# APPENDIX D ENGINEERING EVALUATION

# EE Memo 1 Storm Water Storage Demand

**MEMORANDUM**

| | |
|---|---|
| **Date:** | January 14, 2022 |
| **To:** | Office |
| **From:** | Fred T. Falcone, and Adam M. Dyer |
| **Re:** | EE Memo 1 - Storm Water Storage Demand |
| **File:** | Area 1, Phase 2, Parcel 3, Baltimore, MD<br>File # 13921 |

This memorandum summarizes analyses of storm water management for exposed areas of the Multimedia Cap (MMC) as a result of foundation excavation. Four storm scenarios were examined: a one day long 25-year storm, a two day long 25-year storm, a one day long 100-year storm, and a two day 100-year storm. Two 50 foot x 50 foot x 4 foot ModuTanks were selected for storm water storage at the site. The maximum excavation area that could remain open during each of the four storm scenarios was examined for the given storage volume. The pumping rate required for an assumed excavation area for a one hour long 100-year storm was also computed.

## EXHIBITS

| | |
|---|---|
| Figure 1 | Rainfall Intensity Data from NOAA |
| Attachment A (EE Memo 1) | Required Storage and Pumping Rates Calculations and Sketch |
| Attachment B (EE Memo 1) | Containment Berm Design |
| Attachment C (EE Memo 1) | Pile Driving Displacement Calculations |

## AVAILABLE INFORMATION

1. Drawing FO.102 — Load Limitations Plan
2. Drawing FO.108 — Geomembrane Penetrations Plan

## REFERENCES


1. "National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server at "hdsc.nws.noaa.gov/" accessed on November 12, 2013. Data from NOAA Atlas 14, Volume 2 (2006).
2. "Urban Hydrology for Small Watersheds TR-55", United States Department of Agriculture, Natural Resources Conservation Service (1986).


## DESIGN RAIN EVENTS

Figure 1 of the attached displays data for various storm events and durations at the National Weather Service Baltimore WSO City weather station.

1. A 25-year storm has an accumulation of 6.21 in of precipitation over 24 hours, and
2. A 100-year storm has an accumulation of 8.57 inches of precipitation over 24 hours.

Conservatively, for storm scenarios lasting two days, the amount of precipitation was doubled. The critical rainfall intensity is 2.47 inches per hour (in/hr) and 3.07 in/hr. for a 25-year and 100-year frequency storm events, respectively. The critical intensity occurs for a 1-hour duration. The required pumping rates were determined based on the 100-year rainfall intensity.

## PROPOSED STORMWATER MANAGEMENT SYSTEM

When a storm occurs, rain falling directly into an excavation, bounded by the diversion berm at the top of the excavation slope, will come in contact with soil below the MMC if the excavation subgrade is not covered by Geomembrane. Rain falling outside of the diversion berm will be diverted away from the excavation slope to run off. Infiltration through the MMC Cover Soil to the underlying Drainage Net will not be collected in the excavation because the Drainage Net is dammed at the perimeter of each excavation with Geomembrane dams.

Excavation subgrades will be sloped to a low point, where a pump may be placed to control storm water rise to the capillary break gravel at the down-slope side of the excavation, so that collected water will not exit the excavation through the capillary break gravel layer. Water collected will be pumped to open-top storage tanks where it will be held, sampled, and tested before disposal. Contact and non-contact water testing and disposal procedures are described in the Material Handling and Management Plan.

## DESIGN ASSUMPTIONS

A construction scenario was estimated for the purpose of the storage volume design selection. The design scenario assumed 7,250 square feet (sf) of excavation is open at one time. The volume of water collected in the excavations and the volume of direct catchment was computed for each storm event. Direct catchment is defined as rain falling directly into the storage tank. The critical rainfall intensity of the 100-year event (3.07 in/hr, illustrated on Figure No. 1) was applied to the assumed open excavation area to compute the design pumping rate.

The available space on site allows for two 50 foot x 50 foot x 4 foot high Mod-U-Tank structures surrounded by an asphalt lined spill containment structure which can contain the volume of one Mod-U-Tank.

### Available storage from two 50 foot x 50 foot x 4 foot Mod-U-Tanks

Each tank has an empty capacity of 10,000 cubic feet (cf), assuming it will be filled to a depth of 4 feet. Two tanks have a combined empty capacity of 20,000 cf. The area of a single tank is 2,500 sf, and combined area of the two tanks is 5,000 sf.

### Assumed open excavation area

The open excavation area is based on grouping excavations into “excavation segments”, with roughly 20 to 40 piles in each segment. The assumed open area of 7,250 sf allows for three sets of excavation segments depicted on Drawing FO.108 in separate stages to be open below the Geomembrane at one time.

### Tank Storage and Freeboard Estimates

The quantity of collected and direct catchment rainfall and the tank freeboard estimates are provided in Attachment A (EE Memo 1) and summarized below:

*One day long 25-year storm*

The total precipitation in a one day long 25-year storm is 6.21 inches. The open excavation area of 7,250 sf generates an impacted water volume of 3,752 cf. Direct catchment in one ModuTank (area of 2,500 sf) is a volume of 1,294 cf. The total volume of water to be stored in one tank is 5,046 cf. The tank has 4,954 cf capacity unused, which when distributed over the 50 foot x 50 foot area of the tank represents a freeboard of 2.0 feet.

*Two day long 25-year storm*

The two-day long 25-year storm collects twice the volume of a one-day storm, except that the tank filled on day one (above) has an additional direct catchment of 1,294 cf, which reduces the freeboard in the first tank to 1.5 feet. The second tank is drained of direct catchment during day one, so that on the second day of the storm the second tank storage and freeboard are the same as the one-day storm (above). The design assumes testing of Tank 1 after day 1 allows disposal of Tank 1 to provide storage for potential day 3 rainfall.

To summarize, for or an assumed open excavation area of 7,250 sf and two 50 foot x 50 foot x 4 foot storage tanks the freeboard for a 25-year storm is:

| End of Day | Tank | Direct Catchment (cf) | Contact (cf) | Total (cf) | Remaining Vol. (cf) | Freeboard (ft) |
|---|---|---|---|---|---|---|
| 1 | 1 | 1,294 | 3,752 | 5,046 | 4,954 | 2.0 |
| 1 | 2 | 0 | 0 | 0 | 10,000 | 4.0 |
| 2 | 1 | 1,294 | 0 | 1,294 | 3,661 | 1.5 |
| 2 | 2 | 1,294 | 3,752 | 5,046 | 4,954 | 2.0 |

*One day long 100-year storm*

The total precipitation in a one day long 100-year storm is 8.57 inches. The open excavation area of 7,250 sf. generates an impacted water volume of 5,178 cf. Direct catchment in one Mod-U-Tank (area of 2,500 sf) is a volume of 1,785 cf. The total volume of water to be stored in one tank is 6,963 cf. The tank has 3,037 cf capacity unused, which when distributed over the 50 foot x 50 foot area of the tank represents a freeboard of 1.2 feet.

*Two day long 100-year storm*

The two-day long 100-year storm collects twice the volume of a one-day storm, except that the tank filled on day one (above) has an additional direct catchment of 1,785 cf which reduces the freeboard in the first tank to 0.5 feet. The second tank is drained of direct catchment during day one, so that on the second day of the storm the second tank storage and freeboard are the same as the one-day storm (above). The design assumes testing of Tank 1 after day 1 allows disposal of Tank 1 to provide storage for potential day 3 rainfall.

To summarize, for or an assumed open excavation area of 7,250 sf and two 50 foot x 50 foot x 4 foot storage tanks the freeboard for a 100-year storm is:

| End of Day | Tank | Direct Catchment (cf) | Contact (cf) | Total (cf) | Remaining Vol. (cf) | Freeboard (ft) |
|---|---|---|---|---|---|---|
| 1 | 1 | 1,785 | 5,178 | 6,963 | 3,037 | 1.2 |
| 1 | 2 | 0 | 0 | 0 | 10,000 | 4.0 |
| 2 | 1 | 1,785 | 0 | 1,785 | 1,251 | 0.5 |
| 2 | 2 | 1,785 | 5,178 | 6,963 | 3,037 | 1.2 |

Considering that 17.14 inches of rainfall will fall over the site, the maximum amount of open excavation area during a two day 100-year storm is 7,250 sf, which allows excavation to progress in segments as described in the Detailed Development Plan.

### Required pumping rate for assumed excavation area

Using the assumed open excavation area of 7,250 sf and the 100-year 1-hour rainfall intensity of 3.07 in/hr, the required pumping rate is 231 gallons per minute (gpm). The total required pumping rate must be accommodated by individual pumps in each open excavation, with pumps sized to the individual excavation under management. Pumping rates assume there is no infiltration to the ground at pile cap subgrade. Infiltration to the ground will be collected by the HMS system after some time lag to account for groundwater flow to the piezometer and pump locations. Deployment of pumps in each excavation is intended to minimize the amount of infiltration to prevent overstress of the existing HMS.

### Containment berm and platform design

An asphalt lined tank platform with perimeter asphalt containment berm was designed to contain the volume of one failed 50 foot x 50 foot x 4 foot storage tank, and direct rainfall catchment in the contained area, without storage on the footprint of the second storage tank. After tank failure, the footprint of the failed tank contains water at the depth of the contained pool outside of the tank. The total volume that the containment berm and platform will need to hold is the volume of one ModuTank, or 10,000 cf, and the volume of rain water falling into the containment berm during a 100-year storm event. A 140 foot x 80 foot x 26 inch containment will house two tanks and contain the volume of one failed tank and direct catchment with 4 inches of freeboard. Calculations are provided in Attachment B (EE Memo 1).

## VOLUME DISPLACED BY PILE DRIVING

Pile driving will cause an internal rise of the groundwater table within Area 1 due to the volume of displacement below the groundwater table as the piles are driven. For the estimated pile tip elevations shown on Drawing FO.102, a total displaced volume of approximately 31,000 cf can be expected, resulting in a pumping demand increase of approximately 231,000 gallons. Accounting for a 5 to 10% contingency, we recommend pre-pumping a volume of approximately 250,000 gallons. Calculations are provided in Attachment C (EE Memo 1).

## DISCUSSION

Large storm events can be identified before they occur, such that preparations can be made to manage storm water. Geomembrane may be closed and sealed, or temporary Geomebrane liners (minimum 40mil LLDPE) can be placed and extrusion welded to existing Geomembrane to prevent contact of water with the underlying soil and to prevent flood discharge to the capillary break gravel layer at the excavation perimeter. Because water collected is potentially impacted by contact with the bottom of the excavation, conveyance pipes must be double walled from the pump location to the storage tanks. Leakage water collected in the containment pipe should discharge at the pump location where it can be collected and removed for discharge to the storage tank.

Figure 1
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**NOAA Atlas 14, Volume 2, Version 3 BALTIMORE WSO CITY**
**Station ID: 18-0470**
**Location name: Baltimore, Maryland, USA***
**Latitude: 39.2833°, Longitude: -76.6167°**
**Elevation:**
**Elevation (station metadata): 14 ft****
* source: ESRI Maps
** source: USGS

## POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.345 (0.313-0.381) | 0.414 (0.374-0.456) | 0.492 (0.445-0.543) | 0.549 (0.495-0.606) | 0.620 (0.556-0.685) | 0.673 (0.600-0.744) | 0.724 (0.643-0.804) | 0.774 (0.682-0.861) | 0.835 (0.729-0.935) | 0.883 (0.765-0.994) |
| 10-min | 0.551 (0.499-0.608) | 0.661 (0.598-0.729) | 0.788 (0.712-0.870) | 0.878 (0.791-0.969) | 0.988 (0.886-1.09) | 1.07 (0.956-1.19) | 1.15 (1.02-1.28) | 1.23 (1.08-1.37) | 1.32 (1.15-1.48) | 1.39 (1.20-1.57) |
| 15-min | 0.689 (0.624-0.760) | 0.831 (0.752-0.917) | 0.996 (0.901-1.10) | 1.11 (1.00-1.23) | 1.25 (1.12-1.38) | 1.36 (1.21-1.50) | 1.46 (1.29-1.61) | 1.55 (1.37-1.72) | 1.66 (1.45-1.86) | 1.75 (1.51-1.96) |
| 30-min | 0.945 (0.856-1.04) | 1.15 (1.04-1.27) | 1.42 (1.28-1.56) | 1.61 (1.45-1.78) | 1.86 (1.66-2.05) | 2.04 (1.82-2.26) | 2.23 (1.98-2.47) | 2.41 (2.13-2.68) | 2.65 (2.31-2.96) | 2.83 (2.45-3.18) |
| 60-min | 1.18 (1.07-1.30) | 1.44 (1.30-1.59) | 1.82 (1.64-2.00) | 2.10 (1.89-2.31) | 2.47 (2.21-2.73) | 2.77 (2.47-3.06) | 3.07 (2.72-3.41) | 3.38 (2.98-3.76) | 3.80 (3.31-4.25) | 4.13 (3.57-4.64) |
| 2-hr | 1.41 (1.27-1.56) | 1.72 (1.56-1.90) | 2.18 (1.97-2.41) | 2.53 (2.28-2.80) | 3.03 (2.71-3.34) | 3.43 (3.05-3.80) | 3.86 (3.40-4.28) | 4.30 (3.77-4.79) | 4.93 (4.27-5.53) | 5.44 (4.66-6.13) |
| 3-hr | 1.52 (1.38-1.70) | 1.85 (1.67-2.06) | 2.35 (2.12-2.61) | 2.75 (2.46-3.05) | 3.30 (2.94-3.66) | 3.76 (3.33-4.18) | 4.25 (3.74-4.73) | 4.77 (4.15-5.33) | 5.51 (4.72-6.19) | 6.12 (5.18-6.92) |
| 6-hr | 1.89 (1.72-2.09) | 2.29 (2.08-2.53) | 2.90 (2.62-3.20) | 3.39 (3.06-3.75) | 4.13 (3.69-4.56) | 4.75 (4.21-5.25) | 5.43 (4.76-6.02) | 6.17 (5.34-6.86) | 7.26 (6.18-8.13) | 8.18 (6.86-9.22) |
| 12-hr | 2.31 (2.09-2.59) | 2.80 (2.53-3.13) | 3.56 (3.20-3.98) | 4.22 (3.77-4.71) | 5.21 (4.61-5.82) | 6.09 (5.33-6.79) | 7.07 (6.11-7.91) | 8.16 (6.95-9.16) | 9.84 (8.17-11.1) | 11.3 (9.20-12.8) |
| 24-hr | 2.67 (2.46-2.93) | 3.23 (2.98-3.54) | 4.15 (3.82-4.55) | 4.96 (4.55-5.43) | 6.21 (5.64-6.76) | 7.32 (6.60-7.93) | 8.57 (7.65-9.25) | 9.99 (8.81-10.8) | 12.2 (10.6-13.1) | 14.1 (12.1-15.1) |
| 2-day | 3.09 (2.85-3.37) | 3.74 (3.45-4.08) | 4.80 (4.42-5.24) | 5.71 (5.23-6.22) | 7.08 (6.45-7.69) | 8.27 (7.49-8.97) | 9.60 (8.62-10.4) | 11.1 (9.86-12.0) | 13.3 (11.7-14.4) | 15.3 (13.2-16.5) |
| 3-day | 3.26 (3.00-3.55) | 3.94 (3.63-4.30) | 5.04 (4.65-5.51) | 6.00 (5.50-6.53) | 7.43 (6.77-8.06) | 8.67 (7.85-9.40) | 10.1 (9.03-10.9) | 11.6 (10.3-12.5) | 13.9 (12.2-15.1) | 15.9 (13.8-17.2) |
| 4-day | 3.42 (3.16-3.74) | 4.14 (3.82-4.52) | 5.29 (4.88-5.77) | 6.28 (5.77-6.84) | 7.77 (7.09-8.44) | 9.07 (8.22-9.83) | 10.5 (9.44-11.4) | 12.1 (10.8-13.1) | 14.5 (12.7-15.7) | 16.6 (14.3-18.0) |
| 7-day | 3.98 (3.69-4.33) | 4.80 (4.44-5.21) | 6.07 (5.60-6.59) | 7.15 (6.59-7.75) | 8.77 (8.03-9.48) | 10.2 (9.25-11.0) | 11.7 (10.6-12.6) | 13.4 (12.0-14.5) | 16.0 (14.1-17.2) | 18.1 (15.8-19.6) |
| 10-day | 4.53 (4.22-4.89) | 5.45 (5.07-5.88) | 6.80 (6.32-7.33) | 7.94 (7.36-8.54) | 9.58 (8.84-10.3) | 11.0 (10.1-11.8) | 12.5 (11.3-13.4) | 14.1 (12.7-15.1) | 16.4 (14.6-17.6) | 18.4 (16.2-19.8) |
| 20-day | 6.13 (5.76-6.53) | 7.29 (6.86-7.77) | 8.81 (8.28-9.38) | 10.0 (9.42-10.7) | 11.8 (11.0-12.5) | 13.2 (12.3-14.0) | 14.6 (13.5-15.5) | 16.1 (14.9-17.1) | 18.2 (16.6-19.4) | 19.8 (18.0-21.2) |
| 30-day | 7.57 (7.14-8.04) | 8.95 (8.45-9.51) | 10.6 (10.0-11.3) | 12.0 (11.3-12.7) | 13.9 (13.0-14.7) | 15.4 (14.4-16.3) | 16.9 (15.8-18.0) | 18.5 (17.1-19.7) | 20.6 (19.0-22.0) | 22.3 (20.4-23.8) |
| 45-day | 9.56 (9.06-10.1) | 11.3 (10.7-11.9) | 13.2 (12.5-13.9) | 14.6 (13.8-15.5) | 16.6 (15.6-17.5) | 18.0 (17.0-19.1) | 19.5 (18.3-20.6) | 20.9 (19.5-22.1) | 22.7 (21.2-24.1) | 24.1 (22.3-25.6) |
| 60-day | 11.4 (10.8-12.0) | 13.4 (12.7-14.1) | 15.5 (14.7-16.3) | 17.1 (16.2-18.0) | 19.1 (18.1-20.1) | 20.6 (19.5-21.7) | 22.1 (20.8-23.3) | 23.5 (22.0-24.7) | 25.2 (23.6-26.6) | 26.5 (24.7-28.0) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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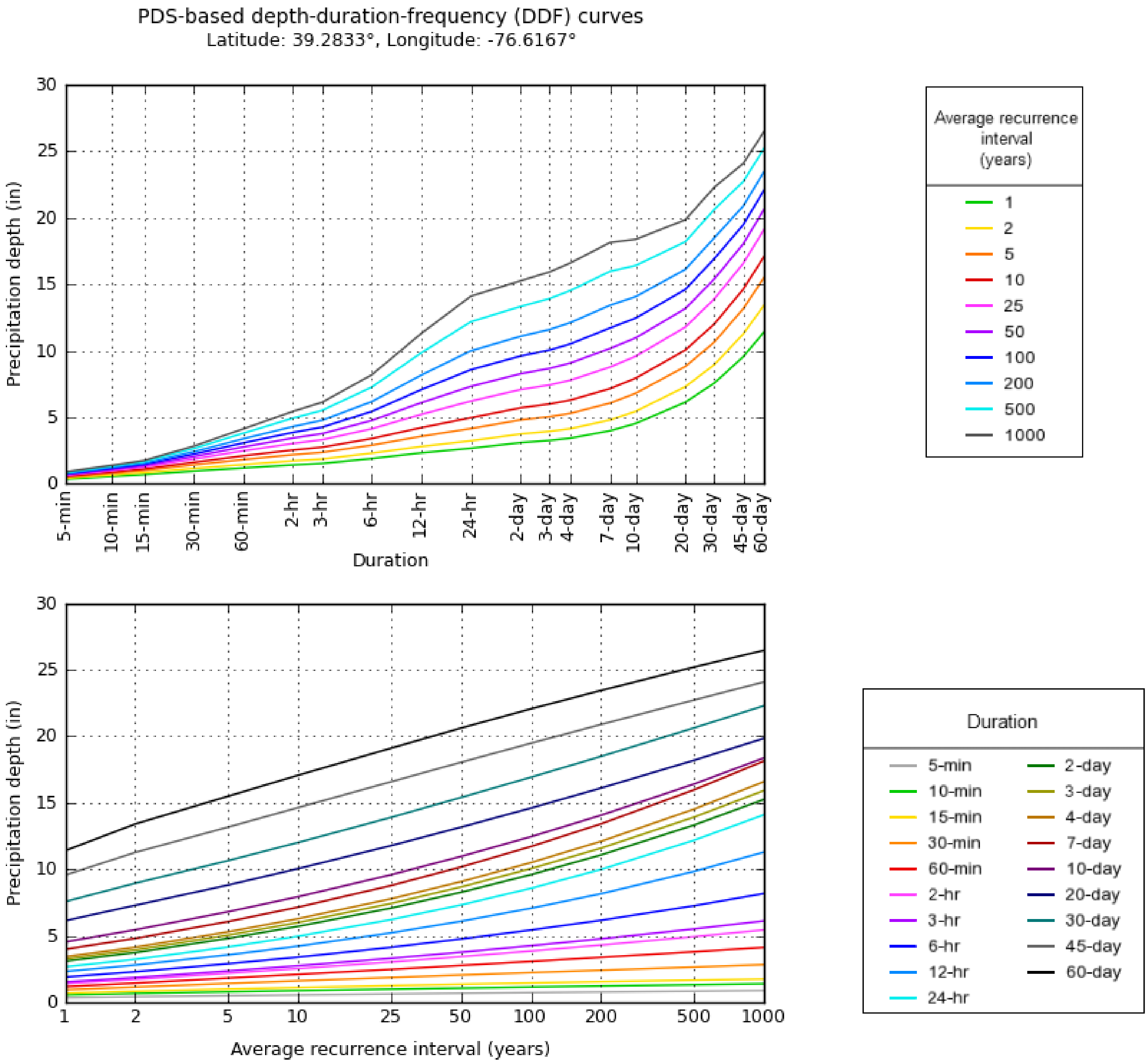
Harbor Point Parcel 3 and Park - Baltimore, Maryland
Beatty Development Group - Baltimore, Maryland
Mueser Rutledge Consulting Engineers, PLLC - New York, New York
EE Memo 1: Storm Water Storage Demand
Job No.: 139221/22 Made By: F.T.F.; Date: 2021-08-09
FIGURE 1 (EE MEMO 1) - RAINFALL INTENSITY DATA FROM NOAA

## PF graphical




NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Tue Feb 2 19:18:36 2021

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## Maps & aerials

**Small scale terrain**

Figure 1
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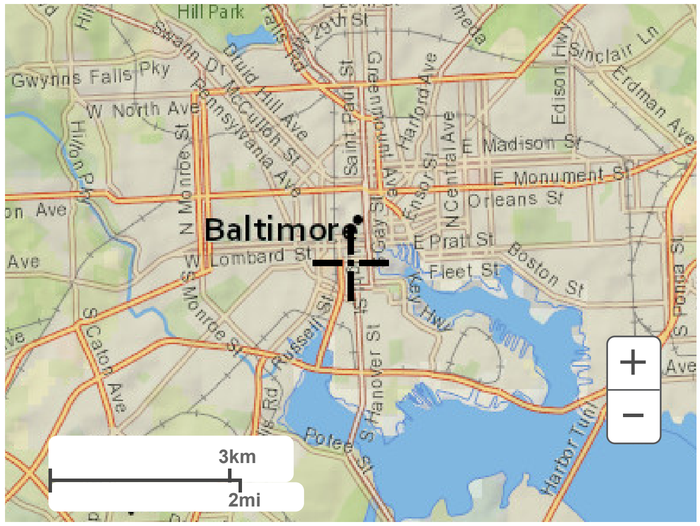
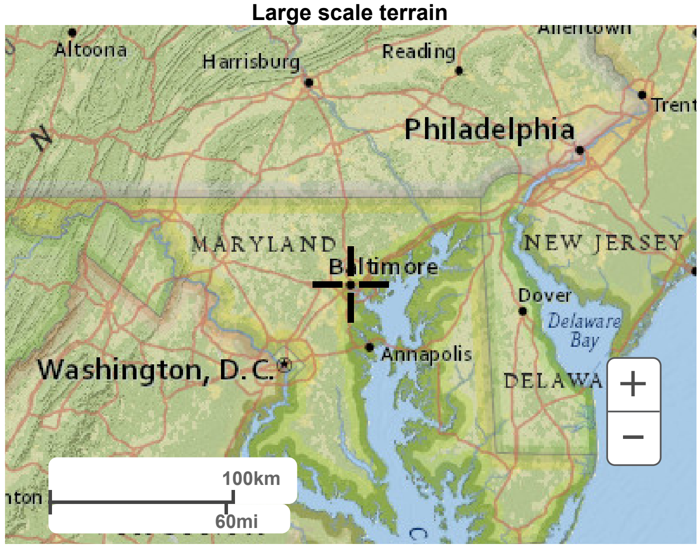
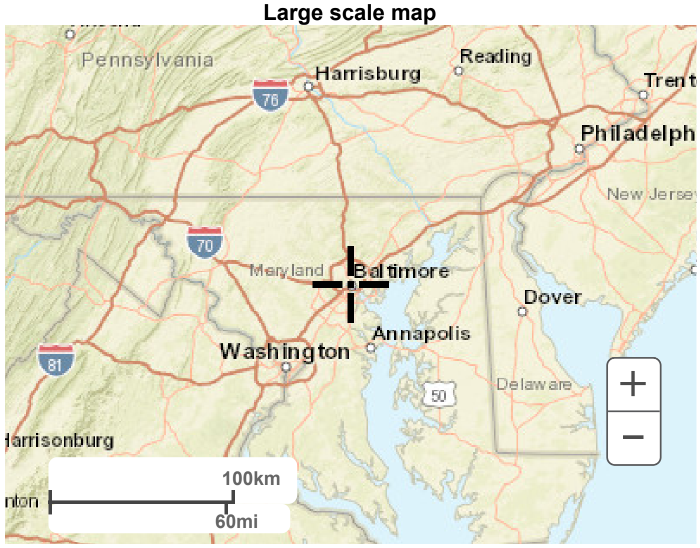



