	SC	26.7															26.7	97.7	2335	1705	15	10.4								123.8		
PD2-GR-005	-22.4	U-4	39.8	-62.2		21.4																														
PD2-GR-005	-22.4	U-4	40.05	-62.45	CL	36.1	35	16	19	1.1		55.9		7													1.3	2600	0.12	0.005	4	1	2000	1.32		113.1	
PD2-GR-005	-22.4	U-5	50	-72.4																																102.3
PD2-GR-005	-22.4	U-5	49.55	-71.95		59.8																														
PD2-GR-005	-22.4	U-5	50.1	-72.5		53.2																														
PD2-GR-005	-22.4	U-5	50.35	-72.75	CH	45.3	53	27	26	0.7		92.4		29																						
PD2-GR-006	-4.9	U-1	8	-12.9																																92.9
PD2-GR-006	-4.9	U-1	7.6	-12.5		85.9																														
PD2-GR-006	-4.9	U-1	7.85	-12.75	MH	82.1															82.1	50.7	210	132	7.1	2.1								92.3		
PD2-GR-006	-4.9	U-1	8.15	-13.05		89.3																														
PD2-GR-006	-4.9	U-1	8.3	-13.2	MH	93.3										93.3	46.5	450	160	0.36														89.9		
PD2-GR-006	-4.9	U-1	8.5	-13.4	MH	93.8	80	40	40	1.3	0.78	92		28													0.23	460	0.27	0.043	2	0.4	800	2.08		90	
PD2-GR-006	-4.9	U-2	18	-22.9																																90.6
PD2-GR-006	-4.9	U-2	17.65	-22.55		78																														
PD2-GR-006	-4.9	U-2	17.9	-22.8	CH	84.2	89	33	56	0.9		95.9		27																						
PD2-GR-006	-4.9	U-3	28	-32.9																																99.2
PD2-GR-006	-4.9	U-3	27.4	-32.3		68.3																														
PD2-GR-006	-4.9	U-3	27.65	-32.55	MH	66															66	60.2	500	330	15	7.3								99.9		
PD2-GR-006	-4.9	U-3	27.95	-32.85		50.8																														
PD2-GR-006	-4.9	U-3	28.2	-33.1	MH	66.5	56	30	26	1.4	0.79	93.1		17													0.7	1400	0.29	0.018	4	0.7	1400	1.37		100.3	
PD2-GR-006	-4.9	U-3	28.5	-33.4		67.2																														
PD2-GR-006	-4.9	U-3	28.75	-33.65	MH	65.3										65.3	59.8	1580	470	0.30														98.8		
PD2-GR-006	-4.9	U-5	43	-47.9																																104.9
PD2-GR-006	-4.9	U-5	42.35	-47.25		44.2																														
PD2-GR-006	-4.9	U-5	42.6	-47.5	CL	54															54	69.1	710	484	10	11.2								106.4		
PD2-GR-006	-4.9	U-5	42.9	-47.8		68.3																														
PD2-GR-006	-4.9	U-5	43	-47.9	CL	55.8										55.8	66.1	2430	680	0.28														103		
PD2-GR-006	-4.9	U-5	43.2	-48.1	CL	50.1	48	27	21	1.1		90.1		18													0.95	1900	0.23	0.007	6	0.8	1600	1.04		106.3	
PD2-GR-006	-4.9	U-6	53	-57.9																																112.1
PD2-GR-006	-4.9	U-6	52.7	-57.6		32.5																														
PD2-GR-006	-4.9	U-6	52.95	-57.85	SC	28.9										28.9	95.0	2990	970	0.32														122.5		
PD2-GR-006	-4.9	U-6	53.25	-58.15		28																														
PD2-GR-006	-4.9	U-6	53.5	-58.4	SC	34.9	32	21	11	1.3		30.6		6													1.7	3400	0.17	0.003	6	1.6	3200	1.19		117.6	
PD2-GR-006	-4.9	U-7	63	-67.9																																107.7
PD2-GR-006	-4.9	U-7	62.3	-67.2		55.4																														
PD2-GR-006	-4.9	U-7	62.55	-67.45	CL	54.9										54.9	67.1	3540	810	0.23														104		
PD2-GR-006	-4.9	U-7	62.85	-67.75		44.8																														
PD2-GR-006	-4.9	U-7	63.1	-68	CL	49.6															49.6	72.6	990	683	5.6	16.5								108.6		
PD2-GR-006	-4.9	U-7	63.4	-68.3		50.7																														
PD2-GR-006	-4.9	U-7	63.65	-68.55	CL	43.8	41	22	19	1.1		87.8		18													2	4000	0.18	0.010	5	1.7	3400	1.36		110.2	
PD2-GR-007	-22.8	U-1	9	-31.8																																102.1
PD2-GR-007	-22.8	U-1	8.2	-31		74																														
PD2-GR-007	-22.8	U-1A	8.45	-31.25	CH	55.3										55.3	66.1	420	200	0.48														102.6		
PD2-GR-007	-22.8	U-1	8.75	-31.55		76.3																														
PD2-GR-007	-22.8	U-1	8.95	-31.75	CH	65.6	51	25	26.0	1.6	0.8	93.8		14													0.23	460	0.22	0.023	4	0.3	600	1.53		97.6	
PD2-GR-007	-22.8	U-2	19	-41.8																																101
PD2-GR-007	-22.8	U-2	18.2	-41		87.9																														
PD2-GR-007	-22.8	U-2	18.7	-41.5		66.5																														
PD2-GR-007	-22.8	U-2	19.25	-42.05		79.8																														
PD2-GR-007	-22.8	U-2C	19.55	-42.35	OH		61	30	31.0		0.6	86.5		12																						
PD2-GR-007	-22.8	U-3	29	-51.8																																105.5
PD2-GR-007	-22.8	U-3A	28.25	-51.05	OH	69.2	65	30	35.0	1.1	0.7	98.9		79																						
PD2-GR-007	-22.8	U-3	28.55	-51.35		74.5																														
PD2-GR-007	-22.8	U-3B	28.8	-51.6	OH	63.5																					0.7	1400	0.27	0.017	6	0.7	1400	1.36		99.8	
PD2-GR-007	-22.8	U-3	29.1	-51.9		41																														
PD2-GR-007	-22.8	U-3C	29.35	-52.15	SP-SM/OH	34.1															34.1	81.0	700	484	15	7.6								108.6		
PD2-GR-007	-22.8	U-4	38.85	-61.65		55.3																														
PD2-GR-007	-22.8	U-4B	39.1	-61.9	CL	55.6										55.6	66.1	2200	550	0.25														102.9		
PD2-GR-007	-22.8	U-4	39.4	-62.2		47.9																														
PD2-GR-007	-22.8	U-4	39.65	-62.45	CL	75.5	42	23	19.0	2.8	1.0	78.6		20													0.8	1600	0.31	0.030	4	0.7	1400	1.23		96.7	
PD2-GR-008	-19.3	U-1	8	-27.3																																91.7
PD2-GR-008	-19.3	U-1	7.15	-26.45		83.6																														
PD2-GR-008	-19.3	U-1A	7.4	-26.7	OH	76.6	82	33	49.0	0.9	0.6	84.6		12													0.3	600	0.26	0.015	7	0.2	400	2.53		96.1	
PD2-GR-008	-19.3	U-1	7.7	-27		88.5																														
PD2-GR-008	-19.3	U-1B	7.95	-27.25	OH	84.9															84.9	50.0	160	101	5.5	2.1								92.4		
PD2-GR-008	-19.3	U-1	8.25	-27.55		91.9																														
PD2-GR-008	-19.3	U-1C	8.5	-27.8	OH	86.7										86.7	49.2	450	140	0.31														91.8		
PD2-GR-008	-19.3	U-2	18	-37.3																																97.6
PD2-GR-008	-19.3	U-2	17.7	-37		81.2																														
PD2-GR-008	-19.3	U-2B	17.95	-37.25	OH	89.3										89.3	48.1	1010	280	0.28														91.1		
PD2-GR-008	-19.3	U-2	18.25	-37.55		61.8																														
PD2-GR-008	-19.3	U-2	18.55	-37.85	OL	36.2	46	26	20.0	0.5	0.7	88.3		19													2	4000	0.13	0.008	1	3.4	6800	4.30		114.1	
PD2-GR-008	-19.3	U-3	28	-47.3																																105.1
PD2-GR-008	-19.3	U-3	27.4	-46.7		69.5																														
PD2-GR-008	-19.3	U-3	27.95	-47.25		55.5																														
PD2-GR-008	-19.3	U-3	28.2	-47.5	CL	51.8										51.8	69.4	1580	350	0.22														105.3		
PD2-GR-008	-19.3	U-3	28.5	-47.8		67.1																														
PD2-GR-008	-19.3	U-3	28.8	-48.1	CL	64.5	49	23	26	1.6		92.8		16													0.6	1200	0.25	0.017	3	0.6	1200	1.11		101.5	
PD2-GR-008	-19.3	U-4	38	-57.3																																101.7
PD2-GR-008	-19.3	U-4	37.2	-56.5		61.4																														
PD2-GR-008	-19.3	U-4	37.75	-57.05		45.5																														
PD2-GR-008	-19.3	U-4	38.3	-57.6		52.3																														

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TABLE 3.7A
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM MARINE SILT STRATUM
1 RIVER STREET
HASTINGS-ON-HUDSON, NEW YORK

BORING NO.	GROUND SURF ELEV.	SAMPLE NO.	DEPTH (ft)	ELEV.	USCS CLASSIFICATION	WATER CONTENT	ATTERBERG LIMITS					% PASSING NO. 200 SIEVE	% SILT	% CLAY	ORGANIC CONTENT	DSS					CU TRIAXIAL						CONSOLIDATION PARAMETERS								UNIT WEIGHT			
							LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX	LLoven/ LLair					w% initial	ρ_d	σv'	peak sh stress (psf)	Su/p	w% initial	ρ_d initial (pcf)	1/2 sdev (lab) (psf)	1/2 sdev (corrected) (psf)	% STRAIN	σ'con (psi)	Corrected					Lab		OCR	DSS (pcf)	CU TRX (pcf)	Consol (pcf)	
																	(pcf)										Pp (tsf)	Pp (psf)	CR	RR	εvo (%)	Pp (tsf)	Pp (psf)					
						(%)						(%)	(%)	(%)	(%)																						
PD2-GR-008	-19.3	U-5	48.3	-67.6		58.5																														
PD2-GR-008	-19.3	U-5C	48.55	-67.85	ML	57.7	49	29	20	1.4		94		23																						
PD2-GR-009	-14.2	U-1	7	-21.2																																93.3
PD2-GR-009	-14.2	U-1A	6.45	-20.65	OH	74.8															74.8	53.8	130	82	12.3	1.8									94.1		
PD2-GR-009	-14.2	U-1	6.75	-20.95		76.8																														
PD2-GR-009	-14.2	U-1B	7	-21.2	OH	76.2	72	32	40	1.1	0.74	95.4		27													0.55	1100	0.29	0.035	2	0.5	1000	5.19			94.3	
PD2-GR-009	-14.2	U-1	7.25	-21.45		68.3																														
PD2-GR-009	-14.2	U-1C	7.5	-21.7	OH	77.8										77.8	52.2	400	170	0.43														92.8			
PD2-GR-009	-14.2	U-2	17	-31.2																																100.1
PD2-GR-009	-14.2	U-2	16.25	-30.45		49.3																														
PD2-GR-010	-14.2	U-3	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	16.8	-31		54.5																														
PD2-GR-009	-14.2	U-2	17.35	-31.55		64.1																														
PD2-GR-009	-14.2	U-2C	17.6	-31.8	OH	63.3	66	38	28	0.9	0.67	81.9		4																						
PD2-GR-009	-14.2	U-3	27	-41.2																																105.1
PD2-GR-009	-14.2	U-3	26.35	-40.55		68																														
PD2-GR-009	-14.2	U-3	26.9	-41.1		51.4																														
PD2-GR-009	-14.2	U-3	27.15	-41.35	CL	60.3	39	21	18	2.2	0.9	94.8		15		60.3	62.6	1520	420	0.28														100.4			
PD2-GR-009	-14.2	U-3	27.3	-41.5	CL	57.5																					0.7	1400	0.23	0.023	4	0.7	1400	1.41		100.3	
PD2-GR-009	-14.2	U-3	27.45	-41.65		48.8																														
PD2-GR-009	-14.2	U-3C	27.7	-41.9	CL	41.4															41.4	81.7	500	356	7.9	7.1									115.5		
PD2-GR-009	-14.2	U-4	37	-51.2																																103.4
PD2-GR-009	-14.2	U-4	36.25	-50.45		65																														
PD2-GR-009	-14.2	U-4	36.8	-51		57.7																														
PD2-GR-009	-14.2	U-4	37.05	-51.25	CH	57.3										57.3	64.5	2090	540	0.26														101.4			
PD2-GR-009	-14.2	U-4	37.35	-51.55		49																														
PD2-GR-009	-14.2	U-4C	37.6	-51.8	CH	70.1	65	32	33	1.2		83.4		14													1.2	2400	0.35	0.027	3	1	2000	1.84		98.6	
PD2-GR-009	-14.2	U-5	47	-61.2																																109.8
PD2-GR-009	-14.2	U-5	46.2	-60.4		28.4																														
PD2-GR-009	-14.2	U-5	46.75	-60.95		45.4																														
PD2-GR-009	-14.2	U-5	47	-61.2	CL		38	24	14																											
PD2-GR-009	-14.2	U-5	47.55	-61.75		43.4																														
PD2-GR-009	-14.2	U-5B	48	-62.2	CL	49.1						83.1		14																						

Notes:
1. Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88).

Legend:
LL_{oven} = liquid limit by oven-dried method
LL_{air} = liquid limit by air-dried method
σ_{dev} = deviator stress at failure
$\sigma'_{confined}$ = effective confining stress
CU TRX = consolidated undrained triaxial test
ε_{vo} - strain at in-situ effective stress
CR = compression ratio (strain per log cycle stress)
RR = recompression ratio (strain per log cycle stress)
Pp = preconsolidation pressure

TABLE 3.7B

SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA ON SAMPLES FROM BASAL SAND STRATUM

1 RIVER STREET

HASTINGS-ON-HUDSON, NEW YORK

										ATTERBERG LIMITS			
BORING NO.	GROUND SURFACE ELEV.	SAMPLE NO.	DEPTH (FT)	ELEV.	USCS CLASSIFICATION	WATER CONTENT (%)	% PASSING NO. 200 SIEVE (%)	% SILT (%)	% CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	LIQUIDITY INDEX
PD2-GR-001	-10.3	S-13	89-91	-100.9	SM	16.5	17.7	15.7	2				
PD2-GR-001	-10.3	S-14	94-96	-105.9	CL	30.2	70.3	63.3	7	25	17	8	1.65
PD2-GR-002A	-24.3	S-8	71-73	-93.6	CL-ML	21.3	73.1	69.1	4				
PD2-GR-002A	-24.3	S-10	81-83	-106.3	SP-SM	24.4	8.6	8.6	0				
PD2-GR-003	-27.7	S-11	77.5-79.5	-106.2	CL-ML	27	94.4	91.4	3				
PD2-GR-003	-27.7	S-14	92.5-94.5	-121.2	CL-ML	27.7	82.4	71.4	11	24	19	5	1.74
PD2-GR-007	-22.8	S-8	62.9-64.9	-86.7	CL	53.2				44	23	21	1.44
PD2-GR-007	-22.8	S-9	67.9-69.9	-91.7	CL	37.7				36	21	15	1.11
PD2-GR-007	-22.8	S-10	72.9-74.9	-96.7	CL	36.6				39	21	18	0.87

Notes:

1. Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88).

ARCADIS Design & Consultancy for natural and built assets

Attachment B

Consolidation Settlement

Calculations

Table 1
Summary of Northwest Extension Area Geotechnical Data

Preliminary Design
Former Anaconda Wire and Cable Plant Site

												Consolidation Parameters (corrected)										
Data Report Year	Boring No.	Ground Surface Elevation	Sample No.	Depth	σ'v	Unit Weight Average	Elev.	Classification USCS	Water Content	Pp	Pp	Cv	Ca	t50	t90	t95	t99	CR	RR	ε_{vo}	OCR[1]	Lab Pp	Lab Pp
	Units			(ft)	(psf)	(pcf)	ft NAVD88		(%)	(tsf)	(psf)	(ft^2/sec)		YR	YR	YR	YR					(tsf)	(psf)
2015	PD2-GR-006	-4.9	U-1	8.5	362.1	90	-13.4	MH	93.8	0.23	460							0.27	0.043	2	2.08	0.4	800
2006	PDGEO-31	3.42	U-1	21	894.6	99.25	-17.58	MH	78.1	0.35	700	1.94444E-06	0.0161	2.9	12.4	16.6	26.1	0.35	0.12	15	0.6	0.48	960
2015	PD2-GR-004	-9.8	U-1	9.55	406.83	93.1	-19.35	CH	75.9	0.4	800							0.25	0.023	4	2.88	0.5	1000
2006	PDGEO-23	3.4	U-1	25	1065	101	-21.6	MH	63.8	0.55	1100	6.48148E-07	0.0107	8.7	37.3	49.7	78.4	0.25	0.09	8.5	0.9	0.41	820
2015	PD2-GR-001	-10.9	U-1B	11.5	489.9	94	-22.45	MH	70.8	0.7	1400							0.31	0.027	4	1.27	0.4	800
2006	PDGEO-21	3.4	U-2	29	1235.4	96.2	-25.6		68.7	0.81	1620	4.62963E-07	0.0115	12.1	52.3	69.6	109.8	0.29	0.07	10.5	1.07	0.72	1440
2006	PDGEO-31	3.42	U-3	31	1320.6	104.45	-27.58	CL	69.3	0.4	800	1.99074E-06	0.0088	2.8	12.2	16.2	25.5	0.24	0.08	15.5	0.5	0.43	860
2006	PDGEO-23	3.4	U-2	31	1320.6	--	-27.6		80.3	0.63	1260	4.62963E-07	0.0089	12.1	52.3	69.6	109.8	0.21	0.1	16.5	0.85	0.45	900
2015	PD2-GR-004	-9.8	U-2	19.75	841.35	100	-29.55	CH	65.1	0.45	900							0.25	0.014	4	1.27	0.6	1200
2006	PDGEO-30	3.28	U-1	33	1405.8	103.45	-29.72	CL	63.5	0.61	1220	6.03009E-06	0.00758	0.9	4.0	5.3	8.4	0.2	0.08	9	0.7	1.2	2400
2006	PDGEO-28	6.96	U-1	38	1618.8	106	-31.04	CL	58.2	0.62	1240	4.76852E-06	0.00946	1.2	5.1	6.8	10.7	0.24	0.05	9.5	0.7	0.86	1720
2015	PD2-GR-005	-22.4	U-1	9.55	406.83	91.2	-31.95	OH	102.5	0.2	400							0.3	0.031	3	2.88	0.2	400
2006	PDGEO-19	3.96	U-1	36	1533.6	109	-32.04	CL	58.9	0.65	1300	9.9537E-07	0.0102	5.6	24.3	32.4	51.1	0.27	0.05	7	0.7	1.1	2200
2006	PDGEO-22	2.67	U-2	35	1491	104.45	-32.33	MH	61.8	0.79	1580	3.47222E-07	0.0152	16.2	69.7	92.8	146.4	0.27	0.09	13	0.94	0.62	1240
2015	PD2-GR-006	-4.9	U-3	28.2	1201.32	100.3	-33.1	MH	66.5	0.7	1400							0.29	0.018	4	1.37	0.7	1400
2006	PDGEO-21	3.4	U-4	38	1618.8	99.9	-34.6		58.6	0.3	600	2.28009E-06	0.0095	2.5	10.6	14.1	22.3	0.21	0.04	9	0.32	0.28	560
2006	PDGEO-28	6.96	U-2	42	1789.2	106.3	-35.04		57.7	1.4	2800	1.55093E-06	0.0042	3.6	15.6	20.8	32.8	0.32	0.09	17	1.4	1.1	2200
2006	PDGEO-29	6.8	U-1	43	1831.8	101.9	-36.2		49.2	0.98	1960	1.37731E-06	0.0079	4.1	17.6	23.4	36.9	0.46	0.11	19	0.93	1.1	2200
2011	HA-411	-29.84	U-1	6.6	281.16	95.7	-36.44	MH or OH	65	0.31	620	--		--	--	--	--	0.216	0.028	9	3		
2011	HA-401A	-16.14	T-1	21	894.6	99.8	-37.14	OH	60	0.44	880							0.19	0.019	7	1.2		
2015	PD2-GR-001	-10.9	U-3C	27.15	1156.59	103.5	-38.05	ML	57.4	0.7	1400							0.22	0.014	4	0.86	0.7	1400
2006	PDGEO-21	3.4	U-5	43	1831.8	107.3	-39.6	CL	36.9	0.68	1360	1.37731E-06	0.0057	4.1	17.6	23.4	36.9	0.25	0.1	0.17	0.64	0.41	820
				Averages =	100.3238				66.45455			1.86432E-06		5.9141	25.4577	33.8936	53.4672	0.266182	0.0585		1.801429		
2015	PD2-GR-003	-27.7	U-2C	13.65	581.49	94.9	-41.35	OH	76.7	0.7	1400							0.3	0.033	4	3.32	0.6	1200
2006	PDGEO-19	3.96	U-3	46	1959.6	112.1	-42.04	CL	51.7	0.9	1800	3.7037E-07	0.0212	15.2	65.3	87.0	137.2	0.31	0.08	14.5	0.8	0.91	1820
2011	HA-401	-16.54	T-1	27	1150.2	100.5	-43.54	OH	75	0.6	1200							0.21	0.015	8	1.4		
2006	PDGEO-28	6.96	U-3	51	2172.6	115	-44.04	CL	34.6	0.6	1200	8.78472E-06	0.00648	0.6	2.8	3.7	5.8	0.17	0.09	12	0.5	0.43	860
2006	PDGEO-24A	4.39	U-2	49	2087.4	110.2	-44.61		47.6	0.81	1620	1.38889E-06	0.0103	4.0	17.4	23.2	36.6	0.27	0.06	10	0.68	0.87	1740
2006	PDGEO-17	4.25	U-2	49	2087.4	103	-44.75		39.5	0.34	680	2.06E-06	1.04E-02	2.7	11.7	15.6	24.7	0.23	0.05	14.5	0.3	0.47	940
2011	HA-401A	-16.14	T-2	31	1320.6	102.5	-47.14	OL	70	0.29	580							0.21	0.025	12	0.5		
2015	PD2-GR-001	-10.9	U-4C	37.05	1578.33	99.4	-47.95	CH	66.4	1.2	2400							0.42	0.016	3	1.23	0.8	1600
2015	PD2-GR-006	-4.9	U-5	43.2	1840.32	106.3	-48.1	CL	50.1	0.95	1900							0.23	0.007	6	1.04	0.8	1600
2011	HA-413	-38.94	U-1	11.25	479.25	99.5	-50.19	CH or OH	66	0.255	510	--		--	--	--	--	0.21	0.02	5.5	1.3		
2006	PDGEO-28	6.96	U-4	58	2470.8	105.4	-51.04		46.4	0.83	1660	2.74306E-06	0.005	2.0	8.8	11.7	18.5	0.16	0.04	7	0.6	1.43	2860
2015	PD2-GR-003	-27.7	U-3C	23.6	1005.36	103.6	-51.3	CH	57.9	0.75	1500							0.28	0.023	5	1.61	0.8	1600
2015	PD2-GR-001	-10.9	U-5A	46	1959.6	105.1	-56.9	CL	54.4	1.5	3000							0.23	0.017	9	1.25	0.9	1800
2011	HA-412	-35.64	U-3	21.65	922.29	97.9	-57.29			1.65	3300	--		--	--	--	--	0.097	0.009	2	4.5		
2015	PD2-GR-006	-4.9	U-6	53.5	2279.1	117.6	-58.4	SC	34.9	1.7	3400							0.17	0.003	6	1.19	1.6	3200
2011	HA-411	-29.84	U-4	29.3	1248.18	103.2	-59.14	CL or OL	65	0.7	1400	--		--	--	--	--	0.133	0.007	4.3	1.2		
				Averages =	104.7625				55.74667			3.06944E-06		4.9293	21.2183	28.2494	44.5635	0.226875	0.030938		1.606667		
2015	PD2-GR-002A	-24.3	U-5A	37.6	1601.76	106.2	-61.9	CL	56.7	0.7	1400							0.2	0.015	8	0.88	0.7	1400
2015	PD2-GR-005	-22.4	U-4	40.05	1706.13	113.1	-62.45	CL	36.1	1.3	2600							0.12	0.005	4	1.32	1	2000
2006	PDGEO-24A	4.39	U-4	72	3067.2	125.2	-67.61		31.5	0.8	1600	2.01389E-06	0.0032	2.8	12.0	16.0	25.2	0.11	0.07	9	0.48	0.55	1100
2015	PD2-GR-006	-4.9	U-7	63.65	2711.49	110.2	-68.55	CL	43.8	2	4000							0.18	0.01	5	1.36	1.7	3400
2015	PD2-GR-003	-27.7	U-5C	48.85	2081.01	111.4	-76.55	ML	40.6	1.5	3000							0.17	0.01	6	1.3	1.2	2400
2011	HA-413	-38.94	U-4	39.25	1672.05	112.2	-78.19	NP		0.7	1400	4.00E-06		1.4	6.05	8.1	12.71	0.168	0.02	9	0.7	0.7	
2011	HA-411	-29.84	U-6	50.3	2142.78	105.7	-80.14	CL	45	1.05	2100	2.00E-05		0.3	1.21	1.6	2.54	0.189	0.006	5.5	1	1	
2015	PD2-GR-002A	-24.3	U-7	57.7	2458.02	117.3	-82	CL	33.4	1.7	3400							0.2	0.007	4	1.11	1.4	2800
2011	HA-413	-38.94	U-6	49.25	2098.05	101	-88.19			1.55	3100	2.00E-06		2.8	12.10	16.1	25.41	0.245	0.031	6.5	1.7	1.7	
				Averages =	111.3667				41.01429			7.00347E-06		1.8224	7.8444	10.4438	16.4752	0.175778	0.019333		1.194		

Notes:

= shallow Marine Silt (1)
= mid-range Marine Silt (2)
= deep Marine Silt (3)

Average all layers = 3.97908E-06 (ft^2/sec)
125.4841923 (ft^2/year)