Large scale terrain




Large scale map




Large scale aerial

Figure 1
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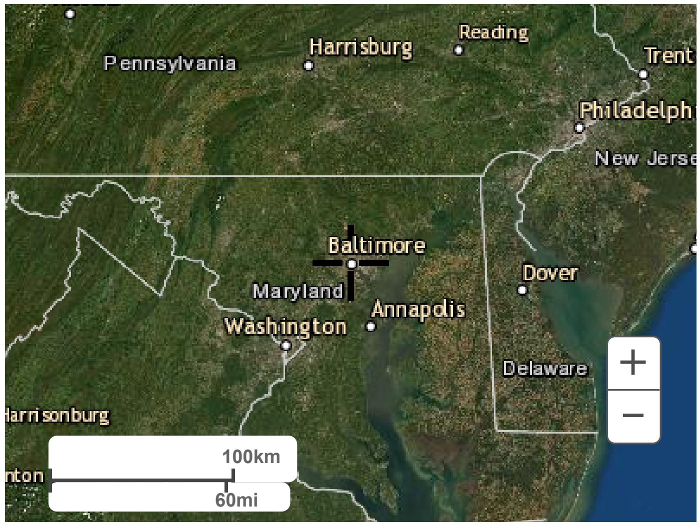


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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

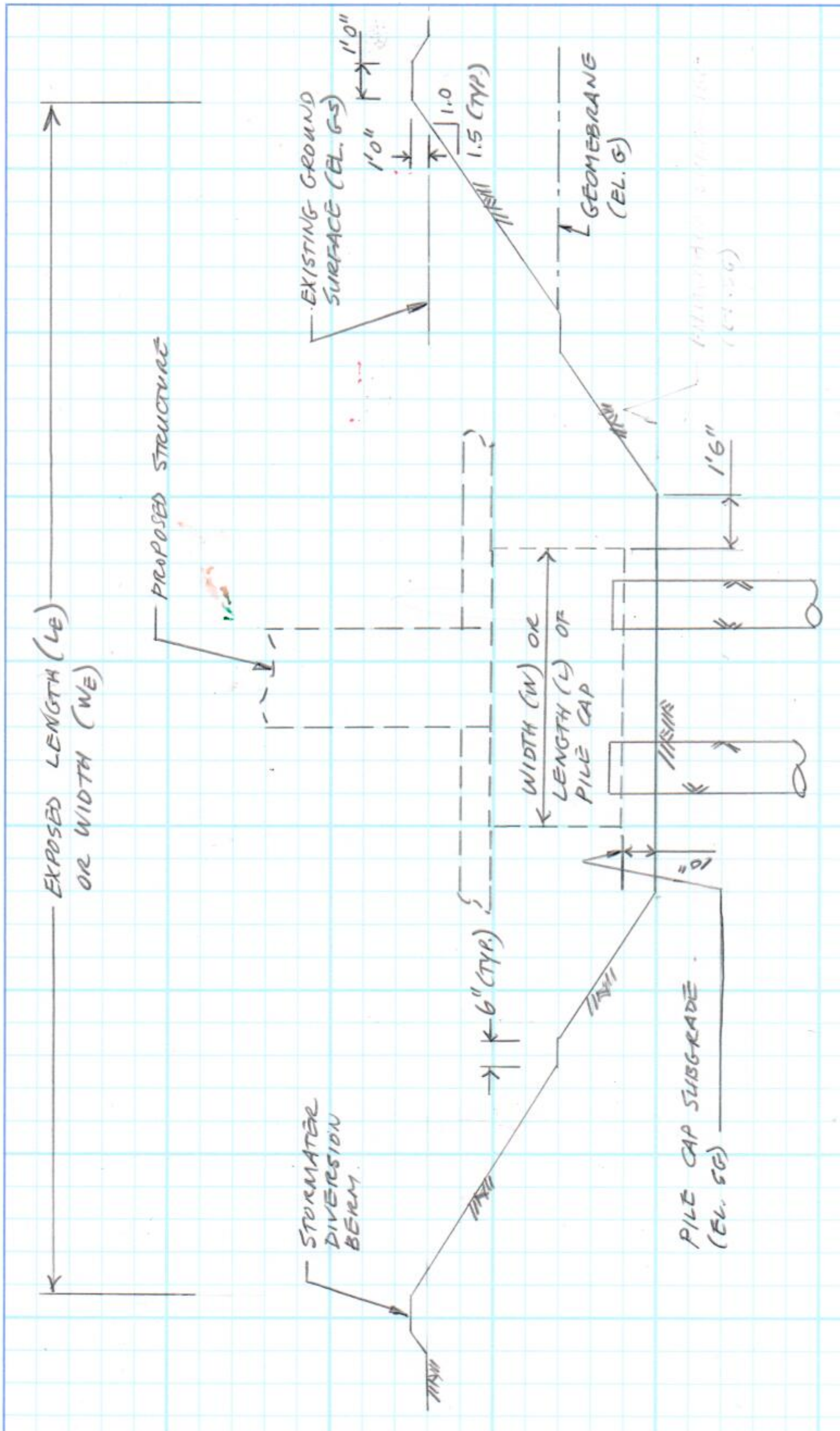
# APPENDIX A
# EE MEMO 1

**MUESER RUTLEDGE CONSULTING ENGINEERS**

SHEET ____ OF ____
FILE 13921
MADE BY AMD DATE 08/12/21
CHECKED BY PTF DATE 08/12/21

PROJECT HARBOR POINT PARCEL 3

SUBJECT FIGURE A-1 EXCAVATION AREA METHODOLOGY SKETCH




NOTE: EL. GS IS ALWAYS < EL. G

$L_E = L + 2\left(1'6" + 1.5\left[EL.\ GS - EL.\ SG + 10" + 1'0"\right] + 6"\right)$

$W_E = W + " \quad "$

FOR RECTANGULAR PILE CAPS: EXPOSED AREA, $A_E = L_E \cdot W_E$

TRIANGULAR PILE CAPS: $A_E = \frac{1}{2} \cdot W_E^2$

# MUESER RUTLEDGE CONSULTING ENGINEERS

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope (ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| EA-E1 | 3 | 4 | 15.5 | 8.5 | 7.0 | 14.0 | 8 | 7.5 | 1278 |
| EA-E1.9 | 4 | 4 | 15.5 | 8.5 | 7.0 | 14.0 | 8 | 8 | 1296 |
| EA-E3.1 | 4 | 4 | 15.5 | 8.5 | 7.0 | 14.0 | 8 | 8 | 1296 |
| EA-E4 | 3 | 4 | 15.5 | 8.5 | 7.0 | 14.0 | 8 | 7.5 | 1278 |
| EA-E5 | 1 | 0 | 15.5 | 12.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| EA-E6 | 1 | 0 | 15.5 | 12.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| EB-E1 | 4 | 4 | 15.5 | 8.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EB-E2 | 4 | 4 | 15.5 | 8.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EB-E3 | 4 | 4 | 15.5 | 8.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EB-E4 | 4 | 4 | 15.5 | 8.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EB-E5 | 1 | 0 | 15.5 | 12.8 | 2.8 | 0.5 | 2 | 2 | 28 |
| EB-E6 | 1 | 0 | 15.5 | 12.8 | 2.8 | 0.5 | 2 | 2 | 28 |
| EC-E1 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| EC-E2 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| EC-E3 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| EC-E4 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| EC-E5 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| EC-E6 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| ED-E1 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| Shear | 32 | 5 | 14.5 | 7.7 | 6.8 | 13.7 | 37 | 46 | 4727 |
| ED-E4 | 5 | 5 | 14.5 | 8.5 | 6.0 | 12.5 | 10 | 10 | 1225 |
| ED-E5 | 2 | 4 | 14.5 | 9.5 | 5.0 | 11.0 | 8 | 3.5 | 765 |
| ED-E6 | 2 | 4 | 14.5 | 9.5 | 5.0 | 11.0 | 8 | 3.5 | 765 |
| EE-E1 | 4 | 4 | 15.0 | 9.0 | 6.0 | 12.5 | 8 | 8 | 1089 |
| EE-E4 | 4 | 4 | 14.5 | 9.0 | 5.5 | 11.8 | 8 | 8 | 992 |
| EE-E5 | 2 | 4 | 14.5 | 9.5 | 5.0 | 11.0 | 8 | 3.5 | 765 |
| EE-E6 | 2 | 4 | 14.5 | 9.5 | 5.0 | 11.0 | 8 | 3.5 | 765 |
| EE.9-E2 | 5 | 5 | 14.5 | 8.5 | 6.0 | 12.5 | 10 | 10 | 1225 |
| EE.9-E3 | 5 | 5 | 14.5 | 8.5 | 6.0 | 12.5 | 10 | 10 | 1225 |
| EF-E1 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EF-E4 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| EF-E5 | 2 | 4 | 14.5 | 9.3 | 5.3 | 11.4 | 8 | 3.5 | 807 |
| EF-E6 | 2 | 4 | 14.5 | 9.3 | 5.3 | 11.4 | 8 | 3.5 | 807 |
| EG-E1 | 4 | 4 | 14.5 | 7.8 | 6.7 | 13.6 | 8 | 8 | 1232 |
| EG-E2 | 5 | 5 | 14.5 | 7.3 | 7.2 | 14.3 | 10 | 10 | 1490 |
| EG-E3 | 5 | 5 | 14.5 | 7.3 | 7.2 | 14.3 | 10 | 10 | 1490 |
| EG-E4 | 4 | 4 | 13.5 | 7.8 | 5.7 | 12.1 | 8 | 8 | 1030 |
| EG-E5 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 641 |
| EG-E6 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 641 |
| EG-E7 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 641 |
| EH-E1 | 4 | 4 | 13.5 | 7.8 | 5.7 | 12.1 | 8 | 8 | 1030 |
| EH-E2 | 5 | 5 | 13.5 | 7.3 | 6.2 | 12.8 | 10 | 10 | 1267 |
| EH-E3 | 5 | 5 | 13.5 | 7.3 | 6.2 | 12.8 | 10 | 10 | 1267 |
| EH-E4 | 4 | 4 | 13.5 | 7.8 | 5.7 | 12.1 | 8 | 8 | 1030 |
| EH-E5 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 638 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope (ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| EH-E6 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 638 |
| EH-E7 | 2 | 4 | 13.5 | 9.3 | 4.2 | 9.8 | 8 | 3.5 | 638 |
| EJ-E0.5 | 1 | 0 | 13.5 | 8.5 | 5.0 | 11.0 | 2 | 2 | 576 |
| EJ-E1 | 4 | 4 | 13.5 | 5.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| EJ-E2 | 5 | 5 | 13.5 | 3.5 | 10.0 | 18.5 | 10 | 10 | 2209 |
| EJ-E3 | 5 | 5 | 13.5 | 3.5 | 10.0 | 18.5 | 10 | 10 | 2209 |
| EJ-E4 | 5 | 5 | 13.5 | 7.3 | 6.3 | 12.9 | 10 | 10 | 1278 |
| EK-E1 | 5 | 5 | 13.0 | 5.7 | 7.3 | 14.5 | 10 | 10 | 1513 |
| EK-E2 | 6 | 5 | 12.5 | 4.5 | 8.0 | 15.5 | 12.5 | 8 | 1697 |
| EK-E3 | 6 | 5 | 12.5 | 2.8 | 9.8 | 18.1 | 12.5 | 8 | 2157 |
| EK-E4 | 5 | 5 | 12.5 | 3.5 | 9.0 | 17.0 | 10 | 10 | 1936 |
| EK.7-E2 | 2 | 4 | 12.5 | 5.8 | 6.8 | 13.6 | 8 | 3.5 | 1084 |
| EK.7-E3 | 2 | 4 | 12.5 | 5.8 | 6.8 | 13.6 | 8 | 3.5 | 1084 |
| EL-E1 | 4 | 4 | 14.0 | 5.5 | 8.5 | 16.3 | 8 | 8 | 1640 |
| EL-E1.9 | 6 | 5 | 12.5 | 4.3 | 8.3 | 15.9 | 12.5 | 8 | 1759 |
| EL-E3.1 | 6 | 5 | 12.5 | 4.3 | 8.3 | 15.9 | 12.5 | 8 | 1759 |
| EL-E4 | 5 | 5 | 12.5 | 5.0 | 7.5 | 14.8 | 10 | 10 | 1560 |
| EM-E1.9 | 2 | 4 | 13.0 | 6.0 | 7.0 | 14.0 | 8 | 3.5 | 1134 |
| EM-E3.1 | 2 | 4 | 12.5 | 6.0 | 6.5 | 13.3 | 8 | 3.5 | 1035 |
| EM-E4 | 2 | 4 | 12.0 | 6.0 | 6.0 | 12.5 | 8 | 3.5 | 941 |
| Single | 1 | 0 | 11.2 | 11.5 | -0.3 | 0.5 | 2 | 2 | 5 |
| Single | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 12.5 | 11.5 | 1.0 | 0.5 | 2 | 2 | 12 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope (ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 11.5 | 11.5 | 0.0 | 0.5 | 2 | 2 | 6 |
| Single | 1 | 0 | 12.0 | 11.5 | 0.5 | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.0 | 11.5 | 0.5 | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.0 | 9.5 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 12.0 | 9.5 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 12.0 | 9.5 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 12.0 | 9.5 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 12.0 | 9.5 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 11.5 | 9.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| Single | 1 | 0 | 11.5 | 7.1 | 4.4 | 0.5 | 2 | 2 | 48 |
| Single | 1 | 0 | 11.5 | 7.1 | 4.4 | 0.5 | 2 | 2 | 48 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| Single | 1 | 0 | 11.5 | 8.5 | 3.0 | 0.5 | 2 | 2 | 30 |

* - Dimensions based on single pile cap excations **Total: 75,570**

Refer to Drawing FO.108 for excavation sequencing

Pile Caps dimensions

| # of piles | Comment | Dim 1 (ft) | Dim 2 (ft) | Thickness (ft) |
|---|---|---|---|---|
| 1 | | 2 | 2 | |
| 2 | | 8.0 | 3.5 | 3.5 |
| 3 | Triangular | 8.0 | 7.5 | 4.0 |
| 4 | | 8.0 | 8.0 | 4.0 |
| 5 | | 10.0 | 10.0 | 4.5 |
| 6 | | 12.5 | 8.0 | 5.3 |
| 7 | | 16.5 | 10.0 | 5.5 |
| 8 | | 16.5 | 10.0 | 5.5 |
| 32 | | 37.0 | 46.0 | 5.3 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope(ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| EA.1-W1.8 | 3 | 4 | 16.5 | 8.5 | 8.0 | 15.5 | 8 | 7.5 | 1502 |
| EA.1-W3.2 | 3 | 4 | 16.5 | 8.5 | 8.0 | 15.5 | 8 | 7.5 | 1502 |
| EA.1-W4 | 3 | 4 | 16.5 | 8.5 | 8.0 | 15.5 | 8 | 7.5 | 1502 |
| EA.1-E12 | 1 | 0 | 16.5 | 12.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EA.1-E13 | 1 | 0 | 16.5 | 12.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EA.1-E14 | 1 | 0 | 16.5 | 12.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EA-W1 | 3 | 4 | 16.5 | 8.5 | 8.0 | 15.5 | 8 | 7.5 | 1502 |
| EA.9-E12 | 2 | 4 | 15.5 | 9.3 | 6.3 | 12.9 | 8 | 3.5 | 987 |
| EA.9-E13 | 1 | 0 | 15.5 | 12.8 | 2.8 | 0.5 | 2 | 2 | 28 |
| EA.9-E14 | 1 | 0 | 15.5 | 12.8 | 2.8 | 0.5 | 2 | 2 | 28 |
| EB.9-E12 | 2 | 4 | 15.5 | 9.5 | 6.0 | 12.5 | 8 | 3.5 | 941 |
| EB.9-E13 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| EB.9-E14 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| EC.9-E12 | 2 | 4 | 15.5 | 9.5 | 6.0 | 12.5 | 8 | 3.5 | 941 |
| EC.9-E13 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| EC.9-E14 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| ED.9-E12 | 2 | 4 | 15.5 | 9.5 | 6.0 | 12.5 | 8 | 3.5 | 941 |
| ED.9-E13 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| ED.9-E14 | 1 | 0 | 15.5 | 13.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| EE.8-E12 | 1 | 0 | 15.5 | 11.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EE.8-E13 | 1 | 0 | 15.5 | 11.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EE.8-E14 | 1 | 0 | 15.5 | 11.5 | 4.0 | 0.5 | 2 | 2 | 42 |
| EF.9-E12 | 1 | 0 | 14.5 | 11.8 | 2.8 | 0.5 | 2 | 2 | 28 |
| EF.9-E13 | 2 | 4 | 14.5 | 9.3 | 5.3 | 11.4 | 8 | 3.5 | 807 |
| EF.9-E14.3 | 1 | 0 | 14.5 | 11.5 | 3.0 | 0.5 | 2 | 2 | 30 |
| EG.9-E13 | 2 | 4 | 14.5 | 8.3 | 6.3 | 12.9 | 8 | 3.5 | 987 |
| EG.9-E14.5 | 1 | 0 | 14.5 | 12.8 | 1.8 | 0.5 | 2 | 2 | 18 |
| EH.9-E13 | 2 | 4 | 13.5 | 8.0 | 5.5 | 11.8 | 8 | 3.5 | 851 |
| EH.9-E14.4 | 1 | 0 | 13.5 | 11.5 | 2.0 | 0.5 | 2 | 2 | 20 |
| EJ.2-E13 | 2 | 4 | 13.5 | 6.1 | 7.4 | 14.6 | 8 | 3.5 | 1216 |
| EJ.2-E14.2 | 1 | 0 | 13.5 | 9.0 | 4.5 | 0.5 | 2 | 2 | 49 |
| EK.2-W1 | 5 | 5 | 13.0 | 5.7 | 7.3 | 14.5 | 10 | 10 | 1513 |
| Single | 1 | 0 | 13.0 | 9.0 | 4.0 | 0.5 | 2 | 2 | 42 |
| EK.8-W1.9 | 8 | 6 | 13.0 | 4.7 | 8.3 | 16.0 | 16.5 | 10 | 2028 |
| EK.8-W3 | 8 | 6 | 13.0 | 4.7 | 8.3 | 16.0 | 16.5 | 10 | 2028 |
| Single | 1 | 0 | 13.0 | 9.0 | 4.0 | 0.5 | 2 | 2 | 42 |
| EK.8-W4 | 4 | 4 | 13.0 | 6.2 | 6.8 | 13.7 | 8 | 8 | 1253 |
| Single | 1 | 0 | 13.0 | 9.0 | 4.0 | 0.5 | 2 | 2 | 42 |
| EM-E8 | 2 | 4 | 12.5 | 5.7 | 6.8 | 13.7 | 8 | 3.5 | 1094 |

MUESER RUTLEDGE CONSULTING ENGINEERS

File No.: 13921/13922

Made by: FTF Date: 4/19/21

Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope(ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| EM-E9 | 3 | 4 | 12.5 | 5.2 | 7.3 | 14.5 | 8 | 7.5 | 1343 |
| EM-E10 | 3 | 4 | 11.5 | 5.2 | 6.3 | 13.0 | 8 | 7.5 | 1132 |
| EM-E11 | 2 | 4 | 11.5 | 5.7 | 5.8 | 12.2 | 8 | 3.5 | 904 |
| EM-E12 | 2 | 4 | 11.5 | 5.7 | 5.8 | 12.2 | 8 | 3.5 | 904 |
| Single | 1 | 0 | 11.5 | 9.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 11.5 | 9.0 | 2.5 | 0.5 | 2 | 2 | 25 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| WA-W1 | 4 | 4 | 16.5 | 5.6 | 10.9 | 19.9 | 8 | 8 | 2275 |
| WA-W2 | 4 | 4 | 16.5 | 8.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| WA-W3 | 4 | 4 | 16.5 | 8.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| WA.2-W4 | 4 | 4 | 16.5 | 8.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| WB-W1 | 4 | 4 | 15.5 | 5.6 | 9.9 | 18.4 | 8 | 8 | 1998 |
| WB-W2 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| WB-W3 | 5 | 5 | 15.5 | 3.1 | 12.4 | 22.1 | 10 | 10 | 2938 |
| WB.2-W4 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| WC-W1 | 5 | 5 | 15.5 | 8.5 | 7.0 | 14.0 | 10 | 10 | 1444 |
| WC.2-W4 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| Shear | 32 | 5 | 15.5 | 8.5 | 7.0 | 14.0 | 37 | 46 | 4810 |
| WD-W1 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| WD.2-W4 | 4 | 4 | 15.5 | 9.0 | 6.5 | 13.3 | 8 | 8 | 1190 |
| WE-W1 | 4 | 4 | 15.5 | 7.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| WE-W2 | 5 | 5 | 15.5 | 7.3 | 8.3 | 15.9 | 10 | 10 | 1743 |
| WE-W3 | 5 | 5 | 15.5 | 7.3 | 8.3 | 15.9 | 10 | 10 | 1743 |
| WE.2-W4 | 4 | 4 | 15.5 | 7.8 | 7.8 | 15.1 | 8 | 8 | 1463 |
| WF-W1 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| WF-W2 | 5 | 5 | 14.5 | 7.3 | 7.3 | 14.4 | 10 | 10 | 1502 |
| WF-W3 | 5 | 5 | 14.5 | 7.3 | 7.3 | 14.4 | 10 | 10 | 1502 |
| WF.2-W4 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| WG-W1 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| WG-W2 | 5 | 5 | 14.5 | 7.3 | 7.3 | 14.4 | 10 | 10 | 1502 |
| WG-W3 | 5 | 5 | 14.5 | 7.3 | 7.3 | 14.4 | 10 | 10 | 1502 |
| WG.2-W4 | 4 | 4 | 14.5 | 7.8 | 6.8 | 13.6 | 8 | 8 | 1243 |
| WH-1 | 4 | 4 | 13.5 | 7.8 | 5.8 | 12.1 | 8 | 8 | 1040 |
| WH-2 | 5 | 5 | 13.5 | 3.3 | 10.3 | 18.9 | 10 | 10 | 2280 |
| WH-3 | 5 | 5 | 13.5 | 3.3 | 10.3 | 18.9 | 10 | 10 | 2280 |
| Single | 1 | 0 | 13.5 | 6.8 | 6.8 | 0.5 | 2 | 2 | 86 |
| Single | 1 | 0 | 13.5 | 6.8 | 6.8 | 0.5 | 2 | 2 | 86 |
| WH.2-W4 | 5 | 5 | 13.5 | 5.3 | 8.3 | 15.9 | 10 | 10 | 1743 |
| WJ-W1 | 5 | 5 | 13.5 | 5.7 | 7.8 | 15.2 | 10 | 10 | 1632 |
| Single | 1 | 0 | 13.5 | 9.0 | 4.5 | 0.5 | 2 | 2 | 9 |
| WJ-W2 | 7 | 6 | 13.5 | 4.7 | 8.8 | 16.7 | 16.5 | 10 | 2166 |
| WJ-W3 | 7 | 6 | 13.5 | 4.7 | 8.8 | 16.7 | 16.5 | 10 | 2166 |

# MUESER RUTLEDGE CONSULTING ENGINEERS

File No.: 13921/13922

Made by: FTF Date: 4/19/21

Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Excavation Area Calculations

| Pile Cap | Number of Piles | Cap Thickness (ft) | Existing Grade (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below Grade | Pile Cap Edge to Excavation Top of Slope(ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Open Excavation (sf) |
|---|---|---|---|---|---|---|---|---|---|
| WJ.2-W4 | 5 | 5 | 13.5 | 5.3 | 8.3 | 15.9 | 10 | 10 | 1743 |
| WK-W1 | 5 | 5 | 13.0 | 5.7 | 7.3 | 14.5 | 10 | 10 | 1513 |
| Single | 1 | 0 | 13.0 | 9.0 | 4.0 | 0.5 | 2 | 2 | 42 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| Single | 1 | 0 | 12.5 | 9.0 | 3.5 | 0.5 | 2 | 2 | 36 |
| * - Dimensions based on single pile cap excations | | | | | | | | **Total:** | **84,888** |

Refer to Drawing FO.108 for excavation sequencing

Pile Caps dimensions

| # of piles | Comment | Dim 1 (ft) | Dim 2 (ft) | Thickness (ft) |
|---|---|---|---|---|
| 1 | | 2 | 2 | |
| 2 | | 8.0 | 3.5 | 3.5 |
| 3 | Triangular | 8.0 | 7.5 | 4.0 |
| 4 | | 8.0 | 8.0 | 4.0 |
| 5 | | 10.0 | 10.0 | 4.5 |
| 6 | | 12.5 | 8.0 | 5.3 |
| 7 | | 16.5 | 10.0 | 5.5 |
| 8 | | 16.5 | 10.0 | 5.5 |
| 32 | | 37.0 | 46.0 | 5.3 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922
Made by: FTF Date: 4/23/21
FOR: Harbor Point Charter Buildings Engineering Evaluation
Checked by: AMD Date: 4/27/21

SUBJECT: Stormwater Management Calculations

Single Tank Dimensions

| | | |
|---|---|---|
| Height | 4 | ft |
| Length | 50 | ft |
| Width | 50 | ft |

Single Tank Area 2,500 sf
Single Tank Volume 10,000 cf

Open Excavation Area 7250 sf

24-hr Rainfall

| Storm (yr) | Rain/24 Hr (in) | Maximum Intensity (in/hr) |
|---|---|---|
| 25 | 6.21 | |
| 100 | 8.57 | 3.07 |

| | | |
|---|---|---|
| **Maximum Pumping Rate** | **231** | **gal/min** |

25- Year Storm

| End of Day | Tank | Direct Catchment (cf) | Contact (cf) | Total (cf) | Remaining Vol. (cf) | Free Board (ft) |
|---|---|---|---|---|---|---|
| 1 | 1 | 1,294 | 3,752 | 5,046 | 4,954 | 2.0 |
| 1 | 2 | 0 | 0 | 0 | 10,000 | 4.0 |
| 2 | 1 | 1,294 | 0 | 1,294 | 3,661 | 1.5 |
| 2 | 2 | 1,294 | 3,752 | 5,046 | 4,954 | 2.0 |

100- Year Storm

| End of Day | Tank | Direct Catchment (cf) | Contact (cf) | Total (cf) | Remaining Vol. (cf) | Free Board (ft) |
|---|---|---|---|---|---|---|
| 1 | 1 | 1,785 | 5,178 | 6,963 | 3,037 | 1.2 |
| 1 | 2 | 0 | 0 | 0 | 10,000 | 4.0 |
| 2 | 1 | 1,785 | 0 | 1,785 | 1,251 | 0.5 |
| 2 | 2 | 1,785 | 5,178 | 6,963 | 3,037 | 1.2 |

# APPENDIX B
# EE MEMO 1

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/23/21

FOR: Harbor Point Charter Buildings Engineering Evaluation Checked by: AMD Date: 4/27/21

SUBJECT: Containment Berm Calculations

Single Tank Dimensions

| | | |
|---|---|---|
| Height | 4 | ft |
| Length | 50 | ft |
| Width | 50 | ft |

| | | |
|---|---|---|
| Single Tank Area | 2,500 | sf |
| Single Tank Volume | 10,000 | cf |

Minimum Area for one failed 50x50x4 tank

| | | |
|---|---|---|
| Height | 1.1 | ft |
| Length | 140 | ft |
| Width | 85 | ft |

| | | |
|---|---|---|
| Total Berm Capacity (1 failed tank) | 10,340 | cy |

| | |
|---|---|
| Direct Catchment (in) | 8.57 |
| Required Free Board(in) | 4 |

**Required Berm Height (in) 26**

# APPENDIX C
# EE MEMO 1

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/20/21

FOR: Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Pile Displacement Calculations

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -20

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| EA-E1 | 3 | 88 |
| EA-E1.9 | 4 | 117 |
| EA-E3.1 | 4 | 117 |
| EA-E4 | 3 | 88 |
| EA-E5 | 1 | 29 |
| EA-E6 | 1 | 29 |
| EB-E1 | 4 | 117 |
| EB-E2 | 4 | 117 |
| EB-E3 | 4 | 117 |
| EB-E4 | 4 | 117 |
| EB-E5 | 1 | 29 |
| EB-E6 | 1 | 29 |
| EC-E1 | 4 | 117 |
| EC-E2 | 4 | 117 |
| EC-E3 | 4 | 117 |
| EC-E4 | 4 | 117 |
| EC-E5 | 1 | 29 |
| EC-E6 | 1 | 29 |
| ED-E1 | 4 | 117 |
| ED-E2 | 32 | 938 |
| ED-E4 | 5 | 147 |
| ED-E5 | 2 | 59 |
| ED-E6 | 2 | 59 |
| EE-E1 | 4 | 117 |
| EE-E4 | 4 | 117 |
| EE-E5 | 2 | 59 |
| EE-E6 | 2 | 59 |
| EE.9-E2 | 5 | 147 |
| EE.9-E3 | 5 | 147 |
| EF-E1 | 4 | 117 |
| EF-E4 | 4 | 117 |
| EF-E5 | 2 | 59 |
| EF-E6 | 2 | 59 |
| EG-E1 | 4 | 117 |
| EG-E2 | 5 | 147 |
| EG-E3 | 5 | 147 |
| EH-E1 | 4 | 117 |
| EA.1-W1.8 | 3 | 88 |
| EA.1-W3.2 | 3 | 88 |
| EA.1-W4 | 3 | 88 |
| EA.1-E12 | 1 | 29 |
| EA.1-E13 | 1 | 29 |
| EA.1-E14 | 1 | 29 |
| EA-W1 | 3 | 88 |
| EA.9-E12 | 2 | 59 |
| EA.9-E13 | 1 | 29 |
| EA.9-E14 | 1 | 29 |
| EB.9-E12 | 2 | 59 |

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -50

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| EG-E4 | 4 | 285 |
| EG-E5 | 2 | 142 |
| EG-E6 | 2 | 142 |
| EG-E7 | 2 | 142 |
| EH-E2 | 5 | 356 |
| EH-E3 | 5 | 356 |
| EH-E4 | 4 | 285 |
| EH-E5 | 2 | 142 |
| EH-E6 | 2 | 142 |
| EH-E7 | 2 | 142 |
| EJ-E0.5 | 1 | 71 |
| EJ-E1 | 4 | 285 |
| EJ-E2 | 5 | 356 |
| EJ-E3 | 5 | 356 |
| EJ-E4 | 5 | 356 |
| EK-E1 | 5 | 356 |
| EK-E2 | 6 | 427 |
| EK-E3 | 6 | 427 |
| EK-E4 | 5 | 356 |
| EK.7-E2 | 2 | 142 |
| EK.7-E3 | 2 | 142 |
| EL-E1 | 4 | 285 |
| EL-E1.9 | 6 | 427 |
| EL-E3.1 | 6 | 427 |
| EL-E4 | 5 | 356 |
| EM-E1.9 | 2 | 142 |
| EM-E3.1 | 2 | 142 |
| EM-E4 | 2 | 142 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -50

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| EE.8-E12 | 1 | 71 |
| EE.8-E13 | 1 | 71 |
| EE.8-E14 | 1 | 71 |
| EF.9-E12 | 1 | 71 |
| EF.9-E13 | 2 | 142 |
| EF.9-E14.3 | 1 | 71 |
| EG.9-E13 | 2 | 142 |
| EG.9-E14.5 | 1 | 71 |
| EH.9-E13 | 2 | 142 |
| EH.9-E14.4 | 1 | 71 |
| EJ.2-E13 | 2 | 142 |
| EJ.2-E14.2 | 1 | 71 |
| EK.2-W1 | 5 | 356 |
| Single | 1 | 71 |
| EK.8-W1.9 | 8 | 570 |
| EK.8-W3 | 8 | 570 |
| Single | 1 | 71 |
| EK.8-W4 | 4 | 285 |
| Single | 1 | 71 |
| EM-E8 | 2 | 142 |
| EM-E9 | 3 | 214 |
| EM-E10 | 3 | 214 |
| EM-E11 | 2 | 142 |
| EM-E12 | 2 | 142 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| WE-W2 | 5 | 356 |
| WE-W3 | 5 | 356 |
| WE.2-W4 | 4 | 285 |
| WF-W1 | 4 | 285 |
| WF-W2 | 5 | 356 |
| WF-W3 | 5 | 356 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/20/21

FOR: Harbor Point Charter Buildings Engineering Evaluation

Checked by: AMD Date: 4/27/21

SUBJECT: Pile Displacement Calculations

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -20

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| EB.9-E13 | 1 | 29 |
| EB.9-E14 | 1 | 29 |
| EC.9-E12 | 2 | 59 |
| EC.9-E13 | 1 | 29 |
| EC.9-E14 | 1 | 29 |
| ED.9-E12 | 2 | 59 |
| ED.9-E13 | 1 | 29 |
| ED.9-E14 | 1 | 29 |
| WA-W1 | 4 | 117 |
| WA-W2 | 4 | 117 |
| WA-W3 | 4 | 117 |
| WA.2-W4 | 4 | 117 |
| WB-W1 | 4 | 117 |
| WB-W2 | 4 | 117 |
| WB-W3 | 5 | 147 |
| WB.2-W4 | 4 | 117 |
| WC-W1 | 5 | 147 |
| WC.2-W4 | 4 | 117 |
| WC-W2.5 | 32 | 938 |
| WD-W1 | 4 | 117 |
| WD.2-W4 | 4 | 117 |
| WE-W1 | 4 | 117 |
| | **Total** | **7,800 cf** |

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -50

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| | **Total** | **10,325 cf** |

Pile Dia. (in) 16
Ground Water El. (ft) 1
Pile Tip El. (ft) -50

| Pile Cap | Number of Piles | Volume Displaced (cf) |
|---|---|---|
| WF.2-W4 | 4 | 285 |
| WG-W1 | 4 | 285 |
| WG-W2 | 5 | 356 |
| WG-W3 | 5 | 356 |
| WG.2-W4 | 4 | 285 |
| WH-1 | 4 | 285 |
| WH-2 | 5 | 356 |
| WH-3 | 5 | 356 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| WH.2-W4 | 5 | 356 |
| WJ-W1 | 5 | 356 |
| Single | 1 | 71 |
| WJ-W2 | 7 | 498 |
| WJ-W3 | 7 | 498 |
| WJ.2-W4 | 5 | 356 |
| WK-W1 | 5 | 356 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| Single | 1 | 71 |
| | **Total** | **12,746 cf** |

| | |
|---|---|
| Total Soil Dispalced (cf) | 30,871 |
| **Total Pumping Demand (gal)** | **230,918** |

# EE Memo 2 Impedance to the Drainage Net

MRCE
built on firm foundations

## MEMORANDUM

**Date:** August 13, 2021

**To:** Office

**From:** Fred T. Falcone, and Adam M. Dyer

**Re:** EE Memo 2 - Impedance to the Drainage Net

**File:** Area 1, Phase 2, Parcel 3 Development, Baltimore, MD
File # 13921

---

This memorandum summarizes the analysis of impedance to flow and changes in flow direction within the drainage net resulting from construction of foundations for the Area 1, Phase 2, Parcel 3 development, and utilities supporting the development.

### EXHIBITS

Figure 1 (EE Memo 2) Evaluation of Impedance to Flow in Drainage Net

Calculation Set 1 (EE Memo 2) Area without Drainage Net
Calculation Set 2 (EE Memo 2) Percent Obstruction to Flow within Drainage Net

### AVAILABLE INFORMATION

1. Drawing C-410 – Utility Composite Plan
2. Drawing C-435 – Storm Drain Profiles
3. Drawing FO.103 – Geomembrane Contours Plan
4. Drawing FO.300 – Existing Conditions Typical Details

### REFERENCES


1. "Corrective Measures Implementation Construction Completion Report, Phase I: Soil-Bentonite Hydraulic Barrier Wall, Phase II: Final Remedial Construction" prepared by Black and Veatch, Volumes I and II, February 2000.
2. "Maryland Stormwater Design Manual, Appendix D.13", Maryland Department of the Environment (MDE), 2009.


### Multimedia Cap

The Detailed Development Plan (DDP) provides a description of the existing Multimedia Cap (MMC). As-built construction details are depicted on Drawing FO.300. The MMC includes a Drainage Net on the Geomembrane. The MMC was constructed such that water that infiltrates the soil cover will flow away from the center of the cap through the Drainage Net and will not pond on the membrane. A contour of the surface of the Geomembrane layer is presented in Ref. 1 and Drawing FO.103. The water flowing through the Drainage Net is discharged into the embankment along the waterside perimeter. Since construction of the MMC portions of the site have been developed. The area directly north of Parcel 3 was developed as the Exelon Tower, Garage and Trading Floor Garage. Roof drains and storm drains from the previously developed area blocks storm water infiltration. The Parcel 3 and Harbor Point Park site has been largely unused, except for temporary parking and temporary structures at the south end of the site. It is presumed that settlement has not created a negative slope of the drainage net and ponding does not occur. For settlement calculations that assess this see EE Memo 3.

The Surface Soil Monitoring Plan (SSMP) utilizes water in the drainage net to monitor performance of the MMC by testing the quality of representative samples of Drainage Net water. Drainage Net water is sampled at five locations, identified as SSMP1, SSMP2, SSMP3, SSMP4, and SSMP4A. At each sampling location the Drainage Net water crosses over a bucket where it enters the embankment; samples are taken from the bucket yearly and tested for total chromium and cyanide. At SSMP1 and SSMP4, the sampling bucket is at the location where the land side toe drain discharges to the embankment. At SSMP2 and SSMP3 a small section of the Geomembrane is funneled to the sampling bucket. Only SSMP1, SSMP2, and SSMP 3 are within, or close to the Limits of Disturbance (LOD) of the Parcel 3 Development. Any water through the drainage net from the project site will drain to the south due to the slope of the drainage net, see Figure 1 (EE Memo 2).

## BUILDING FOUNDATIONS

Development structures will be supported on high capacity piles which penetrate the Geomembrane. Each penetration will be sealed using a mechanical clamp and gasket system. Pile caps extend below the elevation of the surrounding Geomembrane. A Geomembrane dam will be placed around each pile cap to isolate Drainage Net water from the pile cap excavation. This dam will be left in place after pile cap construction is completed.

## UTILITY INSTALLATION

Seven (7) 12 inch, HDPE gravity storm drains will be constructed across the site. Storms drains pass above the elevation of the Geomembrane and pass over the Hydraulic Barrier and terminate at the Infiltration Trench. FO-Series and Civil drawings address design of MMC depression, alteration of the infiltration trench, and location line and grades of the storm drains. Means and methods of construction will be presented in Contractor Work Plans for review and approval.

## OBSTRUCTION TO DRAINAGE NET BELOW DEVELOPMENT STRUCTURES ANALYSIS

Pile cap construction will isolate the pile cap and piles from the drainage net using a Geomembrane dam at the perimeter of each excavation. Drainage Net capacity to carry water between these flow obstructions is reviewed in this section.

Impedance to flow within the Drainage Net was quantified by computing the percentage of Drainage Net removed and not replaced. After development pile caps are completed 41.9% of the site will experience reduced infiltration as a result of the development structures (roofs) and streets (curb, gutter, and storm drains). Only 14.9% of the Drainage Net area has been obstructed by pile cap construction. Therefore, the MMC drainage layer should be capable of managing the anticipated storm water infiltration. For assessment of impedance to flow within the Drainage Net, see Figure 1 (EE Memo 2). The assessment identifies two areas along the west side of the west building where special care will need to be taken during construction to maintain continuity of the Drainage Net.

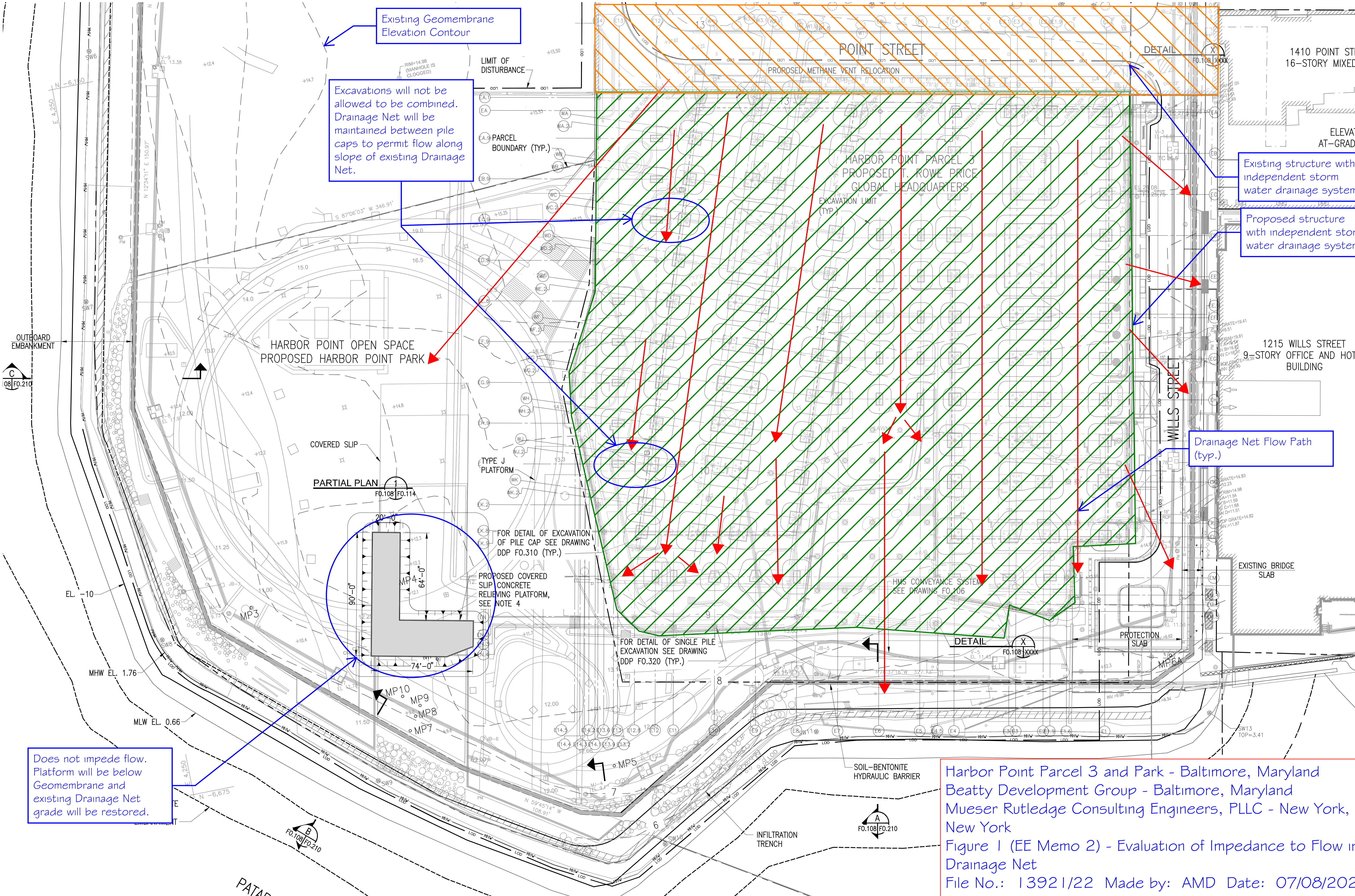
Drainage Net flow capacity becomes restricted at overburden stresses above 2,000 pounds per square foot (psf), which corresponds to an area fill height of 16 feet over the Drainage Net, assuming an average unit weight of 125 pounds per cubic foot (pcf) for the fill soil. Assessment of load on Drainage Net from proposed grades is provided in EE Memo 3.

## SUMMARY

MMC drainage requires revision to accommodate development and to provide the pile support improvement to the MMC and HMS systems for the charter buildings in the development area. Development revisions proposed are acceptable because:

1. The risk of infiltration to the HMS pumps is greatly reduced because development roof drainage will remove direct storm water from 41.9% of the development area.

2. Only 14.9% of the Drainage Net area is obstructed by pile cap construction.
3. Drainage Net flow through the SSMP points will not be effected by the development.




Harbor Point Parcel 3 and Park - Baltimore, Maryland
Beatty Development Group - Baltimore, Maryland
Mueser Rutledge Consulting Engineers, PLLC - New York, New York
Figure 1 (EE Memo 2) - Evaluation of Impedance to Flow in Drainage Net
File No.: 13921/22 Made by: AMD Date: 07/08/2021

**CALCULATION SET 1**
**EE MEMO 2**

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation

Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 1, Table 1-East Building

| Pile Cap | Number of Piles | Cap Thickness (ft) | Top of Pile Cap Elevation (ft) | Excavation Subgrade Elevation | Depth of Excavation Subgrade Below MMC (ft) | Pile Cap Edge to Drainage Dam, B (ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Area Without Drainage Net ($ft^2$) |
|---|---|---|---|---|---|---|---|---|---|
| EA-E1 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA-E1.9 | 4 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 8 | 400 |
| EA-E3.1 | 4 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 8 | 400 |
| EA-E4 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA-E5 | 1 | 0 | 13.5 | 12.5 | N/A | 0.5 | 2 | 2 | 9 |
| EA-E6 | 1 | 0 | 13.5 | 12.5 | N/A | 0.5 | 2 | 2 | 9 |
| EB-E1 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| EB-E2 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| EB-E3 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| EB-E4 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| EB-E5 | 1 | 0 | 13.8 | 12.8 | N/A | 0.5 | 2 | 2 | 9 |
| EB-E6 | 1 | 0 | 13.8 | 12.8 | N/A | 0.5 | 2 | 2 | 9 |
| EC-E1 | 4 | 4 | 14.0 | 9.0 | 3.0 | 5.0 | 8 | 8 | 324 |
| EC-E2 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| EC-E3 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| EC-E4 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| EC-E5 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| EC-E6 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| ED-E1 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| ED-E2 | 32 | 5 | 14.0 | 7.7 | 3.8 | 5.8 | 37 | 46 | 2799 |
| ED-E4 | 5 | 5 | 14.0 | 8.5 | 4.0 | 6.0 | 10 | 10 | 484 |
| ED-E5 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| ED-E6 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| EE-E1 | 4 | 4 | 14.0 | 9.0 | 2.5 | 4.5 | 8 | 8 | 289 |
| EE-E4 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| EE-E5 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| EE-E6 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| EE.9-E2 | 5 | 5 | 14.0 | 8.5 | 4.0 | 6.0 | 10 | 10 | 484 |
| EE.9-E3 | 5 | 5 | 14.0 | 8.5 | 4.0 | 6.0 | 10 | 10 | 484 |
| EF-E1 | 4 | 4 | 12.8 | 7.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| EF-E4 | 4 | 4 | 12.8 | 7.8 | 4.8 | 6.8 | 8 | 8 | 462 |
| EF-E5 | 2 | 4 | 13.8 | 9.3 | 3.3 | 5.3 | 8 | 3.5 | 259 |
| EF-E6 | 2 | 4 | 13.8 | 9.3 | 3.3 | 5.3 | 8 | 3.5 | 259 |
| EG-E1 | 4 | 4 | 12.8 | 7.8 | 2.7 | 4.7 | 8 | 8 | 303 |
| EG-E2 | 5 | 5 | 12.8 | 7.3 | 3.2 | 5.2 | 10 | 10 | 416 |
| EG-E3 | 5 | 5 | 12.8 | 7.3 | 4.2 | 6.2 | 10 | 10 | 502 |
| EG-E4 | 4 | 4 | 12.8 | 7.8 | 3.7 | 5.7 | 8 | 8 | 376 |
| EG-E5 | 2 | 4 | 13.8 | 9.3 | 2.2 | 4.2 | 8 | 3.5 | 196 |
| EG-E6 | 2 | 4 | 13.8 | 9.3 | 2.2 | 4.2 | 8 | 3.5 | 196 |
| EG-E7 | 2 | 4 | 13.8 | 9.3 | 2.2 | 4.2 | 8 | 3.5 | 196 |
| EH-E1 | 4 | 4 | 12.8 | 7.8 | 2.7 | 4.7 | 8 | 8 | 303 |
| EH-E2 | 5 | 5 | 12.8 | 7.3 | 3.2 | 5.2 | 10 | 10 | 416 |
| EH-E3 | 5 | 5 | 12.8 | 7.3 | 3.2 | 5.2 | 10 | 10 | 416 |
| EH-E4 | 4 | 4 | 12.8 | 7.8 | 2.7 | 4.7 | 8 | 8 | 303 |
| EH-E5 | 2 | 4 | 13.8 | 9.3 | 1.2 | 3.2 | 8 | 3.5 | 143 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 1, Table 1-East Building