1. Red numbers removed from averaging due to test quality.

Client: Atlantic Richfield Company
Prepared by: A. Baird Date: 10.11.17
Checked by: R. Kilkenny Date: 10.13.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Cap Material
Analysis for Low End Compressibility

Average Depth to Water = 0 ft bgs
γ_w = 62.4 pcf

Depth, z (ft bgs)	Soil Type	γ (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	Assumed OCR profile OCR	Assumed OCR profile p'_c (psf)
0.0	MS (1)	100.32	0.0	0.0	0	1.8	0.0
0.5	MS (1)	100.32	50.2	31.2	19.0	1.8	34.1
1.0	MS (1)	100.32	100.3	62.4	37.9	1.8	68.3
1.5	MS (1)	100.32	150.5	93.6	56.9	1.8	102.4
2.0	MS (1)	100.32	200.6	124.8	75.8	1.8	136.5
2.5	MS (1)	100.32	250.8	156.0	94.8	1.8	170.7
3.0	MS (1)	100.32	301.0	187.2	113.8	1.8	204.8
3.5	MS (1)	100.32	351.1	218.4	132.7	1.8	238.9
4.0	MS (1)	100.32	401.3	249.6	151.7	1.8	273.1
4.5	MS (1)	100.32	451.5	280.8	170.7	1.8	307.2
5.0	MS (1)	100.32	501.6	312.0	189.6	1.8	341.3
5.5	MS (1)	100.32	551.8	343.2	208.6	1.8	375.4
6.0	MS (1)	100.32	601.9	374.4	227.5	1.8	409.6
6.5	MS (1)	100.32	652.1	405.6	246.5	1.8	443.7
7.0	MS (1)	100.32	702.3	436.8	265.5	1.8	477.8
7.5	MS (1)	100.32	752.4	468.0	284.4	1.8	512.0
8.0	MS (1)	100.32	802.6	499.2	303.4	1.8	546.1
8.5	MS (1)	100.32	852.8	530.4	322.4	1.8	580.2
9.0	MS (1)	100.32	902.9	561.6	341.3	1.8	614.4
9.5	MS (1)	100.32	953.1	592.8	360.3	1.8	648.5
10.0	MS (1)	100.32	1003.2	624.0	379.2	1.8	682.6
10.5	MS (1)	100.32	1053.4	655.2	398.2	1.8	716.8
11.0	MS (1)	100.32	1103.6	686.4	417.2	1.8	750.9
11.5	MS (1)	100.32	1153.7	717.6	436.1	1.8	785.0
12.0	MS (1)	100.32	1203.9	748.8	455.1	1.8	819.2
12.5	MS (1)	100.32	1254.0	780.0	474.0	1.8	853.3
13.0	MS (1)	100.32	1304.2	811.2	493.0	1.8	887.4
13.5	MS (1)	100.32	1354.4	842.4	512.0	1.8	921.5
14.0	MS (1)	100.32	1404.5	873.6	530.9	1.8	955.7
14.5	MS (1)	100.32	1454.7	904.8	549.9	1.8	989.8
15.0	MS (1)	100.32	1504.9	936.0	568.9	1.8	1023.9
15.5	MS (2)	104.76	1556.1	967.2	588.9	1.26	742.1
16.0	MS (2)	104.76	1608.5	998.4	610.1	1.26	768.7
16.5	MS (2)	104.76	1660.9	1029.6	631.3	1.26	795.4
17.0	MS (2)	104.76	1713.3	1060.8	652.5	1.26	822.1
17.5	MS (2)	104.76	1765.7	1092.0	673.7	1.26	848.8
18.0	MS (2)	104.76	1818.0	1123.2	694.8	1.26	875.5
18.5	MS (2)	104.76	1870.4	1154.4	716.0	1.26	902.2
19.0	MS (2)	104.76	1922.8	1185.6	737.2	1.26	928.9
19.5	MS (2)	104.76	1975.2	1216.8	758.4	1.26	955.6
20.0	MS (2)	104.76	2027.6	1248.0	779.6	1.26	982.2
20.5	MS (2)	104.76	2079.9	1279.2	800.7	1.26	1008.9

Depth, z (ft bgs)	Soil Type	γ (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
21.0	MS (2)	104.76	2132.3	1310.4	821.9	1.26	1035.6
21.5	MS (2)	104.76	2184.7	1341.6	843.1	1.26	1062.3
22.0	MS (2)	104.76	2237.1	1372.8	864.3	1.26	1089.0
22.5	MS (2)	104.76	2289.5	1404.0	885.5	1.26	1115.7
23.0	MS (2)	104.76	2341.8	1435.2	906.6	1.26	1142.4
23.5	MS (2)	104.76	2394.2	1466.4	927.8	1.26	1169.1
24.0	MS (2)	104.76	2446.6	1497.6	949.0	1.26	1195.8
24.5	MS (2)	104.76	2499.0	1528.8	970.2	1.26	1222.4
25.0	MS (2)	104.76	2551.4	1560.0	991.4	1.26	1249.1
25.5	MS (2)	104.76	2603.8	1591.2	1012.6	1.26	1275.8
26.0	MS (2)	104.76	2656.1	1622.4	1033.7	1.26	1302.5
26.5	MS (2)	104.76	2708.5	1653.6	1054.9	1.26	1329.2
27.0	MS (2)	104.76	2760.9	1684.8	1076.1	1.26	1355.9
27.5	MS (2)	104.76	2813.3	1716.0	1097.3	1.26	1382.6
28.0	MS (2)	104.76	2865.7	1747.2	1118.5	1.26	1409.3
28.5	MS (2)	104.76	2918.0	1778.4	1139.6	1.26	1435.9
29.0	MS (2)	104.76	2970.4	1809.6	1160.8	1.26	1462.6
29.5	MS (2)	104.76	3022.8	1840.8	1182.0	1.26	1489.3
30.0	MS (2)	104.76	3075.2	1872.0	1203.2	1.26	1516.0
30.5	MS (2)	104.76	3127.6	1903.2	1224.4	1.26	1542.7
31.0	MS (2)	104.76	3179.9	1934.4	1245.5	1.26	1569.4
31.5	MS (2)	104.76	3232.3	1965.6	1266.7	1.26	1596.1
32.0	MS (2)	104.76	3284.7	1996.8	1287.9	1.26	1622.8
32.5	MS (2)	104.76	3337.1	2028.0	1309.1	1.26	1649.5
33.0	MS (2)	104.76	3389.5	2059.2	1330.3	1.26	1676.1
33.5	MS (2)	104.76	3441.9	2090.4	1351.5	1.26	1702.8
34.0	MS (2)	104.76	3494.2	2121.6	1372.6	1.26	1729.5
34.5	MS (2)	104.76	3546.6	2152.8	1393.8	1.26	1756.2
35.0	MS (3)	111	3600.6	2184.0	1416.6	1.2	1700.0
35.5	MS (3)	111	3656.3	2215.2	1441.1	1.2	1729.4
36.0	MS (3)	111	3712.0	2246.4	1465.6	1.2	1758.7
36.5	MS (3)	111	3767.7	2277.6	1490.1	1.2	1788.1
37.0	MS (3)	111	3823.4	2308.8	1514.6	1.2	1817.5
37.5	MS (3)	111	3879.1	2340.0	1539.1	1.2	1846.9
38.0	MS (3)	111	3934.7	2371.2	1563.5	1.2	1876.3
38.5	MS (3)	111	3990.4	2402.4	1588.0	1.2	1905.6
39.0	MS (3)	111	4046.1	2433.6	1612.5	1.2	1935.0
39.5	MS (3)	111	4101.8	2464.8	1637.0	1.2	1964.4
40.0	MS (3)	111	4157.5	2496.0	1661.5	1.2	1993.8
40.5	MS (3)	111	4213.2	2527.2	1686.0	1.2	2023.2
41.0	MS (3)	111	4268.8	2558.4	1710.4	1.2	2052.5
41.5	MS (3)	111	4324.5	2589.6	1734.9	1.2	2081.9
42.0	MS (3)	111	4380.2	2620.8	1759.4	1.2	2111.3
42.5	MS (3)	111	4435.9	2652.0	1783.9	1.2	2140.7
43.0	MS (3)	111	4491.6	2683.2	1808.4	1.2	2170.1
43.5	MS (3)	111	4547.3	2714.4	1832.9	1.2	2199.4
44.0	MS (3)	111	4602.9	2745.6	1857.3	1.2	2228.8
44.5	MS (3)	111	4658.6	2776.8	1881.8	1.2	2258.2
45.0	MS (3)	111	4714.3	2808.0	1906.3	1.2	2287.6
45.5	MS (3)	111	4770.0	2839.2	1930.8	1.2	2317.0
46.0	MS (3)	111	4825.7	2870.4	1955.3	1.2	2346.3
46.5	MS (3)	111	4881.4	2901.6	1979.8	1.2	2375.7
47.0	MS (3)	111	4937.0	2932.8	2004.2	1.2	2405.1
47.5	MS (3)	111	4992.7	2964.0	2028.7	1.2	2434.5
48.0	MS (3)	111	5048.4	2995.2	2053.2	1.2	2463.9
48.5	MS (3)	111	5104.1	3026.4	2077.7	1.2	2493.2
49.0	MS (3)	111	5159.8	3057.6	2102.2	1.2	2522.6

Depth, z (ft bgs)	Soil Type	γ (pcf)	σ_{v0} (psf)	u (psf)	σ'_{v0} (psf)	OCR	p'_c (psf)
49.5	MS (3)	111	5215.5	3088.8	2126.7	1.2	2552.0
50.0	MS (3)	111	5271.1	3120.0	2151.1	1.2	2581.4
50.5	MS (3)	111	5326.8	3151.2	2175.6	1.2	2610.8
51.0	MS (3)	111	5382.5	3182.4	2200.1	1.2	2640.1
51.5	MS (3)	111	5438.2	3213.6	2224.6	1.2	2669.5
52.0	MS (3)	111	5493.9	3244.8	2249.1	1.2	2698.9
52.5	MS (3)	111	5549.6	3276.0	2273.6	1.2	2728.3
53.0	MS (3)	111	5605.2	3307.2	2298.0	1.2	2757.7
53.5	MS (3)	111	5660.9	3338.4	2322.5	1.2	2787.0
54.0	MS (3)	111	5716.6	3369.6	2347.0	1.2	2816.4
54.5	MS (3)	111	5772.3	3400.8	2371.5	1.2	2845.8
55.0	MS (3)	111	5828.0	3432.0	2396.0	1.2	2875.2
55.5	MS (3)	111	5883.7	3463.2	2420.5	1.2	2904.6
56.0	MS (3)	111	5939.3	3494.4	2444.9	1.2	2933.9
56.5	MS (3)	111	5995.0	3525.6	2469.4	1.2	2963.3
57.0	MS (3)	111	6050.7	3556.8	2493.9	1.2	2992.7
57.5	MS (3)	111	6106.4	3588.0	2518.4	1.2	3022.1
58.0	MS (3)	111	6162.1	3619.2	2542.9	1.2	3051.5
58.5	MS (3)	111	6217.8	3650.4	2567.4	1.2	3080.8
59.0	MS (3)	111	6273.4	3681.6	2591.8	1.2	3110.2
59.5	MS (3)	111	6329.1	3712.8	2616.3	1.2	3139.6
60.0	MS (3)	111	6384.8	3744.0	2640.8	1.2	3169.0

ft bgs = feet below ground surface

z = depth

γ_w = unit weight of water; γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

$s_{u,UU,est.}$ = undrained shear strength assuming unconsolidated, undrained (UU) test conditions estimated based on assumed OCR

Client: Atlantic Richfield Company
Prepared by: A. Baird Date: 10.11.17
Checked by: R. Kilkenny Date: 10.13.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Bulkhead Design ID 01

h_{cap} =	26	ft
γ_w =	62.4	pcf
$\gamma_{moist,cap}$ =	60	pcf
$\gamma_{sat,cap}$ =	90	pcf
Depth to Water =	6	ft bgs
Δp =	912	psf
t =	100	yrs
t_p =	9.3	yrs

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
															Secondary Compression	
0.0	-25.0	MS (1)	100	0.0	912	912	1.80	0	0.270	0.024	0.000	0				
0.5	-25.5	MS (1)	100	19.0	912	931	1.80	34	0.270	0.024	0.237	2.84	27.276	0.0135	0.08	0.08
1.0	-26.0	MS (1)	100	37.9	912	950	1.80	68	0.270	0.024	0.174	4.93	13.916	0.0135	0.08	0.17
1.5	-26.5	MS (1)	100	56.9	912	969	1.80	102	0.270	0.024	0.145	6.67	9.462	0.0135	0.08	0.25
2.0	-27.0	MS (1)	100	75.8	912	988	1.80	137	0.270	0.024	0.126	8.18	7.236	0.0135	0.08	0.33
2.5	-27.5	MS (1)	100	94.8	912	1007	1.80	171	0.270	0.024	0.113	9.54	5.900	0.0135	0.08	0.42
3.0	-28.0	MS (1)	100	113.8	912	1026	1.80	205	0.270	0.024	0.102	10.76	5.009	0.0135	0.08	0.50
3.5	-28.5	MS (1)	100	132.7	912	1045	1.80	239	0.270	0.024	0.093	11.88	4.373	0.0135	0.08	0.58
4.0	-29.0	MS (1)	100	151.7	912	1064	1.80	273	0.270	0.024	0.086	12.91	3.896	0.0135	0.08	0.67
4.5	-29.5	MS (1)	100	170.7	912	1083	1.80	307	0.270	0.024	0.080	13.87	3.524	0.0135	0.08	0.75
5.0	-30.0	MS (1)	100	189.6	912	1102	1.80	341	0.270	0.024	0.074	14.76	3.228	0.0135	0.08	0.84
5.5	-30.5	MS (1)	100	208.6	912	1121	1.80	375	0.270	0.024	0.069	15.60	2.985	0.0135	0.08	0.92
6.0	-31.0	MS (1)	100	227.5	912	1140	1.80	410	0.270	0.024	0.065	16.38	2.782	0.0135	0.08	1.00
6.5	-31.5	MS (1)	100	246.5	912	1159	1.80	444	0.270	0.024	0.061	17.11	2.611	0.0135	0.08	1.09
7.0	-32.0	MS (1)	100	265.5	912	1177	1.80	478	0.270	0.024	0.058	17.80	2.464	0.0135	0.08	1.17
7.5	-32.5	MS (1)	100	284.4	912	1196	1.80	512	0.270	0.024	0.054	18.45	2.337	0.0135	0.08	1.25
8.0	-33.0	MS (1)	100	303.4	912	1215	1.80	546	0.270	0.024	0.051	19.07	2.226	0.0135	0.08	1.34
8.5	-33.5	MS (1)	100	322.4	912	1234	1.80	580	0.270	0.024	0.049	19.65	2.127	0.0135	0.08	1.42
9.0	-34.0	MS (1)	100	341.3	912	1253	1.80	614	0.270	0.024	0.046	20.21	2.040	0.0135	0.08	1.50
9.5	-34.5	MS (1)	100	360.3	912	1272	1.80	648	0.270	0.024	0.044	20.73	1.962	0.0135	0.08	1.59
10.0	-35.0	MS (1)	100	379.2	912	1291	1.80	683	0.270	0.024	0.041	21.23	1.892	0.0135	0.08	1.67
10.5	-35.5	MS (1)	100	398.2	912	1310	1.80	717	0.270	0.024	0.039	21.70	1.828	0.0135	0.08	1.75
11.0	-36.0	MS (1)	100	417.2	912	1329	1.80	751	0.270	0.024	0.037	22.15	1.770	0.0135	0.08	1.84
11.5	-36.5	MS (1)	100	436.1	912	1348	1.80	785	0.270	0.024	0.036	22.58	1.717	0.0135	0.08	1.92
12.0	-37.0	MS (1)	100	455.1	912	1367	1.80	819	0.270	0.024	0.034	22.99	1.669	0.0135	0.08	2.01
12.5	-37.5	MS (1)	100	474.0	912	1386	1.80	853	0.270	0.024	0.032	23.37	1.624	0.0135	0.08	2.09
13.0	-38.0	MS (1)	100	493.0	912	1405	1.80	887	0.270	0.024	0.031	23.74	1.583	0.0135	0.08	2.17
13.5	-38.5	MS (1)	100	512.0	912	1424	1.80	922	0.270	0.024	0.029	24.09	1.545	0.0135	0.08	2.26
14.0	-39.0	MS (1)	100	530.9	912	1443	1.80	956	0.270	0.024	0.028	24.43	1.510	0.0135	0.08	2.34
14.5	-39.5	MS (1)	100	549.9	912	1462	1.80	990	0.270	0.024	0.027	24.75	1.477	0.0135	0.08	2.42
15.0	-40.0	MS (1)	100	568.9	912	1481	1.80	1024	0.270	0.024	0.025	25.05	1.446	0.0135	0.08	2.51
15.5	-40.5	MS (2)	105	588.9	912	1501	1.26	742	0.272	0.017	0.032	25.44	2.023	0.0136	0.08	2.59
16.0	-41.0	MS (2)	105	610.1	912	1522	1.26	769	0.272	0.017	0.042	25.94	1.980	0.0136	0.08	2.67
16.5	-41.5	MS (2)	105	631.3	912	1543	1.26	795	0.272	0.017	0.041	26.43	1.940	0.0136	0.08	2.76
17.0	-42.0	MS (2)	105	652.5	912	1564	1.26	822	0.272	0.017	0.039	26.90	1.903	0.0136	0.08	2.84
17.5	-42.5	MS (2)	105	673.7	912	1586	1.26	849	0.272	0.017	0.038	27.36	1.868	0.0136	0.08	2.93
18.0	-43.0	MS (2)	105	694.8	912	1607	1.26	875	0.272	0.017	0.037	27.81	1.835	0.0136	0.08	3.01

DRAFT PRELIMINARY

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	σ'_{v0} + Δp (psf)	OCR	p_c' (psf)	C_{cs}	C_{rs}	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha s}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
18.5	-43.5	MS (2)	105	716.0	912	1628	1.26	902	0.272	0.017	0.036	28.24	1.805	0.0136	0.08	3.10
19.0	-44.0	MS (2)	105	737.2	912	1649	1.26	929	0.272	0.017	0.035	28.66	1.775	0.0136	0.08	3.18
19.5	-44.5	MS (2)	105	758.4	912	1670	1.26	956	0.272	0.017	0.034	29.07	1.748	0.0136	0.08	3.26
20.0	-45.0	MS (2)	105	779.6	912	1692	1.26	982	0.272	0.017	0.033	29.48	1.722	0.0136	0.08	3.35
20.5	-45.5	MS (2)	105	800.7	912	1713	1.26	1009	0.272	0.017	0.033	29.87	1.698	0.0136	0.08	3.43
21.0	-46.0	MS (2)	105	821.9	912	1734	1.26	1036	0.272	0.017	0.032	30.25	1.674	0.0136	0.08	3.52
21.5	-46.5	MS (2)	105	843.1	912	1755	1.26	1062	0.272	0.017	0.031	30.62	1.652	0.0136	0.08	3.60
22.0	-47.0	MS (2)	105	864.3	912	1776	1.26	1089	0.272	0.017	0.030	30.98	1.631	0.0136	0.08	3.68
22.5	-47.5	MS (2)	105	885.5	912	1797	1.26	1116	0.272	0.017	0.029	31.33	1.611	0.0136	0.08	3.77
23.0	-48.0	MS (2)	105	906.6	912	1819	1.26	1142	0.272	0.017	0.029	31.67	1.592	0.0136	0.08	3.85
23.5	-48.5	MS (2)	105	927.8	912	1840	1.26	1169	0.272	0.017	0.028	32.01	1.574	0.0136	0.08	3.94
24.0	-49.0	MS (2)	105	949.0	912	1861	1.26	1196	0.272	0.017	0.027	32.34	1.556	0.0136	0.08	4.02
24.5	-49.5	MS (2)	105	970.2	912	1882	1.26	1222	0.272	0.017	0.027	32.66	1.540	0.0136	0.08	4.11
25.0	-50.0	MS (2)	105	991.4	912	1903	1.26	1249	0.272	0.017	0.026	32.97	1.524	0.0136	0.08	4.19
25.5	-50.5	MS (2)	105	1012.6	912	1925	1.26	1276	0.272	0.017	0.025	33.27	1.508	0.0136	0.08	4.27
26.0	-51.0	MS (2)	105	1033.7	912	1946	1.26	1303	0.272	0.017	0.025	33.57	1.494	0.0136	0.08	4.36
26.5	-51.5	MS (2)	105	1054.9	912	1967	1.26	1329	0.272	0.017	0.024	33.86	1.480	0.0136	0.08	4.44
27.0	-52.0	MS (2)	105	1076.1	912	1988	1.26	1356	0.272	0.017	0.024	34.15	1.466	0.0136	0.08	4.53
27.5	-52.5	MS (2)	105	1097.3	912	2009	1.26	1383	0.272	0.017	0.023	34.42	1.453	0.0136	0.08	4.61
28.0	-53.0	MS (2)	105	1118.5	912	2030	1.26	1409	0.272	0.017	0.023	34.70	1.441	0.0136	0.08	4.70
28.5	-53.5	MS (2)	105	1139.6	912	2052	1.26	1436	0.272	0.017	0.022	34.96	1.429	0.0136	0.08	4.78
29.0	-54.0	MS (2)	105	1160.8	912	2073	1.26	1463	0.272	0.017	0.022	35.22	1.417	0.0136	0.08	4.86
29.5	-54.5	MS (2)	105	1182.0	912	2094	1.26	1489	0.272	0.017	0.021	35.48	1.406	0.0136	0.08	4.95
30.0	-55.0	MS (2)	105	1203.2	912	2115	1.26	1516	0.272	0.017	0.021	35.72	1.395	0.0136	0.08	5.03
30.5	-55.5	MS (2)	105	1224.4	912	2136	1.26	1543	0.272	0.017	0.020	35.97	1.385	0.0136	0.08	5.12
31.0	-56.0	MS (2)	105	1245.5	912	2158	1.26	1569	0.272	0.017	0.020	36.21	1.375	0.0136	0.08	5.20
31.5	-56.5	MS (2)	105	1266.7	912	2179	1.26	1596	0.272	0.017	0.019	36.44	1.365	0.0136	0.08	5.28
32.0	-57.0	MS (2)	105	1287.9	912	2200	1.26	1623	0.272	0.017	0.019	36.67	1.356	0.0136	0.08	5.37
32.5	-57.5	MS (2)	105	1309.1	912	2221	1.26	1649	0.272	0.017	0.019	36.89	1.347	0.0136	0.08	5.45
33.0	-58.0	MS (2)	105	1330.3	912	2242	1.26	1676	0.272	0.017	0.018	37.11	1.338	0.0136	0.08	5.54
33.5	-58.5	MS (2)	105	1351.5	912	2263	1.26	1703	0.272	0.017	0.018	37.32	1.329	0.0136	0.08	5.62
34.0	-59.0	MS (2)	105	1372.6	912	2285	1.26	1730	0.272	0.017	0.017	37.53	1.321	0.0136	0.08	5.71
34.5	-59.5	MS (2)	105	1393.8	912	2306	1.26	1756	0.272	0.017	0.017	37.74	1.313	0.0136	0.08	5.79
35.0	-60.0	MS (3)	111	1416.6	912	2329	1.20	1700	0.174	0.009	0.012	37.87	1.370	0.0087	0.05	5.84
35.5	-60.5	MS (3)	111	1441.1	912	2353	1.20	1729	0.174	0.009	0.012	38.02	1.361	0.0087	0.05	5.90
36.0	-61.0	MS (3)	111	1465.6	912	2378	1.20	1759	0.174	0.009	0.012	38.16	1.352	0.0087	0.05	5.95
36.5	-61.5	MS (3)	111	1490.1	912	2402	1.20	1788	0.174	0.009	0.012	38.30	1.343	0.0087	0.05	6.00
37.0	-62.0	MS (3)	111	1514.6	912	2427	1.20	1817	0.174	0.009	0.011	38.44	1.335	0.0087	0.05	6.06
37.5	-62.5	MS (3)	111	1539.1	912	2451	1.20	1847	0.174	0.009	0.011	38.57	1.327	0.0087	0.05	6.11
38.0	-63.0	MS (3)	111	1563.5	912	2476	1.20	1876	0.174	0.009	0.011	38.71	1.319	0.0087	0.05	6.17
38.5	-63.5	MS (3)	111	1588.0	912	2500	1.20	1906	0.174	0.009	0.011	38.83	1.312	0.0087	0.05	6.22
39.0	-64.0	MS (3)	111	1612.5	912	2525	1.20	1935	0.174	0.009	0.011	38.96	1.305	0.0087	0.05	6.27
39.5	-64.5	MS (3)	111	1637.0	912	2549	1.20	1964	0.174	0.009	0.010	39.08	1.298	0.0087	0.05	6.33
40.0	-65.0	MS (3)	111	1661.5	912	2573	1.20	1994	0.174	0.009	0.010	39.21	1.291	0.0087	0.05	6.38
40.5	-65.5	MS (3)	111	1686.0	912	2598	1.20	2023	0.174	0.009	0.010	39.32	1.284	0.0087	0.05	6.44
41.0	-66.0	MS (3)	111	1710.4	912	2622	1.20	2053	0.174	0.009	0.010	39.44	1.278	0.0087	0.05	6.49
41.5	-66.5	MS (3)	111	1734.9	912	2647	1.20	2082	0.174	0.009	0.010	39.56	1.271	0.0087	0.05	6.54
42.0	-67.0	MS (3)	111	1759.4	912	2671	1.20	2111	0.174	0.009	0.009	39.67	1.265	0.0087	0.05	6.60
42.5	-67.5	MS (3)	111	1783.9	912	2696	1.20	2141	0.174	0.009	0.009	39.78	1.259	0.0087	0.05	6.65
43.0	-68.0	MS (3)	111	1808.4	912	2720	1.20	2170	0.174	0.009	0.009	39.89	1.254	0.0087	0.05	6.70
43.5	-68.5	MS (3)	111	1832.9	912	2745	1.20	2199	0.174	0.009	0.009	39.99	1.248	0.0087	0.05	6.76
44.0	-69.0	MS (3)	111	1857.3	912	2769	1.20	2229	0.174	0.009	0.009	40.10	1.243	0.0087	0.05	6.81
44.5	-69.5	MS (3)	111	1881.8	912	2794	1.20	2258	0.174	0.009	0.008	40.20	1.237	0.0087	0.05	6.87
45.0	-70.0	MS (3)	111	1906.3	912	2818	1.20	2288	0.174	0.009	0.008	40.30	1.232	0.0087	0.05	6.92
45.5	-70.5	MS (3)	111	1930.8	912	2843	1.20	2317	0.174	0.009	0.008	40.40	1.227	0.0087	0.05	6.97