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| EH-E6 | 2 | 4 | 13.8 | 9.3 | 1.2 | 3.2 | 8 | 3.5 | 143 |
| EH-E7 | 2 | 4 | 13.8 | 9.3 | 1.2 | 3.2 | 8 | 3.5 | 143 |
| EJ-E0.5 | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| EJ-E1 | 4 | 4 | 10.8 | 5.8 | 4.8 | 6.8 | 8 | 8 | 462 |
| EJ-E2 | 5 | 5 | 9.0 | 3.5 | 7.0 | 9.0 | 10 | 10 | 784 |
| EJ-E3 | 5 | 5 | 9.0 | 3.5 | 7.0 | 9.0 | 10 | 10 | 784 |
| EJ-E4 | 5 | 5 | 12.8 | 7.3 | 3.3 | 5.3 | 10 | 10 | 420 |
| EK-E1 | 5 | 5 | 11.2 | 5.7 | 3.8 | 5.8 | 10 | 10 | 467 |
| EK-E2 | 6 | 5 | 10.8 | 4.5 | 5.0 | 7.0 | 12.5 | 8 | 583 |
| EK-E3 | 6 | 5 | 9.0 | 2.8 | 6.8 | 8.8 | 12.5 | 8 | 765 |
| EK-E4 | 5 | 5 | 9.0 | 3.5 | 6.0 | 8.0 | 10 | 10 | 676 |
| EK.7-E2 | 2 | 4 | 10.3 | 5.8 | 3.8 | 5.8 | 8 | 3.5 | 293 |
| EK.7-E3 | 2 | 4 | 10.3 | 5.8 | 3.8 | 5.8 | 8 | 3.5 | 293 |
| EL-E1 | 4 | 4 | 10.5 | 5.5 | 4.0 | 6.0 | 8 | 8 | 400 |
| EL-E1.9 | 6 | 5 | 10.5 | 4.3 | 5.3 | 7.3 | 12.5 | 8 | 608 |
| EL-E3.1 | 6 | 5 | 10.5 | 4.3 | 5.3 | 7.3 | 12.5 | 8 | 608 |
| EL-E4 | 5 | 5 | 10.5 | 5.0 | 4.5 | 6.5 | 10 | 10 | 529 |
| EM-E1.9 | 2 | 4 | 10.5 | 6.0 | 3.5 | 5.5 | 8 | 3.5 | 276 |
| EM-E3.1 | 2 | 4 | 10.5 | 6.0 | 3.5 | 5.5 | 8 | 3.5 | 276 |
| EM-E4 | 2 | 4 | 10.5 | 6.0 | 3.5 | 5.5 | 8 | 3.5 | 276 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation

Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 1, Table 1-East Building

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.5 | 9.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 8.1 | 7.1 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 8.1 | 7.1 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 9.5 | 8.5 | N/A | 0.5 | 2 | 2 | 9 |
| | | | | | | | | **Total($ft^2$):** | **25200** |

**Pile Caps dimensions**

| # of piles | Comments | Dim 1 (ft) | Dim 2 (ft) | Thickness |
|---|---|---|---|---|
| 1 | | 2 | 2 | |
| 2 | | 8.0 | 3.5 | 3.5 |
| 3 | Triangular | 8.0 | 7.5 | 4.0 |
| 4 | | 8.0 | 8.0 | 4.0 |
| 5 | | 10.0 | 10.0 | 4.5 |
| 6 | | 12.5 | 8.0 | 5.3 |
| 7 | | 16.5 | 10.0 | 5.5 |
| 8 | | 16.5 | 10.0 | 5.5 |
| 32 | | 37.0 | 46.0 | 5.3 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation

Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 1, Table 2-West Building

| Pile Cap | Number of Piles | Cap Thicknes s (ft) | Top of Pile Cap Elevation (ft) | Excavation Subgrade Elevation (ft) | Depth of Excavatio n Subgrade Below MMC (ft) | Pile Cap Edge to Drainage Dam, B (ft) | Length of Pile Cap (ft) | Width of Pile Cap (ft) | Area Without Drainage Net ($ft^2$) |
|---|---|---|---|---|---|---|---|---|---|
| EA.1-W1.8 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA.1-W3.2 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA.1-W4 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA.1-E12 | 1 | 0 | 13.5 | 12.5 | N/A | 0.5 | 2 | 2 | 9 |
| EA.1-E13 | 1 | 0 | 13.5 | 12.5 | N/A | 0.5 | 2 | 2 | 9 |
| EA.1-E14 | 1 | 0 | 13.5 | 12.5 | N/A | 0.5 | 2 | 2 | 9 |
| EA-W1 | 3 | 4 | 13.5 | 8.5 | 4.0 | 6.0 | 8 | 7.5 | 390 |
| EA.9-E12 | 2 | 4 | 13.8 | 9.3 | 3.3 | 5.3 | 8 | 3.5 | 259 |
| EA.9-E13 | 1 | 0 | 13.8 | 12.8 | N/A | 0.5 | 2 | 2 | 9 |
| EA.9-E14 | 1 | 0 | 13.8 | 12.8 | N/A | 0.5 | 2 | 2 | 9 |
| EB.9-E12 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| EB.9-E13 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| EB.9-E14 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| EC.9-E12 | 2 | 4 | 14.0 | 9.5 | 3.0 | 5.0 | 8 | 3.5 | 243 |
| EC.9-E13 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| EC.9-E14 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| ED.9-E12 | 2 | 4 | 14.0 | 9.5 | 2.0 | 4.0 | 8 | 3.5 | 184 |
| ED.9-E13 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| ED.9-E14 | 1 | 0 | 14.0 | 13.0 | N/A | 0.5 | 2 | 2 | 9 |
| EE.8-E12 | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| EE.8-E13 | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| EE.8-E14 | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| EF.9-E12 | 1 | 0 | 12.8 | 11.8 | N/A | 0.5 | 2 | 2 | 9 |
| EF.9-E13 | 2 | 4 | 13.8 | 9.3 | 2.3 | 4.3 | 8 | 3.5 | 198 |
| EF.9-E14.3 | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| EG.9-E13 | 2 | 4 | 12.8 | 8.3 | 2.8 | 4.8 | 8 | 3.5 | 228 |
| EG.9-E14.5 | 1 | 0 | 13.8 | 12.8 | N/A | 0.5 | 2 | 2 | 9 |
| EH.9-E13 | 2 | 4 | 12.5 | 8.0 | 2.5 | 4.5 | 8 | 3.5 | 213 |
| EH.9-E14.4 | 1 | 0 | 12.5 | 11.5 | N/A | 0.5 | 2 | 2 | 9 |
| EJ.2-E13 | 2 | 4 | 10.6 | 6.1 | 4.4 | 6.4 | 8 | 3.5 | 339 |
| EJ.2-E14.2 | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| EK.2-W1 | 5 | 5 | 11.2 | 5.7 | 3.8 | 5.8 | 10 | 10 | 467 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| EK.8-W1.9 | 8 | 6 | 11.2 | 4.7 | 4.8 | 6.8 | 16.5 | 10 | 710 |
| EK.8-W3 | 8 | 6 | 11.2 | 4.7 | 4.8 | 6.8 | 16.5 | 10 | 710 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| EK.8-W4 | 4 | 4 | 11.2 | 6.2 | 3.3 | 5.3 | 8 | 8 | 346 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| EM-E8 | 2 | 4 | 10.2 | 5.7 | 3.8 | 5.8 | 8 | 3.5 | 296 |
| EM-E9 | 3 | 4 | 10.2 | 5.2 | 4.3 | 6.3 | 8 | 7.5 | 414 |
| EM-E10 | 3 | 4 | 10.2 | 5.2 | 4.3 | 6.3 | 8 | 7.5 | 414 |
| EM-E11 | 2 | 4 | 10.2 | 5.7 | 3.8 | 5.8 | 8 | 3.5 | 296 |
| EM-E12 | 2 | 4 | 10.2 | 5.7 | 3.8 | 5.8 | 8 | 3.5 | 296 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 1, Table 2-West Building

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| WA-W1 | 4 | 4 | 10.6 | 5.6 | 6.9 | 8.9 | 8 | 8 | 666 |
| WA-W2 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WA-W3 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WA.2-W4 | 4 | 4 | 13.8 | 8.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WB-W1 | 4 | 4 | 10.6 | 5.6 | 6.9 | 8.9 | 8 | 8 | 666 |
| WB-W2 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| WB-W3 | 5 | 5 | 8.6 | 3.1 | 9.4 | 11.4 | 10 | 10 | 1076 |
| WB.2-W4 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| WC-W1 | 5 | 5 | 14.0 | 8.5 | 4.0 | 6.0 | 10 | 10 | 484 |
| WC.2-W4 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| WC-W2.5 | 32 | 5 | 14.8 | 8.5 | 3.0 | 5.0 | 37 | 46 | 2632 |
| WD-W1 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| WD.2-W4 | 4 | 4 | 14.0 | 9.0 | 3.5 | 5.5 | 8 | 8 | 361 |
| WE-W1 | 4 | 4 | 12.8 | 7.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WE-W2 | 5 | 5 | 12.8 | 7.3 | 4.3 | 6.3 | 10 | 10 | 506 |
| WE-W3 | 5 | 5 | 12.8 | 7.3 | 4.3 | 6.3 | 10 | 10 | 506 |
| WE.2-W4 | 4 | 4 | 12.8 | 7.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WF-W1 | 4 | 4 | 12.8 | 7.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WF-W2 | 5 | 5 | 12.8 | 7.3 | 4.3 | 6.3 | 10 | 10 | 506 |
| WF-W3 | 5 | 5 | 12.8 | 7.3 | 4.3 | 6.3 | 10 | 10 | 506 |
| WF.2-W4 | 4 | 4 | 12.8 | 7.8 | 3.8 | 5.8 | 8 | 8 | 380 |
| WG-W1 | 4 | 4 | 12.8 | 7.8 | 3.3 | 5.3 | 8 | 8 | 342 |
| WG-W2 | 5 | 5 | 12.8 | 7.3 | 3.8 | 5.8 | 10 | 10 | 462 |
| WG-W3 | 5 | 5 | 12.8 | 7.3 | 3.8 | 5.8 | 10 | 10 | 462 |
| WG.2-W4 | 4 | 4 | 12.8 | 7.8 | 3.3 | 5.3 | 8 | 8 | 342 |
| WH-1 | 4 | 4 | 12.8 | 7.8 | 2.8 | 4.8 | 8 | 8 | 306 |
| WH-2 | 5 | 5 | 8.8 | 3.3 | 7.3 | 9.3 | 10 | 10 | 812 |
| WH-3 | 5 | 5 | 8.8 | 3.3 | 7.3 | 9.3 | 10 | 10 | 812 |
| Single | 1 | 0 | 7.8 | 6.8 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 7.8 | 6.8 | N/A | 0.5 | 2 | 2 | 9 |
| WH.2-W4 | 5 | 5 | 10.8 | 5.3 | 5.3 | 7.3 | 10 | 10 | 600 |
| WJ-W1 | 5 | 5 | 11.2 | 5.7 | 4.8 | 6.8 | 10 | 10 | 557 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| WJ-W2 | 7 | 6 | 11.2 | 4.7 | 5.8 | 7.8 | 16.5 | 10 | 822 |
| WJ-W3 | 7 | 6 | 11.2 | 4.7 | 5.8 | 7.8 | 16.5 | 10 | 822 |
| WJ.2-W4 | 5 | 5 | 10.8 | 5.3 | 5.3 | 7.3 | 10 | 10 | 600 |
| WK-W1 | 5 | 5 | 11.2 | 5.7 | 4.8 | 6.8 | 10 | 10 | 557 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| Single | 1 | 0 | 10.0 | 9.0 | N/A | 0.5 | 2 | 2 | 9 |
| | | | | | | | | **Total($ft^2$):** | **27243** |

**CALCULATION SET 2**
**EE MEMO 2**

# MUESER RUTLEDGE CONSULTING ENGINEERS

File No.: 13921/13922

Made by: FTF Date: 4/19/21

FOR: Harbor Point Area 1, Phase 2, Parcel 3 Engineering Evaluation

Checked by: AMD Date: 4/26/21

SUBJECT: Calculation 2

| | | |
|---|---|---|
| Limits of Disturbance (LOD) Area(ft2) | 351251 | ALOD |
| Total Building Area(ft2) | 147282 | |
| East Building Obstructed Drainage Net Area(ft2) | 27243 | |
| West Building Obstructed Drainage Net Area(ft2) | 25200 | |
| Total Obstructed Drainage Net Area(ft2) | 52443 | AOBS |

Obstructed Drainage Net (%) $1-\frac{A_{LOD}-AOBS}{A_{LOD}}=$ 14.93%

## EE Memo 3 Estimated Settlement Under Development Fill

|M|R|C|E|
built on firm foundations

# MEMORANDUM

**Date:** January 14, 2022

**To:** Office

**From:** Patrick E. Donaldson, Fred T. Falcone Jr., and Adam M. Dyer

**Re:** Estimated Settlement Under Development Fill

**File:** Area 1, Phase 2, Parcel 3, Baltimore, MD
File # 13921/13922

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This memorandum summarizes analyses of estimated settlement resulting from fill placed for the development. The purpose of these estimates is to determine if the proposed grading scheme will cause settlement which may influence the integrity of the multimedia cap (MMC) and to determine what loading conditions are allowed at different locations across the site. Additionally, where excess settlement or loads were determined, alternative construction methods or engineered solutions are recommended.

## EXHIBITS

| | |
|---|---|
| Figure 1 (EE Memo 3) | Existing Conditions and Site Constraints |
| Figure 2 (EE Memo 3) | Load Limitation Plan |
| Figure 3 (EE Memo 3) | Analysis Zones and Fill Assessment |
| Figure 4 (EE Memo 3) | Recommended Fill Plan |
| Attachment A (EE Memo 3) | Stratum O Laboratory Testing Data |
| Attachment B (EE Memo 3) | Settlement and Overburden Calculations |

## AVAILABLE INFORMATION

1. Drawing FO.101 — Subsurface Features Plan
2. Drawing FO.109 — Geomembrane Protections Plan
3. Drawing FO.111 — Park Promenade Structures Partial Plan
4. Drawing FO.332 — ERS Component Protections Details

## REFERENCES


1. Drawing No. C-310, Grading Plan – C-310, Detailed Development Plan, dated August 2, 2021.
2. Drawing No. I-1, Criteria for Interim Use Harbor Point Site Area 1 West of Wills Street, dated September 10, 2003.

## SUBSURFACE CONDITIONS

Subsurface conditions consist of a layer of fill underlain by a compressible organic clay stratum or a series of sand and silt strata. The organic clay strata, Stratum O, is at the south and west side of the site, outside of the historic shoreline, nearest to the Patapsco River. Where found, the organic clay stratum ranged in thickness from approximately 10 feet to over 20 feet. This compressible stratum is generally described as soft brown to black organic silty clay with trace vegetation and fine sand, and is typically given a USCS classification of OH or OL. This clay layer is underlain by the series of very compact sand and very stiff silt strata found beneath the surficial fill inboard of the historic shoreline. The sand and silt strata extend to bedrock at approximately Elev. -80. Groundwater is managed by the HMS at or below low tide at approximately Elev. 0 to Elev. +1.

## HISTORIC EARTHWORK

As part of the corrective measures during the 1990s Honeywell pre-loaded the site in areas of potentially high settlement, see Drawing FO.101. Historic earthwork operations in the vicinity of the site include:

S-B Barrier Construction c. 1999:

The S-B Barrier trench was excavated in close proximity to the south and west sides of the bulkhead structures. At the completion of the trench excavation, excess non-hazardous soil spoils were stockpiled to provide surcharge weight to consolidate the clay stratum in an area immediately to the east of the Type J Platform.

MMC Construction c. 1999:

After completion of the S-B Barrier, the MMC was constructed including soil cover to the present grade.

In general, it is assumed that the preloading successfully consolidated the clay to the surcharge load in all of the surcharge schemes.

This historic surcharging is significant to the current settlement analysis when determining whether the compressible clay will be in a recompression or virgin compression loading condition as a result of fill placement to achieve the proposed grades. If the proposed new grade is above that of the historic pre-load, a significant magnitude of settlement can be expected due to virgin compression of the underlying material. If the proposed new grades are below the historic pre-load only recompression settlement will occur.

## ASSESSMENT OF SETTLEMENT POTENTIAL

An overlay of proposed grades, existing conditions and historic conditions was examined to analyze areas of settlement concern. Where grades were shown to rise, the areas were examined for both the presence of underlying organic clay and if there was a history of preloading. Additionally, where grade is proposed to increase, those areas were examined with respect to the Figure 2 (EE Memo 3) and the change in net loading due to the rising grades.

Areas where grades are proposed to rise 1-foot or more and are outboard of the historic shoreline have underlying organic clay stratum, were analyzed for potential settlement and consolidation.

## COMPRESSIBILITY CHARACTERISTICS

Previous laboratory testing indicates a good correlation between natural water content and compression ratio, swell index, and initial void ratio, see Attachment A. To assess the compressibility characteristics of Stratum O, natural water content of borings within the vicinity of each analysis area was investigated. An average water content of 60% was determined from boring MR-801 used to estimate compressibility characteristics for Stratum O to be used in the calculations. Boring MR-801, conducted in 2013, was considered to most closely resemble recent conditions of Stratum O at the site due to its location and date conducted.

## ANALYSIS AND ASSUMPTIONS

In general, the final proposed grades were analyzed for bearing capacity and settlement constraints. Bearing capacities are limited based on Figure 2 (EE Memo 3) and is based on the underlying compressible deposits, abandoned pile supported deteriorated platforms, and flow in the Drainage Net. Total settlement is limited to less than 2 inches settlement of the Geomembrane. This limits strain on the Geomembrane and retains a positive slope for surface water infiltration to drain through the Drainage Net to the Toe Drain or Infiltration Trench.

The 2 inches of allowable settlement of the Geomembrane for areas outside of existing abandoned pile supported platforms was previously established during the Area 1, Phase 1, Exelon Project. Calculations showing that a positive slope for the Drainage Net is maintained with 2 inches of settlement are provided in Attachment B. The calculations assume that 2 inches of settlement occur between the edge of the building (pile supported) and the El. +7 contour of the Geomembrane (14.7 feet away at the closest position). The Collapsed Section of the Covered Slip is limited to zero net loading or unloading (see EE Memo 6). The Covered Slip north of the Collapsed Section is either shielded by the former Building 23 foundations, or will be shielded by the future relieving platform designed by MRCE and will not be loaded by future site filling, see calculations in Attachment B and EE Memo 6 for additional information.

The drainage net across the entire site, regardless of location, is limited to a maximum load of 2,000 psf (Ref. 2). The loading conditions for the site based on the results of the analysis performed in this memo are provided in Figure 2 (EE Memo 3).

For fill load assessments it is assumed that:

- In place unit weight of the Cover Soil is about 120 pounds per cubic foot (pcf)
- Placed unit weight of Regular Weight Fill (RWF) is about 125 pcf
- Placed unit weight of Lightweight Fill (LWF) is about 55 pcf
- Placed unit weight of reinforced concrete is about 150 pcf

### Settlement Analysis

Settlement is computed as the sum of three contributors. These include elastic compression, consolidation, and secondary compression. For this analysis, in areas where re-compression only is anticipated, it is assumed that secondary compression is negligible. In areas where virgin compression is anticipated, elastic compression and secondary compression are negligible with respect to engineering improvements necessary to alleviate settlement concerns. It was assumed that strata at and below the hard silty clay of Stratum M or the compact sands of Stratum S-4 were incompressible under the potential loadings.

#### Consolidation

Consolidation settlement compressible strata estimates were developed using one-dimensional consolidation theory after Terzaghi (1947). Profiles were determined for analysis based on the nearest boring data and are shown on the calculations in Attachment B. The compressible stratum was divided into sub-layers approximately two to five feet in thickness. The ground water table was assumed to be at El. +0.66. An initial calculation was conducted for estimated settlement from 1997 to 2020 due to the MMC construction. This calculation was conducted to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMC construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

A second calculation was then conducted to estimate primary and secondary consolidation of the compressible Stratum O due to the proposed development from existing conditions, with the updated compressibility parameters.

### Analysis

After a review of the site grading plan and the proposed grade changes, the site was divided in three zones A, B, and C, as shown on Figure 3 (EE Memo 3). Zone A is where the pile supported platform is planned, Zone B is where proposed grade changes are less than 1 foot, and Zone C is where proposed grade increases are greater than 1 foot. Seven locations, S-1 through S-7 were chosen for settlement and/or overburden analysis. The locations are shown on Figure 3 (EE Memo 3).

As discussed in EE Memo 6, the Type J Platform is limited to 600 psf over the Drainage Net. Overburden analyses were performed at this location, as shown in Figure 3 (EE Memo 3), to balance site filling and proposed live loads in these areas. The analyses considered replacement of regular weight fill with lightweight fill to maintain load restriction.

An overburden analysis was performed at the proposed Mechanically Stabilized Earth (MSE) Wall location (adjacent to the grand staircase) due to the height of the planned fill. The analysis was performed to manage lightweight fill placement with regular weight fill placement and an imposed truck load to maintain less than 2000 psf loading on the Drainage Net.

For all areas, the applied soil pressure from proposed grading changes was calculated and compared to the load limitations on Figure 2 (EE Memo 3).

Settlement was calculated at three areas where historic preloading was not conducted (locations S-1, S-5, and S-7). At all three areas the compressible Stratum O was considered to be normally consolidated. Location S-6, near the edge of a pre-loaded area, was calculated as if pre-loading had not occurred. Estimated settlement was calculated and compared to an allowable settlement of 2 inches. Allowable settlement is based on the change in slope of the Drainage Net due to differential settlement, and is controlled by the allowable strain and shear resistance of the Geomembrane. Settlement calculations were not performed at locations S-2, S-3, and S-4 because these locations either are shielded by the existing Building 23 foundations (S-2), will be shielded by the proposed pile supported relieving platform (S-3), or there is Stratum O is not present (S-4).

Settlement and overburden pressure analysis calculations are included in Attachment B.

## CONCLUSIONS

Analyses at the seven locations, S-1 through S-7, further divided the site into seven areas, as shown on Figure 4 (EE Memo 3). Analyses indicated the results described below.

<u>Area 1 – Building Ground Floor Slab</u>

Ground floor slab north of the limits of compressible deposits will be slab on grade. Slab on grade subgrade will be at least 12 inches below existing grade and considering a 250 psf live loading is well below the 2,000 psf Drainage Net stress limitation for Load Limitation Area A. No compressible deposits are present in this area and settlement will be negligible.

Ground floor slab south of the limits of compressible deposits will be a pile supported platform and subgrade will be either on grade or will require partial excavation of the Cover Soil within Load Limitation Area C, and results in a net unloading. Therefore, no settlement and no drag down of adjacent piles will occur.

Area 2 – Park Areas with Less than 12 Inches of Fill

Grade change will be less than 12 inches in this area. The resultant load on the Drainage Net assuming RWF will be up to 425 psf. The area overlies former Building 23 with abandoned intact structural slab and pile caps and falls within Load Limitation Areas B and C. Load from proposed grade changes will be carried by the abandoned deep foundations and beyond the compressible deposits. Therefore, settlement will be negligible.

Area 3 – Park Areas with Greater than 12 Inches of Fill

Grade change will be up to 3 feet in this area. The resultant load on the Drainage Net assuming RWF will predominantly be up to 613 psf. This area falls predominantly within Load Limitation Area C and is below the bearing capacity limitations. Portions of this area fall within Load Limitation Area A and have a resultant load on the Drainage Net of over 2,000 psf. This area has been subdivided into Area 5 (Location S-3). However, portions of this area overlie the L-Shaped area of the Covered Slip (Location S-2) this area was then subdivided into Areas 4. Locations S-1, S-5 and S-6 were estimated to have approximately 2 inches or less of settlement. Location S-7 was estimated to have approximately 5 ½ inches of settlement and will require LWF and was subdivided into Area 7. Settlement monitoring is recommended for this area to monitor the effectiveness of the light weight fill placement

Area 4 – L-Shaped Section of Covered Slip

A pile supported relieving platform has been designed for this area. The pile supported platform shields the covered slip from loading caused by filling. See EE Memo 6 for additional information.

**Areas Requiring Lightweight Materials:**

Area 5 – Grand Staircase Fill and MSE Wall

Overburden pressure on Drainage Net at the top of the grand staircase (and MSE Wall) was calculated to be greater than the allowable loading limits using a live load of 250 psf and RWF. Similar to location S-7, replacement of RWF with LWF was analyzed. Replacement of 4 feet of RWF with LWF was calculated to be below the Load Limitation Zone A (2,000 psf). LWF is recommended to be added where proposed grades exceed Elev. +23 adjacent to the grand staircase, along the MSE Wall.