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	σ'_{v0} + Δp (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
46.0	-71.0	MS (3)	111	1955.3	912	2867	1.20	2346	0.174	0.009	0.008	40.49	1.222	0.0087	0.05	7.03
46.5	-71.5	MS (3)	111	1979.8	912	2892	1.20	2376	0.174	0.009	0.008	40.59	1.217	0.0087	0.05	7.08
47.0	-72.0	MS (3)	111	2004.2	912	2916	1.20	2405	0.174	0.009	0.008	40.68	1.213	0.0087	0.05	7.14
47.5	-72.5	MS (3)	111	2028.7	912	2941	1.20	2434	0.174	0.009	0.008	40.77	1.208	0.0087	0.05	7.19
48.0	-73.0	MS (3)	111	2053.2	912	2965	1.20	2464	0.174	0.009	0.007	40.86	1.203	0.0087	0.05	7.24
48.5	-73.5	MS (3)	111	2077.7	912	2990	1.20	2493	0.174	0.009	0.007	40.95	1.199	0.0087	0.05	7.30
49.0	-74.0	MS (3)	111	2102.2	912	3014	1.20	2523	0.174	0.009	0.007	41.03	1.195	0.0087	0.05	7.35
49.5	-74.5	MS (3)	111	2126.7	912	3039	1.20	2552	0.174	0.009	0.007	41.12	1.191	0.0087	0.05	7.40
50.0	-75.0	MS (3)	111	2151.1	912	3063	1.20	2581	0.174	0.009	0.007	41.20	1.187	0.0087	0.05	7.46
50.5	-75.5	MS (3)	111	2175.6	912	3088	1.20	2611	0.174	0.009	0.007	41.28	1.183	0.0087	0.05	7.51
51.0	-76.0	MS (3)	111	2200.1	912	3112	1.20	2640	0.174	0.009	0.007	41.36	1.179	0.0087	0.05	7.57
51.5	-76.5	MS (3)	111	2224.6	912	3137	1.20	2670	0.174	0.009	0.007	41.44	1.175	0.0087	0.05	7.62
52.0	-77.0	MS (3)	111	2249.1	912	3161	1.20	2699	0.174	0.009	0.006	41.52	1.171	0.0087	0.05	7.67
52.5	-77.5	MS (3)	111	2273.6	912	3186	1.20	2728	0.174	0.009	0.006	41.59	1.168	0.0087	0.05	7.73
53.0	-78.0	MS (3)	111	2298.0	912	3210	1.20	2758	0.174	0.009	0.006	41.67	1.164	0.0087	0.05	7.78
53.5	-78.5	MS (3)	111	2322.5	912	3235	1.20	2787	0.174	0.009	0.006	41.74	1.161	0.0087	0.05	7.84
54.0	-79.0	MS (3)	111	2347.0	912	3259	1.20	2816	0.174	0.009	0.006	41.81	1.157	0.0087	0.05	7.89
54.5	-79.5	MS (3)	111	2371.5	912	3283	1.20	2846	0.174	0.009	0.006	41.88	1.154	0.0087	0.05	7.94
55.0	-80.0	MS (3)	111	2396.0	912	3308	1.20	2875	0.174	0.009	0.006	41.95	1.151	0.0087	0.05	8.00
55.5	-80.5	MS (3)	111	2420.5	912	3332	1.20	2905	0.174	0.009	0.006	42.02	1.147	0.0087	0.05	8.05
56.0	-81.0	MS (3)	111	2444.9	912	3357	1.20	2934	0.174	0.009	0.006	42.08	1.144	0.0087	0.05	8.10
56.5	-81.5	MS (3)	111	2469.4	912	3381	1.20	2963	0.174	0.009	0.005	42.15	1.141	0.0087	0.05	8.16
57.0	-82.0	MS (3)	111	2493.9	912	3406	1.20	2993	0.174	0.009	0.005	42.21	1.138	0.0087	0.05	8.21
57.5	-82.5	MS (3)	111	2518.4	912	3430	1.20	3022	0.174	0.009	0.005	42.27	1.135	0.0087	0.05	8.27
58.0	-83.0	MS (3)	111	2542.9	912	3455	1.20	3051	0.174	0.009	0.005	42.33	1.132	0.0087	0.05	8.32
58.5	-83.5	MS (3)	111	2567.4	912	3479	1.20	3081	0.174	0.009	0.005	42.40	1.129	0.0087	0.05	8.37
59.0	-84.0	MS (3)	111	2591.8	912	3504	1.20	3110	0.174	0.009	0.005	42.45	1.127	0.0087	0.05	8.43
59.5	-84.5	MS (3)	111	2616.3	912	3528	1.20	3140	0.174	0.009	0.005	42.51	1.124	0.0087	0.05	8.48
60.0	-85.0	MS (3)	111	2640.8	912	3553	1.20	3169	0.174	0.009	0.005	42.57	1.121	0.0087	0.05	8.54
			average	1247.5							total settlement	3.547 ft				0.711

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)

$c_{c\varepsilon}$ = modified compression index (aka compression ratio) of cohesive soil

$c_{r\varepsilon}$ = modified recompression index (aka recompression ratio) of cohesive soil

Settlement below wick drains 0.064 ft

0.762452057 in

ft bgs = feet below ground surface

z = depth

γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

Δp = stress increase below load

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

Client: Atlantic Richfield Company
Prepared by: A. Baird Date: 10.11.17
Checked by: R. Kilkenny Date: 10.13.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Bulkhead Design ID 02

h_{cap} =	33	ft
γ_w =	62.4	pcf
$\gamma_{moist,cap}$ =	60	pcf
$\gamma_{sat,cap}$ =	90	pcf
Depth to Water =	6	ft bgs
Δp =	1,105	psf
t =	100	yrs
t_p =	9.3	yrs

													Secondary Compression			
Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	C_{cs}	C_{rs}	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha s}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
0.0	-25.0	MS (1)	100	0.0	1105	1105	1.80	0	0.270	0.024	0.000	0				
0.5	-25.5	MS (1)	100	19.0	1105	1124	1.80	34	0.270	0.024	0.248	2.98	32.936	0.0135	0.08	0.08
1.0	-26.0	MS (1)	100	37.9	1105	1143	1.80	68	0.270	0.024	0.185	5.19	16.746	0.0135	0.08	0.17
1.5	-26.5	MS (1)	100	56.9	1105	1162	1.80	102	0.270	0.024	0.156	7.06	11.349	0.0135	0.08	0.25
2.0	-27.0	MS (1)	100	75.8	1105	1181	1.80	137	0.270	0.024	0.137	8.70	8.651	0.0135	0.08	0.33
2.5	-27.5	MS (1)	100	94.8	1105	1200	1.80	171	0.270	0.024	0.123	10.18	7.032	0.0135	0.08	0.42
3.0	-28.0	MS (1)	100	113.8	1105	1219	1.80	205	0.270	0.024	0.112	11.53	5.952	0.0135	0.08	0.50
3.5	-28.5	MS (1)	100	132.7	1105	1238	1.80	239	0.270	0.024	0.103	12.77	5.181	0.0135	0.08	0.58
4.0	-29.0	MS (1)	100	151.7	1105	1257	1.80	273	0.270	0.024	0.096	13.92	4.603	0.0135	0.08	0.67
4.5	-29.5	MS (1)	100	170.7	1105	1276	1.80	307	0.270	0.024	0.089	14.99	4.153	0.0135	0.08	0.75
5.0	-30.0	MS (1)	100	189.6	1105	1295	1.80	341	0.270	0.024	0.084	16.00	3.794	0.0135	0.08	0.84
5.5	-30.5	MS (1)	100	208.6	1105	1314	1.80	375	0.270	0.024	0.079	16.95	3.499	0.0135	0.08	0.92
6.0	-31.0	MS (1)	100	227.5	1105	1333	1.80	410	0.270	0.024	0.074	17.84	3.254	0.0135	0.08	1.00
6.5	-31.5	MS (1)	100	246.5	1105	1352	1.80	444	0.270	0.024	0.070	18.68	3.046	0.0135	0.08	1.09
7.0	-32.0	MS (1)	100	265.5	1105	1371	1.80	478	0.270	0.024	0.067	19.48	2.868	0.0135	0.08	1.17
7.5	-32.5	MS (1)	100	284.4	1105	1390	1.80	512	0.270	0.024	0.063	20.24	2.714	0.0135	0.08	1.25
8.0	-33.0	MS (1)	100	303.4	1105	1409	1.80	546	0.270	0.024	0.060	20.96	2.579	0.0135	0.08	1.34
8.5	-33.5	MS (1)	100	322.4	1105	1428	1.80	580	0.270	0.024	0.057	21.65	2.460	0.0135	0.08	1.42
9.0	-34.0	MS (1)	100	341.3	1105	1447	1.80	614	0.270	0.024	0.055	22.30	2.354	0.0135	0.08	1.50
9.5	-34.5	MS (1)	100	360.3	1105	1465	1.80	648	0.270	0.024	0.052	22.92	2.260	0.0135	0.08	1.59
10.0	-35.0	MS (1)	100	379.2	1105	1484	1.80	683	0.270	0.024	0.050	23.52	2.175	0.0135	0.08	1.67
10.5	-35.5	MS (1)	100	398.2	1105	1503	1.80	717	0.270	0.024	0.048	24.09	2.097	0.0135	0.08	1.75
11.0	-36.0	MS (1)	100	417.2	1105	1522	1.80	751	0.270	0.024	0.045	24.64	2.027	0.0135	0.08	1.84
11.5	-36.5	MS (1)	100	436.1	1105	1541	1.80	785	0.270	0.024	0.044	25.16	1.963	0.0135	0.08	1.92
12.0	-37.0	MS (1)	100	455.1	1105	1560	1.80	819	0.270	0.024	0.042	25.66	1.905	0.0135	0.08	2.01
12.5	-37.5	MS (1)	100	474.0	1105	1579	1.80	853	0.270	0.024	0.040	26.14	1.851	0.0135	0.08	2.09
13.0	-38.0	MS (1)	100	493.0	1105	1598	1.80	887	0.270	0.024	0.038	26.60	1.801	0.0135	0.08	2.17
13.5	-38.5	MS (1)	100	512.0	1105	1617	1.80	922	0.270	0.024	0.037	27.04	1.755	0.0135	0.08	2.26
14.0	-39.0	MS (1)	100	530.9	1105	1636	1.80	956	0.270	0.024	0.035	27.47	1.712	0.0135	0.08	2.34
14.5	-39.5	MS (1)	100	549.9	1105	1655	1.80	990	0.270	0.024	0.034	27.87	1.672	0.0135	0.08	2.42
15.0	-40.0	MS (1)	100	568.9	1105	1674	1.80	1024	0.270	0.024	0.033	28.26	1.635	0.0135	0.08	2.51
15.5	-40.5	MS (2)	105	588.9	1105	1694	1.26	742	0.272	0.017	0.040	28.74	2.283	0.0136	0.08	2.59
16.0	-41.0	MS (2)	105	610.1	1105	1715	1.26	769	0.272	0.017	0.049	29.33	2.231	0.0136	0.08	2.67
16.5	-41.5	MS (2)	105	631.3	1105	1736	1.26	795	0.272	0.017	0.048	29.90	2.183	0.0136	0.08	2.76
17.0	-42.0	MS (2)	105	652.5	1105	1758	1.26	822	0.272	0.017	0.046	30.45	2.138	0.0136	0.08	2.84
17.5	-42.5	MS (2)	105	673.7	1105	1779	1.26	849	0.272	0.017	0.045	30.99	2.096	0.0136	0.08	2.93
18.0	-43.0	MS (2)	105	694.8	1105	1800	1.26	875	0.272	0.017	0.044	31.52	2.056	0.0136	0.08	3.01

DRAFT PRELIMINARY

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	σ'_{v0} + Δp (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
18.5	-43.5	MS (2)	105	716.0	1105	1821	1.26	902	0.272	0.017	0.043	32.04	2.019	0.0136	0.08	3.10
19.0	-44.0	MS (2)	105	737.2	1105	1842	1.26	929	0.272	0.017	0.042	32.54	1.983	0.0136	0.08	3.18
19.5	-44.5	MS (2)	105	758.4	1105	1864	1.26	956	0.272	0.017	0.041	33.03	1.950	0.0136	0.08	3.26
20.0	-45.0	MS (2)	105	779.6	1105	1885	1.26	982	0.272	0.017	0.040	33.50	1.919	0.0136	0.08	3.35
20.5	-45.5	MS (2)	105	800.7	1105	1906	1.26	1009	0.272	0.017	0.039	33.97	1.889	0.0136	0.08	3.43
21.0	-46.0	MS (2)	105	821.9	1105	1927	1.26	1036	0.272	0.017	0.038	34.43	1.861	0.0136	0.08	3.52
21.5	-46.5	MS (2)	105	843.1	1105	1948	1.26	1062	0.272	0.017	0.037	34.87	1.834	0.0136	0.08	3.60
22.0	-47.0	MS (2)	105	864.3	1105	1969	1.26	1089	0.272	0.017	0.036	35.31	1.809	0.0136	0.08	3.68
22.5	-47.5	MS (2)	105	885.5	1105	1991	1.26	1116	0.272	0.017	0.035	35.73	1.784	0.0136	0.08	3.77
23.0	-48.0	MS (2)	105	906.6	1105	2012	1.26	1142	0.272	0.017	0.035	36.15	1.761	0.0136	0.08	3.85
23.5	-48.5	MS (2)	105	927.8	1105	2033	1.26	1169	0.272	0.017	0.034	36.55	1.739	0.0136	0.08	3.94
24.0	-49.0	MS (2)	105	949.0	1105	2054	1.26	1196	0.272	0.017	0.033	36.95	1.718	0.0136	0.08	4.02
24.5	-49.5	MS (2)	105	970.2	1105	2075	1.26	1222	0.272	0.017	0.032	37.34	1.698	0.0136	0.08	4.11
25.0	-50.0	MS (2)	105	991.4	1105	2097	1.26	1249	0.272	0.017	0.032	37.72	1.678	0.0136	0.08	4.19
25.5	-50.5	MS (2)	105	1012.6	1105	2118	1.26	1276	0.272	0.017	0.031	38.09	1.660	0.0136	0.08	4.27
26.0	-51.0	MS (2)	105	1033.7	1105	2139	1.26	1303	0.272	0.017	0.030	38.46	1.642	0.0136	0.08	4.36
26.5	-51.5	MS (2)	105	1054.9	1105	2160	1.26	1329	0.272	0.017	0.030	38.82	1.625	0.0136	0.08	4.44
27.0	-52.0	MS (2)	105	1076.1	1105	2181	1.26	1356	0.272	0.017	0.029	39.17	1.609	0.0136	0.08	4.53
27.5	-52.5	MS (2)	105	1097.3	1105	2202	1.26	1383	0.272	0.017	0.029	39.51	1.593	0.0136	0.08	4.61
28.0	-53.0	MS (2)	105	1118.5	1105	2224	1.26	1409	0.272	0.017	0.028	39.85	1.578	0.0136	0.08	4.70
28.5	-53.5	MS (2)	105	1139.6	1105	2245	1.26	1436	0.272	0.017	0.027	40.18	1.563	0.0136	0.08	4.78
29.0	-54.0	MS (2)	105	1160.8	1105	2266	1.26	1463	0.272	0.017	0.027	40.50	1.549	0.0136	0.08	4.86
29.5	-54.5	MS (2)	105	1182.0	1105	2287	1.26	1489	0.272	0.017	0.026	40.82	1.536	0.0136	0.08	4.95
30.0	-55.0	MS (2)	105	1203.2	1105	2308	1.26	1516	0.272	0.017	0.026	41.13	1.523	0.0136	0.08	5.03
30.5	-55.5	MS (2)	105	1224.4	1105	2330	1.26	1543	0.272	0.017	0.025	41.43	1.510	0.0136	0.08	5.12
31.0	-56.0	MS (2)	105	1245.5	1105	2351	1.26	1569	0.272	0.017	0.025	41.73	1.498	0.0136	0.08	5.20
31.5	-56.5	MS (2)	105	1266.7	1105	2372	1.26	1596	0.272	0.017	0.024	42.03	1.486	0.0136	0.08	5.28
32.0	-57.0	MS (2)	105	1287.9	1105	2393	1.26	1623	0.272	0.017	0.024	42.31	1.475	0.0136	0.08	5.37
32.5	-57.5	MS (2)	105	1309.1	1105	2414	1.26	1649	0.272	0.017	0.024	42.60	1.464	0.0136	0.08	5.45
33.0	-58.0	MS (2)	105	1330.3	1105	2435	1.26	1676	0.272	0.017	0.023	42.87	1.453	0.0136	0.08	5.54
33.5	-58.5	MS (2)	105	1351.5	1105	2457	1.26	1703	0.272	0.017	0.023	43.15	1.443	0.0136	0.08	5.62
34.0	-59.0	MS (2)	105	1372.6	1105	2478	1.26	1730	0.272	0.017	0.022	43.41	1.433	0.0136	0.08	5.71
34.5	-59.5	MS (2)	105	1393.8	1105	2499	1.26	1756	0.272	0.017	0.022	43.68	1.423	0.0136	0.08	5.79
35.0	-60.0	MS (3)	111	1416.6	1105	2522	1.20	1700	0.174	0.009	0.015	43.85	1.483	0.0087	0.05	5.84
35.5	-60.5	MS (3)	111	1441.1	1105	2546	1.20	1729	0.174	0.009	0.015	44.03	1.472	0.0087	0.05	5.90
36.0	-61.0	MS (3)	111	1465.6	1105	2571	1.20	1759	0.174	0.009	0.015	44.21	1.462	0.0087	0.05	5.95
36.5	-61.5	MS (3)	111	1490.1	1105	2595	1.20	1788	0.174	0.009	0.015	44.38	1.451	0.0087	0.05	6.00
37.0	-62.0	MS (3)	111	1514.6	1105	2620	1.20	1817	0.174	0.009	0.014	44.56	1.441	0.0087	0.05	6.06
37.5	-62.5	MS (3)	111	1539.1	1105	2644	1.20	1847	0.174	0.009	0.014	44.73	1.432	0.0087	0.05	6.11
38.0	-63.0	MS (3)	111	1563.5	1105	2669	1.20	1876	0.174	0.009	0.014	44.89	1.422	0.0087	0.05	6.17
38.5	-63.5	MS (3)	111	1588.0	1105	2693	1.20	1906	0.174	0.009	0.014	45.05	1.413	0.0087	0.05	6.22
39.0	-64.0	MS (3)	111	1612.5	1105	2718	1.20	1935	0.174	0.009	0.013	45.21	1.404	0.0087	0.05	6.27
39.5	-64.5	MS (3)	111	1637.0	1105	2742	1.20	1964	0.174	0.009	0.013	45.37	1.396	0.0087	0.05	6.33
40.0	-65.0	MS (3)	111	1661.5	1105	2767	1.20	1994	0.174	0.009	0.013	45.53	1.388	0.0087	0.05	6.38
40.5	-65.5	MS (3)	111	1686.0	1105	2791	1.20	2023	0.174	0.009	0.013	45.68	1.380	0.0087	0.05	6.44
41.0	-66.0	MS (3)	111	1710.4	1105	2816	1.20	2053	0.174	0.009	0.012	45.83	1.372	0.0087	0.05	6.49
41.5	-66.5	MS (3)	111	1734.9	1105	2840	1.20	2082	0.174	0.009	0.012	45.97	1.364	0.0087	0.05	6.54
42.0	-67.0	MS (3)	111	1759.4	1105	2865	1.20	2111	0.174	0.009	0.012	46.12	1.357	0.0087	0.05	6.60
42.5	-67.5	MS (3)	111	1783.9	1105	2889	1.20	2141	0.174	0.009	0.012	46.26	1.350	0.0087	0.05	6.65
43.0	-68.0	MS (3)	111	1808.4	1105	2914	1.20	2170	0.174	0.009	0.012	46.40	1.343	0.0087	0.05	6.70
43.5	-68.5	MS (3)	111	1832.9	1105	2938	1.20	2199	0.174	0.009	0.011	46.53	1.336	0.0087	0.05	6.76
44.0	-69.0	MS (3)	111	1857.3	1105	2963	1.20	2229	0.174	0.009	0.011	46.67	1.329	0.0087	0.05	6.81
44.5	-69.5	MS (3)	111	1881.8	1105	2987	1.20	2258	0.174	0.009	0.011	46.80	1.323	0.0087	0.05	6.87
45.0	-70.0	MS (3)	111	1906.3	1105	3012	1.20	2288	0.174	0.009	0.011	46.93	1.316	0.0087	0.05	6.92
45.5	-70.5	MS (3)	111	1930.8	1105	3036	1.20	2317	0.174	0.009	0.011	47.06	1.310	0.0087	0.05	6.97

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	σ'_{v0} + Δp (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
46.0	-71.0	MS (3)	111	1955.3	1105	3060	1.20	2346	0.174	0.009	0.010	47.19	1.304	0.0087	0.05	7.03
46.5	-71.5	MS (3)	111	1979.8	1105	3085	1.20	2376	0.174	0.009	0.010	47.31	1.299	0.0087	0.05	7.08
47.0	-72.0	MS (3)	111	2004.2	1105	3109	1.20	2405	0.174	0.009	0.010	47.43	1.293	0.0087	0.05	7.14
47.5	-72.5	MS (3)	111	2028.7	1105	3134	1.20	2434	0.174	0.009	0.010	47.55	1.287	0.0087	0.05	7.19
48.0	-73.0	MS (3)	111	2053.2	1105	3158	1.20	2464	0.174	0.009	0.010	47.67	1.282	0.0087	0.05	7.24
48.5	-73.5	MS (3)	111	2077.7	1105	3183	1.20	2493	0.174	0.009	0.010	47.79	1.277	0.0087	0.05	7.30
49.0	-74.0	MS (3)	111	2102.2	1105	3207	1.20	2523	0.174	0.009	0.010	47.90	1.271	0.0087	0.05	7.35
49.5	-74.5	MS (3)	111	2126.7	1105	3232	1.20	2552	0.174	0.009	0.009	48.01	1.266	0.0087	0.05	7.40
50.0	-75.0	MS (3)	111	2151.1	1105	3256	1.20	2581	0.174	0.009	0.009	48.12	1.261	0.0087	0.05	7.46
50.5	-75.5	MS (3)	111	2175.6	1105	3281	1.20	2611	0.174	0.009	0.009	48.23	1.257	0.0087	0.05	7.51
51.0	-76.0	MS (3)	111	2200.1	1105	3305	1.20	2640	0.174	0.009	0.009	48.34	1.252	0.0087	0.05	7.57
51.5	-76.5	MS (3)	111	2224.6	1105	3330	1.20	2670	0.174	0.009	0.009	48.44	1.247	0.0087	0.05	7.62
52.0	-77.0	MS (3)	111	2249.1	1105	3354	1.20	2699	0.174	0.009	0.009	48.55	1.243	0.0087	0.05	7.67
52.5	-77.5	MS (3)	111	2273.6	1105	3379	1.20	2728	0.174	0.009	0.009	48.65	1.238	0.0087	0.05	7.73
53.0	-78.0	MS (3)	111	2298.0	1105	3403	1.20	2758	0.174	0.009	0.008	48.75	1.234	0.0087	0.05	7.78
53.5	-78.5	MS (3)	111	2322.5	1105	3428	1.20	2787	0.174	0.009	0.008	48.85	1.230	0.0087	0.05	7.84
54.0	-79.0	MS (3)	111	2347.0	1105	3452	1.20	2816	0.174	0.009	0.008	48.95	1.226	0.0087	0.05	7.89
54.5	-79.5	MS (3)	111	2371.5	1105	3477	1.20	2846	0.174	0.009	0.008	49.04	1.222	0.0087	0.05	7.94
55.0	-80.0	MS (3)	111	2396.0	1105	3501	1.20	2875	0.174	0.009	0.008	49.14	1.218	0.0087	0.05	8.00
				1131.9							total settlement	4.095 ft				0.666

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)

$c_{c\varepsilon}$ = modified compression index (aka compression ratio) of cohesive soil

$c_{r\varepsilon}$ = modified recompression index (aka recompression ratio) of cohesive soil

Settlement below wick drains 0.101 ft

1.210879919 in

ft bgs = feet below ground surface

z = depth

γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

Δp = stress increase below load

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

Client: Atlantic Richfield Company
Prepared by: A. Baird Date: 10.11.17
Checked by: R. Kilkenny Date: 10.13.17

Northwest Area Bulkhead Extension
Hastings-on-Hudson, NY
Settlement Analysis
October 2017
Revision 0

Subject: Consolidation Settlement Calculations for Bulkhead Design ID 03

h_{cap} =	11	ft
γ_w =	62.4	pcf
$\gamma_{moist,cap}$ =	60	pcf
$\gamma_{sat,cap}$ =	90	pcf
Depth to Water =	6	ft bgs
Δp =	498	psf
t =	100	yrs
t_p =	9.3	yrs