Area 6 - Park Areas with Greater than 12 Inches of Fill Requiring LWF

Over-excavation and replacement with LWF was analyzed assuming excavation to the warning layer, at approximately Elev. +9, and placement of 3 feet 6 inches of LWF, followed by placement of RWF, above to proposed grade showed estimated settlement of about 2 inches and is within the allowable range. LWF is recommended to replace 3 feet 6 inches of RWF in this area.

Area 7 – Type J Platform

Over-excavation and replacement with LWF was analyzed assuming excavation to 6 inches above the Drainage Net and placement of 4 feet of LWF, followed by placement of RWF to proposed grade. This results in a load of less than 600 psf (net additional load of 50 psf) on the Drainage Net over the Type J Platform. This area accounts for approximately 40 linear feet of the type J Platform. The remainder of the platform requires placement of 3.5 feet of LWF which results in no net load on the platform. The areas with net loading are shown on Figure 4 (EE Memo 3). Settlement monitoring is recommended for this area to monitor the effectiveness of the light weight fill placement.

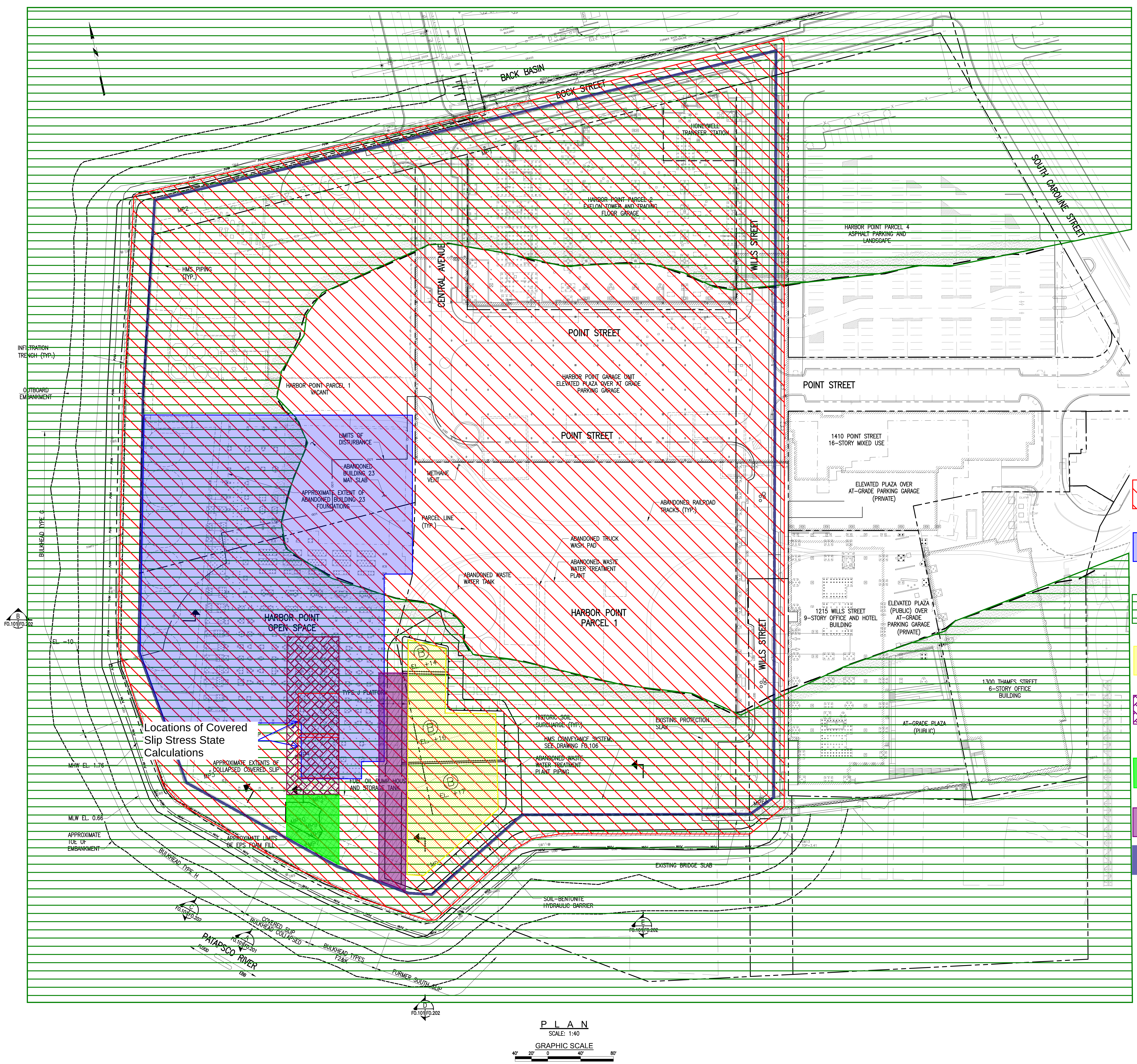
## SUMMARY

| Analysis Area[1] | Description of Location | Load Under RWF (psf) | Estimated Settlement Under RWF (in) | Load Under LWF (psf) | Estimated Settlement Under LWF (in) | Conclusion |
|---|---|---|---|---|---|---|
| 1 | Building Ground Floor Slab | Net Unloading | Net unloading, no settlement and no drag load on adjacent piles. | | | |
| 2 | Park Areas with < 12 inches Fill | 425 | < 1/2 | n/a | n/a | Ok with RWF. |
| 3 (S-1)[2] | Park Areas with > 12 inches Fill | 650 | 2 1/4 | n/a | n/a | Portions cover areas which exceed Load Limitation Zones A, C, D, and E. Will need lightweight fill and other protective measures. Therefore, Area 3 subdivided, See Areas 4, 5, 6 and 7. |
| 3 (S-4)[2] | | 713 | 2 | n/a | n/a | |
| 3 (S-6)[2] | | 588 | 1 ¾ | n/a | n/a | |
| 4 (S-2) | L-Shaped Section of Covered Slip | n/a | n/a | 391 | n/a | With LWF, no net additional load |
| 5 (S-4) | Grand Staircase Fill | 2250 | n/a | 1970 | n/a | LWF placement required for stress on Drainage Net limitations. |
| 6 (S-7) | Park Area with > 12 inches Fill Requiring LWF | 713 | 5 1/2 | 478 | 2 | LWF placement required for settlement limitations. |
| 7 (S-2) | Type J Platform | 763 | n/a | 443 | n/a | LWF required for no net increase in load |

Notes:
1. For approximate extents of areas, see Figure 2 (EE Memo 3).
2. S-x represents settlement analysis location.

F:\139\13921\Task 12 - DDP\Memos\Memo 3 - Settlement Calculations\Memo 3 - Estimated Settlement Under Development Fill.docx

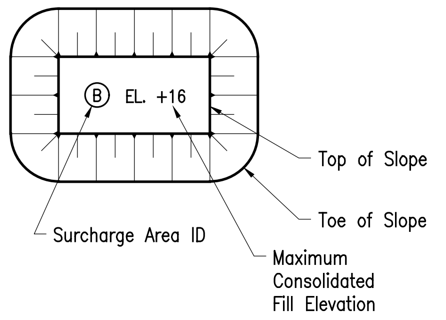
# EXHIBITS




NOTES:

1. For general notes, see Drawing DDP F0.100.
2. A Multimedia Cap (MMC) exists throughout the Limits of Disturbance. For details of MMC construction, see Drawing DDP F0.300.
3. Areas of compressible deposits have been surcharged. Refer to Phase II Construction Completion Report for details.
4. Abandoned structures exist below the MMC including steel rails with timber ties, cobblestones, timber relieving platforms with voids below; timber bulkheads; steel cofferdams; brick, concrete, and rubble stone foundations; timber and concrete piles. For descriptions of structures, see Geotechnical Report. For bulkhead sections see Drawing DDP F0.201. For details, see Drawing. DDP F0.102. Known structures include:
   - A. Bulkhead Type G
   - B. Bulkhead Type H
   - C. Covered Slip
   - D. Collapsed Covered Slip
   - E. Bulkhead Type F2 and K
   - F. Type J Platform
   - G. Abandoned Foundations
5. Locations of abandoned structures shown are approximate.

SURCHARGE LEGEND:




LEGEND:

Area where compressible deposits encountered in borings, see Drawing CDP G-100

Approximate limits of Historic Shoreline

LIMITING FEATURES

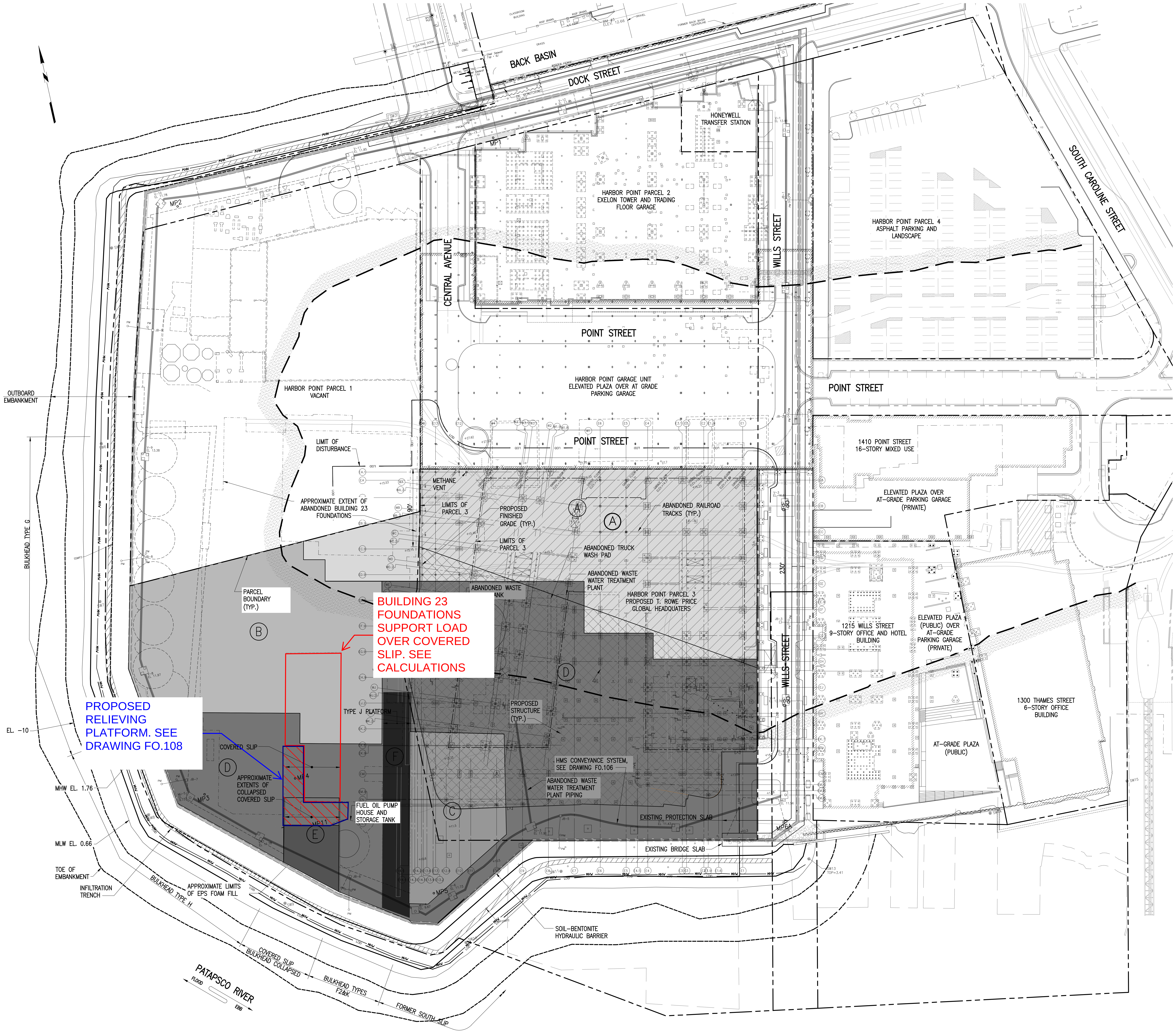
1. Drainage net - Limited to 2000psf
2. Buried Building 23 Foundations and Coffer Dam - Limited to between 500psf and 1250psf
3. Compressible clay deposits - Limited to 2 inches of settlement
4. Pre-Load Area - Limited to 2 inches of settlement
5. Covered Slip - Limited to no net loading or unloading where not supported by buried foundations or planned relieving platform
6. Collapsed Covered Slip - Limited to no net loading or unloading
7. Type J Platform - Limited to no net loading or unloading
8. Soil Bentonite Hydraulic Barrier - Limited to no net loading or unloading without bridge slab

When any limiting features overlap, the condition that allows less load governs (I.E. drainage net over the collapsed covered slip is limited to no net loading or unloading)

Refer to Figure 2, Load Limitations Plan, for additional loading information.

Harbor Point Parcel 3 and Park - Baltimore, Maryland
Beatty Development Group - Baltimore, Maryland
Mueser Rutledge Consulting Engineers, PLLC - New York, New York
EE Memo 3: Estimated Settlement Under Development Fill
Job No.: 13922; Made By: F.T.F.; Date: 2021-07-09

# FIGURE 1 (EE MEMO 3) - EXISTING CONDITIONS AND SITE CONSTRAINTS




NOTES:

1. For general notes, see Drawing DDP FO.001.
2. For notes on existing subsurface features, see Drawing DDP FO.101.
3. Estimated pile tip elevations indicated hereon are for preliminary design and cost estimation purposes only and are applicable only to the areas indicated. A Pile Indicator Program is required to determine final order lengths for West Building. For details of the Pile Indictor Program, see Drawing DDP FO.002.

MMC LOADING LIMITATIONS:

- (A) – Net loading of up to 2,000 pounds per square foot (psf) permitted on Drainage Net. This is inclusive of existing Cover Soil. Granular fill or Concrete slab on grade are permitted in this area.
- (B) – Net loading of up to 1,250 psf of load permitted on the MMC Geosynthetic Layers. This is inclusive of existing Cover Soil. Granular fill is permitted in this area.
- (C) – Net loading of up to 800 psf permitted on the MMC Geosynthetic Layers. This is inclusive of existing Cover Soil. Granular fill is permitted in this area.
- (D) – Net loading of up to 500 psf is permitted on the MMC Geosynthetic Lyaers. This is inclusive of existing Cover Soil. Granular fill is permitted in this area.
- (E) – No net loading or unloading is permitted. Existing 6 inches of CR-6 may be replaced by 12 inches of topsoil.
- (F) – Net loading of up to 600 psf is permitted on the MMC Geosynthetic Layers. This is inclusive of existing Cover Soil. Granular fill is permitted in this area.
- Area to be improved to allow Area D loading

LEGEND:

- Area where compressible deposits encountered in borings, see Drawing DDP FO.100
- Approximate limits of Historic Shoreline

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FIGURE 2 (EE MEMO 3) - LOAD LIMITATIONS PLAN

# LEGEND

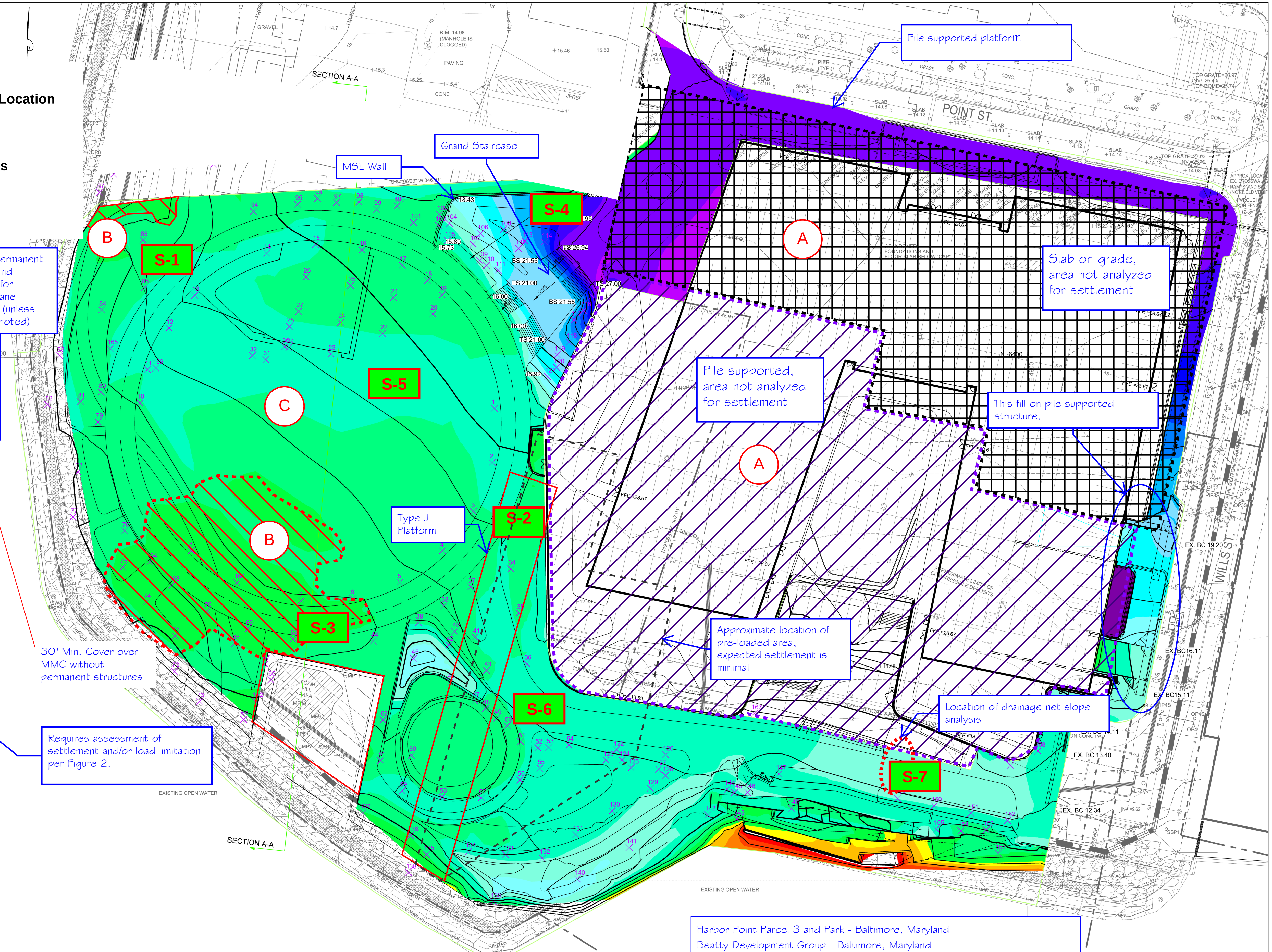
| | |
|---|---|
| S-1 | Settlement or Overburden Analysis Location |
| A | Slab on Grade, No Organics |
| A | Pile Supported Platform, No Analysis |
| B | Grade Increase of 1ft or Less |
| C | Grade Increase of 1ft or More |

GEOMEMBRANE = ELEV. 0

2.5' COVER

Elevations Table Legend

| Number | Minimum Elevation | Maximum Elevation | Color |
|---|---|---|---|
| 1 | 0.000 | 0.500 | |
| 2 | 0.500 | 1.000 | |
| 3 | 1.000 | 1.500 | |
| 4 | 1.500 | 2.000 | |
| 5 | 2.000 | 2.500 | |
| 6 | 2.500 | 3.000 | |
| 7 | 3.000 | 3.500 | |
| 8 | 3.500 | 4.000 | |
| 9 | 4.000 | 4.500 | |
| 10 | 4.500 | 5.000 | |
| 11 | 5.000 | 5.500 | |
| 12 | 5.500 | 6.000 | |
| 13 | 6.000 | 6.500 | |
| 14 | 6.500 | 7.000 | |
| 15 | 7.000 | 7.500 | |
| 16 | 7.500 | 8.000 | |
| 17 | 8.000 | 8.500 | |
| 18 | 8.500 | 9.000 | |
| 19 | 9.000 | 9.500 | |
| 20 | 9.500 | 10.000 | |
| 21 | 10.000 | 10.500 | |
| 22 | 10.500 | 11.000 | |
| 23 | 11.000 | 11.500 | |
| 24 | 11.500 | 12.000 | |
| 25 | 12.000 | 12.500 | |
| 26 | 12.500 | 13.000 | |
| 27 | 13.000 | 13.500 | |
| 28 | 13.500 | 14.000 | |
| 29 | 14.000 | 14.500 | |
| 30 | 14.500 | 15.000 | |
| 31 | 15.000 | 15.500 | |
| 32 | 15.500 | 16.000 | |
| 33 | 16.000 | 16.500 | |
| 34 | 16.500 | 17.000 | |
| 35 | 17.000 | 17.500 | |
| 36 | 17.500 | 18.000 | |
| 37 | 18.000 | 18.500 | |
| 38 | 18.500 | 19.000 | |
| 39 | 19.000 | 19.500 | |

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EE Memo 3: Estimated Settlement Under Development Fill
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## FIGURE 3 (EE MEMO 3)-ANALYSIS ZONES AND FILL ASSESSMENT

SCALE: 1" = 30'

T.ROWE PRICE GLOBAL HEADQUARTERS
1307 POINT STREET
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**GEOMEMBRANE COVER EXHIBIT**
SCALE: 1" = 30'

| DRAWN BY: DJB | CHECKED BY: RAF | DATE: AUGUST 12, 2021 |
|---|---|---|

# LEGEND

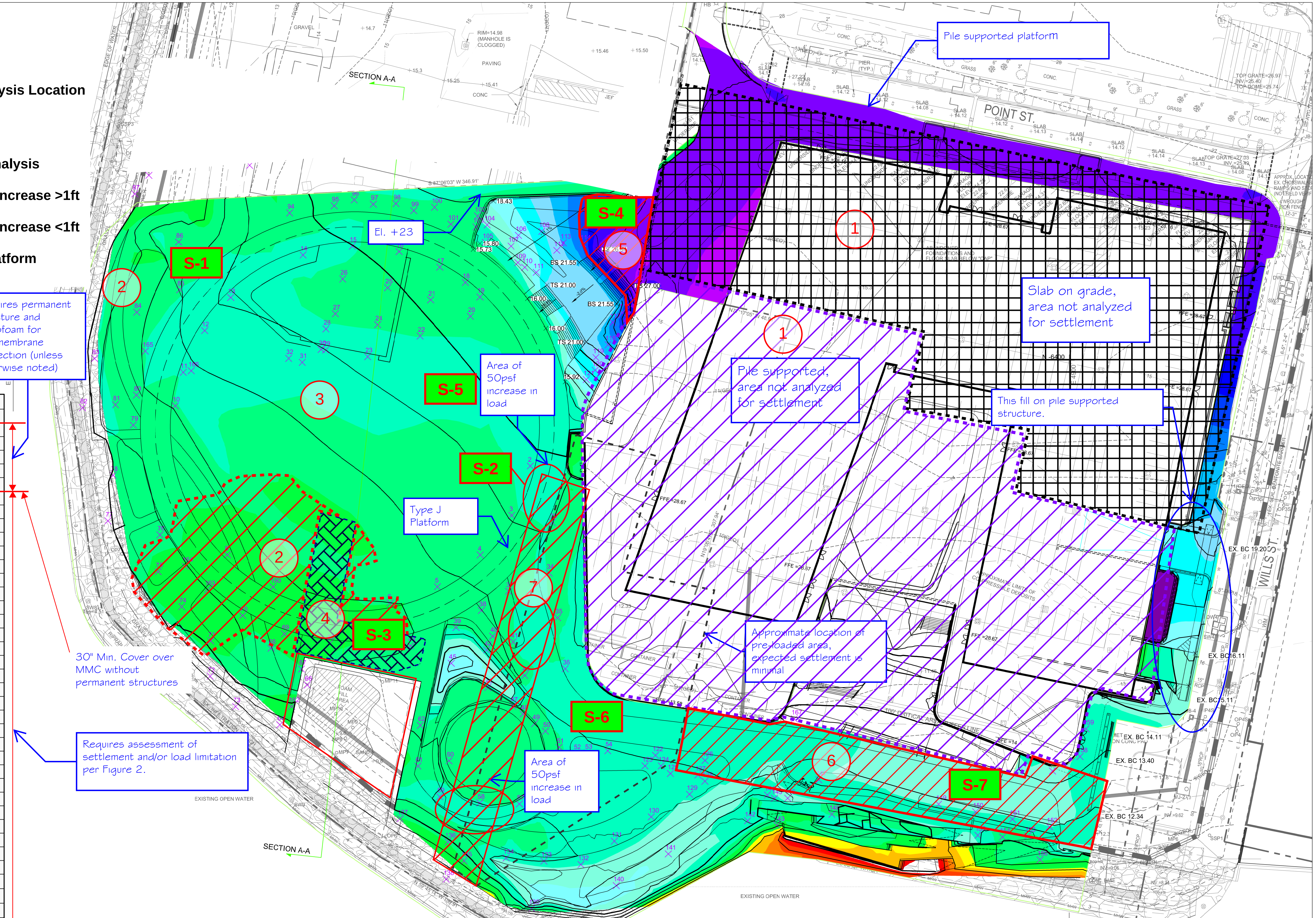
- S-1 — Settlement or Overburden Analysis Location
- 1 — Slab on Grade, No Organics
- 1 — Pile Supported Platform, No Analysis
- 2 — Acceptable Settlement, Grade Increase >1ft
- 3 — Acceptable Settlement, Grade Increase <1ft
- 4 — Covered Slip with Relieving Platform
- 5/6/7 — Lightweight Fill Required

GEOMEMBRANE = ELEV. 0

2.5' COVER

Elevations Table Legend

| Number | Minimum Elevation | Maximum Elevation | Color |
|---|---|---|---|
| 1 | 0.000 | 0.500 | |
| 2 | 0.500 | 1.000 | |
| 3 | 1.000 | 1.500 | |
| 4 | 1.500 | 2.000 | |
| 5 | 2.000 | 2.500 | |
| 6 | 2.500 | 3.000 | |
| 7 | 3.000 | 3.500 | |
| 8 | 3.500 | 4.000 | |
| 9 | 4.000 | 4.500 | |
| 10 | 4.500 | 5.000 | |
| 11 | 5.000 | 5.500 | |
| 12 | 5.500 | 6.000 | |
| 13 | 6.000 | 6.500 | |
| 14 | 6.500 | 7.000 | |
| 15 | 7.000 | 7.500 | |
| 16 | 7.500 | 8.000 | |
| 17 | 8.000 | 8.500 | |
| 18 | 8.500 | 9.000 | |
| 19 | 9.000 | 9.500 | |
| 20 | 9.500 | 10.000 | |
| 21 | 10.000 | 10.500 | |
| 22 | 10.500 | 11.000 | |
| 23 | 11.000 | 11.500 | |
| 24 | 11.500 | 12.000 | |
| 25 | 12.000 | 12.500 | |
| 26 | 12.500 | 13.000 | |
| 27 | 13.000 | 13.500 | |
| 28 | 13.500 | 14.000 | |
| 29 | 14.000 | 14.500 | |
| 30 | 14.500 | 15.000 | |
| 31 | 15.000 | 15.500 | |
| 32 | 15.500 | 16.000 | |
| 33 | 16.000 | 16.500 | |
| 34 | 16.500 | 17.000 | |
| 35 | 17.000 | 17.500 | |
| 36 | 17.500 | 18.000 | |
| 37 | 18.000 | 18.500 | |
| 38 | 18.500 | 19.000 | |
| 39 | 19.000 | 19.500 | |




Harbor Point Parcel 3 and Park - Baltimore, Maryland
Beatty Development Group - Baltimore, Maryland
Mueser Rutledge Consulting Engineers, PLLC - New York, New York
EE Memo 3: Estimated Settlement Under Development Fill
Job No.: 13922; Made By: F.T.F.; Date: 2021-08-13

FIGURE 4 (EE MEMO 3)- RECOMMENDED FILL PLAN

T.ROWE PRICE GLOBAL HEADQUARTERS
1307 POINT STREET
BALTIMORE, MARYLAND 21231

**GEOMEMBRANE COVER EXHIBIT**
SCALE: 1" = 30'

DRAWN BY: DJB | CHECKED BY: RAF | DATE: AUGUST 12, 2021

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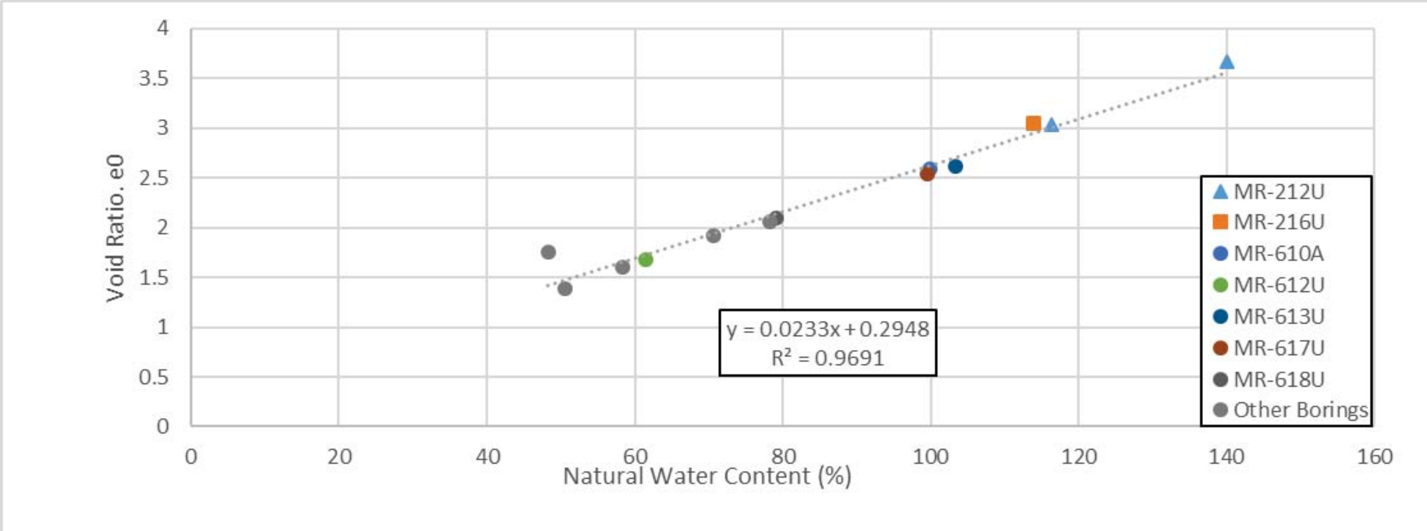
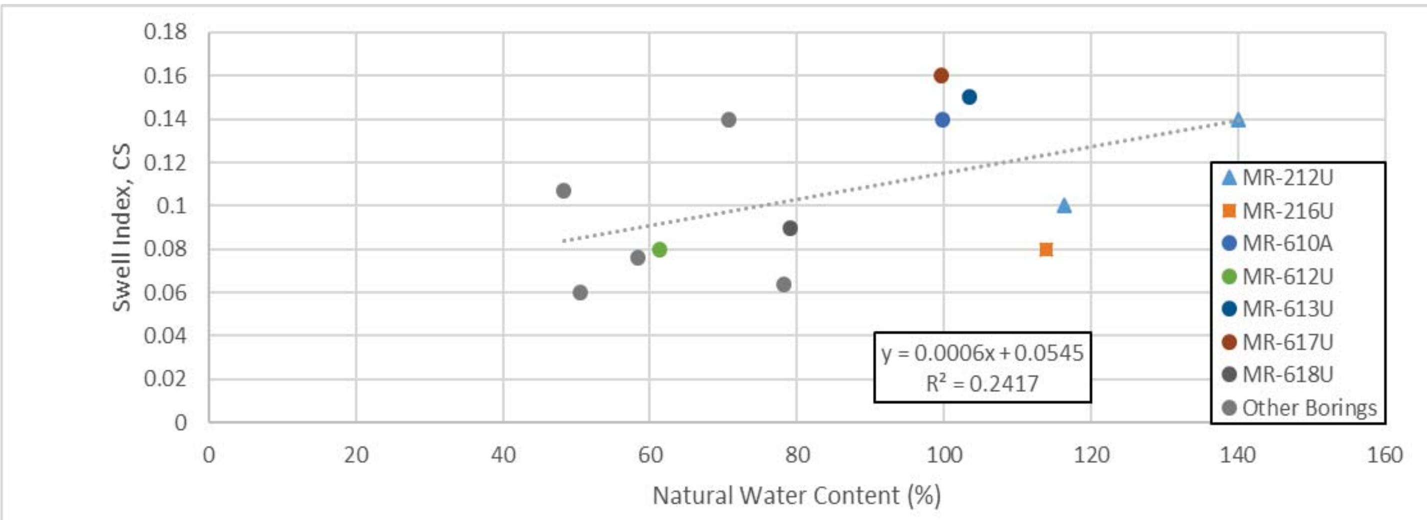
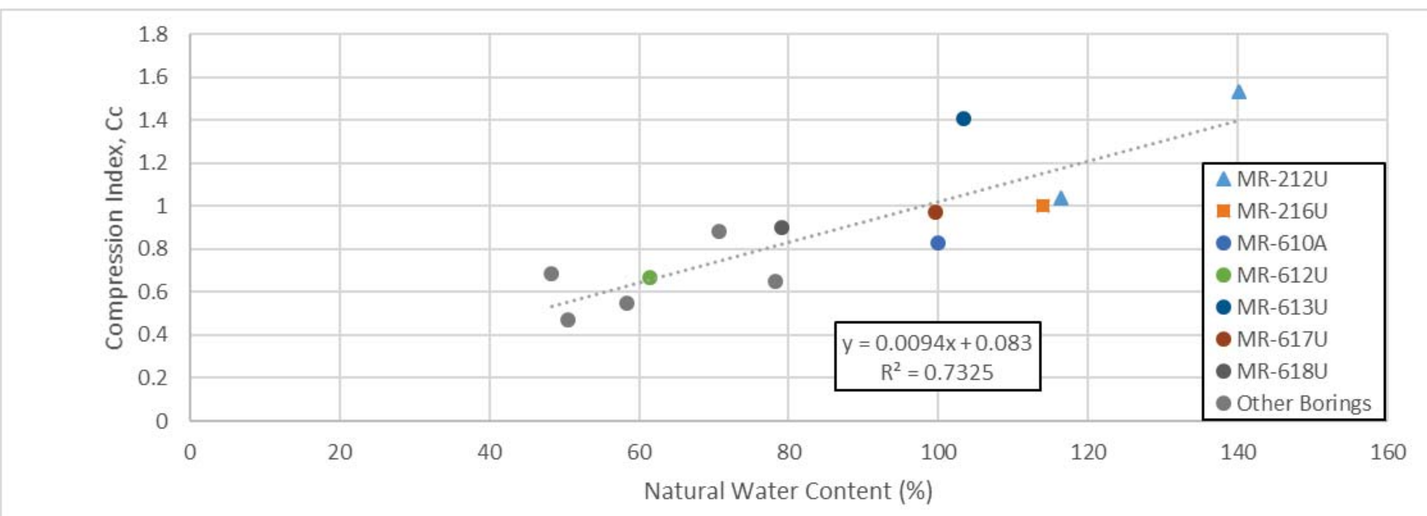
# APPENDIX A
# EE MEMO 3




**NOTES:**

1. Laboratory test data obtained from subsurface investigations performed by MRCE and Black & Veatch between 1988 and 2013. For test data, see Appendix B.
2. Data from "Other Borings" fall outside the limits of the Parcel 3 and Park sites.
3. Swell Index shows considerable variation, likely due to variations in overconsolidation.

| HARBOR POINT PARCEL 3 | | | |
|---|---|---|---|
| BALTIMORE | | | MARYLAND |
| **MUESER RUTLEDGE CONSULTING ENGINEERS** | | | |
| 14 PENN PLAZA – 225 W 34TH STREET, NEW YORK NY 10122 | | | |
| SCALE | MADE BY: FTF | DATE: 11/21/2020 | FILE No. |
| N/A | CH'KD BY: AMD | DATE: 12/19/2020 | 13921/22 |
| STRATUM O CHARACTERIZATION | | | FIGURE 4<br>**EE MEMO 3** |

# MUESER RUTLEDGE CONSULTING ENGINEERS

## BORING LOG

**BORING NO.** MR-801
**SHEET 1 OF** 5
**FILE NO.** 11896A
**SURFACE ELEV.** +12
**RES. ENGR.** ADAM M. DYER

PROJECT: EXELON TOWER & TF GARAGE
LOCATION: BALTIMORE, MARYLAND

| DAILY PROGRESS | SAMPLE NO. | SAMPLE DEPTH | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION | STRATA | DEPTH | CASING BLOWS | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 12:30 | 1D | 0.0 | 10-6 | Red brown & tan silty fine sand, trace clay, | | ** | DRILLED | **Asphalt 0 to 0.4' |
| 04-22-13 | | 2.0 | 10-9 | gravel, brick (Fill) (SM) | | | AHEAD | 1D: REC=13", DPC=(-) |
| Monday | | | | | | | 4" | |
| Breezy | 2D | 3.0 | 8-6 | Red brown silty fine to medium sand, some | | | STEEL | REC=18", DPC=(-) |
| 55°F | | 5.0 | 7-15 | clay pockets, trace gravel (Fill)(SM) | | 5 | | |
| | 3D | 5.0 | 4-6 | Brown silty fine to medium sand, trace gravel, | | | | REC=14", DPC=(-) |
| | | 7.0 | 8-15 | red clay pockets (Fill) (SM) | F | | | |
| | | | | | | | | |
| | 4D | 8.0 | 8-10 | Gray silty gravel, some fine to coarse sand, trace | | | | 1st Attempt, no |
| | | 10.0 | 14-18 | organic sandy silt pockets (Fill) (GM) | | 10 | | recovery, 2nd attempt, |
| | | | | | | | | REC=10", DPC=(-) |
| | | | | | | | | |
| 15:30 | | | | | | 13 | | Wash change at 13' to |
| 08:30 | | | | | | | | gray brown. |
| 04-23-13 | 5D | 14.0 | 3-5 | Stiff gray organic silty clay, trace fine to medium | | 15 | | REC=24", DPC=(-) |
| Tuesday | | 16.0 | 3-4 | sand (OH) | | | | WC=22, pp=1.25 |
| Overcast | | | | | | | | |
| 50°F | 6U | 17.0 | PUSH=24" | Medium gray organic clayey silt, trace fine | | | | REC=21", DPC=(-) |
| | | 19.0 | REC=21" | sand, shells (OL-CL) | | | | WC=32, pp=0.5 |
| | 7D | 19.0 | 2-2 | Medium gray organic fine sandy clay, trace | | 20 | | REC=22", DPC=(-) |
| | | 21.0 | 3-3 | medium sand (OL) | | | | WC=24, pp=0.5 |
| | | | | | | | | |
| | 8U | 22.0 | PUSH=24" | Medium gray organic silty clay, trace fine | O | | | REC=24", DPC=(-) |
| | | 24.0 | REC=24" | sand, shells (OH) | | | | WC=61, pp=0.75 |
| | 9D | 24.0 | 2-2 | Medium gray organic silty clay (OL) | | 25 | | REC=24", DPC=(-) |
| | | 26.0 | 2-3 | 10U TOP: Medium to soft gray organic silty | | | | WC=38, pp=0.75 |
| | | | | clay, trace fine sand, shells (OH) | | | | 10U: REC=24", DPC=(-) |
| | 10U | 27.0 | PUSH=24" | 10U BOT: Medium gray brown organic silty | | | | 10U Top: WC=64 |
| | | 29.0 | REC=24" | clay, trace fine sand, peat (OH) | | | | 10U Bot: WC=95, pp=1.25 |
| | 11D | 29.0 | 2-2 | Stiff gray organic clayey silt, trace black | | 30 | | REC=24", DPC=(-) |
| | | 31.0 | 4-4 | peat layer, fine sand (OL) | | | | WC=27, pp=1.25 |
| | | | | | | 32 | | Wash change to gray |
| | | | | | | | | at 32'. Rig chatter from |
| | | | | | | | | 32' to 38'. |
| | 12D | 34.0 | 16-23 | Gray fine to coarse sandy gravel, trace silt | S2 | 35 | | 1st Attempt REC=0" |
| | | 36.0 | 23-22 | (GM) | | | | 2nd attempt with 3" spo |
| | | | | | | | | REC=12", DPC=(-) |
| | | | | | | 38 | | |
| | | | | | | | | |
| | 13D | 39.0 | 8-12 | Hard red & white silty clay (CL) | | | | |
| | | 41.0 | 21-27 | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | 14D | 44.0 | 26-50 | Hard white clayey silt, trace fine sand parti | | | | |
| | | 45.6 | 85-50/2" | (ML) | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 16:30 | | | | | | | | |
| 07:30 | 15D | 49.0 | 48-50/2" | White fine sandy silt (ML) | | 50 | | REC=8", DPC=(-) |
| 04-24, Wed. | | 49.6 | | | | | | |
| Sun, 60°F-80°F | | | | | | | | |

Stratum O Water Content Summary:

Range: 22% to 95%

Average Water Contents from Undisturbed Tube Samples: 32%, 61%, 64%, 95%

Assume wc = 60%

**MUESER RUTLEDGE CONSULTING ENGINEERS**

## BORING LOG

| | | | |
|---|---|---|---|
| PROJECT: | EXELON TOWER & TF GARAGE | **BORING NO.** | MR-801 |
| LOCATION: | BALTIMORE, MARYLAND | **SHEET 2 OF** | 5 |
| | | **FILE NO.** | 11896A |
| | | **SURFACE ELEV.** | +12 |
| | | **RES. ENGR.** | ADAM M. DYER |

| DAILY PROGRESS | SAMPLE NO. | SAMPLE DEPTH | SAMPLE BLOWS/6" | **SAMPLE DESCRIPTION** | STRATA | DEPTH | CASING BLOWS | **REMARKS** |
|---|---|---|---|---|---|---|---|---|
| Cont'd | | | | | | | | |
| 04-24-13 | | | | | | | | |
| Wednesday | | | | | | | | |
| Sunny | | | | | | | | |
| 60°F-80°F | 16D | 54.0 | 35-85 | Tan & gray silty fine sand & fine sandy silt | | **55** | | REC=14", DPC=(-) |
| | | 55.2 | 50/2" | (SM+ML) | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | **S3** | | | |
| | 17D | 59.0 | 45-80 | Top 7": Do 15D (SM+ML) | | **60** | | 17D Top: REC=14", |
| | | 60.2 | 50/2" | Bot 7": Light gray coarse sandy gravel, trace | | | | DPC=(-) |
| | | | | silt (GM) | | | | 17D Bot: DPC=(-) |
| | | | | | | | | |
| | | | | | | | | |
| | 18D | 64.0 | 36-78 | White silty fine sand, trace coarse sand, iron | | **65** | | REC=14", DPC=(-) |
| | | 65.2 | 50/2" | staining (SM) | | | | |
| | | | | | | | | |
| | | | | | | **67.5** | | |
| | | | | | | | | |
| | 19D | 69.0 | 38-62 | Hard white & orange clayey silt, trace fine to | | **70** | | REC=14", DPC=(-) |
| | | 70.2 | 50/2" | medium sand (Decomposed Rock) (ML) | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | 20D | 74.0 | 58-50/1" | White & orange hard clayey silt, trace fine to coa | | **75** | | REC=7", DPC=(-) |
| | | 74.6 | | sand (Decomposed Rock) (ML) | **DR** | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | 21D | 79.0 | 12-21 | Red brown clayey silt, trace fine sand, (trace | | **80** | | REC=12", DPC=(-) |
| | | 80.4 | 71/5" | relict rock structure) (ML) | | | | Spoon bouncing at |
| | | | | | | | | 80.3'. |
| | | | | | | **82.5** | | |
| | | | | | | | | |
| | 22D | 84.0 | 50/4" | Brown & yellow fine to coarse sand, some silt, | | **85** | | REC=4", DPC=(+) |
| | | 84.4 | | clay (Decomposed Rock) (SM) | | | | Spoon bouncing at 84' |
| | | | | | | | | |
| | | | | | **TZ** | | | |
| | 23D | 89.0 | 100/3" | Gray & white silty fine to coarse sand | | **90** | | REC=3", DPC=(-) |
| | | 89.3 | | (Decomposed Rock) (SM) | | | | Spoon bouncing at 89.3 |
| | | | | | | | | |
| | | | | | | | | Hard drilling from 93.5' |
| 16:00 | | | | | | | | to 94'. |
| 07:30 | 24D | 94.0 | 50/1" | Do 23D (Decomposed Rock) (SM) | | **94.1** | 3* | REC<1", DPC=(-) |
| 04-25-13 | | 94.1 | | | | | 3* | Spoon bouncing at 94' |
| Thursday | 1C | 94.1 | REC=92% | Weathered to intermediate gray gneiss, trace | | | 3* | *Coring time in |
| Sunny | | 99.1 | RQD=78% | pegmatite layers, jointed, weathered joints | | | 3* | minutes per foot. |
| 55°F | | | | (Weathered Rock) | **WR** | | 3* | |
| | 2C | 99.1 | REC=97% | Intermediate gray gneiss, trace pegmatite layers | | **100** | 3* | |
| | | 104.1 | RQD=76% | jointed, weathered joints (Weathered Rock) | | | 3* | |
| | | | | | | | 2* | |

# MUESER RUTLEDGE CONSULTING ENGINEERS

## BORING LOG

| | |
|---|---|
| BORING NO. | MR-801 |
| SHEET 3 OF | 5 |
| FILE NO. | 11896A |
| SURFACE ELEV. | +12 |
| RES. ENGR. | ADAM M. DYER |

PROJECT: EXELON TOWER & TF GARAGE
LOCATION: BALTIMORE, MARYLAND

| DAILY PROGRESS | SAMPLE NO. | SAMPLE DEPTH | SAMPLE BLOWS/6" | SAMPLE DESCRIPTION | STRATA | DEPTH | CASING BLOWS | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Cont'd 04-25-13 Thurs., Sunny 55°F, 16:00 | | | | | WR | | 3* | |
| | | | | | | | 2* | |
| | | | | | | 104.1 | | End of Boring at 104.1'. |
| | | | | | | | | WC=Water Content in percent of dry weight. |
| | | | | | | 110 | | pp=Pocket Penetrometer Unconfined Compressive Strength in tsf. |
| | | | | | | 115 | | |
| | | | | | | 120 | | |
| | | | | | | 125 | | |
| | | | | | | 130 | | |
| | | | | | | 135 | | |
| | | | | | | 140 | | |
| | | | | | | 145 | | |
| | | | | | | 150 | | |

# MUESER RUTLEDGE CONSULTING ENGINEERS
## ROCK CORE SKETCH

**BORING NO.** MR-801
**SHEET** 4 **OF** 5
**FILE NO.** 11896A-90
**SURFACE ELEV.**
**RES. ENGR.** A. DYER

PROJECT: EXELON TOWER & TF GARAGE

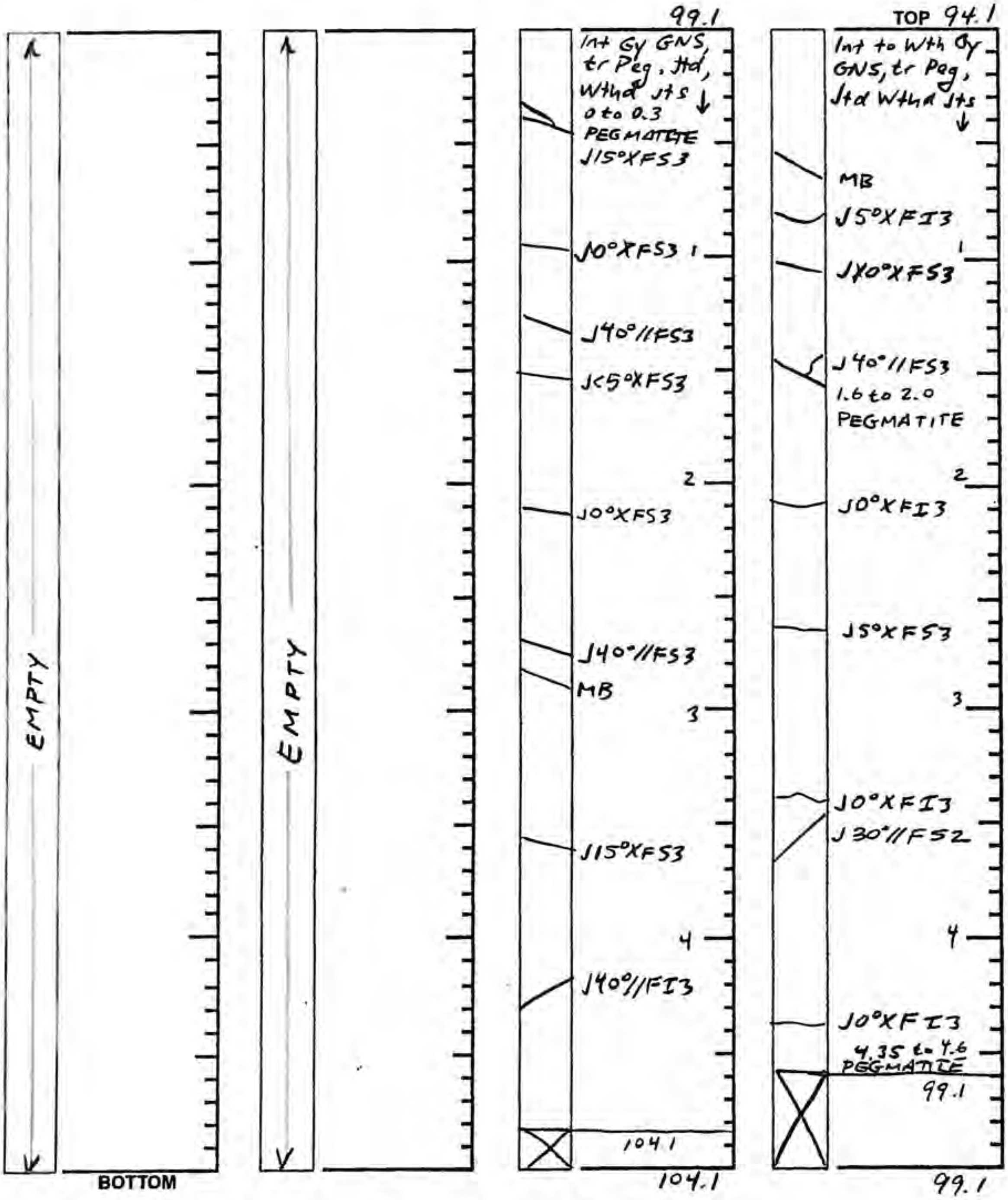
LOCATION: BALTIMORE, MARYLAND

| Run No. | REC / RQD |
|---|---|
| | |

| Run No. | REC / RQD |
|---|---|
| | |

| Run No. | REC / RQD |
|---|---|
| 2C | 97%/76% |

| Run No. | REC / RQD |
|---|---|
| 1C | 92%/78% |




**ROCK CORE SKETCH LEGEND**

**JOINTING**
- J - Joint
- MB - Mechanical Break
- ⊀ - Angle w/ Horizontal
- // - Parallel
- X - Crossing
- F - Foliation
- S - Stratification
- U - Unfoliated or Unstratified