													Secondary Compression			
Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
0.0	-25.0	MS (1)	100	0.0	498	498	1.80	0	0.270	0.024	0.000	0				
0.5	-25.5	MS (1)	100	19.0	498	517	1.80	34	0.270	0.024	0.202	2.42	15.146	0.0135	0.08	0.08
1.0	-26.0	MS (1)	100	37.9	498	536	1.80	68	0.270	0.024	0.140	4.10	7.851	0.0135	0.08	0.17
1.5	-26.5	MS (1)	100	56.9	498	555	1.80	102	0.270	0.024	0.112	5.44	5.419	0.0135	0.08	0.25
2.0	-27.0	MS (1)	100	75.8	498	574	1.80	137	0.270	0.024	0.094	6.57	4.203	0.0135	0.08	0.33
2.5	-27.5	MS (1)	100	94.8	498	593	1.80	171	0.270	0.024	0.081	7.55	3.474	0.0135	0.08	0.42
3.0	-28.0	MS (1)	100	113.8	498	612	1.80	205	0.270	0.024	0.071	8.40	2.987	0.0135	0.08	0.50
3.5	-28.5	MS (1)	100	132.7	498	631	1.80	239	0.270	0.024	0.063	9.16	2.640	0.0135	0.08	0.58
4.0	-29.0	MS (1)	100	151.7	498	650	1.80	273	0.270	0.024	0.057	9.85	2.379	0.0135	0.08	0.67
4.5	-29.5	MS (1)	100	170.7	498	669	1.80	307	0.270	0.024	0.051	10.46	2.177	0.0135	0.08	0.75
5.0	-30.0	MS (1)	100	189.6	498	688	1.80	341	0.270	0.024	0.046	11.02	2.015	0.0135	0.08	0.84
5.5	-30.5	MS (1)	100	208.6	498	707	1.80	375	0.270	0.024	0.042	11.52	1.882	0.0135	0.08	0.92
6.0	-31.0	MS (1)	100	227.5	498	726	1.80	410	0.270	0.024	0.038	11.98	1.771	0.0135	0.08	1.00
6.5	-31.5	MS (1)	100	246.5	498	745	1.80	444	0.270	0.024	0.035	12.40	1.678	0.0135	0.08	1.09
7.0	-32.0	MS (1)	100	265.5	498	763	1.80	478	0.270	0.024	0.032	12.78	1.598	0.0135	0.08	1.17
7.5	-32.5	MS (1)	100	284.4	498	782	1.80	512	0.270	0.024	0.029	13.13	1.528	0.0135	0.08	1.25
8.0	-33.0	MS (1)	100	303.4	498	801	1.80	546	0.270	0.024	0.027	13.45	1.467	0.0135	0.08	1.34
8.5	-33.5	MS (1)	100	322.4	498	820	1.80	580	0.270	0.024	0.024	13.75	1.414	0.0135	0.08	1.42
9.0	-34.0	MS (1)	100	341.3	498	839	1.80	614	0.270	0.024	0.022	14.02	1.366	0.0135	0.08	1.50
9.5	-34.5	MS (1)	100	360.3	498	858	1.80	648	0.270	0.024	0.020	14.26	1.323	0.0135	0.08	1.59
10.0	-35.0	MS (1)	100	379.2	498	877	1.80	683	0.270	0.024	0.019	14.48	1.285	0.0135	0.08	1.67
10.5	-35.5	MS (1)	100	398.2	498	896	1.80	717	0.270	0.024	0.017	14.69	1.250	0.0135	0.08	1.75
11.0	-36.0	MS (1)	100	417.2	498	915	1.80	751	0.270	0.024	0.015	14.87	1.219	0.0135	0.08	1.84
11.5	-36.5	MS (1)	100	436.1	498	934	1.80	785	0.270	0.024	0.014	15.04	1.190	0.0135	0.08	1.92
12.0	-37.0	MS (1)	100	455.1	498	953	1.80	819	0.270	0.024	0.013	15.19	1.163	0.0135	0.08	2.01
12.5	-37.5	MS (1)	100	474.0	498	972	1.80	853	0.270	0.024	0.011	15.33	1.139	0.0135	0.08	2.09
13.0	-38.0	MS (1)	100	493.0	498	991	1.80	887	0.270	0.024	0.010	15.45	1.117	0.0135	0.08	2.17
13.5	-38.5	MS (1)	100	512.0	498	1010	1.80	922	0.270	0.024	0.009	15.56	1.096	0.0135	0.08	2.26
14.0	-39.0	MS (1)	100	530.9	498	1029	1.80	956	0.270	0.024	0.008	15.65	1.077	0.0135	0.08	2.34
14.5	-39.5	MS (1)	100	549.9	498	1048	1.80	990	0.270	0.024	0.007	15.73	1.059	0.0135	0.08	2.42
15.0	-40.0	MS (1)	100	568.9	498	1067	1.80	1024	0.270	0.024	0.006	15.80	1.042	0.0135	0.08	2.51
15.5	-40.5	MS (2)	105	588.9	498	1087	1.26	742	0.272	0.017	0.013	15.96	1.465	0.0136	0.08	2.59
16.0	-41.0	MS (2)	105	610.1	498	1108	1.26	769	0.272	0.017	0.023	16.24	1.441	0.0136	0.08	2.67
16.5	-41.5	MS (2)	105	631.3	498	1129	1.26	795	0.272	0.017	0.022	16.50	1.420	0.0136	0.08	2.76
17.0	-42.0	MS (2)	105	652.5	498	1150	1.26	822	0.272	0.017	0.021	16.76	1.399	0.0136	0.08	2.84
17.5	-42.5	MS (2)	105	673.7	498	1172	1.26	849	0.272	0.017	0.020	17.00	1.380	0.0136	0.08	2.93
18.0	-43.0	MS (2)	105	694.8	498	1193	1.26	875	0.272	0.017	0.019	17.23	1.362	0.0136	0.08	3.01

DRAFT PRELIMINARY

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	σ'_{v0} + Δp (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
18.5	-43.5	MS (2)	105	716.0	498	1214	1.26	902	0.272	0.017	0.019	17.46	1.346	0.0136	0.08	3.10
19.0	-44.0	MS (2)	105	737.2	498	1235	1.26	929	0.272	0.017	0.018	17.67	1.330	0.0136	0.08	3.18
19.5	-44.5	MS (2)	105	758.4	498	1256	1.26	956	0.272	0.017	0.017	17.88	1.315	0.0136	0.08	3.26
20.0	-45.0	MS (2)	105	779.6	498	1278	1.26	982	0.272	0.017	0.017	18.08	1.301	0.0136	0.08	3.35
20.5	-45.5	MS (2)	105	800.7	498	1299	1.26	1009	0.272	0.017	0.016	18.27	1.287	0.0136	0.08	3.43
21.0	-46.0	MS (2)	105	821.9	498	1320	1.26	1036	0.272	0.017	0.015	18.46	1.275	0.0136	0.08	3.52
21.5	-46.5	MS (2)	105	843.1	498	1341	1.26	1062	0.272	0.017	0.015	18.64	1.262	0.0136	0.08	3.60
22.0	-47.0	MS (2)	105	864.3	498	1362	1.26	1089	0.272	0.017	0.014	18.81	1.251	0.0136	0.08	3.68
22.5	-47.5	MS (2)	105	885.5	498	1383	1.26	1116	0.272	0.017	0.014	18.97	1.240	0.0136	0.08	3.77
23.0	-48.0	MS (2)	105	906.6	498	1405	1.26	1142	0.272	0.017	0.013	19.13	1.230	0.0136	0.08	3.85
23.5	-48.5	MS (2)	105	927.8	498	1426	1.26	1169	0.272	0.017	0.013	19.29	1.220	0.0136	0.08	3.94
24.0	-49.0	MS (2)	105	949.0	498	1447	1.26	1196	0.272	0.017	0.012	19.44	1.210	0.0136	0.08	4.02
24.5	-49.5	MS (2)	105	970.2	498	1468	1.26	1222	0.272	0.017	0.012	19.58	1.201	0.0136	0.08	4.11
25.0	-50.0	MS (2)	105	991.4	498	1489	1.26	1249	0.272	0.017	0.011	19.71	1.192	0.0136	0.08	4.19
25.5	-50.5	MS (2)	105	1012.6	498	1511	1.26	1276	0.272	0.017	0.011	19.85	1.184	0.0136	0.08	4.27
26.0	-51.0	MS (2)	105	1033.7	498	1532	1.26	1303	0.272	0.017	0.011	19.97	1.176	0.0136	0.08	4.36
26.5	-51.5	MS (2)	105	1054.9	498	1553	1.26	1329	0.272	0.017	0.010	20.10	1.168	0.0136	0.08	4.44
27.0	-52.0	MS (2)	105	1076.1	498	1574	1.26	1356	0.272	0.017	0.010	20.21	1.161	0.0136	0.08	4.53
27.5	-52.5	MS (2)	105	1097.3	498	1595	1.26	1383	0.272	0.017	0.009	20.33	1.154	0.0136	0.08	4.61
28.0	-53.0	MS (2)	105	1118.5	498	1616	1.26	1409	0.272	0.017	0.009	20.44	1.147	0.0136	0.08	4.70
28.5	-53.5	MS (2)	105	1139.6	498	1638	1.26	1436	0.272	0.017	0.009	20.54	1.140	0.0136	0.08	4.78
29.0	-54.0	MS (2)	105	1160.8	498	1659	1.26	1463	0.272	0.017	0.008	20.64	1.134	0.0136	0.08	4.86
29.5	-54.5	MS (2)	105	1182.0	498	1680	1.26	1489	0.272	0.017	0.008	20.74	1.128	0.0136	0.08	4.95
30.0	-55.0	MS (2)	105	1203.2	498	1701	1.26	1516	0.272	0.017	0.008	20.83	1.122	0.0136	0.08	5.03
30.5	-55.5	MS (2)	105	1224.4	498	1722	1.26	1543	0.272	0.017	0.007	20.92	1.116	0.0136	0.08	5.12
31.0	-56.0	MS (2)	105	1245.5	498	1744	1.26	1569	0.272	0.017	0.007	21.01	1.111	0.0136	0.08	5.20
31.5	-56.5	MS (2)	105	1266.7	498	1765	1.26	1596	0.272	0.017	0.007	21.09	1.106	0.0136	0.08	5.28
32.0	-57.0	MS (2)	105	1287.9	498	1786	1.26	1623	0.272	0.017	0.007	21.17	1.101	0.0136	0.08	5.37
32.5	-57.5	MS (2)	105	1309.1	498	1807	1.26	1649	0.272	0.017	0.006	21.25	1.096	0.0136	0.08	5.45
33.0	-58.0	MS (2)	105	1330.3	498	1828	1.26	1676	0.272	0.017	0.006	21.32	1.091	0.0136	0.08	5.54
33.5	-58.5	MS (2)	105	1351.5	498	1849	1.26	1703	0.272	0.017	0.006	21.39	1.086	0.0136	0.08	5.62
34.0	-59.0	MS (2)	105	1372.6	498	1871	1.26	1730	0.272	0.017	0.006	21.46	1.082	0.0136	0.08	5.71
34.5	-59.5	MS (2)	105	1393.8	498	1892	1.26	1756	0.272	0.017	0.005	21.52	1.077	0.0136	0.08	5.79
35.0	-60.0	MS (3)	111	1416.6	498	1915	1.20	1700	0.174	0.009	0.004	21.57	1.126	0.0087	0.05	5.84
35.5	-60.5	MS (3)	111	1441.1	498	1939	1.20	1729	0.174	0.009	0.005	21.63	1.121	0.0087	0.05	5.90
36.0	-61.0	MS (3)	111	1465.6	498	1964	1.20	1759	0.174	0.009	0.005	21.68	1.116	0.0087	0.05	5.95
36.5	-61.5	MS (3)	111	1490.1	498	1988	1.20	1788	0.174	0.009	0.004	21.74	1.112	0.0087	0.05	6.00
37.0	-62.0	MS (3)	111	1514.6	498	2013	1.20	1817	0.174	0.009	0.004	21.79	1.107	0.0087	0.05	6.06
37.5	-62.5	MS (3)	111	1539.1	498	2037	1.20	1847	0.174	0.009	0.004	21.84	1.103	0.0087	0.05	6.11
38.0	-63.0	MS (3)	111	1563.5	498	2062	1.20	1876	0.174	0.009	0.004	21.89	1.099	0.0087	0.05	6.17
38.5	-63.5	MS (3)	111	1588.0	498	2086	1.20	1906	0.174	0.009	0.004	21.93	1.095	0.0087	0.05	6.22
39.0	-64.0	MS (3)	111	1612.5	498	2111	1.20	1935	0.174	0.009	0.004	21.98	1.091	0.0087	0.05	6.27
39.5	-64.5	MS (3)	111	1637.0	498	2135	1.20	1964	0.174	0.009	0.004	22.02	1.087	0.0087	0.05	6.33
40.0	-65.0	MS (3)	111	1661.5	498	2159	1.20	1994	0.174	0.009	0.003	22.06	1.083	0.0087	0.05	6.38
40.5	-65.5	MS (3)	111	1686.0	498	2184	1.20	2023	0.174	0.009	0.003	22.10	1.079	0.0087	0.05	6.44
41.0	-66.0	MS (3)	111	1710.4	498	2208	1.20	2053	0.174	0.009	0.003	22.14	1.076	0.0087	0.05	6.49
41.5	-66.5	MS (3)	111	1734.9	498	2233	1.20	2082	0.174	0.009	0.003	22.18	1.073	0.0087	0.05	6.54
42.0	-67.0	MS (3)	111	1759.4	498	2257	1.20	2111	0.174	0.009	0.003	22.21	1.069	0.0087	0.05	6.60
42.5	-67.5	MS (3)	111	1783.9	498	2282	1.20	2141	0.174	0.009	0.003	22.25	1.066	0.0087	0.05	6.65
43.0	-68.0	MS (3)	111	1808.4	498	2306	1.20	2170	0.174	0.009	0.003	22.28	1.063	0.0087	0.05	6.70
43.5	-68.5	MS (3)	111	1832.9	498	2331	1.20	2199	0.174	0.009	0.003	22.31	1.060	0.0087	0.05	6.76
44.0	-69.0	MS (3)	111	1857.3	498	2355	1.20	2229	0.174	0.009	0.003	22.34	1.057	0.0087	0.05	6.81
44.5	-69.5	MS (3)	111	1881.8	498	2380	1.20	2258	0.174	0.009	0.002	22.37	1.054	0.0087	0.05	6.87
45.0	-70.0	MS (3)	111	1906.3	498	2404	1.20	2288	0.174	0.009	0.002	22.40	1.051	0.0087	0.05	6.92
45.5	-70.5	MS (3)	111	1930.8	498	2429	1.20	2317	0.174	0.009	0.002	22.42	1.048	0.0087	0.05	6.97

DRAFT PRELIMINARY

Depth,z (ft bgs)	Elevation (ft)	Soil Type	γ (pcf)	σ'_{v0} (psf)	Δp (psf)	$\sigma'_{v0} + \Delta p$ (psf)	OCR	p_c' (psf)	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Consolidation Settlement (ft)	Cumulative Consolidation Settlement (in.)	σ'_v / σ'_p	$C_{\alpha\varepsilon}$	Secondary Compression (in.*)	Cumulative Secondary Compression (in.)
46.0	-71.0	MS (3)	111	1955.3	498	2453	1.20	2346	0.174	0.009	0.002	22.45	1.046	0.0087	0.05	7.03
46.5	-71.5	MS (3)	111	1979.8	498	2478	1.20	2376	0.174	0.009	0.002	22.47	1.043	0.0087	0.05	7.08
47.0	-72.0	MS (3)	111	2004.2	498	2502	1.20	2405	0.174	0.009	0.002	22.50	1.040	0.0087	0.05	7.14
47.5	-72.5	MS (3)	111	2028.7	498	2527	1.20	2434	0.174	0.009	0.002	22.52	1.038	0.0087	0.05	7.19
48.0	-73.0	MS (3)	111	2053.2	498	2551	1.20	2464	0.174	0.009	0.002	22.54	1.035	0.0087	0.05	7.24
48.5	-73.5	MS (3)	111	2077.7	498	2576	1.20	2493	0.174	0.009	0.002	22.56	1.033	0.0087	0.05	7.30
49.0	-74.0	MS (3)	111	2102.2	498	2600	1.20	2523	0.174	0.009	0.002	22.58	1.031	0.0087	0.05	7.35
49.5	-74.5	MS (3)	111	2126.7	498	2625	1.20	2552	0.174	0.009	0.001	22.60	1.028	0.0087	0.05	7.40
50.0	-75.0	MS (3)	111	2151.1	498	2649	1.20	2581	0.174	0.009	0.001	22.61	1.026	0.0087	0.05	7.46
50.5	-75.5	MS (3)	111	2175.6	498	2674	1.20	2611	0.174	0.009	0.001	22.63	1.024	0.0087	0.05	7.51
51.0	-76.0	MS (3)	111	2200.1	498	2698	1.20	2640	0.174	0.009	0.001	22.64	1.022	0.0087	0.05	7.57
51.5	-76.5	MS (3)	111	2224.6	498	2723	1.20	2670	0.174	0.009	0.001	22.66	1.020	0.0087	0.05	7.62
52.0	-77.0	MS (3)	111	2249.1	498	2747	1.20	2699	0.174	0.009	0.001	22.67	1.018	0.0087	0.05	7.67
52.5	-77.5	MS (3)	111	2273.6	498	2772	1.20	2728	0.174	0.009	0.001	22.68	1.016	0.0087	0.05	7.73
53.0	-78.0	MS (3)	111	2298.0	498	2796	1.20	2758	0.174	0.009	0.001	22.69	1.014	0.0087	0.05	7.78
53.5	-78.5	MS (3)	111	2322.5	498	2821	1.20	2787	0.174	0.009	0.001	22.70	1.012	0.0087	0.05	7.84
54.0	-79.0	MS (3)	111	2347.0	498	2845	1.20	2816	0.174	0.009	0.001	22.71	1.010	0.0087	0.05	7.89
54.5	-79.5	MS (3)	111	2371.5	498	2869	1.20	2846	0.174	0.009	0.001	22.72	1.008	0.0087	0.05	7.94
55.0	-80.0	MS (3)	111	2396.0	498	2894	1.20	2875	0.174	0.009	0.001	22.73	1.007	0.0087	0.05	8.00
55.5	-80.5	MS (3)	111	2420.5	498	2918	1.20	2905	0.174	0.009	0.001	22.74	1.005	0.0087	0.05	8.05
56.0	-81.0	MS (3)	111	2444.9	498	2943	1.20	2934	0.174	0.009	0.001	22.74	1.003	0.0087	0.05	8.10
56.5	-81.5	MS (3)	111	2469.4	498	2967	1.20	2963	0.174	0.009	0.000	22.75	1.001	0.0087	0.05	8.16
57.0	-82.0	MS (3)	111	2493.9	498	2992	1.20	2993	0.174	0.009	0.000	22.75	1.000	0.0087	0.05	8.21
57.5	-82.5	MS (3)	111	2518.4	498	3016	1.20	3022	0.174	0.009	0.000	22.76	0.998	0.0087	0.05	8.27
58.0	-83.0	MS (3)	111	2542.9	498	3041	1.20	3051	0.174	0.009	0.000	22.76	0.997	0.0087	0.05	8.32
58.5	-83.5	MS (3)	111	2567.4	498	3065	1.20	3081	0.174	0.009	0.000	22.77	0.995	0.0087	0.05	8.37
59.0	-84.0	MS (3)	111	2591.8	498	3090	1.20	3110	0.174	0.009	0.000	22.77	0.993	0.0087	0.05	8.43
59.5	-84.5	MS (3)	111	2616.3	498	3114	1.20	3140	0.174	0.009	0.000	22.77	0.992	0.0087	0.05	8.48
60.0	-85.0	MS (3)	111	2640.8	498	3139	1.20	3169	0.174	0.009	0.000	22.78	0.990	0.0087	0.05	8.54
			average	1247.5							total settlement	1.898 ft				0.711

* Assume Cae/Cc = 0.05 +- 0.01 (Terzaghi, Peck, Mesri, pg. 110)

$c_{c\varepsilon}$ = modified compression index (aka compression ratio) of cohesive soil

$c_{r\varepsilon}$ = modified recompression index (aka recompression ratio) of cohesive soil

Settlement below wick drains 0.010 ft

0.125622392 in

ft bgs = feet below ground surface

z = depth

γ = unit weight of soil

γ = unit weight of soil

σ_{v0} = total overburden stress; u = hydrostatic pressure; σ'_{v0} = effective overburden stress

Δp = stress increase below load

OCR = overconsolidation ratio (assumed)

p'_c = preconsolidation stress (aka maximum past effective stress)

Client:	BP			Hastings-On-Hudson
Prepared by:	A. Baird	Date:	10.11.17	Preliminary Design
Checked by:	R. Kilkenny	Date:	10.13.17	NW Extension Settlement Analysis
				October 2017
				Revision 0

Subject: Time-Rate of Consolidation with Pre-Compression Load

Magnitude of Expected Consolidation

Analysis Section	Total Expected Primary Consolidation (ft)
01	3.5
02	4.1
03	1.9

Time to Consolidate without Wick Drains or Surcharge

Analysis Section	Cv Weighted Avg (ft^2/sec)	Consolidation Time (years)			
		t_{50}	t_{90}	t_{95}	t_{99}
01	3.97908E-06	1.4	6.1	8.1	12.8
02	4.25839E-06	1.0	4.4	5.9	9.3
03	4.41113E-06	1.7	7.5	9.9	15.7

Precompression Load Calculation

Analysis Section	01	02	03	
Additional Design Load (σ_p) (psf)	912	1,105	498	
Average effective overburden (σ_0) (psf)	1,247	1,132	1,247	
Cv (weighted avg) (ft^2/year)	125.4841923	134.292453	139.109522	
Drainage Height H_{dr} (ft)	*30*	*26.5*	*35*	
Lightweight Fill Height (from Sediment Surface to +0) (ft)	20	27	5	
Surcharge Water Drawdown (ft)	*10*	*10*	*5*	Input
Submerged Lightweight Fill Surcharge (psf)	*276*	*469.2*	*0*	
Moist Lightweight Fill Surcharge (psf)	*600*	*600*	*300*	
Surcharge Additional Fill above +0 (ft)	*6*	*6*	*6*	Input
Surcharge from Additional Fill above +0 (psf)	*720*	*720*	*720*	
Preload (σ_f) (psf)	1596	1789.2	1020	
σ_p/σ_0	0.73106873	0.9764204	0.399202	
σ_f/σ_p	1.75	1.61889251	2.04819277	
U (%)	49.8	53.7	42.2	
Tv (Table 10.6 of Das: Principles of Foundation Engineering)	0.197	0.23	0.138	Must be Manually Updated After Every Change
Time to Settlement of Final Design Load (t_2) (years)	1.4	1.2	1.2	

Client:	BP			Hastings-On-Hudson
Prepared by:	A. Baird	Date:	10.11.17	Preliminary Design
Checked by:	R. Kilkenny	Date:	10.13.17	NW Extension Settlement Analysis
				October 2017
				Revision 0

Subject: Time-Rate of Consolidation with Wick Drains

Parameters

Drain Spacing, d =	8	ft
Drain Width, a =	10	cm
Drain Thickness, b =	0.16	cm

Location	C_v (ft^2/year)
TB-01	125.4841923
TB-02	134.2924528
TB-03	139.109522

Pattern Factor =	1.05		
d_e =	8.4	ft	diameter of effective zone of drainage
d_w =	0.212	ft	equivalent diameter of wick drain
n =	39.58		
m =	2.93		

Consolidation time for various percents of consolidation

		01			02			03		
Average Degree of Consolidation	**Time Factor**	**Time (Months)**	**Time (Years)**	**Time (Days)**	**Time (Months)**	**Time (Years)**	**Time (Days)**	**Time (Months)**	**Time (Years)**	**Time (Days)**
10%	0.039	0.3	0.0	8	0.2	0.0	7	0.2	0.0	7
20%	0.082	0.6	0.0	17	0.5	0.0	16	0.5	0.0	15
30%	0.131	0.9	0.1	27	0.8	0.1	25	0.8	0.1	24
40%	0.187	1.3	0.1	38	1.2	0.1	36	1.1	0.1	35
50%	0.254	1.7	0.1	52	1.6	0.1	49	1.5	0.1	47
60%	0.336	2.3	0.2	69	2.1	0.2	64	2.0	0.2	62
70%	0.441	3.0	0.2	91	2.8	0.2	85	2.7	0.2	82
80%	0.590	4.0	0.3	121	3.7	0.3	113	3.6	0.3	109
90%	0.844	5.7	0.5	173	5.3	0.4	162	5.1	0.4	156
95%	1.098	7.4	0.6	225	6.9	0.6	210	6.7	0.6	203
99%	1.687	11.4	0.9	346	10.6	0.9	324	10.3	0.9	312

APPENDIX C

List of Technical Specifications

Proposed Specifications

At a minimum, the technical specifications will include the following:

Section	Specification Title	
Division 01 - General Requirements		**OU #**
01 12 13 (01 11 00)	Summary of Work, Multiple Prime/Single Prime (Summary of Work)	Both
01 14 00	Work Restrictions	Both
01 30 53 (01 30 00)	Site Security	Both
01 31 19.13 & 01 31 19.23 (01 31 19)	Project Meetings	Both
01 33 00	Submittal Procedures	Both
01 35 29	Contractors Health and Safety Plan (Health, Safety and Emergency Response Procedures)	Both
01 41 00	Regulatory Requirements	Both
01 45 00	Quality Control	Both
01 51 05 (01 51 00)	Temporary Utilities	OU1
01 52 11	Engineer's Field Office	Both
01 52 13	Contractor's Field Offices and Sheds	Both
01 55 13	Access Roads and Parking Areas	Both
01 55 26	Maintenance and Protection of Traffic (Traffic Control)	Both
01 57 05	Temporary Controls	Both
01 71 23	Field Engineering	Both
01 71 33	Protection of Adjacent Construction	Both
01 74 19	Construction Waste Management and Disposal	Both
01 77 19	Closeout Requirements	Both
Division 02 - Existing Conditions		**OU #**
02 41 00	Demolition and GIB for Demolition (Demolition)	OU1
02 51 29	Surface Cleaning Decontamination	OU1
02 60 00	Handling, Transportation, and Disposal of Impacted Material (OU1)	OU1
02 71 00	Water Treatment (Temporary Water Management System)	OU1
02 81 00	Handling, Transportation, and Disposal of Impacted Material (OU2)	OU2
Division 03 - Concrete		**OU #**
03 40 00	Precast Concrete	OU1
Division 05 – Metals		**OU #**
05 12 00	Structural Steel Framing	OU1
Division 31 - Earthwork		**OU #**
31 05 19	Geosynthetics for Earthwork	OU1
31 22 00	Grading	OU1
31 23 16	Excavation	OU1
31 23 19	Dewatering	OU1
31 23 23	Fill Materials (includes Compaction)	Both
31 25 00	Erosion and Sedimentation Controls	OU1

31 50 00	Excavation Support and Protection	OU1
31 56 00	Slurry Walls	OU1
Division 32 – Exterior Improvements		**OU #**
32 72 00	Wetland Restoration	OU1
32 91 19.13 (32 92 00)	Topsoil Placement and Grading (Lawns and Meadows)	OU1
Division 33 – Utilities		**OU #**
33 05 05	Buried Piping Installation	OU1
33 05 61	Concrete Manholes	OU1
Division 35 - Waterway and Marine Construction		**OU #**
35 31 16.19	Steel Sheet Piling Bulkhead	OU1
35 53 23	Dredging and In-Water Fill	OU2

APPENDIX D

Hastings on Hudson Remedial Construction Concepts

Hastings-on-Hudson
Remedial Construction Concepts

Hastings-on-Hudson, New York



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Hastings-on-Hudson Pre-design Inputs

EXECUTIVE SUMMARY

Envirocon, Inc. (Envirocon) prepares this Remedial Construction Concepts / Pre-design Inputs in coordination with Haley & Aldrich of New York (H&A). The conceptual inputs are arranged in an outline format with subject elements prepared in conjunction with H&A. Highlights of the review concepts include the following. Potential disposal facilities and sources of offsite import materials were identified. Means of transport including ingress to and egress from the site were vetted. Transport of materials via barge on the Hudson River is the best alternative identified to date, due to trucking constraints through the village of Hastings-on-Hudson and into the site, and also constraints on the use of the freight rail line adjacent to the site. The optimal Intermodal type container to ship materials was identified. The use of a Roll-on/Roll-off Landing Barge to access the barges from the site shoreline is recommended also.

Another recommendation is to not contractually lock into disposal facilities prematurely, but to use vendor competition to secure the most effective and cost-effective services, including transportation means. The use of trans-load facilities on the west side of the Hudson will also be an instrumental part of the barging operations. Site logistics including the management of spatial constraints was vetted for anticipated site operations. Finally, production operational rates were estimated for the important remedial activities. Envirocon understands the production rates may vary, but assumptions were made in coordination with the remedial design concepts.

1.0 IDENTIFY WASTE DISPOSAL FACILITIES

a. Identify disposal facilities which will accept the wastes generated at the site, including:

- TSCA (PCB > 50 ppm) -The main disposal facility candidates for these materials are as follows:
  i. Waste Management- Emelle landfill in Alabama. Emelle can accept TSCA or RCRA in unlimited quantity.
  ii. Waste Management--Model City NY. Model City is severely limited by capacity constraints; existing cells very limited quantities and new-cell permits are in limbo.
  iii. US Ecology, Belleville MI- Can accept TSCA or RCRA Hazwaste
  iv. Heritage, Roachdale IN- Can accept TSCA (under MegaRule) or RCRA
  v. Clean Harbors, Lone Mountain OK- can accept TSCA (under MegaRule) or RCRA
  vi. Chemical Waste Management, Port Arthur, TX—for very high PCB NAPL-impacted sediment or soils. It is possible that incineration could be required for soils/sediments with high PCB concentrations, but this requires further due diligence.
  vii. Clean Harbors, Deer Park TX- for high PCB concentration NAPL-impacted
  viii. Clean Harbors, Aragonite UT- for high PCB concentration NAPL-impacted
- Hazardous, Non-TSCA (PCB < 50 mg/kg)

i. Any of the above
ii. Or if allowed by permit, more local Subtitle D facilities

- Hazardous Non-TSCA (Exceed TCLP Lead)
  iii. Clean Earth, NJ

Please see Attachment A which lists the various disposal facility options for each waste classification.

In addition regarding Non-TSCA material category that is < 50 mg/kg PCB, there are other options that may be considered. If the material is not classified as a RCRA waste by listing or by characteristic, and is less than 50 mg/kg PCB, it would qualify for disposal at a RCRA Subtitle D facility. This disposal scenario would offer advantages in cost savings and in closer proximity of the disposal facility to the site. This option is presented as a value-added engineering alternate disposal approach. USEPA approval would need to be provided via the CERCLA 'off-site' rule. BP would also consider whether they have 1) approved the facility for disposal previously; and 2) have a material 'footprint' of previously placed material at any of these potential RCRA Subtitle D facilities. In this case (subtitle D facility) it is expected materials would be transported by barge to the trans-loading facility and ultimately would be transported by haul truck to the disposal facility.

Similarly, regarding Hazardous Non-TSCA classified material which exceeds TCLP for lead, there may be other value added options for disposal. The disposal vendor may provide chemical stabilization services off-site that may render the material Non-Hazardous, which would allow it to be disposed at a RCRA Subtitle D facility. The other factors referenced above regarding approvals of the disposal facility would apply also.

The following information indicates the status of potential disposal facilities as designated in Wastetrak as of February 2016. While the facilities are designated "At Risk" or "Approved", they are all viable options according to the BP System. The deciphering factor for designation is the facility audit score.

Hazardous TSCA

- Waste Management- Emelle – Approved
- Waste Management--Model City NY – At Risk
- US Ecology, Belleville MI- At Risk
- Heritage, Roachdale IN- Approved
- Clean Harbors, Lone Mountain OK- At Risk
- Chemical Waste Management, Port Arthur, TX – Approved
- Clean Harbors, Deer Park TX - At Risk
- Clean Harbors, Aragonite UT- At Risk

Hazardous Non-TSCA (Exceed TCLP Lead)

- Clean Earth, NJ – At Risk

b. For each facility, identify the following:

- Means to get waste to the facility (e.g., barge, rail, truck)
  i. WM Emelle- rail to about 12 miles from the facility with final trucking/transload provided by the facility
  ii. US Ecology Belleville- rail to Romulus, MI with final trucking/transload provided by the facility
  iii. Heritage Roachdale- rail to ~ 40 miles from the facility with final trucking/transload to be arranged
  iv. Clean Harbors, Lone Mountain- rail with direct off-load at the facility (excavators dig out gondolas)

Regarding the potential incineration of high PCB concentration sediments or soils (if ever determined to be required), the transport will follow the same logistics trail as the lesser concentration soils and sediment material.

For this project, the transportation logistics and infrastructure seem to favor US Ecology and Heritage.

- Characterization requirements (e.g., additional sampling after waste characterization)

The characterization requirements for waste profiling and subsequent sampling and analytical frequency to confirm waste profiling requirements are met are determined on a disposal facility specific basis. It is Envirocon's experience that a typical frequency required by disposal facilities to characterize material being disposed can range from one sample per 200 CY to one sample per 2,000 CY.

- Any maximum concentrations for the contaminants of concern, or other waste characteristic limitations?

There are many complexities involved with mixed wastes and the Mega Rule. The waste segregation program on-site should specifically be targeted to segregate TSCA from non-TSCA materials and to segregate hazardous TCLP lead materials from PCB (TSCA and non-TSCA) impacted materials as much as practicable. Lone Mountain can accept hazardous lead impacted materials without concern for Land Disposal Restrictions (LDR) issues and can accept mixed waste. The LDR for lead for direct landfilling impacted materials is 7.5 mg/L TCLP. Pre-treatment for lead stabilization would need to be conducted if the LDR for lead is exceeded. Heritage can perform pre-treatment for lead exceeding that LDR, but not if it contains any PCB's.

Generally, the Mega Rule has three parts, A, C and D. Regarding Part A, that portion of the rule governs small quantities. Part B is risk based and manages large quantities, while Part D is performance based. Envirocon has received some general operating and permitting information from a number of the disposal facilities contemplated, and can make these available if requested.

- Other limitations including but not limited to volume limitations (daily, total), debris size, stabilization requirements, etc.

Please see Attachment B for a summary of disposal facility constraints in reference to the points listed above.

2.0 IDENTIFY IMPORT SOURCES

a. Provide sources for the following imported material, including transportations options suitable to the volumes required

The following materials will be imported by bulk on barge via the Hudson River.

- Light-weight fill—Norlite Cohoes NY (near Albany), truck to Port of Coyman (Albany), transload into barges, 4-5 months to produce ~20,000 CY; recommends ¾" by Number 4 material (ASTM standard) or Northeast Solite in Saugerties NY(south of Albany)
- On-shore fill—Tilcon NY; barge to site
- Off-shore fill—Tilcon NY; barge to site
- Riprap—Tilcon NY; barge to site
- Topsoil—to be located, barge to site
- Portland cement—Tilcon NY; barge to site (in enclosed containers for pneumatic removal)

The sources of import materials via barge are provided by Tilcon as listed in Attachment C. These sources listed have access to barge loading in bulk on the Hudson River. Also included in Attachment C is a summary of the Norlite light-weight fill specification.

Topsoil sourcing is yet to be located and identified. The make-up material for the sand and organic material layer which is to be blended is yet to be identified.

b. Identify limitations to each of the sources including volumes, transportation methods, required testing, time of year, etc.

The materials will be imported by bulk on barge via the Hudson River as listed above.

- Volume limitations- virtually no limitations
- Transportation methods- all barge
- Required testing- to be determined
- Time of year- normal construction season for that area (April/May to November/December); river freeze in mid-winter would eliminate any import.

3.0 WASTE TRANSPORTATION / IMPORT TRANSPORTATION OPTIONS.

a. For Each Rail, Truck and Barge (and any others or combinations), provide:

- Pros / cons for each transport option;
- Approximate scale/timing of each options for both import and export (e.g., quantity/traffic per day/week/month)
- Additional infrastructure requirements for each option (e.g., dock, rail spur, roads and Landing Barge)
- Volumes (ranges and most likely) that can be transported in each option.
- Other considerations (e.g., can roll-offs be transported on barge for less handling in multiple transport, etc.)

Please see below as these items are discussed with the different options.

b. Recommendations for transport options or combinations of different options.

- Highway truck transport considerations

1. Two limitations inhibit the use of trucks for large-scale transport of impacted materials or for import of materials:
   a. The truck route into and out of Hastings-on-Hudson passes through largely residential areas along Route 9 to the north to the I-287 passes through several school zones and through the village of Hastings-on-Hudson. In the past, every truck required a Village police escort into or out of the site.
   b. The crossing bridge adjacent to the Hastings-on-Hudson rail station makes a very sharp turn from West Main Street into the frontage road to access the Hastings site.

2. It is recommended that vehicle traffic in and out of the site be limited to cars, delivery vehicles (e.g. UPS, FedEx), service vehicles where needed (e.g. surveyors, vacuum trucks), and only those necessary larger trucks that can conveniently be escorted and that can traverse the West Main Street bridge.

- Rail transport of TSCA/Haz for disposal

1. Generally there are advantages to be able to handle materials once on the site, and transport them all the way to a disposal facility. They would be loaded, burrito-wrapped, and shipped off the site via rail. However, for the reasons below (Rail Spur at Hastings), it is unlikely that direct loading of railcars (gondolas with burrito wrap or intermodal containers) will be feasible, due to the rail spur use limitations imposed by Metro North.

2. It is also not feasible to use any kind of over-water gondola "Floats" (rail barges), due to the difficulty of mating the rails at the waterfront, challenges with finding an off-load point on the other side of the Hudson, and availability of service/permitting at the offload point.

3. Rail is the preferred method of transport from the west side of the Hudson transload location to the TSCA and RCRA disposal facilities, either via gondola (burrito-wrapped) or in intermodal (IM) containers. In either case, any across-the-water barging must be handled in a container by a permitted barge carrier. At the transload facility located across the river (west side), the containers are offloaded and either loaded onto intermodal rail cars or unloaded into burrito-wrapped gondolas. Typical intermodal containers hold approximately 15 CY each. One type is 20' long x 8' wide x 6.75' high and can be loaded to an approximate weight of 22.5 tons. Some disposal firms provide the containers, and have sufficient quantities to support the remedial operations. The number of containers and rail cars (intermodal or gondola) are determined to support the production operation and are optimized based on turnaround, demurrage, and transit times.

- Rail Spur at Hastings

Please see Attachment D which includes two photos. One shows the switch from the mainline to the Hastings site spur where switches further down the track allow movement between all four mainline tracks. The second photo shows a group of Metro North Maintenance-of-Way gondolas sitting on that spur, thus proving that the mainline-to-spur switch and the southern end of the spur are currently operational from the perspective of Metro North.

1. Switches are in-place south of the facility, and Metro North is using part of the old spur parallel to the mainlines for holding some gondolas for their track maintenance-of-way department.

2. The old spur parallel to the mainlines could be rebuilt and extended into the site with some grade adjustments south of the Hastings station.

3. Rail service to the north requires crossing the Hudson at Selkirk Junction, near Albany.

4. There would have to be special freight service arranged with CSX or CP (which also retains right of use). Though CSX and CP have freight trackage rights, they are subordinated rights, subject to approval by Metro North. CSX has limited track use rights, subject to Metro North's approval vs unlimited track use rights and Metro North is trying to get the municipal waste off the tracks, and is unlikely to favor any use of the track for impacted soils or sediments. The fact that Metro North is storing their rock (ballast) gondolas on the siding, and thus owns the spur gives them additional leverage. If CSX could work out a deal with Metro North, it would likely be for limited service, say 1-2 days per week vs daily and the pricing rate is indeterminate at this time.

5. Metro North's schedule at Hastings is almost round-the-clock, with a window between approximately 02:30 and 05:00 each day. That is not to say that freight service couldn't be arranged during Metro North's scheduled service times, but requires agreement and coordination of switching to allow safe track movement.

6. The track footprint on-site at Hastings must be designed for loading, loaded car storage, storage of empties, and allowance of engine switching (front to back) for the freight locomotive.

7. On-site trackage construction and operations are likely to be less expensive than the parallel track spur upgrade, due to the need for union rail labor construction on the portion within the CSX/Metro North right-of-way.

8. Freight traffic along the CSX line is sporadic and light. Thus it is likely that special trains are needed for disposal materials, along with coordination between CSX and Metro North. It is not clear that freight service can actually be accomplished at Hastings at this time, without directly contacting CSX to enquire.

- Roll-on/Roll-off Landing Barge

Attachment E includes a number of photos of a potential Roll-on/Roll-off Landing Barge system that would be a good application for the Hastings on Hudson site. Each photo is provided with a caption detailing the contents of the photo. Also attached are some dimensions and calculations related to a prior project where the Landing Barge and Landing Barge Ramp were used to transport materials into a site at Roosevelt Island NY; these are provided to assist the design team with the positioning of the Landing Barge system at the Hastings site. The system is described further as follows.

1. This system is far more flexible and feasible than trying to make a fixed loading pier along the waterfront. That is due to the necessity to match angles with the tidal fluctuations and also the safety aspects and clearances for moving containers onto and off of deck barges.

2. The Landing Barge has two barge loading ramps (north and south) parallel to the shoreline, plus provision for a third barge on the waterside. It is connected to land by a Landing Barge Ramp of 60' length and 53' width. The Landing Barge Ramp connects the spudded floating Landing Barge to the land to a "hard-point" that allows for trucks or mobile container lift units (forklift, container crane, or container lifter).

3. The Landing Barge can also be configured to run materials via conveyors from import material barges.

- Transload facilities

Attachment F shows a flow diagram for loading material in waste containers, loading containers on barges, transporting across the river to a transload facility, and loading waste containers to rail from the transload facility for final disposal. The diagram is Baseline Flow of Export Materials. Attachment G contains photos of the waste containers.

1. There are approximately 22 identified potential transload facilities in the west side of the NY/NJ harbor, where disposal materials can be transferred to rail, truck, or truck-to-rail.
2. The selection of a transload facility is determined by TSCA/HW disposal options and the total cost of transport and disposal. It is anticipated that the disposal facilities can make those general arrangements as part of the unit price for disposal.

- T&D Contracting Strategy

1. There is a general concern that disposal companies attempt to "lock-in" their solution in the design process, thus gaining a premium or preferred position over their competition. To avoid that, it is recommended that maximum flexibility be built into the design. For example, rather than subsidize rail gondola from the site at BP expense, allow the disposal company to attempt to build the spur, arrange for freight operations, and compare those costs to the barge-across-the-Hudson to a western-side transload facility.

2. Ideally, allow the pre-qualified disposal companies to make freight and transload arrangements end-to-end and compete for the work, rather than "locking-in" to a single disposal firm or method. Each competing firm will use their best logistics capabilities to develop a least-cost solution, thus allowing BP to select the best value disposal means from the competing firms. The bidding process should not take an inordinate amount of time to develop the bids and should be able to be conducted during remedial design and remedial action plan development.

A request for base bid could be prepared and a bid evaluation scoring system developed to determine best value. Envirocon suggests that risks associated with transportation and disposal vendor services be monetized as a bid contingency within BP's project budget to assure that services can be implemented if a selected vendor offering an alternate bid cannot achieve it in actual performance. Such would be the case, for example, if a disposal vendor proposed an alternate for direct-loadout from the Hastings site via a rail spur that the vendor would try to build and operate, in spite of the now-understood challenges of gaining freight access through cooperation with Metro North. This will allow the risks to be identified with potential impacts quantified as a result. Perhaps some risk sharing can be negotiated up-front with the transportation and disposal facility vendors if BP so elects.

- Import Materials Transport

1. In almost all cases, import materials must come in by barge. The truck vehicular limitations have already been discussed. Also, there is virtually no rail import feasibility to the Hastings site. Freight service is limited and the materials providers have limited rail loading access at their point of origin locations.
2. For barge materials import, either crane/clam diggers may be used, or in some cases there may be value in setting up conveyors.
3. The barge loading/unloading Landing Barge previously discussed can be configured to both import in bulk and export in containers, in some cases simultaneously.

4.0 MATERIALS HANDLING QUESTIONS

a. What are the typical methods used to track and transport excavated/dredged materials on site?

- We are discussing using 40-yard roll-offs for identification, storage and transportation (e.g., onto the barge?) of on-site spoils. Have you seen this used?

Envirocon understands this approach and has utilized it previously. This is the recommended approach after excavation spoils are processed for final load-out. Optimum sizing of the Intermodal (IM) style containers is approximately 40-CY each (by container dimensions for the standard ones) but the weight is the determining loading capacity factor as discussed below; this container volume will match the containers best suited to be loaded onto barges for transportation and subsequent trans-loading.

The IM style containers (8'X 20' X 6.75' tall each) stack up to eight boxes (normally from six to seven boxes) on a rail car designed for the container. They are stacked two high on the rail cars. Due to lifting constraints, the capacity of material loaded in each container (excavated soils and dredged stabilized sediment) is approximately 15 CY of material for each IM container which is approximately 22.5 tons at 1.5 tons per CY for each container. Including the weight of the container, each box will weigh

approximately 25 tons. Each rail car can manage approximately 165 to 175 tons, while the Deck Barges typically have a capacity from 600 to 1,000 tons.

A WA500 size loader with forks can handle a loaded 20' intermodal box. It has a tipping wt. capacity of 54,000 lbs. There are also rubber tire intermodal container handlers that look more like a conventional fork lift. It is unknown how a conventional forklift would act in the multi angle environment of land to floating Landing Barge to deck barge scenario.

- For dewatering & bulking, has your experience been to have separate TSCA/Non-TSCA processing equipment trains?

Envirocon recommends that it is efficient and effective to have separate TSCA and non- TSCA processing trains as long as there is sufficient characterization data to support the segregation. The characterization data must be at a horizontal and vertical frequency that allows a detailed excavation/dredge model to be prepared. This will allow efficient excavation and segregation for both TSCA and non-TSCA materials and subsequent material handling.

There must also be sufficient area on-site to support both the TSCA and non TSCA staging operations for both waste characterization material streams. Frequency of testing (stock pile size) and analytical turn-around- time will influence the staging area footprint.

- What is a typical "batch" size for bulking/stabilizing /sampling?

During the course of conducting similar remedial action projects, Envirocon has used batching sizes for stabilization and sampling from 50 tons (or CY) to 500 tons (or CY). If we are using this sampling approach to characterize TSCA versus non TSCA waste material, a 'batch' size of 250- tons may be appropriate and has been used previously for verifying TSCA versus non-TSCA material. This batching size can be also used for batch stabilization/processing of materials to meet landfill disposal frequency and criteria. Each batch size of 250 ton will fill 12 IM containers with a capacity of 22.5 tons each.

- How do we segregate and/or sample debris to determine if it is TSCA or non-TSCA? Do you typically sample debris (TSCA vs non-TSCA)

If detailed soil/sediment characterization is conducted thereby allowing for excavation/dredging segregation of TSCA versus non-TSCA materials, then the debris associated with the characterized material in-place may be assumed to also be TSCA or non-TSCA materials.

Conversely, debris can be segregated based on obvious presence of contamination by confirming NAPL that may contain PCB's for example. That would be the first course of segregating potentially TSCA impacted debris versus non-TSCA debris. Wipe tests can be conducted to verify classification of debris as

TSCA or non-TSCA material. This type of characterization program can be difficult to execute and manage however.

If in place characterization is not allowed, Envirocon recommends starting with visual contamination of debris as a standard, with some simple decontamination of larger impervious debris proposed to manage that waste material. If debris is obviously impacted with NAPL product then it may be assumed to be TSCA waste or a wipe test would be conducted on representative amounts of the material to determine TSCA versus non-TSCA status.

- Does 12"+ and 12"- debris get disposed differently or is just the separation method that is different?

Debris is sized to meet landfill disposal criteria, which are different for different disposal facilities. All debris will be segregated and disposed in a similar manner. Debris that does not meet disposal facility sizing requirements will be sized during processing operations to meet the necessary criteria for the respective disposal facility.

- Should we assume we'll need a staging area for timber/debris or just process as they are generated?

Some timber/debris can be processed as it is managed when removed. Envirocon recommends a debris staging area to stockpile and size timber and debris that requires additional processing. The objective is to maintain this area in a relatively small footprint. The majority or at least a significant amount of debris can be maintained with the soils and sediments in which they are encountered and removed. The debris will be loaded while mixed with soils and stabilized sediments into the containers so that potential void spaces are minimized or eliminated when loading and transporting debris.

- Evaluate the methods, costs, and rates to process/dispose concrete slabs (to result in 1'' minus material)?

Envirocon evaluated processing concrete slab in our first constructability review conducted in 2008. If the target sizing is 12" to 18" material which meets off-site disposal sizing requirements for example, then only a hammer and/or processor attachment would suffice. A crusher will be used if a 4" minus product is to be produced. Long rebar will be removed with a demo saw or torch. Short rebar will fall out during processing or will be cut off if too long to meet landfill or on-site placing requirements.

Using a hammer and/or processor will be the most productive method to process the concrete slab if 12" to 18" material sizing is acceptable. Using a crusher in addition to this equipment to produce less than 4-in. sizing is approximately 2/3 of the production rate for sizing to 12-in. to 18-in. Sizing to 1-in. minus concrete would require detailed crushing operations if that sizing is required for on-site placement. This may result in a production rate corresponding to 1/2 of the 12-in to 18-in. concrete sizing operation.

Clean concrete can be sent for recycling. There are multiple recycling facilities in the NYC area. If this is a limited volume, for example 2,000 tons, it could be trucked to local recycler over a period of time.

b. Barge Option Questions (as it seems the most likely scenario).

- We have estimated that it may take two – three days to load a barge (this is based on our proposed tracking/storage of using 40-yard roll-offs. Loading 40 roll-offs onto a barge may take 20+ hours. This may just keep up with excavation rates. In order to bring in other materials and even roll-offs for waste removal, it seems that we would need room for at least TWO barges with cranes on each. Does this make sense?

The most likely type of container for impacted material transport off the site is an IM container. These containers can be loaded and staged for barge transport. By staging the containers, the flat deck barge can arrive and be loaded in a relatively short period of time. Depending on the size of the deck barge the loading process may be a few hours. A typical barge transport cycle would involve the deck barge and tug arriving with empty containers, offloading the empty containers, loading the full containers, then the tug and deck barge leaving for the transload site.

Utilizing the Landing Barge the containers can be handled with a large loader with forks or a container handler. Either piece of equipment is rubber tired; no crane is required for this setup. The floating Landing Barge allows three sides for barge tie up. Containers can be handled in one location and offloading materials in another location. Should bulk materials need to be offloaded, a material handler or long reach excavator could be used. With the Landing Barge, a crane is not necessary for offloading bulk materials. The size of the material transport barge (hopper barge) will influence the size of the material handler / long reach excavator.

- If other barges for storage or off-site fill are needed, we can easily see that room is needed for 4 barges at any time, two with cranes and two with other means of bulk unloading. Is this anticipated?

Please see the scenario explained above. If conventional spud barges with cranes are utilized, there will be a need for alternate tie-up facilities. Depending on the size of the transport barge, one may be tied- off to the crane spud barge while another is being offloaded.

- Where would the docks generally be located, and how would the area of the dock be remediated/rebuilt? After all other remediation? Before all other?

Envirocon evaluated pile supported docks and concluded that design, construction costs and schedule were significant depending on the use. For instance, a dock facility that would handle a rail gondola and berth a rail barge requires large concrete foundations, requires a year to construct and costs greater than

$10 Million. The forces from mobile equipment transitioning from a fixed dock to a barge are significant and have similar requirements as noted above.

A floating Landing Barge with land based Landing Barge Ramp is a good solution for addressing the forces involved with loading/offloading barges. The second generation Landing Barge (photos included in Attachment E) is a working facility proven to have the capabilities described above.

The Landing Barge would be located in the southern area of the property adjacent to the IRM sheet pile (for draft purpose). The access to the Landing Barge would require investigation for any needed improvement. The sheet pile is destined to be removed for slope back so its purpose in this scenario is strictly to provide draft. A Landing Barge Ramp from the land to the floating Landing Barge positions the load behind the sheet pile. This load can be distributed with crane mats or similar method. This southern area would be maintained as access to the late stage of the project when the barge transport is complete. This area would then be incorporated into the slope back lines and grades.

- What would a general description of the dock area be (size, orientation, piles, time to construct, recoverable at the end of the project, etc.)

The barge Landing Barge is about 45’ wide and 130’ long. It is a floating structure with spuds and is comprised of 3 Landing Barge Ramps: a Landing Barge Ramp to land and two Landing Barge Ramps on either end for on-loading/off-loading to a deck barge. The side opposite of the land Landing Barge Ramp can be used as a tie-off for a material barge. The material barge can be offloaded with a piece of equipment positioned on the Landing Barge.

- What are the major issues with the construction of the barge?

The Landing Barge has significant capacity and can handle hundreds of tons of load. The bigger restriction is the Landing Barge Ramp capacity. The present ramp is designed for loaded tractor trailers. A more robust ramp may be needed for the concentrated load of the forklift loader with loaded intermodal container (about 62 tons). Another key consideration with the present configuration is the Landing Barge needs to be lower or level with the deck barge being loaded/unloaded.

At 60 foot length, the Landing Barge Ramp can reach inland of the IRM Wall. Depending on existing draft at the IRM Wall, the Landing Barge may be positioned within 20 feet of the Wall allowing the ramp to be supported 40 feet inland from the wall. This should provide flexibility in the load transfer for Wall protection.

The loads to be supported by the ground inland of the IRM Wall will need to be evaluated with the applicable safety factor desired for the existing Wall. Crane mats or temporary pile may be needed to

support the Landing Barge Ramp to protect the IRM Wall until it is removed at the completion of the Landing Barge use.