**SURFACE**
- C - Curved
- I - Irregular
- S - Straight

**CONDITION**
- 1 - Slick
- 2 - Smooth
- 3 - Rough

**SKETCH SYMBOLS**
- Joint
- Healed Joint
- Broken
- Part of Core Not Recovered
- Cavities or Vugs In Core
- Clay
- Sand
- Empty Space

**NOTES** RUNS 1C & 2C have a Wthd to Int Hardness

# MUESER RUTLEDGE CONSULTING ENGINEERS

**BORING NO.** MR-801
**SHEET** 5 **OF** 5

**PROJECT** EXELON TOWER & TF GARAGE — **FILE NO.** 11896A
**LOCATION** BALTIMORE, MARYLAND — **SURFACE ELEV.** +12
**BORING LOCATION** SEE BORING LOCATION PLAN — **DATUM** BC & CD

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

| TYPE OF BORING RIG | | TYPE OF FEED DURING CORING | | CASING USED: X YES / NO | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TRUCK | MOBILE B-61 | MECHANICAL | | DIA., IN. | 4 | DEPTH, FT. FROM | 0 | TO | 18.5 |
| SKID | | HYDRAULIC | X | DIA., IN. | | DEPTH, FT. FROM | | TO | |
| BARGE | | OTHER | | DIA., IN. | | DEPTH, FT. FROM | | TO | |
| OTHER | | | | | | | | | |

TYPE AND SIZE OF:

D-SAMPLER: 2" & 1-3/8" O. D. SPLIT SPOON
U-SAMPLER:
S-SAMPLER:
CORE BARREL: NQ DOUBLE TUBE
CORE BIT: DIAMOND BIT
DRILL RODS: AWJ

DRILLING MUD USED: X YES / NO
DIAMETER OF ROTARY BIT, IN.: 3-7/8
TYPE OF DRILLING MUD: BENTONITE & EZ-MUD

AUGER USED: X YES / NO
TYPE AND DIAMETER, IN.: 4-1/4 & 8 I. D. & O. D., 0' TO 4'

*CASING HAMMER, LBS. ___ AVERAGE FALL, IN. ___
SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*ROPE, 2 WRAPS, 6" C/H., SAFETY HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

| DATE | TIME | DEPTH OF HOLE | DEPTH OF CASING | DEPTH TO WATER | CONDITIONS OF OBSERVATION |
|---|---|---|---|---|---|
| 04-25-13 | 07:15 | 94.1 | 38.5 | 10 | SITE CONTROLLED BY GROUND WATER PUMPING TO |
| | | | | | WEST, OVERNIGHT MUD LEVEL. |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

PIEZOMETER INSTALLED: YES / X NO — SKETCH SHOWN ON

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| STANDPIPE: | TYPE | | ID, IN. | | LENGTH, FT. | | TOP ELEV. |
| INTAKE ELEMENT: | TYPE | | OD, IN. | | LENGTH, FT. | | TIP ELEV. |
| FILTER: | MATERIAL | | OD, IN. | | LENGTH, FT. | | BOT. ELEV. |

PAY QUANTITIES

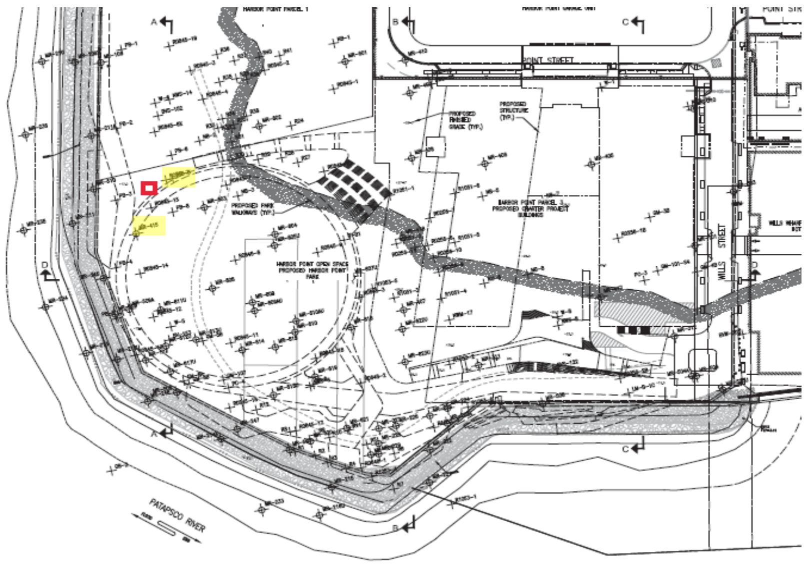
| | | | | |
|---|---|---|---|---|
| 3.5" DIA. DRY SAMPLE BORING | LIN. FT. | | NO. OF 3" SHELBY TUBE SAMPLES | |
| 3.5" DIA. U-SAMPLE BORING | LIN. FT. | | NO. OF 3" UNDISTURBED SAMPLES | 3 |
| CORE DRILLING IN ROCK | LIN. FT. | | OTHER: DAYS | 3.5 |

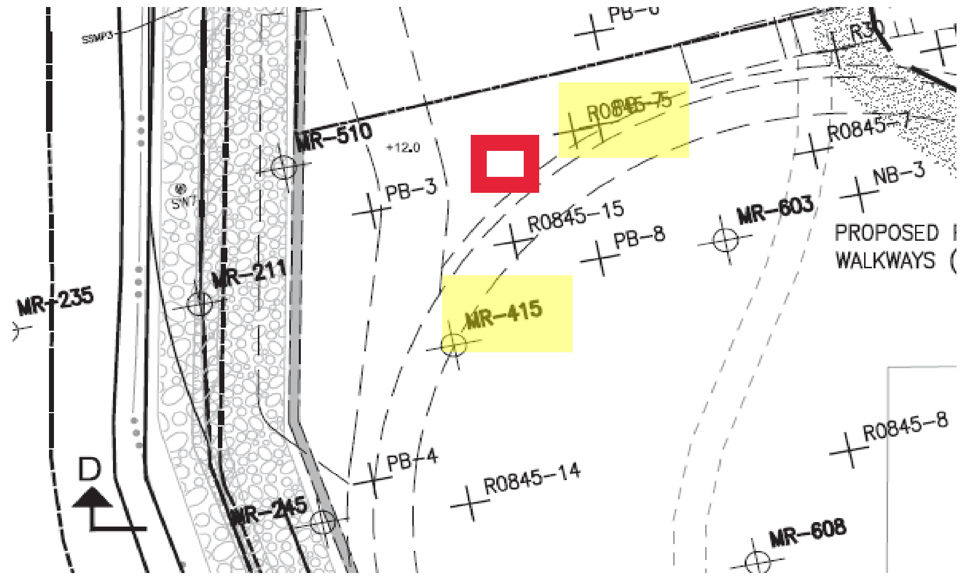
BORING CONTRACTOR: GEO-TECHNOLOGY ASSOCIATES, INC.
DRILLER: ANDY BISSETT — HELPERS: KYLE KOZAK
REMARKS: BORING FOR PILE LOAD TEST.
RESIDENT ENGINEER: ADAM M. DYER — DATE: 04-25-13
CLASSIFICATION CHECK: ANDREW R. KLAETSCH — TYPING CHECK: ADAM M. DYER

# APPENDIX B
# EE MEMO 3

SUBJECT: Settlement and Consolidation Calculation for Location S-1

**Location:** As shown below: From Dwg CDP G-100.00, dated 12/22/2020.

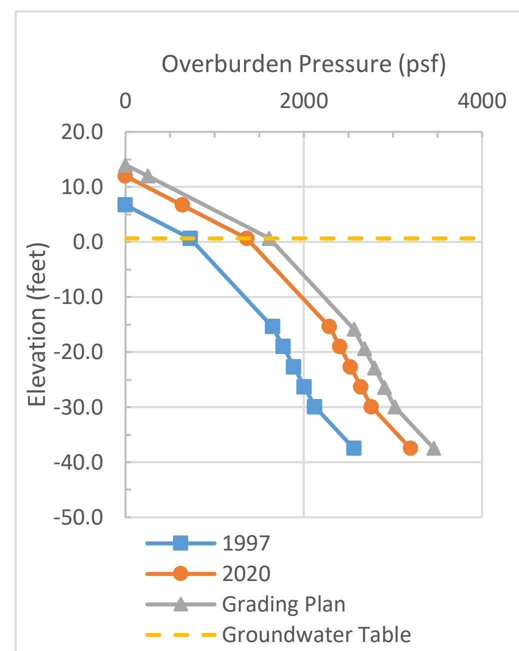





**Stratigraphy and Soil Properties:**

Boring logs used: MR-415 and R0847-5

| | 1993 | | 2020 | | 2020 (settled) | | Grading Plan | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) |
| F or RWF | 6.7 | 0.66 | 12.0 | 0.66 | 12.0 | 0.66 | 14.0 | 0.66 | 120 / 125 |
| F (bGW) | 0.66 | -15.4 | 0.66 | -15.4 | 0.66 | -15.9 | 0.66 | -15.9 | 57.6 |
| O | -15.4 | -29.9 | -15.4 | -29.9 | -15.9 | -18.6 | -15.9 | -29.9 | 32.6 |
| S-2 | -29.9 | -37.5 | -29.9 | -37.5 | -18.6 | -26.1 | -29.9 | -37.5 | 57.6 |
| M/S-4 | -37.5 | | -37.5 | | -26.1 | | -37.5 | | - |
| | | | | | | | | | |




Notes:
1. Groundwater table at Elev. +0.66.
2. Change in height of Stratum O in 2020 (settled) is a reflection of the calculated settlement and consolidation from 1997 to 2020 below.

**Calculate settlement and consolidation due to Fill placement from the MMR construction in 1997:**

Settlement is initially calculated from 1997 to 2020 to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMR construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

Parameters:

| | | |
|---|---|---|
| Avg. Water Content for Stratum O, $w_n$ = | 60 % | Average from water content from boring MR-801 who's conditions most closely resemble the current state soils. |
| Initial Void Ration, $e_0$ = | $0.233 \cdot w_n + 0.2948$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Compression Index, Cc = | $0.0094 \cdot w_n + 0.083$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Young's Modulus of Sands, Ei = | 740000 psf | Used for Stratums F, S-1, and S-2, from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Secondary Compression Ratio, Cα ≈ | Cc*0.05 ± 0.01 | Mesri and Godlewski (1977) |

Calculations:

| | | |
|---|---|---|
| Immediate Settlement, δi = | $\sum \Delta\sigma i \frac{Hi * I}{Ei}$ | Influence Factor, I = 1.0, for 1-D Loading |
| Consolidation Settlement, δs = | $\sum \frac{H_i}{1+e_{0i}} C_{ci} \log_{10} \frac{\sigma'_{vf}}{\sigma'_{vi}}$ | Assume only virgin compression occurs ($\sigma'_{vi} = p'_c$) |
| Secondary Settlement, Ss = | $\sum H_i C_{\alpha i} \log_{10} \frac{\Delta t}{t_p}$ | Assume Δt/tp = 10; from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Final Void Ration, $e_1$ = | $e_0 + \frac{\Delta H}{H*(1+e_0)}$ | |

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-1

| | | 1997 | | | 2020 | | | | | | | | 1997 to 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_0$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs | $e_1$ |
| F (added) | 120 | | | | 12.0 | 0 | 318 | - | - | - | - | - | - | - | - |
| | | | | | 6.7 | 636 | | | | | | | | | |
| F | 120 | 6.7 | 0 | 362 | 6.7 | 636 | 998 | - | - | - | - | 740000 | 0.06 | - | - |
| | | 0.66 | 725 | | 0.66 | 1361 | | | | | | | | | |
| F (bGW) | 57.6 | 0.66 | 725 | 1187 | 0.66 | 1361 | 1823 | - | - | - | - | 740000 | 0.17 | - | - |
| | | -15.4 | 1650 | | -15.4 | 2286 | | | | | | | | | |
| O1 | 32.6 | -15.4 | 1650 | 1709 | -15.4 | 2286 | 2345 | 60 | 1.693 | 0.647 | 0.032 | - | 1.44 | 0.117 | 1.597 |
| | | -19.0 | 1768 | | -19.0 | 2404 | | | | | | | | | |
| O2 | 32.6 | -19.0 | 1768 | 1827 | -19.0 | 2404 | 2463 | 60 | 1.693 | 0.647 | 0.032 | - | 1.36 | 0.117 | 1.602 |
| | | -22.7 | 1886 | | -22.7 | 2522 | | | | | | | | | |
| O3 | 32.6 | -22.7 | 1886 | 1945 | -22.7 | 2522 | 2581 | 60 | 1.693 | 0.647 | 0.032 | - | 1.28 | 0.117 | 1.606 |
| | | -26.3 | 2004 | | -26.3 | 2640 | | | | | | | | | |
| O4 | 32.6 | -26.3 | 2004 | 2063 | -26.3 | 2640 | 2699 | 60 | 1.693 | 0.647 | 0.032 | - | 1.22 | 0.117 | 1.610 |
| | | -29.9 | 2123 | | -29.9 | 2759 | | | | | | | | | |
| S-2 | 57.6 | -29.9 | 2123 | 2341 | -29.9 | 2759 | 2977 | - | - | - | - | 740000 | 0.08 | - | - |
| | | -37.5 | 2560 | | -37.5 | 3196 | | | | | | | | | |
| M/S-4 | - | | | | | | | | | | | | | | |

Immediate Settlement, δi = 0.31 inches
Consolidation Settlement, δc = 5.30 inches
Secondary Settlement, δs = 0.469 inches

**Total = δi + δc + δs = 6.07 inches**

**Calculate settlement and consolidation due to Fill placement above the MMR for the Proposed Grading Plan:**

Notes:
1. Initial void ratios are from the final void ratios in the calculation above.
2. Soil properties and calculations are the same as used above.

| | | 2020 (settled) | | | Grading Plan | | | | | | | | 2020 to Grading Plan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_1$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs |
| RWF (added) | 125 | | | | 14.0 | 0 | 125 | - | - | - | - | - | - | - |
| | | | | | 12.0 | 250 | | | | | | | | |
| F | 120 | 12.0 | 0 | 680 | 12.0 | 250 | 930 | - | - | - | - | 740000 | 0.05 | - |
| | | 0.7 | 1361 | | 0.7 | 1611 | | | | | | | | |
| F (bGW) | 57.6 | 0.7 | 1361 | 1837 | 0.7 | 1611 | 2087 | - | - | - | - | 740000 | 0.07 | - |
| | | -15.9 | 2314 | | -15.9 | 2564 | | | | | | | | |
| O1 | 32.6 | -15.9 | 2314 | 2371 | -15.9 | 2564 | 2621 | 57 | 1.597 | 0.615 | 0.031 | - | 0.43 | 0.108 |
| | | -19.4 | 2428 | | -19.4 | 2678 | | | | | | | | |
| O2 | 32.6 | -19.4 | 2428 | 2485 | -19.4 | 2678 | 2735 | 57 | 1.602 | 0.617 | 0.031 | - | 0.42 | 0.108 |
| | | -22.9 | 2542 | | -22.9 | 2792 | | | | | | | | |
| O3 | 32.6 | -22.9 | 2542 | 2599 | -22.9 | 2792 | 2849 | 57 | 1.606 | 0.618 | 0.031 | - | 0.40 | 0.108 |
| | | -26.4 | 2656 | | -26.4 | 2906 | | | | | | | | |
| O4 | 32.6 | -26.4 | 2656 | 2713 | -26.4 | 2906 | 2963 | 57 | 1.610 | 0.619 | 0.031 | - | 0.38 | 0.109 |
| | | -29.9 | 2771 | | -29.9 | 3021 | | | | | | | | |
| S-2 | 57.6 | -29.9 | 2771 | 2989 | -29.9 | 3021 | 3239 | - | - | - | - | 740000 | 0.03 | - |
| | | -37.5 | 3208 | | -37.5 | 3458 | | | | | | | | |
| M/S-4 | | | | | | | | | | | | | | |

Immediate Settlement, δi = 0.14 inches
Consolidation Settlement, δc = 1.63 inches
Secondary Settlement, δs = 0.433 inches

**Total = δi + δc + δs = 2.21 inches**

Settlement of approximately 2-inches is acceptable.

**Calculate Overburden on MMC:**

Estimated Existing Overburden Pressure on MMC = 300 psf
Estimated Overburden Pressure on MMC at Proposed Grade = 550 psf < 1,250 psf (Load Limitation Zone B)

SUBJECT: Overburden Stress on MMC at Locations S-2

**Location S-2:** Type J Plarform 2.5 feet of fill

Existing Conditions:

| | | |
|---|---|---|
| Assumed Existing Depth to Top of MMC = | 2.5 | ft |
| $\gamma_{Fill}$ = | 120 | pcf |
| Assumed Existing Overburden Pressure on MMC = | 300 | psf |
| Allowable Live Load = | 100 | psf |
| Total Existing Pressure on MMC = | 400 | psf |

Proposed Conditions:

Increase Grade with Regular Weight Fill (RWF):

| | | | | | |
|---|---|---|---|---|---|
| Approx. Maxmimum Grade Increase = | 2.5 | ft | | | |
| $\gamma_{RWF}$ = | 125 | pcf | | | |
| Estimated Overburden Pressure on MMC = | 612.5 | psf | | | |
| Allowable Live Load = | 100 | psf | | | |
| Total Estimated Pressure on MMC = | 712.5 | psf | > | 400 | psf |

**Overburden Pressure Increase Not Accpetable per Load Limitation Plan.**

Increase Grade with Excavation to MMC, and Placement of LWF

Approx. Maxmimum Grade Increase = 2.5 ft

| | γ (pcf) | H (ft) | σ (psf) | | | |
|---|---|---|---|---|---|---|
| Live Load | - | - | 100 | | | |
| $\gamma_{Fill}$ = | 120 | 0.5 | 60 | | | |
| Landscaping Layer | 125 | 0.5 | 62.5 | | | |
| LWF | 55 | 4 | 220 | | | |
| Total = | | 5 | 443 | < | 400 | psf |

**Location S-2:** Type J Plarform 2 feet of fill

Existing Conditions:

| | | |
|---|---|---|
| Assumed Existing Depth to Top of MMC = | 2.5 | ft |
| $\gamma_{Fill}$ = | 120 | pcf |
| Assumed Existing Overburden Pressure on MMC = | 300 | psf |
| Allowable Live Load = | 100 | psf |
| Total Existing Pressure on MMC = | 400 | psf |

Proposed Conditions:

Increase Grade with Regular Weight Fill (RWF):

| | | | | | |
|---|---|---|---|---|---|
| Approx. Maxmimum Grade Increase = | 2.5 | ft | | | |
| $\gamma_{RWF}$ = | 125 | pcf | | | |
| Estimated Overburden Pressure on MMC = | 612.5 | psf | | | |
| Allowable Live Load = | 150 | psf | | | |
| Total Estimated Pressure on MMC = | 762.5 | psf | > | 400 | psf |

**Overburden Pressure Increase Not Accpetable per Load Limitation Plan.**

Increase Grade with Excavation to MMC, and Placement of LWF

Approx. Maxmimum Grade Increase = 2.5 ft

| | γ (pcf) | H (ft) | σ (psf) | | | |
|---|---|---|---|---|---|---|
| Live Load | - | - | 100 | | | |
| $\gamma_{Fill}$ = | 120 | 0.5 | 60 | | | |
| Landscaping Layer | 125 | 0.5 | 62.5 | | | |
| LWF | 55 | 3.5 | 193 | | | |
| Total = | | 4.5 | 415 | < | 400 | psf |

**No overburden increase, acceptable**

SUBJECT: Overburden Stress on MMC at Locations S-3

**Location S-3:**

Existing Conditions:

| | | |
|---|---|---|
| Assumed existing depth to top of MMC = | 2.5 | ft |
| $\gamma_{Fill}$ = | 120 | pcf |
| Assumed Existing Overburden Pressure on MMC = | 300 | psf |
| Allowable Live Load = | 100 | psf |
| Total Existing Pressure on MMC = | 400 | psf |

Proposed Conditions:

Increase Grade with Regular Weight Fill (RWF):

| | | | | | |
|---|---|---|---|---|---|
| Approx. Maxmimum Grade Increase = | 2 | ft | | | |
| $\gamma_{RWF}$ = | 125 | pcf | | | |
| Estimated Overburden Pressure on MMC = | 550 | psf | | | |
| Allowable Live Load = | 100 | psf | | | |
| Total Estimated Pressure on MMC = | 650 | psf | > | 400 | psf |

**Overburden Pressure Increase Not Accpetable per Load Limitation Plan.**

Increase Grade with Excavation to MMC, and Placement of LWF and Geogrids:

Approx. Maxmimum Grade Increase = 2 ft

| | γ (pcf) | H (ft) | σ (psf) | | | |
|---|---|---|---|---|---|---|
| Live Load | - | - | 100 | | | |
| Landscaping Layer | 125 | 1 | 125 | | | |
| LWF & Geogrids | 55 | 3.5 | 193 | | | |
| Total = | | 4.5 | 418 | ≈ | 400 | psf |

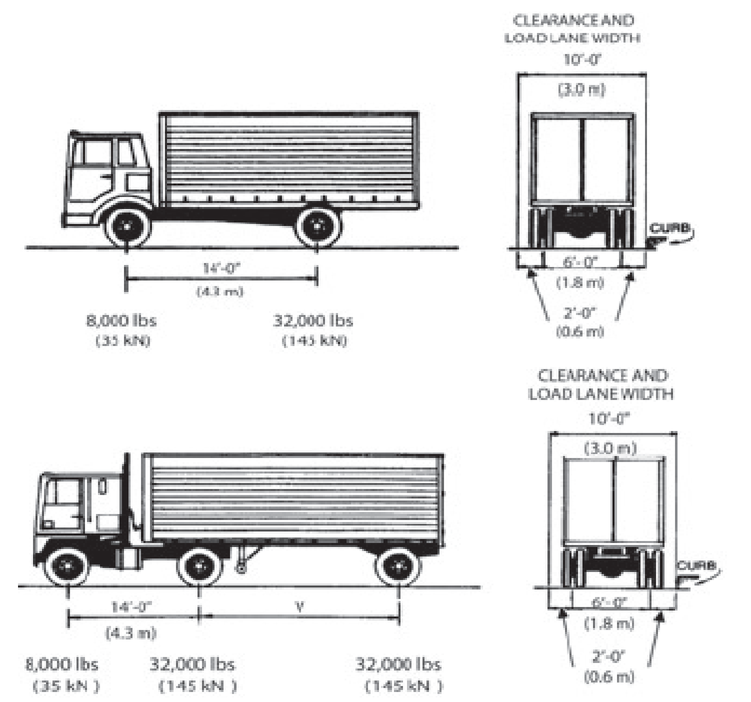
**Approximately No Effective Load Increase; Acceptable.**

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Overburden Stress on MMC Near Grand Staircase (Location S-4)

| | | | |
|---|---|---|---|
| $L_{H20}$ = | 14 ft | $L_{HS20}$ = | 28 ft |
| $W_{H20}$ = | 6 ft | $W_{HS20}$ = | 6 ft |
| $A_{H20}$ = | 84 ft2 | $A_{HS20}$ = | 168 ft2 |
| $P_{H20}$ = | 40000 lbs | $P_{HS20}$ = | 72000 lbs |
| $p_{H20}$ = | 476 psf | $p_{HS20}$ = | 429 psf |

Use $p_{H20}$ = 476 psf at surface.