The Landing Barge requires support of the land side Landing Barge Ramp. It has draft requirements associated with the material or transfer barges that will dock against it. The empty Landing Barge draft is 2.5 feet. Under load the draft may increase to 4 feet.

- How quickly can material be on-loaded or off-loaded?

Material on-loading/off-loading operations are predicated on the mobile equipment being utilized for this activity. For instance a material handler with a 3-CY clam will off load a bulk material delivery faster than a long reach excavator with 2-CY bucket. Loading intermodal boxes onto a deck barge with a large loader w/ forks or a rubber tire IM container handler is faster than rigging the boxes to a large crane.

c. Excavation Strategies

- When would you perform the south slopeback excavation - early or late in construction?

Envirocon suggests leaving the barge loading area (likely southern side) to the end. The slope- back work will bring the water line into the property. We need to maximize draft at the barge loading area so the Landing Barge should be located at the sheet pile wall. Leaving the south end area until the latter stages of the project will allow access to the Landing Barge. The south end of the site is less impacted and the excavated material can be reused for localized fill.

- The current assumptions are that Support of Excavation (SOE) sheeting will have to be to 45 feet to cut off water. Is there an alternative?

Envirocon has not identified feasible alternatives from a cost-effectiveness or constructability viewpoint. Nevertheless, one option is to use a shield system instead of sheet pile that incorporates intermediate wales and struts. This will require pumping substantial volumes of infiltrating water. When sinking shafts in soft or wet ground one method of ground support is to install refrigeration tubing and actually freeze the subgrade. This is a relatively costly and time consuming method.

- How do you recommend tackling prompt backfill of completed excavations versus storage of processed soils/sediment for reuse?

Some excavations may be isolated by placing sheetpile around the excavation cell perimeter. After required confirmation sampling, the cells will be backfilled as soon as practicable. Processed soils/sediments that are verified to be usable for site backfill will be staged on-site and used as backfill as quickly as possible so as to minimize staging area required. In addition, off-site borrow material will be imported and staged on site for use as backfill. If water is encountered in the bottom of excavation,

granular (i.e., minimal fines) material can be backfilled to above the water level to attain compaction. Site materials may subsequently be used for backfill above this elevation.

Careful coordination is critical between the excavation and backfilling programs accounting for soil/sediment re-use and backfill material import. Minimizing site footprint required for staging all backfill materials is a critical objective to meet project success.

d. Production Rates.

- Production rates currently assumed are 200 tons/day for excavation, 600 tons/day for mechanical dredging and 500 tons/day for backfill and compaction. Please confirm these rates and/or provide ranges based on equipment or crew sizing.

Envirocon's input for various activity production rates are as follows:

Excavation cells-- 225 CY/day

The excavation rate for one crew assuming sheeting is already installed and mass excavating could be as high as 500 to 700 CY per day. The surgical nature and stock piling requirements will limit the excavator operator to be accurate and have the excavation checked for grade or use an expensive GPS machine set up. The excavation rate needs also to take into account the hauling of the material to the stockpile area. Will the trucks need to be deconned before leaving the excavation as well as at the stockpile location? Taking these type of factors into account we recommend 200 to 250 CY per day.

Envirocon believes excavation of the slope back can be conducted without sheeting. The sheeting provided a supported excavation without sloping to prevent unnecessary volume. The slope back is an open excavation.

Backfill/Compaction within cells-- 265 CY/day

This really depends on the compaction spec and backfill material – how readily does it compact. Will compaction tests be required? Compacting on unconsolidated fill can be challenging. Will a small compaction unit be lowered into the excavation or will the excavator have a compaction attachment? An excavator will need to distribute the backfill around the excavation footprint which requires time. 265 is reasonable with proper resources and a realistic spec.

Install SOE Sheeting (40 ft deep)-- 39 LF/day

The biggest challenge may be missing or working around the existing piles. SOE alignment includes shallow-preclearing to attempt avoiding piles. Obstructions and hard driving are expected to be encountered at greater depths. Most of the blow counts through the fill are less than 20 blows/ft, but there

are values between 20-40 blows/ft periodically and an occasional 100+ blows/ft. The 20 to 40 blows/ft material may require an impact driver which may deform the sheets rendering them unusable if they can be removed. The 100+ blows/ft material will most likely be a refusal situation.

Extract SOE Sheeting-- 52 LF/day (assuming some is salvageable)

If sheeting is driven with a vibratory hammer at > 1' per minute it should come out with a vibratory hammer.

Percentage of salvageable sheeting-- 70%

It is estimated that the percentage of salvageable sheeting is 70% salvageable while 30% is non-salvageable. This is a reasonable estimate based on available blow counts.

Excavation dewatering rate-- 100 GPM (two (2) 50 GPM pumps)

The flow rate is limited by the water treatment plant more so than the pumps. If we can dewater excavations at near 100 GPM (assuming the treatment plant can keep up), the dewatering time is pretty minimal compared to sheeting, excavating, and backfilling. The dewatering effort during excavation will need to be maintained as the sheeting will weep or leak to some extent.

Mechanical Dredge-- 400 CY/day

The dredge process is assumed to be comprised of three phases: 1) debris clearing; 2) mechanical dredging with environmental bucket; 3) cleanup pass with environmental bucket. The mechanical dredge production rate of 400 CY/day is reasonable if the dredge cuts are at least 2-ft. deep and the same bucket is used for the debris clearing and mechanical dredging. During the cleanup passes the dredge production rate will decrease significantly. Typical densities for sediment are 1.1 to 1.35 tons per CY in-place. A production rate of 400 CY/day will translate to 600 ton/day after sediment decanting and amendment stabilization. Regarding the clean-up dredge pass, the production rate may correlate to 100-150 CY per day.

5.0 SITE STRATEGY

a. Production rates of various activities

This is addressed in 4.d.

b. Docking locations and timing of construction with remediation

Envirocon recommends the south area for the Landing Barge Ramp barge (docking). See 4.c.

c. Shipping container options (gondola car to barge, intermodal container, bulk on barge)

Roll-off container or IM containers are the options for mounting containers on barges as discussed previously. Roll-off containers have rollers and an undercarriage rail not conducive to handling with forks. Envirocon recommends an open-top container such as the IM container described herein. The containers are covered by impermeable tarps, tied down and secured. IM containers are also available with movable hard lids which would be utilized if required.

d. Sheet pile of surgical excavations

For the larger excavation cells, sheetpile may be installed to enclose the excavation perimeter to aid in excavation and water management while minimizing excavated volumes due to slope-back. After excavation confirmation, backfilling should begin as soon as practicable, so that the next excavation cells may be worked. The work sequencing will be coordinated so that a number of excavation/backfill cells are progressing at the same time. This will allow sheetpile driving/removal, excavation and backfilling to be performed in various phases at multiple cells which provides for more concurrent, continual and productive operations.

e. Excavation and Backfill of surgical excavations

See above.

f. Where to load and offload various barges (you may recall we used the north end last time, but we may be able to build out the south end)?

This is a sequencing item and is useful for the project life. The position used during the demolition project will be part of the bump out. The southern area Envirocon wanted to use in 2009 was denied because of concern for the waterloo sheetpile. That same sheetpile will be removed for the slope back. The south site area is the correct location for project life. The sequencing relative to that area which will allow access to the barge offloading / load-out operations is a critical part of the design.

g. Dredging means and methods

The dredge process is assumed to be comprised of three phases: 1) debris clearing; 2) mechanical dredging with environmental bucket (inventory dredging); 3) cleanup pass with environmental bucket (residual dredging). Dredging means and methods includes mechanical dredging for the inventory dredging. A clean-up dredge pass will likely be required. Mechanical dredging may be conducted for the clean-up dredge pass. Envirocon recommends at least considering a hydraulic suction dredge option for the clean- up pass considering the dredge depth. This approach may be more productive and effective. The disadvantage is that it will likely require a greater footprint on-site for dewatering operations using filter presses, geotubes or similar dewatering technologies.

h. Dredged sediment and excavated soils dewatering and stabilization approach

Envirocon evaluated bench scale treatability tests conducted by Kemron. The results indicate:

- Filter pressing- only is satisfactory for both off-site transportation and on-site re-use of excavated soils.
- Portland Cement addition- only was satisfactory for dredged sediments.

Envirocon understands some potential inherent constraints in performing representative sampling and treatability testing on a small scale basis. Envirocon recommends that every avenue of approach is considered and tested for lime based reagent stabilization for excavated soils. These approaches include mixing of lime based reagents with the soils while conducting gravity dewatering. The objective would be to identify a more productive and cost-effective alternate to filter pressing if feasible.

Design parameters for stabilization of dredged sediments and soils include sizing of process, staging and storage areas required on-site, off-loading techniques from barges, and storage means for soils and sediments. Minimizing process, staging and storage areal footprints on-site is a critical design objective. One potential option for dredged sediment which helps to address the site area constraints and effective off-loading of dredged sediment is to stabilize the sediment on the transport barge or scow before offloading. In addition, it may be more feasible to store excavated soils and sediments in a secured bulk form on-site rather than in the individual IM containers before soils/sediments are fully processed and characterized for disposition.

ATTACHMENT A
DISPOSAL FACILITY SUMMARY

Envirocon

DISPOSAL FACILITY SUMMARY

Waste Classification	CWM Port Arthur, TX	Deer Park, TX	Aragonite, UT	WM-- Emelle, AL	US Ecology-- Belleville, MI	US Ecology-- Idaho	Heritage-- Roachdale, IN	Clean Harbors-- Lone Mtn., OK	Clean Earth, NJ	RCRA Subtitle D Facilities
TSCA High Level PCB	✓	✓	✓							
TSCA (PCB > 50 ppm)				✓	✓	✓	✓	✓		
TSCA and Haz (exceed TCLP lead)								✓		
Haz, non TSCA (PCB < 50 ppm)				✓	✓	✓	✓	✓		✓
Haz, non TSCA (exceed TCLP lead)						✓		✓	✓	

ATTACHMENT B
DISPOSAL FACILITY CONSTRAINTS

Envirocon

DISPOSAL FACILITY CONSTRAINTS

Issue	Facility: WM Emelle	EQ Wayne	HER Roachdale	CH Lone Mountain
Means to get waste to the facility (e.g., barge, rail, truck)	Barge - Rail - Truck	Barge - Rail - Truck	Barge - Rail - Truck	Barge - Rail
Characterization requirements (e.g., additional sampling after waste characterization)	TBD	TBD	Sample @35,000 CY	TBD
Any maximum concentrations for the contaminants of concern, or other waste characteristic limitations?	PCB- None LDR for lead for direct landfilling is 7.5 mg/L TCLP	PCB- None LDR for lead for direct landfilling is 7.5 mg/L TCLP	PCB- None LDR for lead for direct landfilling is 7.5 mg/L TCLP	PCB- None, Pb- None LDR for lead for direct landfilling is 7.5 mg/L TCLP
Other limitations including but not limited to volume limitations (daily, total), debris size, stabilization requirements, etc.*	None	None	None	None

*Emelle, Wayne, and Roachdale have Pb constraints based on LDRs

ATTACHMENT C
TILCON IMPORT
MATERIALS SUMMARY

Envirocon

TILCON IMPORT MATERIALS SUMMARY

OU	ITEM	QTY	UNIT	DESCRIPTION	COMMENTS	ORIGIN
OU-1	Total Remaining Fill Requirement	208,000	CY	Import fill req'd to get to 2 ft below final grade	Screenings	Haverstraw
OU-1	Import - Gravel Transition Zone (2 ft)	6,317	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Topsoil (6 inches)	11,678	CY	topsoil to final grade	Certified clean	N/A
OU-1	Import - Clean fill (18 inches)	35,034	CY	clean fill to 6 in. below final grade	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Stone (thickness varies)	3,912	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Stone (2 feet)	10,567	CY	onshore cover	NYS DOT Type 2 subbase	Clinton Pt.
OU-1	Import - Riprap (Armor: 2' of 12" D50)	7,699	CY	south slopeback, Old Marina	14" - 24" Average	Clinton Pt.
OU-1	Import - Riprap (Filter: 2' of 6" D50)	5,775	CY	south slopeback, Old Marina	4" - 10" Average	Clinton Pt.
	6" sand layer	1,924	CY		Stone Sand	Clinton Pt.
OU-2	Lightweight fill*	20,907	CY	for NW extension backfill	saturated unit weight of 90 pcf, expanded shale aggregate (See more details below)	N/A
OU-2	Offshore Backfill	~25,000-45,000	CY	Offshore cap for Nearshore/Backwater/Deepwater	Screenings	Haverstraw
OU-2	Offshore Cap	7,888	CY	up to numbers for Cap	Stone Sand	Clinton Pt.
OU-2	Offshore Cap	3,944	CY		1-1/2" Washed	Clinton Pt.
OU-2	Offshore Cap	3,944	CY		Capping - sand with organic content	N/A

New items added.

*Lightweight Fill: Lightweight fill shall consist of rotary kiln dried expanded shale aggregate as manufactured by Norlite Corporation or equivalent, 3/8 in. aggregate size, having a maximum in-place dry unit weight of 50 pcf and a maximum in place saturated unit weight of 90 pcf and a minimum friction angle of 32 degrees. Expanded shale lightweight fill shall meet the requirements of ASTM C330. Contractor may propose equivalent suppliers of expanded shale lightweight fill subject to the approval of the Engineer. The criteria for approval shall be: a) expanded shale lightweight fill shall be chemically inert and non-corrosive and durable, b) no by-product slag, cinders or by products of coal combustion shall be permitted, c) the maximum soundness loss when tested with 5 cycles of magnesium sulfate shall be 10% in accordance with ASTM C-88, and d) the lightweight fill shall satisfy the unit weights and friction angle requirements.

NORTHEAST SOLITE CORPORATION

NORTHEAST SOLITE CORPORATION

PO Box 437, Mount Marion, NY 12456 PHONE (845) 246-2646 FAX (845) 246-3356

Website: www.nesolite.com

Recommended general procedures for Geofill installation of Solite® are as follows:

- The Solite® material should conform to ASTM – C330 with a gradation 7 % (+/- 2 %) maximum retained on the ¾" sieve.
- If stockpiled on site, care should be taken not to contaminate the material with soil or other aggregates.
- No vehicular traffic shall drive across the material until after it is placed and compacted in the work.
- The material should be placed in the work by front-end loader or other means and leveled into 12" to 18" lifts.
- After placement it shall be compacted in two or three passes with a smooth drum non-vibratory roller with a maximum capacity of no more than 10 tons.
- The "target" in place density of the fill shall be 62 (+/- 2) pcf.
- Care should be taken not to over compact the material so as not to increase the in place density beyond the optimum value.

The method for determining "yield" is as follows:

In place density (pcf) x 27 cu ft / cu yd = lbs / cu yd.

2000(lbs /ton) / lbs / cu yd = cu yd / ton

Example:

60 pcf x 27 cu ft / cu yd = 1620 lbs /cu yd
2000 lbs/ton / 1620 lbs/cu yd = 1.234 cu yds / ton

Therefore, the expected yield of 60 pcf compacted material is 1.234 cubic yards of fill per ton of Solite®.

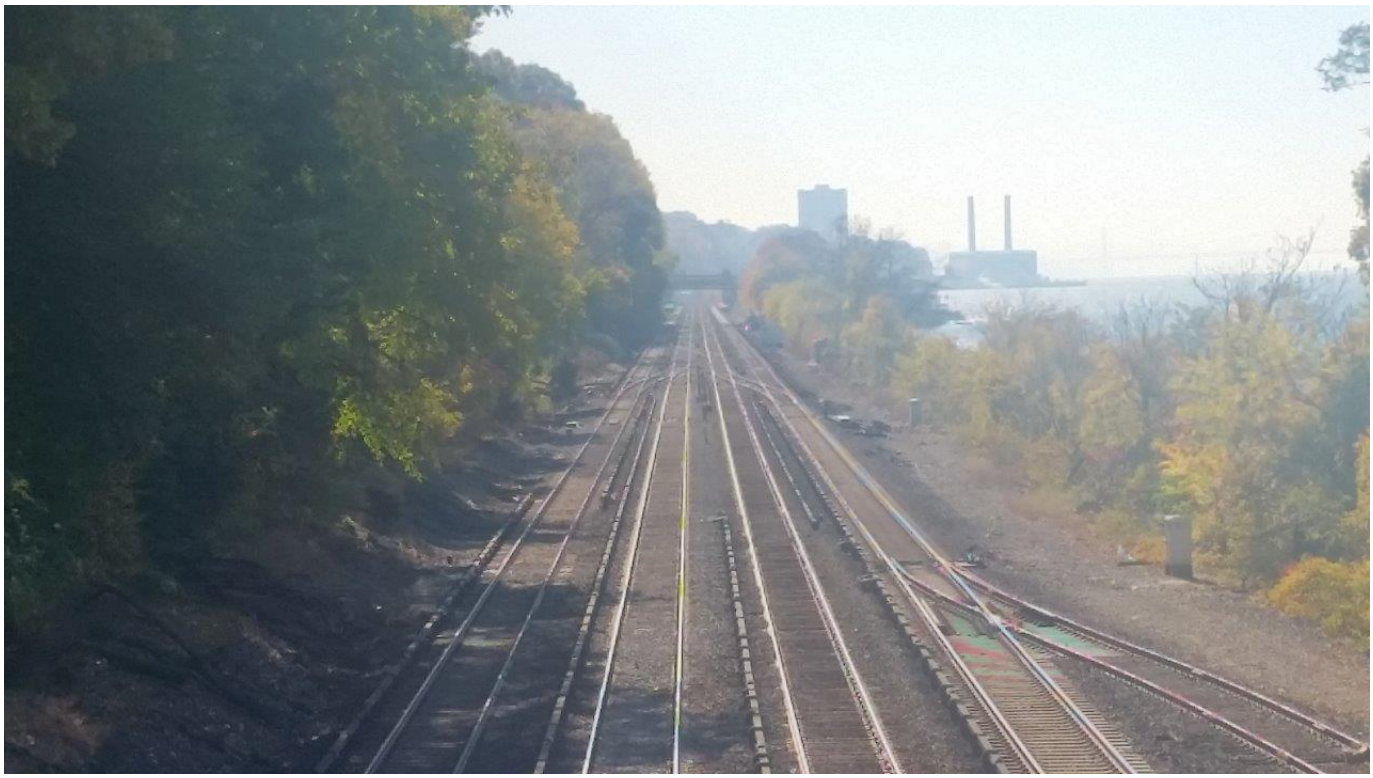
Using this algorithm, the following in place densities equate to the following yields:

59 pcf	1.255 cu yds / ton
60 pcf	1.234 cu yds / ton
61 pcf	1.214 cu yds / ton
62 pcf	*1.194 cu yds / ton*
63 pcf	1.175 cu yds / ton
64 pcf	1.157 cu yds / ton

ATTACHMENT D
RAIL PHOTOS

Envirocon

RAIL PHOTOS





ATTACHMENT E
ROLL-ON / ROLL-OFF LANDING BARGE PLATFORM PHOTOS & ADDITIONAL INFORMATION

Envirocon

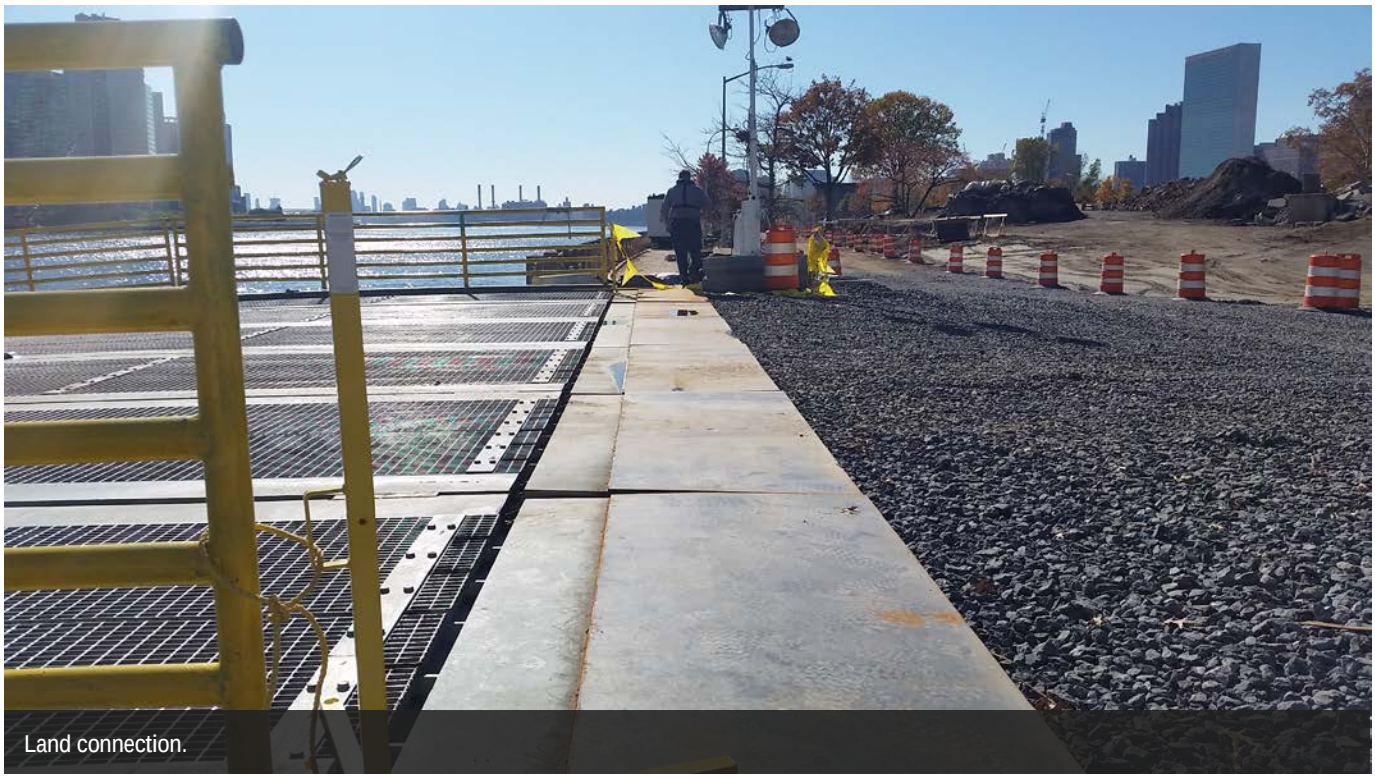
ROLL-ON/ROLL-OFF LANDING BARGE PLATFORM PHOTOS



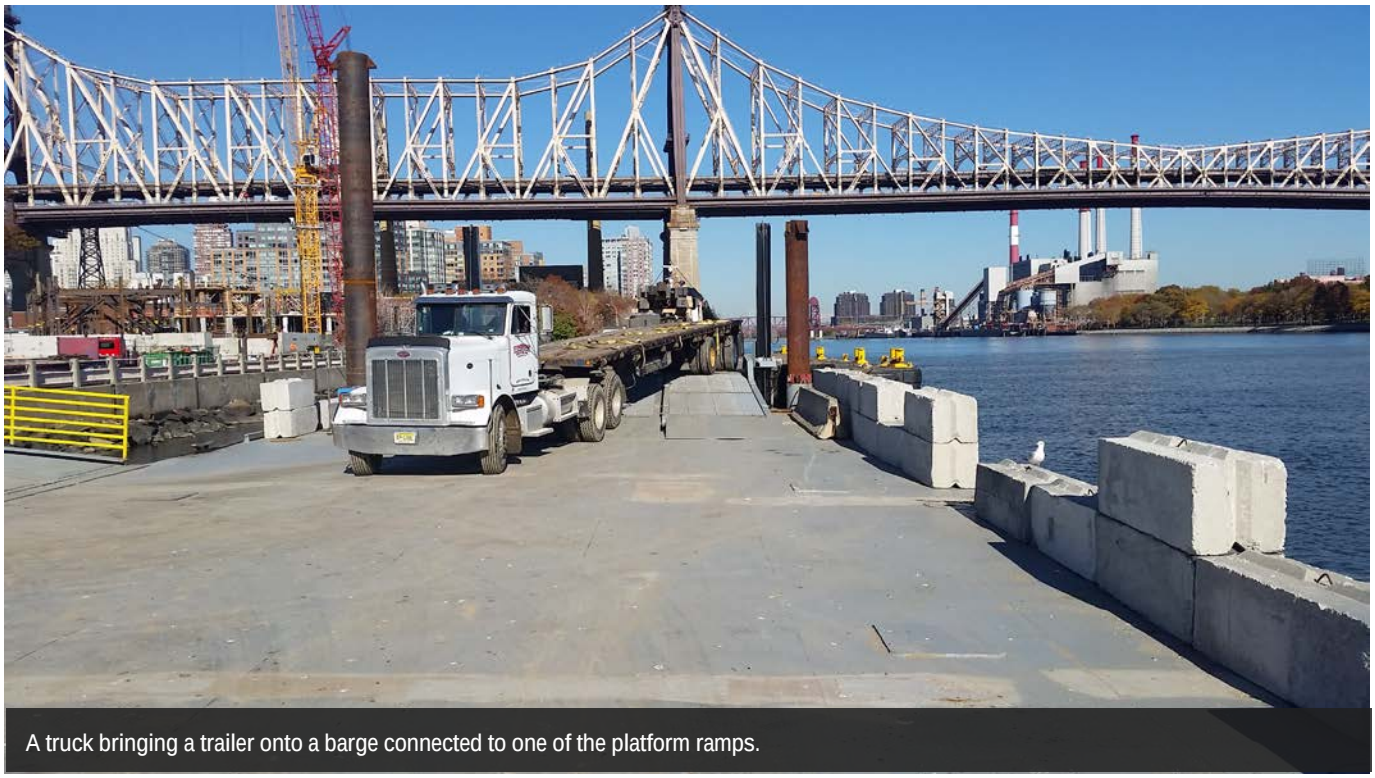
From the floating platform to land.



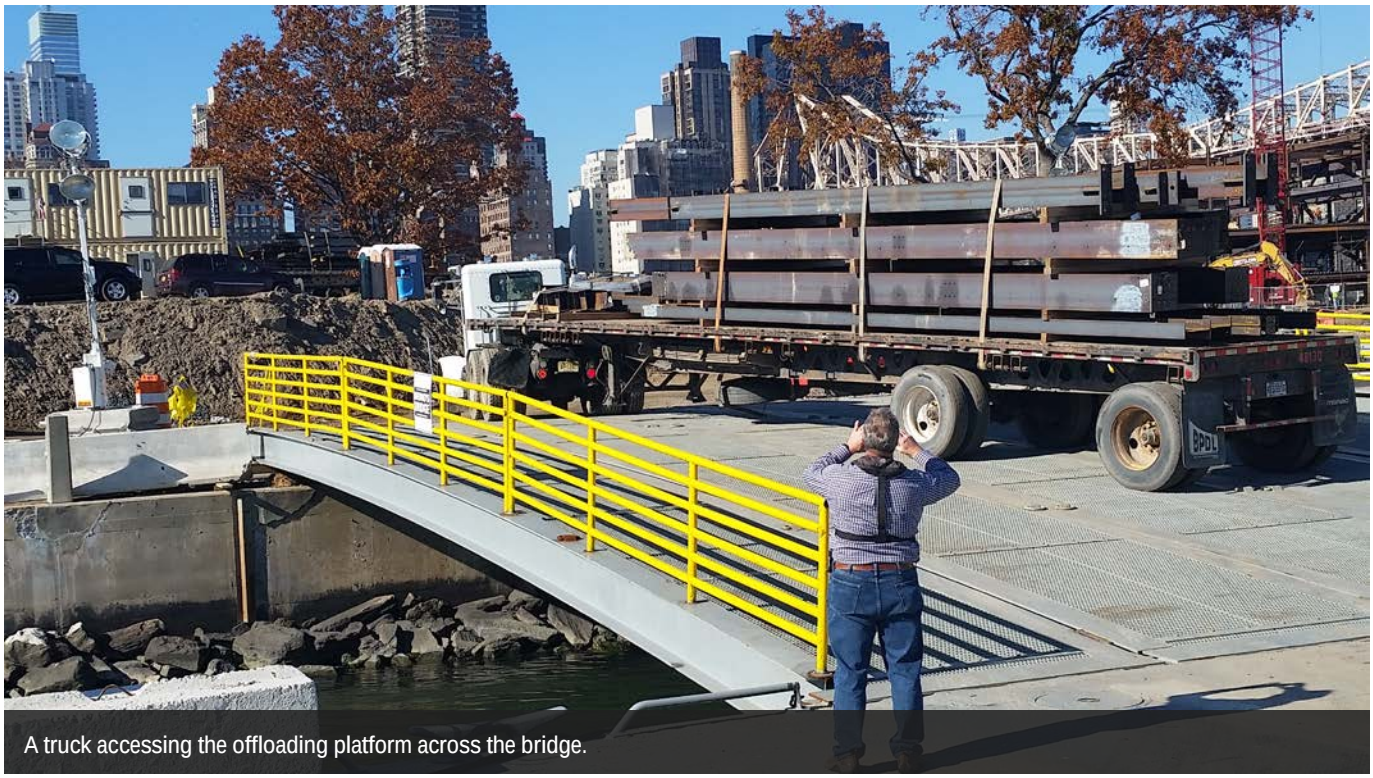
Note the floating “plastic” to allow minor movements and also the rotating pin to allow for water elevation changes (there’s a second rotating pin at the platform end).



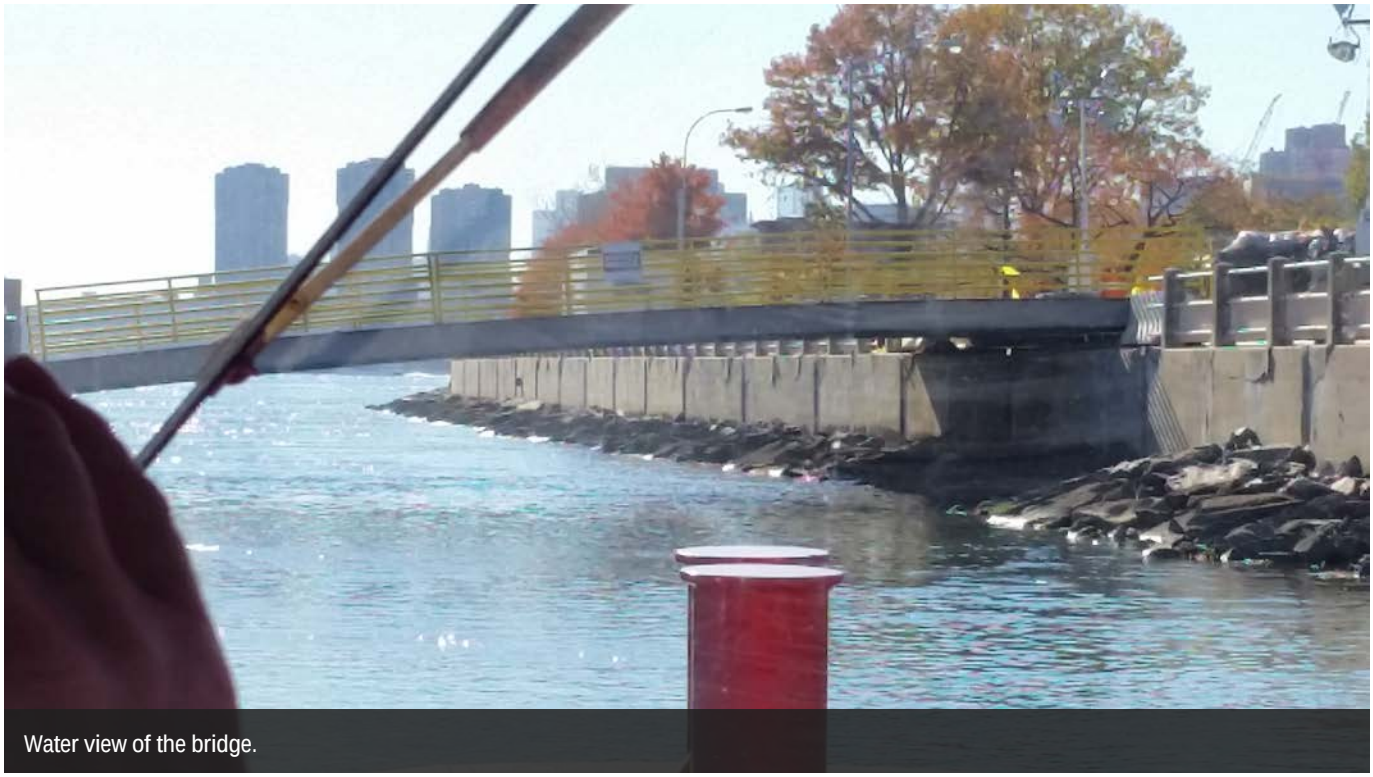
Land connection.



A truck bringing a trailer onto a barge connected to one of the platform ramps.



A truck accessing the offloading platform across the bridge.



Water view of the bridge.



One barge connected to one end of the floating platform.

ROLL-ON/ROLL-OFF LANDING BARGE PLATFORM ADDITIONAL INFORMATION

This information was provided by Miller's Launch Inc. regarding their Landing Barge and Landing Barge Ramp applications to another site's project. The calculations were representative of the project at Roosevelt Island NY where the unit is currently deployed. For further information, please contact Mr. Sven van Batavia, Vice President of Miller's Launch, Pier 7 1/2 Staten Island NY 10301, (718) 727-7303, sven@millerslaunch.com.

Geometric and Load Inputs

Geometry

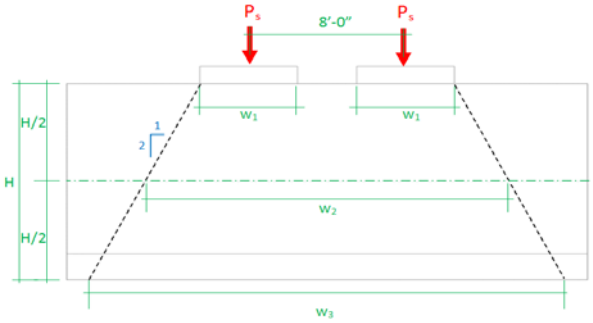
L_1=	2.0	ft
L_2=	2.83	ft
H=	11.25	ft
w_1=	5	ft
w_2=	18.625	ft
w_3=	24.3	ft
Θ_1=	26.0	deg
Θ_1=	0.454	rad

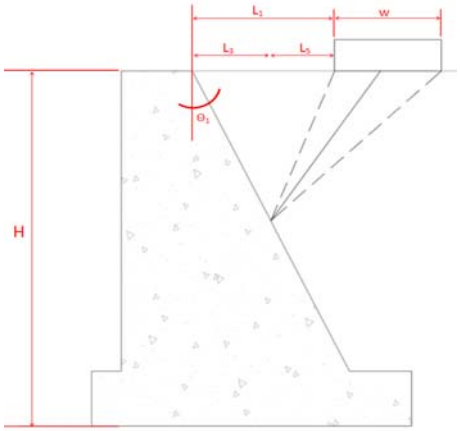
Loads

DL=	1.39	klf
LL=	94	kips
w=	5.0	ft
q=	1.29	klf/ft

Soil Properties

ø=	40.0	deg
ø=	0.698	rad
β=	0.0	deg
β=	0.0	rad
γ=	135.0	pcf
γ_w=	62.4	pcf
γ_c=	150	pcf





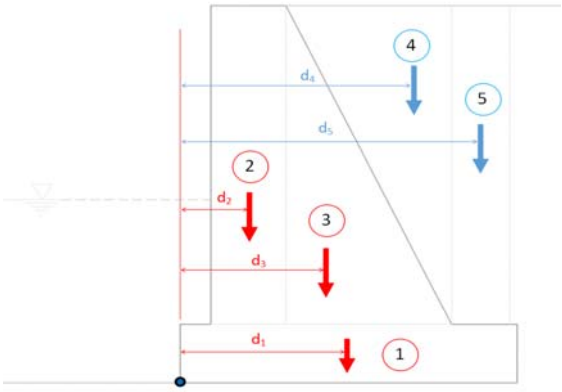
Self Weight

Concrete

1	Height=	1.75 ft	Width=	9.00 ft	
	A_1=	15.75 ft^2	W_1=	2.36 kips	
			d_1=	4.5 ft	
2	Height=	9.5 ft	Width=	2.00 ft	
	A_2=	19 ft^2	W_2=	2.85 kips	
	ToeWidth=	0.833	d_2=	1.833 ft	
3	Height=	9.5 ft	Width=	4.63 ft	
	A_3=	22.01 ft^2	W_3=	3.30 kips	
			d_3=	4.38 ft	

Soil

4	Height=	9.5 ft	Width=	4.63 ft	
	A_4=	22.01 ft^2	W_4=	2.97 kips	
			d_4=	5.92 ft	
5	Height=	9.5 ft	Width=	1.75 ft	
	A_5=	16.63 ft^2	W_5=	2.24 kips	
			d_5=	8.34 ft	



Lateral Earth Pressure (Active)

Based on Coulomb Theory. Friction on wall assumed to be 0.67*phi

$ø_w$=	26.667 deg		Z_1=	5.75 ft	
	0.465 rad		Z_2=	5.5 ft	
K_a=	0.462				

$P_{a,1}$

$P_{a,1}$=	1.030 kip	H_1=	7.42 ft	
$P_{h,1}$=	0.625 kip	V_1=	4.70 ft	
$P_{v,1}$=	0.819 kip			

$P_{a,2}$

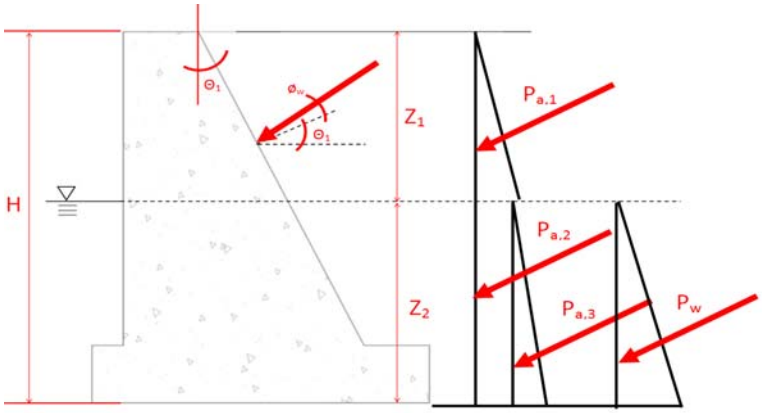
$P_{a,2}$=	1.970 kip	H_2=	2.75 ft	
$P_{h,2}$=	1.195 kip	V_2=	6.98 ft	
$P_{v,2}$=	1.567 kip			

$P_{a,3}$

$P_{a,3}$=	0.530 kip	H_3=	1.83 ft	
$P_{h,3}$=	0.321 kip	V_3=	7.43 ft	
$P_{v,3}$=	0.421 kip			

P_w

P_W=	0.9438 kip	H_w=	1.83 ft	
$P_{h,w}$=	0.848 kip	V_w=	7.43 ft	
$P_{v,w}$=	0.414 kip			

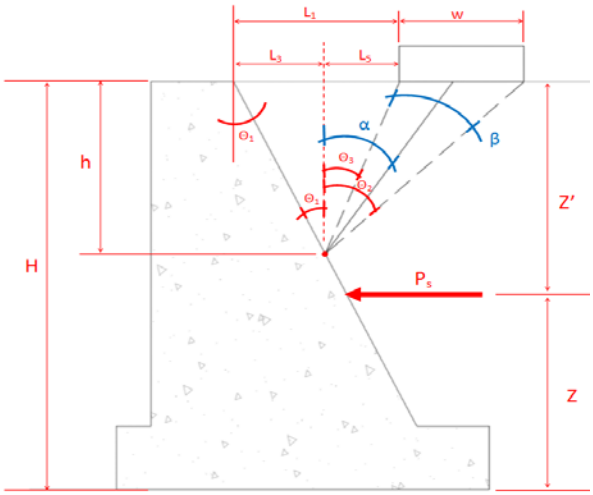


Lateral Earth Pressure (Passive)

Based on Rankine Theory.

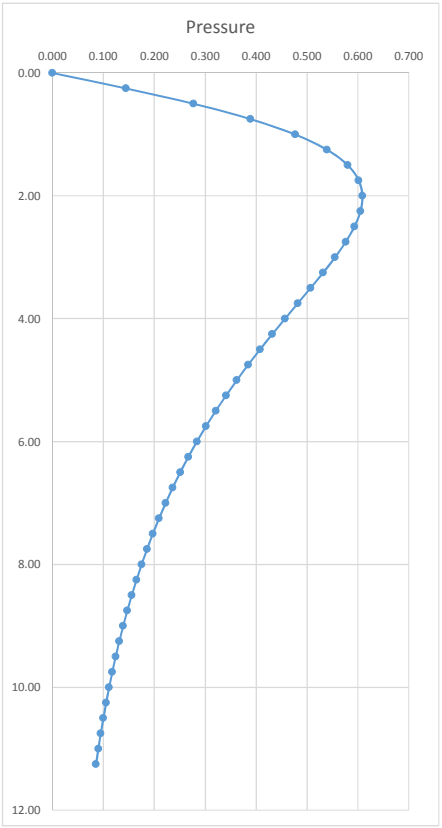
γ_1=	135.0 pcf		Kp=	2.00	
γ_2=	72.6 pcf		H3=	5.25	ft
γ_3=	100.0 pcf		Pp=	1.04	kips

Surcharge



$L_{1,eq}$=	2	ft
ΣP_i=P=	3.5	kips(per ft)
Z'=	4.3	ft
Z=	6.9	ft
M=	24.2	k-ft (per ft)

h	L_3	L_5	Θ_3	Θ_2	β	β/2	alpha	p_h	P_i	P_i*h
(ft)	ft	ft	rad	rad	rad	rad		kips/ft	kip	
0.00	0.000	2.000	1.571	1.571	0.000	0.000	1.571	0.000		
0.25	0.000	2.000	1.446	1.535	0.089	0.044	1.491	0.144	0.018	0.005
0.50	0.000	2.000	1.326	1.499	0.174	0.087	1.413	0.277	0.053	0.026
0.75	0.000	2.000	1.212	1.464	0.252	0.126	1.338	0.389	0.083	0.062
1.00	0.000	2.000	1.107	1.429	0.322	0.161	1.268	0.477	0.108	0.108
1.25	0.000	2.000	1.012	1.394	0.382	0.191	1.203	0.540	0.127	0.159
1.50	0.000	2.000	0.927	1.360	0.432	0.216	1.143	0.580	0.140	0.210
1.75	0.000	2.000	0.852	1.326	0.474	0.237	1.089	0.602	0.148	0.258
2.00	0.000	2.000	0.785	1.292	0.507	0.254	1.039	0.609	0.151	0.303
2.25	0.000	2.000	0.727	1.260	0.533	0.267	0.993	0.605	0.152	0.341
2.50	0.000	2.000	0.675	1.228	0.553	0.277	0.951	0.593	0.150	0.375
2.75	0.000	2.000	0.629	1.196	0.568	0.284	0.913	0.576	0.146	0.402
3.00	0.000	2.000	0.588	1.166	0.578	0.289	0.877	0.555	0.141	0.424
3.25	0.000	2.000	0.552	1.136	0.584	0.292	0.844	0.532	0.136	0.442
3.50	0.000	2.000	0.519	1.107	0.588	0.294	0.813	0.507	0.130	0.455
3.75	0.000	2.000	0.490	1.079	0.589	0.295	0.784	0.482	0.124	0.464
4.00	0.000	2.000	0.464	1.052	0.588	0.294	0.758	0.457	0.117	0.469
4.25	0.000	2.000	0.440	1.025	0.585	0.293	0.732	0.432	0.111	0.472
4.50	0.000	2.000	0.418	0.999	0.581	0.291	0.709	0.408	0.105	0.472
4.75	0.000	2.000	0.399	0.975	0.576	0.288	0.687	0.384	0.099	0.470
5.00	0.000	2.000	0.381	0.951	0.570	0.285	0.666	0.362	0.093	0.467
5.25	0.000	2.000	0.364	0.927	0.563	0.282	0.646	0.341	0.088	0.461
5.50	0.000	2.000	0.349	0.905	0.556	0.278	0.627	0.321	0.083	0.455
5.75	0.000	2.000	0.335	0.883	0.548	0.274	0.609	0.302	0.078	0.447
6.00	0.000	2.000	0.322	0.862	0.540	0.270	0.592	0.284	0.073	0.439
6.25	0.000	2.000	0.310	0.842	0.532	0.266	0.576	0.267	0.069	0.430
6.50	0.000	2.000	0.298	0.822	0.524	0.262	0.560	0.251	0.065	0.421
6.75	0.000	2.000	0.288	0.804	0.516	0.258	0.546	0.236	0.061	0.411
7.00	0.000	2.000	0.278	0.785	0.507	0.254	0.532	0.222	0.057	0.401
7.25	0.000	2.000	0.269	0.768	0.499	0.249	0.519	0.209	0.054	0.391
7.50	0.000	2.000	0.261	0.751	0.490	0.245	0.506	0.197	0.051	0.381
7.75	0.000	2.000	0.253	0.735	0.482	0.241	0.494	0.186	0.048	0.371
8.00	0.000	2.000	0.245	0.719	0.474	0.237	0.482	0.175	0.045	0.361
8.25	0.000	2.000	0.238	0.704	0.466	0.233	0.471	0.165	0.043	0.351
8.50	0.000	2.000	0.231	0.689	0.458	0.229	0.460	0.156	0.040	0.341
8.75	0.000	2.000	0.225	0.675	0.450	0.225	0.450	0.147	0.038	0.331
9.00	0.000	2.000	0.219	0.661	0.442	0.221	0.440	0.139	0.036	0.322
9.25	0.000	2.000	0.213	0.648	0.435	0.217	0.430	0.131	0.034	0.313
9.50	0.000	2.000	0.207	0.635	0.428	0.214	0.421	0.124	0.032	0.303
9.75	0.000	2.000	0.202	0.623	0.420	0.210	0.412	0.118	0.030	0.295
10.00	0.000	2.000	0.197	0.611	0.413	0.207	0.404	0.111	0.029	0.286
10.25	0.000	2.000	0.193	0.599	0.406	0.203	0.396	0.105	0.027	0.278
10.50	0.000	2.000	0.188	0.588	0.400	0.200	0.388	0.100	0.026	0.270
10.75	0.000	2.000	0.184	0.577	0.393	0.197	0.381	0.095	0.024	0.262
11.00	0.000	2.000	0.180	0.567	0.387	0.193	0.373	0.090	0.023	0.254
11.25	0.000	2.000	0.176	0.557	0.381	0.190	0.366	0.086	0.022	0.247



Surcharge (Horizontal Friction)

nu=	0.25	(assumed UHMW to Steel)
Ph=	1.61	kips
M=	18.10	k-ft

Overturning

Resisting

Loads	Magnitude	Arm	Moment
	kips	ft	kip-ft
Self Weight			
1	2.36	4.5	10.63
2	2.85	1.833	5.23
3	3.30	4.38	14.45
4	2.97	5.92	17.60
5	2.24	8.34	18.72

$\Sigma_{resisting}$= 66.63 kip-ft

Driving

Loads	Magnitude	Arm	Moment	
	kips	ft	kip-ft	
Lateral Earth Pressure				
$P_{h,1}$	0.625	7.42	4.63	
$P_{h,2}$	1.195	2.75	3.29	
$P_{h,3}$	0.321	1.83	0.59	
$P_{h,w}$	0.848	1.83	1.56	
$P_{v,1}$	0.819	4.70	-3.85	
$P_{v,2}$	1.567	6.98	-10.93	
$P_{v,3}$	0.421	7.43	-3.13	
$P_{v,w}$	0.414	7.43	-3.07	
Surcharge				
P_s	3.5	6.9	24.24	18.620
Surcharge (Horizontal Friction)				
PH	1.6	11.3	9.05	6.952

$\Sigma_{overturning}$= 22.4 kip-ft

$\Sigma_{overturning}$= 14.65 kip-ft (for Bearing)

Overturning Factor of Safety = Resisting/Overturning

FS= 2.98 >2.0 OK

Bearing Pressure

Eccentricity

x= 3.067 ft B= 9 ft (width of footing)

e= 1.43 ft <1.5 OK

Bearing Pressure

Q= 17.0 kips A= 9 ft^2

M_y= 24.3 kip-ft

x= 4.5 ft

I_y= 60.75 ft^4

q_{max}= 3.68 kip/ft2 q_{allow}= 12 ksf (NYC Building Code 2008)

q_{min}= 0.08 kip/ft2

Bearing Factor of Safety = Bearing Capacity/Bearing Pressure

FS= 3.26 >3.0 OK

Sliding

Resisting

μ= 0.531709

Loads	Normal	18.6ft Force	30ft Force
	kips	kips	kips
Self Weight			
1	2.36	1.26	1.26
2	2.85	1.52	1.52
3	3.30	1.76	1.76
4	2.97	1.58	1.58
5	2.24	1.19	1.19
	Total	**7.3**	**7.3**
Lateral Earth Pressure(Active)			
$P_{v,1}$	0.819	0.44	0.27
$P_{v,2}$	1.567	0.83	0.52
$P_{v,3}$	0.421	0.22	0.14
$P_{v,w}$	0.414	0.22	0.14
	Total	**1.7**	**1.1**
Lateral Earth Pressure (Passive)			
Pp=	1.04		

Total Resisting 10.0 kips (18.6 ft)

9.4 kips (30 ft)

Driving

Loads	18.6ft Magnitude	30ft Magnitude
	kips	kips
Lateral Earth Pressure		
$P_{h,1}$	0.625	0.39
$P_{h,2}$	1.195	0.74
$P_{h,3}$	0.321	0.20
$P_{h,w}$	0.848	0.53
Surcharge		
P_s	3.5	2.18
Surcharge (Horizontal Friction)		
P_h	1.6	1.00

Total Resisting 8.1 kips (18.6 ft)

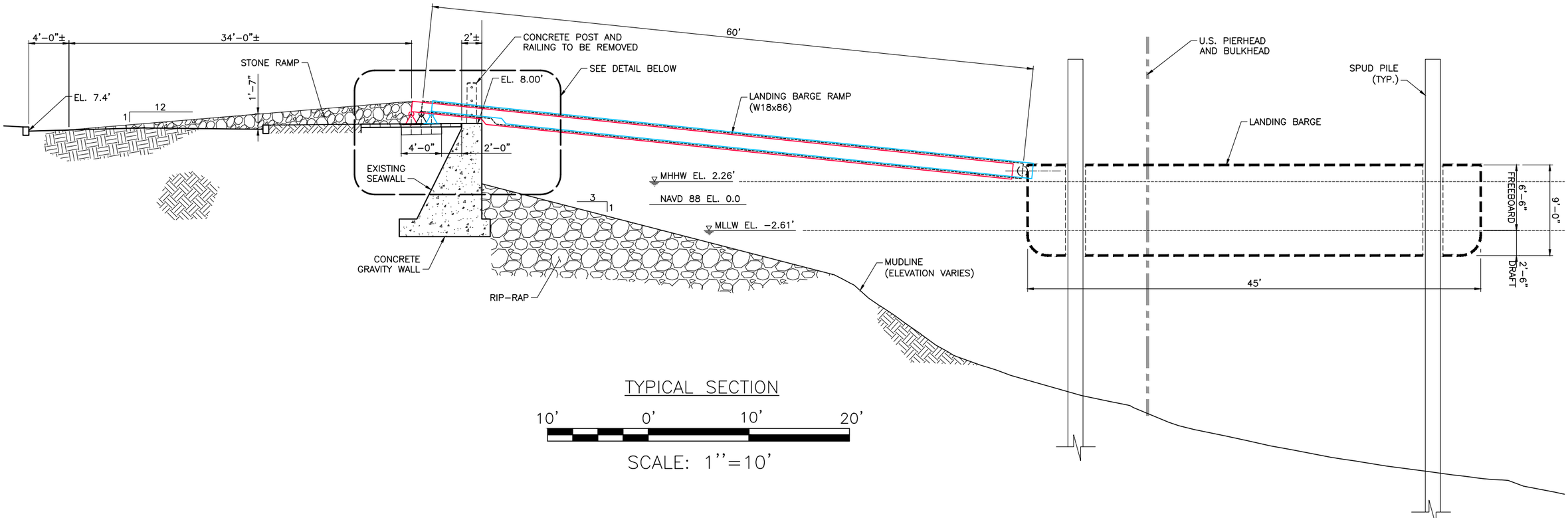
5.0 kips (30 ft)

Sliding Factor of Safety = Resisting/Driving (Over 18.6ft)

FS= 1.240 <1.5 NG

Sliding Factor of Safety = Resisting/Driving (Over 30ft)

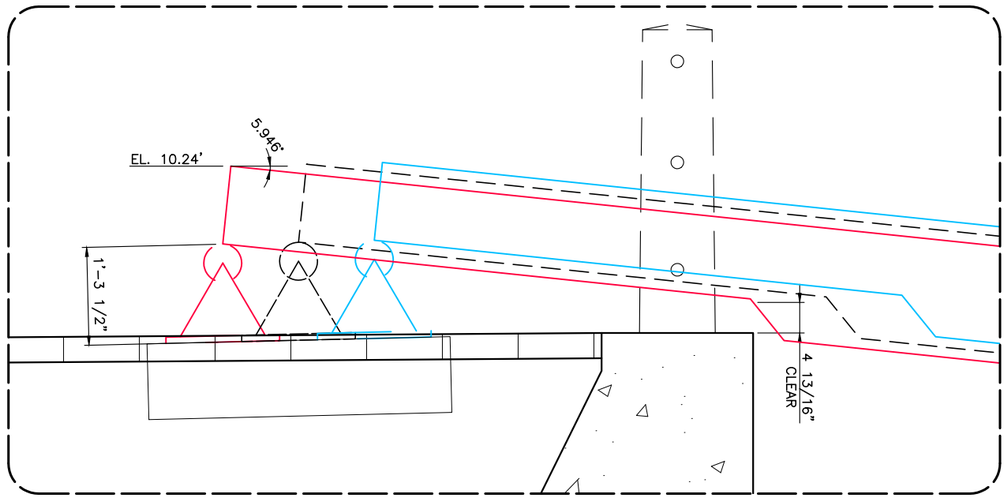
FS= 1.868 >1.5 OK

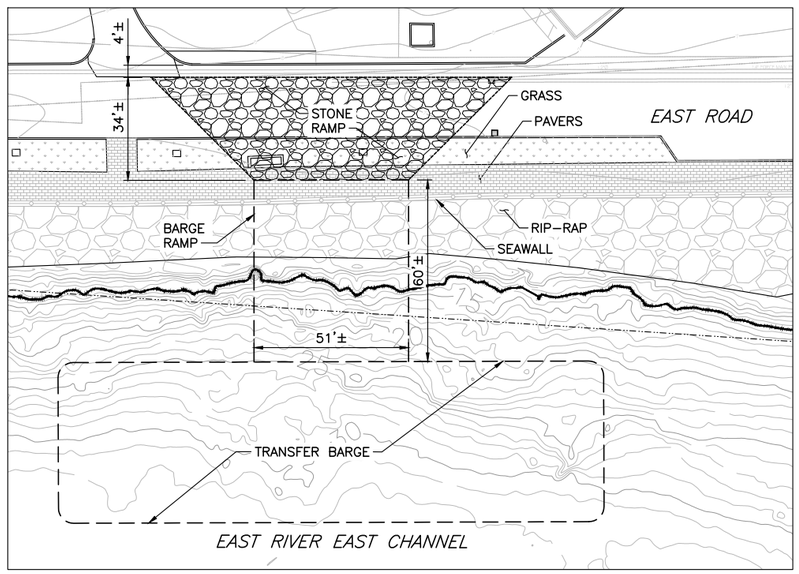


TYPICAL SECTION

10' 0' 10' 20'

SCALE: 1''=10'





RAMP PLAN

50' 0' 50' 100'

SCALE: 1''=50'

moffatt & nichol

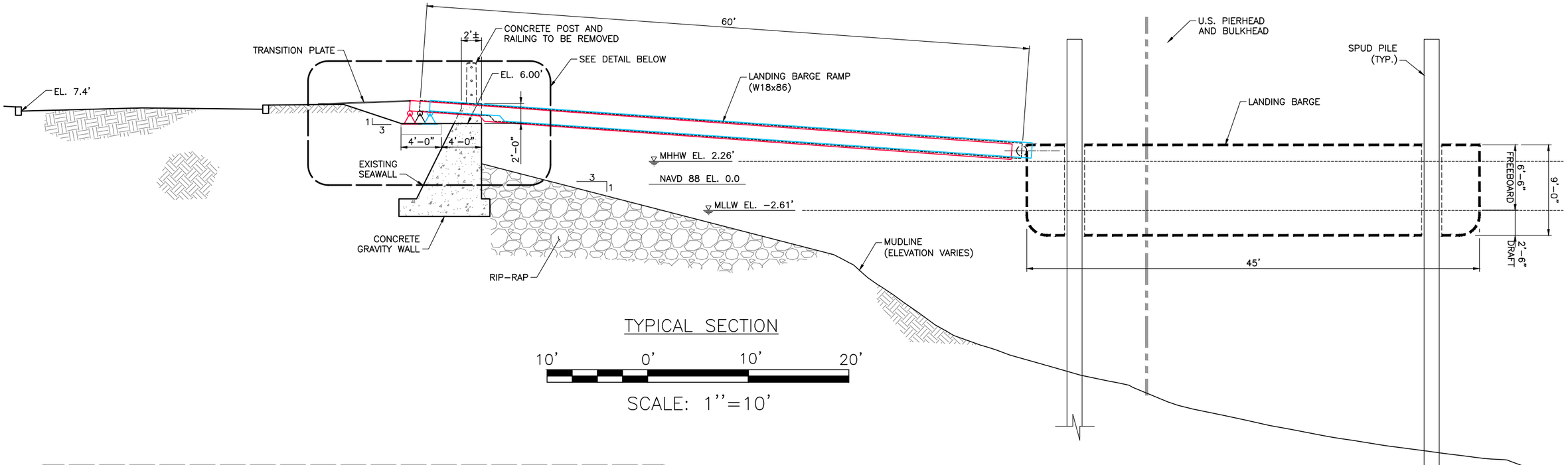
NOTES:

1. HYDROGRAPHIC SURVEY PROVIDED BY ROGERS SURVEYING, PLLC DATED 02/19/13.
2. SOUNDINGS AND/OR ELEVATIONS REFER TO NAVD 88.

CORNELL TECH CAMPUS
ROOSEVELT ISLAND, NY

MARINE TRANSFER FACILITY TYPICAL SECTION

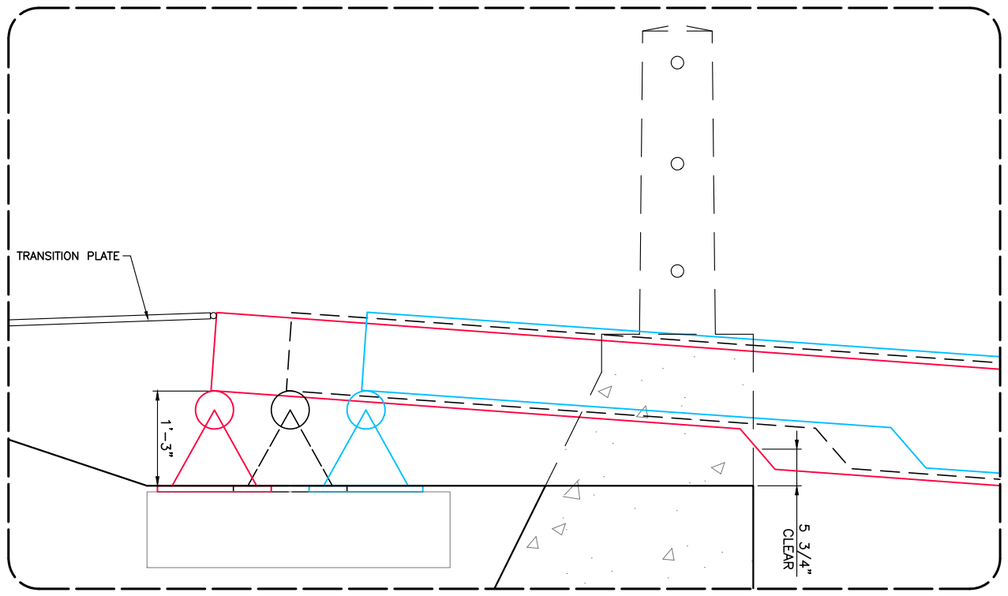
FIG. 5

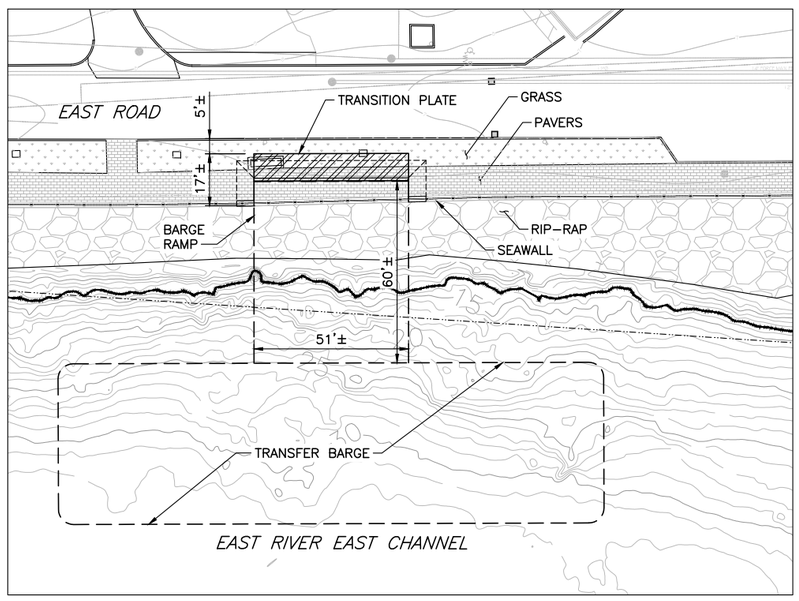


TYPICAL SECTION

10' 0' 10' 20'

SCALE: 1''=10'





RAMP PLAN

50' 0' 50' 100'

SCALE: 1''=50'

moffatt & nichol

NOTES:

1. HYDROGRAPHIC SURVEY PROVIDED BY ROGERS SURVEYING, PLLC DATED 02/19/13.
2. SOUNDINGS AND/OR ELEVATIONS REFER TO NAVD 88.

CORNELL TECH CAMPUS
ROOSEVELT ISLAND, NY

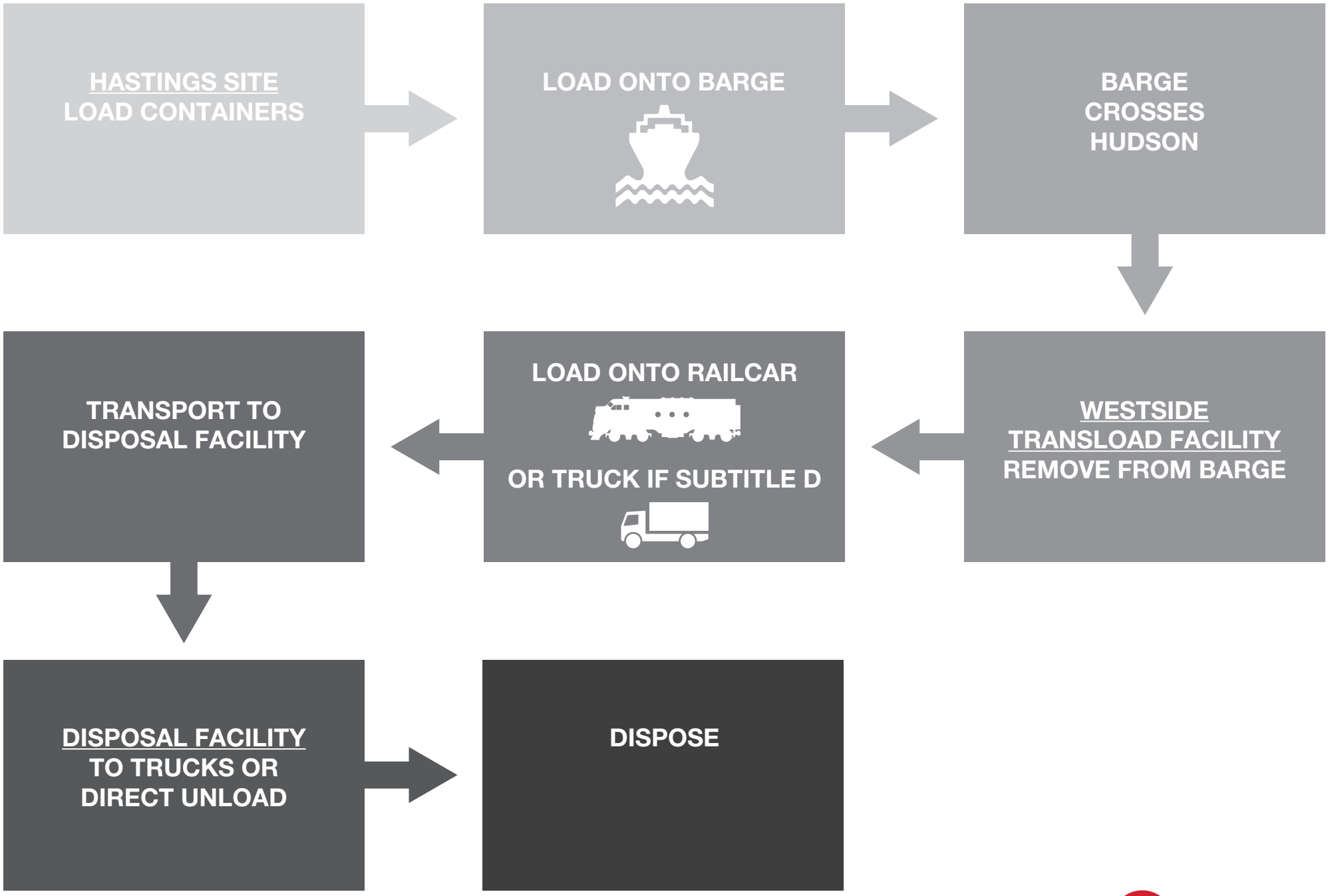
MARINE TRANSFER FACILITY
TYPICAL SECTION

FIG. 6

ATTACHMENT F
BASELINE FLOW OF EXPORT MATERIALS

Envirocon

BASELINE FLOW OF IMPACTED SOIL / DREDGE MATERIALS EXPORT



Envirocon

ATTACHMENT G
WASTE CONTAINER PHOTOS

Envirocon

WASTE CONTAINER PHOTOS



NYC waste containers barge

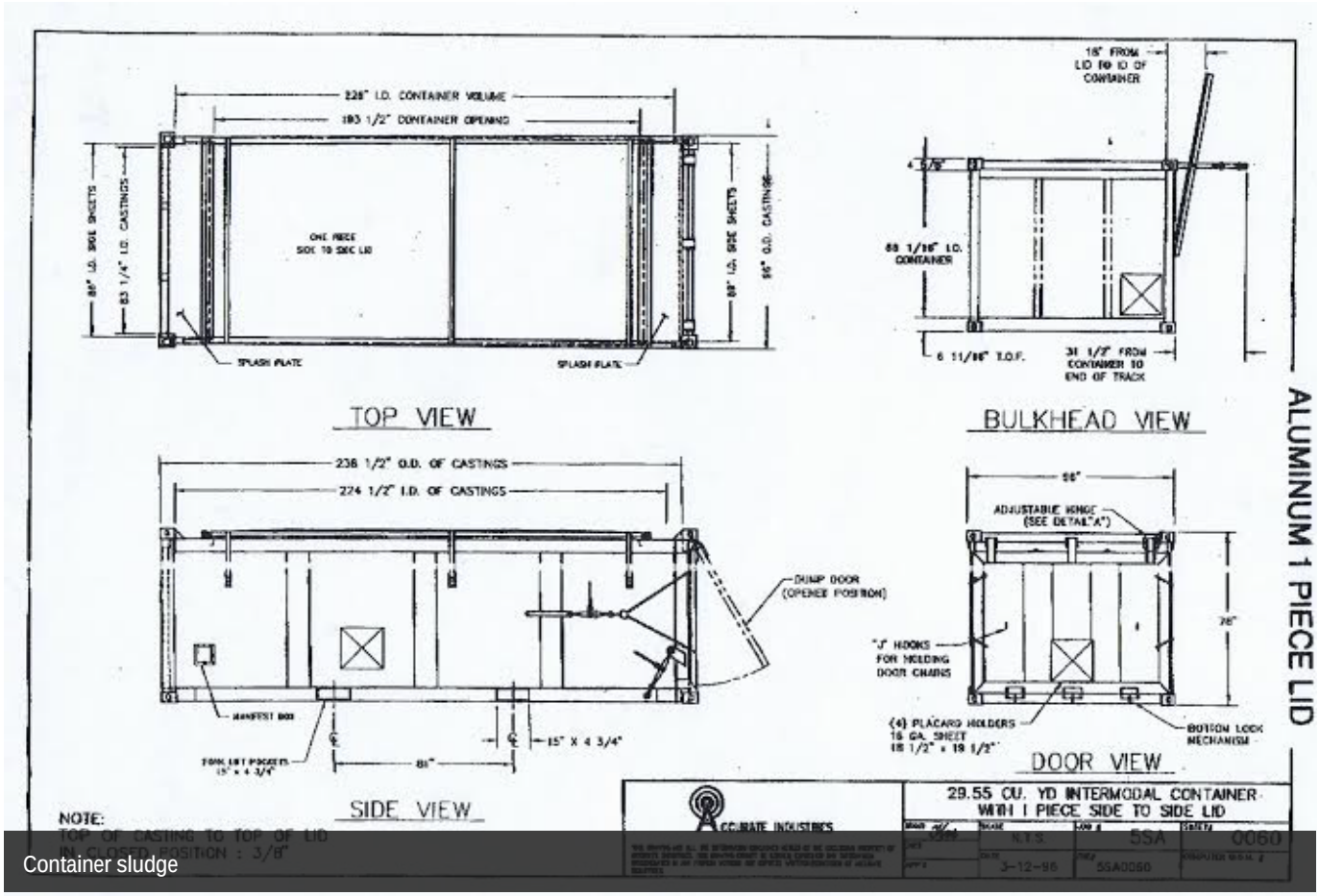


Containers on flat car





HH Bulker 6



Container sludge

APPENDIX E

Cost Estimate

Preliminary Design Cost Estimate - OU1
Harbor at Hastings Site (Former Anaconda Wire Cable Plant Site)
Hastings-On-Hudson, New York
Atlantic Richfield Company

NO.	ITEM	ESTIMATED QUANTITY	UNIT (EA, LF, LS)	UNIT PRICE	OU-1 ESTIMATED COST
General Site-Wide					
1	GC Indirect Cost	1	LS	$4,786,000	$4,786,000
2	Site Security	1	LS	$1,660,000	$1,660,000
3	Health & Safety	1	LS	$1,587,000	$1,587,000
4	Housekeeping	1	LS	$2,724,000	$2,724,000
5	Site Prep	1	LS	$1,234,000	$1,234,000
6	Water Treatment	1	LS	$1,000,000	$1,000,000
7	Mobilization/Demobilization	1	LS	$2,663,000	$2,663,000
8	Survey	1	LS	$941,000	$941,000
9	Stormwater& Erosion Control	1	LS	$918,000	$918,000
10	**Clearing**	1	LS	$372,000	$372,000
11	**Demo**	1	LS	$973,000	$973,000
12	**Building 52 Stabilization (N/A, Building 52 Demo Complete)**	0	LS	$0	$0
13	**Utility Relocation and Installation**	1	LS	$2,334,000	$2,334,000
OU-1 On-Shore Earthwork					
14	SOE For Upland Excavation	1	LS	$8,012,000	$8,012,000
15	Upland Excavation	1	LS	$9,805,000	$9,805,000
16	Backfill Excavation Cells to Original Grade	1	LS	$5,184,000	$5,184,000
17	Cut/Fill for Slopeback (Sloped Shoreline)	1	LS	$1,001,000	$1,001,000
18	Material Handling	1	LS	$34,326,000	$34,326,000
19	Sheeting for South Property	1	LS	$910,000	$910,000
20	**Instrumentation**	1	LS	$201,000	$201,000
CAP/Cover					
21	On-Shore (North)	1	LS	$6,833,000	$6,833,000
22	On-Shore (South)	1	LS	$6,996,000	$6,996,000
23	Slopeback Armor	1	LS	$1,732,000	$1,732,000
24	DNAPL Extraction System	1	LS	$2,000,000	$2,000,000
25	**Groundwater Treatment**	1	LS	$400,000	$400,000
	Subtotal Installation Costs				$98,592,000
	Const. Monitoring/Quality Assurance				$7,693,000
	Contractor Fee	10%			$9,859,000
	Contingency	30%			$34,843,000
	Total Installation Cost				$150,987,000

Preliminary Design Cost Estimate - OU1
Harbor at Hastings Site (Former Anaconda Wire Cable Plant Site)
Hastings-On-Hudson, New York
Atlantic Richfield Company

Preliminary Design						
26	Pre-design Investigation and Pilot Tests		1	LS	$1,500,000	$1,500,000
27	Engineering and Design		1	LS	$1,560,000	$1,560,000
	Contingency	30%				$920,000
	Total PDI & Design					$3,980,000

Estimated Annual O&M and Monitoring Costs						
28	Armor Stone		1	LS	$42,000	$42,000
29	Cover & Site Maintenance		1	LS	$15,000	$15,000
30	Groundwater Treatment		1	LS	$64,000	$64,000
31	DNAPL Extraction System		1	LS	$108,000	$108,000
32	Cathodic Protection Energy Costs		1	LS	$2,000	$2,000
33	SMP & Reporting		1	LS	$40,000	$40,000
	Subtotal O&M (Yearly)					$271,000
	Subtotal O&M Costs: (30 Yr NPV)					$5,860,000
	Contingency	**30%**				$1,840,000
	Total O&M and Monitoring					$7,971,000

Total Project Cost						
	Grand Total Project Costs					$162,938,000

Note:
1. All unit costs shown in the cost estimate were obtained from Haley & Aldrich's 2011 Feasibility Study - Appendix N.

Preliminary Design Cost Estimate - OU2
Harbor at Hastings Site (Former Anaconda Wire Cable Plant Site)
Hastings-On-Hudson, New York
Atlantic Richfield Company

NO.	ITEM	ESTIMATED QUANTITY	UNIT (EA, LF, LS)	UNIT PRICE	ESTIMATED COST
General Site-Wide					
1	GC Indirect Cost	1	LS	$4,579,000.00	$4,579,000.00
2	Site Security	1	LS	$1,179,000.00	$1,179,000.00
3	Health & Safety	1	LS	$1,112,000.00	$1,112,000.00
4	Housekeeping	1	LS	$1,816,000.00	$1,816,000.00
5	Site Prep	1	LS	$1,624,000.00	$1,624,000.00
6	Water Treatment	1	LS	$1,064,000.00	$1,064,000.00
7	Mobilization/Demobilization	1	LS	$879,000.00	$879,000.00
General OU-2					
8	Bathymetry Survey	1	EA	$7,000.00	$7,000.00
9	Pile Removal	1	LS	$466,000.00	$466,000.00
10	Nearshore/Backwater Turbidity Control	1	LS	$1,593,000.00	$1,593,000.00
11	Habitat Enhancement - Allowance	1	LS	$250,000.00	$250,000.00
12	Material Handling for Pile Removal	1	LS	$459,000.00	$459,000.00
Backwater Area					
13	Dredge	6,000	CY	$128.83	$773,000.00
14	Backfill	--	CY	--	--
15	Cap	6,000	CY	$164.83	$989,000.00
16	Temporary Sheeting	--	LF	--	--
17	Material Handling	1	LS	$1,842,000	$1,842,000.00
Nearshore Area					
18	Dredge	33,200	CY	$128.83	$4,277,000.00
19	Backfill	0	CY	$128.83	$0.00
20	Cap	27,400	CY	$164.83	$4,516,000.00
21	Material Handling	1	LS	$4,019,000.00	$4,019,000.00
Deepwater Area					
22	Dredge	8,400	CY	$197.00	$1,655,000.00
23	Backfill	6,000	CY	$233.00	$1,398,000.00
24	Cap	0	CY	$164.83	$0.00
25	Material Handling	1	LS	$3,217,000.00	$3,217,000.00
Northwest Area					
26	Dredge	0	LS	$41,000.00	$0.00
27	Cap	--	CY	--	--
28	Backfill (Armor or Lightweight Fill)	24,000	CY	$3,864,000.00	$3,864,000.00
29	Sheeting and Turbidity Control	1	LS	$10,258,000.00	$10,258,000.00
30	Material Handling	1	LS	$93,000.00	$93,000.00
31	Modifications for Seismic Load - Allowance	67,244	SF	$21.09	$1,418,000.00
32	Mitigation - Allowance	1	LS	$1,202,000.00	$1,202,000.00
OU-2 Dependent Costs - Allowances					
33	GW Control (Additional Cost for Slopeback Construction)	--	LS	--	--
34	Potential DNAPL System (Additional Cost for Slopeback Construction)	--	LS	--	--

Subtotal Installation Costs		$54,549,000.00
Const. Monitoring/Quality Assurance		$5,212,000.00
Contractor Fee	10%	$5,455,000.00
NPV of Capital Costs Discount		--
Contingency	30%	$19,565,000.00
Total Installation Cost		$84,781,000.00

Preliminary Design Cost Estimate - OU2
Harbor at Hastings Site (Former Anaconda Wire Cable Plant Site)
Hastings-On-Hudson, New York
Atlantic Richfield Company

Preliminary Design						
35	Pre-design Investigation and Pilot Tests		1	LS	$5,110,000.00	$5,110,000.00
36	Engineering and Design		1	LS	$2,600,000.00	$2,600,000.00
	Contingency	30%				$2,310,000.00
	Total PDI & Design					$10,020,000.00

Estimated Annual O&M and Monitoring Costs						
37	Armor Stone		0	LS	$15,000.00	$0.00
38	Habitat Enhancement		1	LS	$12,000.00	$12,000.00
39	Cathodic Protection and Energy Costs		1	LS	$21,000.00	$21,000.00
40	Offshore Monitoring and Maintenance		1	LS	$270,000.00	$270,000.00
41	Bulkhead		1	LS	$46,000.00	$46,000.00
	Subtotal O&M (Yearly)					$349,000.00
	Subtotal O&M Costs: (30 Yr NPV)					$7,550,000.00
	Contingency	**30%**				$2,370,000.00
	Total O&M and Monitoring					$9,920,000.00

Total Project Cost						
	Grand Total Project Costs					$104,721,000.00

Notes:
1. Backwater area includes costs for the Old Marina and Kinnally Cove
2. Nearshore Area includes costs for the North Boat Slip, South Boat Slip and all Nearshore Areas south of the Northwest Extension Area.
3. All unit costs shown in the cost estimate were obtained from Haley & Aldrich's 2011 Feasibility Study - Appendix M.

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