These sketches illustrate the AASHTO-approved live loading specifications for standard H20 and HS20 trucks.
*Source: AASHTO* Standard Specifications for Highway Bridges.

Membrane El. = 12
Max Fill grade El. = 28
Max Fill Height, z = 16 ft

Height of Fill = 12 ft @ $\gamma_{Fill}$ = 125 pcf
Height of LWF = 4 ft @ $\gamma_{LWF}$ = 55 pcf
Total Height of Fill & LWF = 16 ft

Total Fill $\sigma_{v\_Fill\&LWF}$ = 1720 psf

Vert. $\sigma_{v\_H20}$ at z = 63 psf (from WinStress analysis for H20 of 8'x14' at (4,7,z); where z = Total Height of Fill & LWF)
126 psf w FS = 2

Total $\sigma_v$ at z = 1846 psf

Acceptable for Load Limitation Zone A, < 2000 ? OK

FS = 1.1 = $\sigma_v$ at z / 2000 psf

If only RWF was used, $\sigma_v$ = 2126 psf = $\sigma_{v\_Fill}$ + $\sigma_{vH20}$

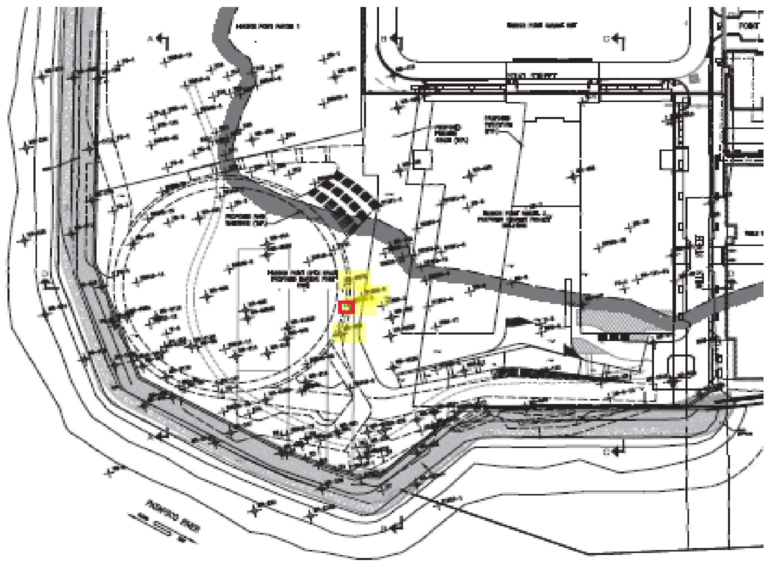
**M U E S E R   R U T L E D G E   C O N S U L T I N G   E N G I N E E R S PLLC**

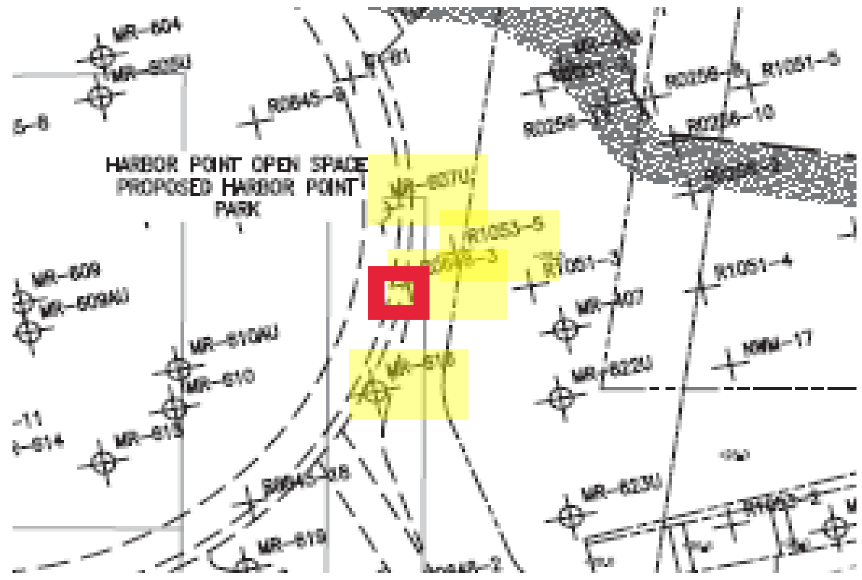
| | | | |
|---|---|---|---|
| MADE BY: | PED | DATE: | 4/14/2021 |
| CHECKED BY: | FTF | DATE: | 4/20/2021 |

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-5

**Location:** As shown below: From Dwg CDP G-100.00, dated 12/22/2020.

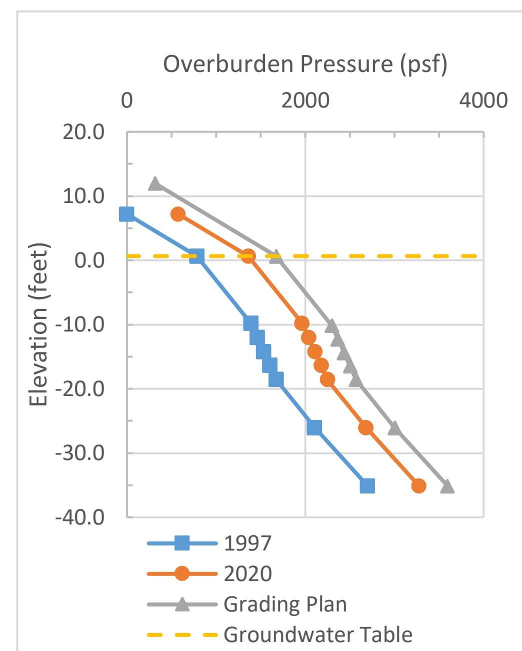





**Stratigraphy and Soil Properties:**

Boring logs used: MR-607U, MR-616, R-0648-3, R1053-5

| | 1993 | | 2020 | | 2020 (settled) | | Grading Plan | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) |
| F or RWF | 7.2 | 0.66 | 12.0 | 0.66 | 12.0 | 0.66 | 14.5 | 0.66 | 120 / 125 |
| F (bGW) | 0.66 | -9.8 | 0.66 | -9.8 | 0.66 | -10.1 | 0.66 | -10.1 | 57.6 |
| O | -9.8 | -18.6 | -9.8 | -18.6 | -10.1 | -18.6 | -10.1 | -18.6 | 32.6 |
| S-1 | -18.6 | -26.1 | -18.6 | -26.1 | -18.6 | -26.1 | -18.6 | -26.1 | 57.6 |
| S-2 | -26.1 | -35.1 | -26.1 | -35.1 | -26.1 | -35.1 | -26.1 | -35.1 | 65.6 |
| M | -35.1 | -42.1 | -35.1 | -42.1 | -35.1 | -42.1 | -35.1 | -42.1 | - |




Notes:
1. Groundwater table at Elev. +0.66.
2. Change in height of Stratum O in 2020 (settled) is a reflection of the calculated settlement and consolidation from 1997 to 2020 below.

**Calculate settlement and consolidation due to Fill placement from the MMR construction in 1997:**

Settlement is initially calculated from 1997 to 2020 to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMR construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

Parameters:

Avg. Water Content for Stratum O, $w_n$ = 60 % — Average from water content from boring MR-801 who's conditions most closely resemble the current state soils.

Initial Void Ration, $e_0$ = $0.233*w_n + 0.2948$ — Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report.

Compression Index, Cc = $0.0094*w_n + 0.083$ — Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report.

Young's Modulus of Sands, Ei = 740000 psf — Used for Stratums F, S-1, and S-2, from MRCE's EE Memo 1, Dec. 2013 for Exelon Building.

Secondary Compression Ratio, Cα ≈ Cc*0.05 ± 0.01 — Mesri and Godlewski (1977)

Calculations:

Immediate Settlement, δi = $\sum \Delta\sigma i \frac{Hi * I}{Ei}$ — Influence Factor, I = 1.0, for 1-D Loading

Consolidation Settlement, δs = $\sum \frac{H_i}{1+e_{0i}} C_{ci} \log_{10} \frac{\sigma'_{vf}}{\sigma'_{vi}}$ — Assume only virgin compression occurs ($\sigma'_{vi} = p'_c$)

Secondary Settlement, Ss = $\sum H_i C_{\alpha i} \log_{10} \frac{\Delta t}{t_p}$ — Assume Δt/tp = 10; from MRCE's EE Memo 1, Dec. 2013 for Exelon Building.

Final Void Ration, $e_1$ = $e_0 + \frac{\Delta H}{H*(1+e_0)}$

SUBJECT: Settlement and Consolidation Calculation for Location S-5

| | | 1997 | | | 2020 | | | | | | | | 1997 to 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_0$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs | $e_1$ |
| F (added) | 120 | | | | 12.0 | 0 | 288 | - | - | - | - | - | - | - | - |
| | | | | | 7.20 | 576 | | | | | | | | | |
| F | 120 | 7.2 | 0 | 392 | 7.2 | 576 | 968 | - | - | - | - | 740000 | 0.06 | - | - |
| | | 0.66 | 785 | | 0.66 | 1361 | | | | | | | | | |
| F (bGW) | 57.6 | 0.66 | 785 | 1087 | 0.66 | 1361 | 1663 | - | - | - | - | 740000 | 0.10 | - | - |
| | | -9.8 | 1389 | | -9.8 | 1965 | | | | | | | | | |
| O1 | 32.6 | -9.8 | 1389 | 1424 | -9.8 | 1965 | 2000 | 60 | 1.693 | 0.647 | 0.032 | - | 0.93 | 0.071 | 1.590 |
| | | -12.0 | 1460 | | -12.0 | 2036 | | | | | | | | | |
| O2 | 32.6 | -12.0 | 1460 | 1496 | -12.0 | 2036 | 2072 | 60 | 1.693 | 0.647 | 0.032 | - | 0.89 | 0.071 | 1.594 |
| | | -14.2 | 1531 | | -14.2 | 2107 | | | | | | | | | |
| O3 | 32.6 | -14.2 | 1531 | 1567 | -14.2 | 2107 | 2143 | 60 | 1.693 | 0.647 | 0.032 | - | 0.86 | 0.071 | 1.598 |
| | | -16.4 | 1603 | | -16.4 | 2179 | | | | | | | | | |
| O4 | 32.6 | -16.4 | 1603 | 1638 | -16.4 | 2179 | 2214 | 60 | 1.693 | 0.647 | 0.032 | - | 0.83 | 0.071 | 1.601 |
| | | -18.6 | 1674 | | -18.6 | 2250 | | | | | | | | | |
| S-1 | 57.6 | -18.6 | 1674 | 1890 | -18.6 | 2250 | 2466 | - | - | - | - | 740000 | 0.07 | - | - |
| | | -26.1 | 2106 | | -26.1 | 2682 | | | | | | | | | |
| S-2 | 65.6 | -26.1 | 2106 | 2402 | -26.1 | 2682 | 2978 | - | - | - | - | 740000 | 0.08 | - | - |
| | | -35.1 | 2698 | | -35.1 | 3274 | | | | | | | | | |

Immediate Settlement, δi = 0.31 inches
Consolidation Settlement, δc = 3.51 inches
Secondary Settlement, δs = 0.283 inches

**Total = δi + δc + δs = 4.10 inches**

**<u>Calculate settlement and consolidation due to Fill placement above the MMR for the Proposed Grading Plan:</u>**

Notes:
1. Initial void ratios are from the final void ratios in the calculation above.
2. Soil properties and calculations are the same as used above.

| | | 2020 (settled) | | | Grading Plan | | | | | | | | 2020 to Grading Plan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_1$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs |
| RWF | 125 | | | | 14.5 | 0 | 156 | - | - | - | - | - | - | - |
| | | | | | 12.0 | 313 | | | | | | | | |
| F | 120 | 12.0 | 0 | 680 | 12.0 | 313 | 993 | - | - | - | - | 740000 | 0.06 | - |
| | | 0.7 | 1361 | | 0.7 | 1673 | | | | | | | | |
| F (bGW) | 57.6 | 0.7 | 1361 | 1672 | 0.7 | 1673 | 1984 | - | - | - | - | 740000 | 0.05 | - |
| | | -10.1 | 1983 | | -10.1 | 2295 | | | | | | | | |
| O1 | 32.6 | -10.1 | 1983 | 2017 | -10.1 | 2295 | 2330 | 56 | 1.590 | 0.613 | 0.031 | - | 0.37 | 0.065 |
| | | -12.2 | 2052 | | -12.2 | 2364 | | | | | | | | |
| O2 | 32.6 | -12.2 | 2052 | 2086 | -12.2 | 2364 | 2399 | 56 | 1.594 | 0.614 | 0.031 | - | 0.36 | 0.065 |
| | | -14.4 | 2120 | | -14.4 | 2433 | | | | | | | | |
| O3 | 32.6 | -14.4 | 2120 | 2155 | -14.4 | 2433 | 2467 | 57 | 1.598 | 0.615 | 0.031 | - | 0.35 | 0.065 |
| | | -16.5 | 2189 | | -16.5 | 2502 | | | | | | | | |
| O4 | 32.6 | -16.5 | 2189 | 2224 | -16.5 | 2502 | 2536 | 57 | 1.601 | 0.616 | 0.031 | - | 0.34 | 0.065 |
| | | -18.6 | 2258 | | -18.6 | 2570 | | | | | | | | |
| S-1 | 57.6 | -18.6 | 2258 | 2474 | -18.6 | 2570 | 2786 | - | - | - | - | 740000 | 0.04 | - |
| | | -26.1 | 2690 | | -26.1 | 3002 | | | | | | | | |
| S-2 | 65.6 | -26.1 | 2690 | 2986 | -26.1 | 3002 | 3298 | - | - | - | - | 740000 | 0.05 | - |
| | | -35.1 | 3282 | | -35.1 | 3594 | | | | | | | | |

Immediate Settlement, δi = 0.20 inches
Consolidation Settlement, δc = 1.43 inches
Secondary Settlement, δs = 0.259 inches

**Total = δi + δc + δs = 1.89 inches**

Resulting settlement is < 2-inches and is therefore acceptable.

**<u>Calculate Overburden on MMC:</u>**

Estimated Existing Overburden Pressure on MMC = 300 psf
Estimated Overburden Pressure on MMC at Proposed Grade = 613 psf

> 500 psf (Load Limitation Zone D), however, limitation is due to soil conditions, MMC has acceptable load of 2,000 psf. Assume remnant Building 23 foundations will bear 50% of overburden load.

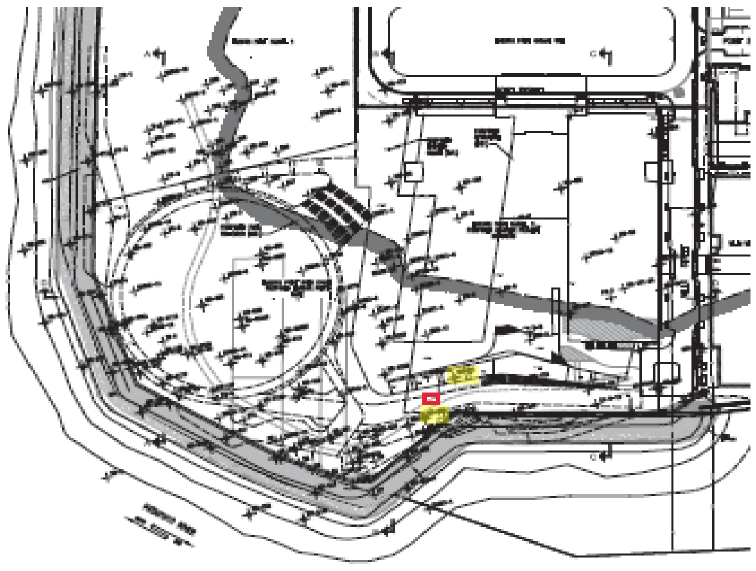
| SHEET NO.: | 1 | OF | 2 |
|---|---|---|---|
| | | FILE NO.: | 13921 |
| MADE BY: | PED | DATE: | 4/14/2021 |
| CHECKED BY: | FTF | DATE: | 4/20/2021 |

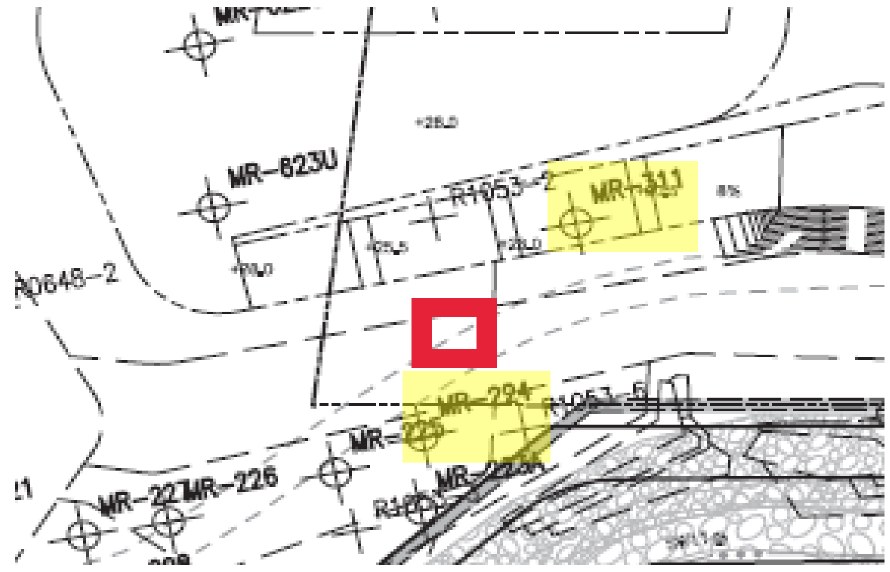
**MUESER RUTLEDGE CONSULTING ENGINEERS PLLC**

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-6

**Location:** As shown below: From Dwg CDP G-100.00, dated 12/22/2020.

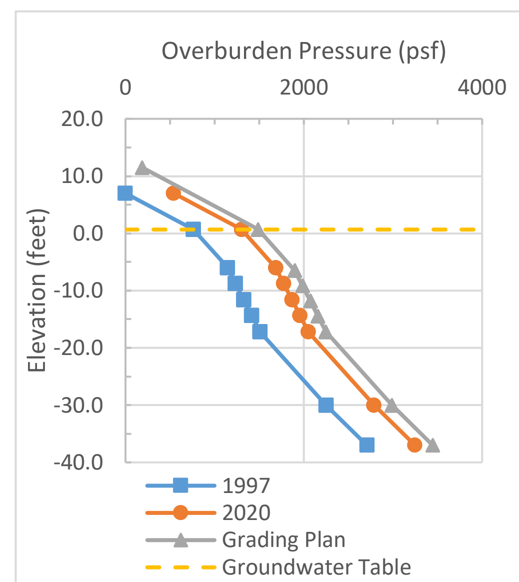





**Stratigraphy and Soil Properties:**

Boring logs used: MR-311 & MR-224

| | 1993 | | 2020 | | 2020 (settled) | | Grading Plan | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stratum** | Elevs: Top | / Bottom | Elevs: Top | / Bottom | Elevs: Top | / Bottom | Elevs: Top | / Bottom | γ' (pcf) |
| F or RWF | 7.0 | 0.66 | 11.5 | 0.66 | 11.5 | 0.66 | 13.0 | 0.66 | 120 / 125 |
| F(bgw) | 0.66 | -6.0 | 0.66 | -6.00 | 0.66 | -6.4 | 0.66 | -6.4 | 57.6 |
| O | -6.0 | -17.2 | -6.00 | -17.15 | -6.4 | -17.15 | -6.4 | -17.2 | 32.6 |
| S-1 | -17.2 | -30.0 | -17.15 | -30.00 | -17.15 | -30.00 | -17.2 | -30.0 | 57.6 |
| S-2 | -30.0 | -37.0 | -30.00 | -37.00 | -30.00 | -37.00 | -30.0 | -37.0 | 65.6 |
| S-3 | -37.0 | -47.0 | -37.00 | -47.00 | -37.00 | -47.00 | -37.0 | -47.0 | 62.6 |
| S-4 | -47.0 | -63.3 | -47.0 | -63.3 | -47.0 | -63.3 | -47.0 | -63.3 | |




Notes:
1. Groundwater table at Elev. +0.66.
2. Change in height of Stratum O in 2020 (settled) is a reflection of the calculated settlement and consolidation from 1997 to 2020 below.

**Calculate settlement and consolidation due to Fill placement from the MMR construction in 1997:**

Settlement is initially calculated from 1997 to 2020 to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMR construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

Parameters:

| | | |
|---|---|---|
| Avg. Water Content for Stratum O, $w_n$ = | 60 % | Average from water content from boring MR-801 who's conditions most closely resemble the current state soils. |
| Initial Void Ration, $e_0$ = | $0.233 * w_n + 0.2948$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Compression Index, Cc = | $0.0094 * w_n + 0.083$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Young's Modulus of Sands, Ei = | 740000 psf | Used for Stratums F, S-1, and S-2, from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Secondary Compression Ratio, Cα ≈ | Cc*0.05 ± 0.01 | Mesri and Godlewski (1977) |

Calculations:

| | | |
|---|---|---|
| Immediate Settlement, δi = | $\sum \Delta\sigma i \frac{Hi * I}{Ei}$ | Influence Factor, I = 1.0, for 1-D Loading |
| Consolidation Settlement, δs = | $\sum \frac{H_i}{1+e_{0i}} C_{ci} \log_{10} \frac{\sigma'_{vf}}{\sigma'_{vi}}$ | Assume only virgin compression occurs ($\sigma'_{vi} = p'_c$) |
| Secondary Settlement, Ss = | $\sum H_i C_{\alpha i} \log_{10} \frac{\Delta t}{t_p}$ | Assume Δt/tp = 10; from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Final Void Ration, $e_1$ = | $e_0 + \frac{\Delta H}{H*(1+e_0)}$ | |

MADE BY: PED DATE: 4/14/2021
CHECKED BY: FTF DATE: 4/20/2021

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-6

| | | 1997 | | | 2020 | | | | | | | | 1997 to 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_0$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs | $e_1$ |
| F (added) | 120 | | | | 11.5 | 0 | 270 | - | - | - | - | - | - | - | - |
| | | | | | 7.0 | 540 | | | | | | | | | |
| F | 120 | 7.0 | 0 | 380 | 7.0 | 540 | 920 | - | - | - | - | 740000 | 0.06 | - | - |
| | | 0.7 | 761 | | 0.7 | 1301 | | | | | | | | | |
| F(bgw) | 57.6 | 0.7 | 761 | 953 | 0.7 | 1301 | 1493 | - | - | - | - | 740000 | 0.06 | - | - |
| | | -6.0 | 1144 | | -6.0 | 1684 | | | | | | | | | |
| O1 | 32.6 | -6.0 | 1144 | 1190 | -6.0 | 1684 | 1730 | 60 | 1.693 | 0.647 | 0.032 | - | 1.31 | 0.090 | 1.580 |
| | | -8.8 | 1235 | | -8.8 | 1775 | | | | | | | | | |
| O2 | 32.6 | -8.8 | 1235 | 1281 | -8.8 | 1775 | 1821 | 60 | 1.693 | 0.647 | 0.032 | - | 1.23 | 0.090 | 1.587 |
| | | -11.6 | 1326 | | -11.6 | 1866 | | | | | | | | | |
| O3 | 32.6 | -11.6 | 1326 | 1372 | -11.6 | 1866 | 1912 | 60 | 1.693 | 0.647 | 0.032 | - | 1.16 | 0.090 | 1.592 |
| | | -14.4 | 1417 | | -14.4 | 1957 | | | | | | | | | |
| O4 | 32.6 | -14.4 | 1417 | 1462 | -14.4 | 1957 | 2002 | 60 | 1.693 | 0.647 | 0.032 | - | 1.10 | 0.090 | 1.597 |
| | | -17.2 | 1508 | | -17.2 | 2048 | | | | | | | | | |
| S-1 | 57.6 | -17.2 | 1508 | 1878 | -17.2 | 2048 | 2418 | - | - | - | - | 740000 | 0.11 | - | - |
| | | -30.0 | 2248 | | -30.0 | 2788 | | | | | | | | | |
| S-2 | 65.6 | -30.0 | 2248 | 2478 | -30.0 | 2788 | 3018 | - | - | - | - | 740000 | 0.06 | - | - |
| | | -37.0 | 2707 | | -37.0 | 3247 | | | | | | | | | |
| S-3 | 62.6 | -37.0 | 2707 | 3020 | -37.0 | 3247 | 3560 | - | - | - | - | 740000 | 0.09 | - | - |
| | | -47.0 | 3333 | | -47.0 | 3873 | | | | | | | | | |

Immediate Settlement, δi = 0.38 inches
Consolidation Settlement, δc = 4.79 inches
Secondary Settlement, δs = 0.361 inches

**Total = δi + δc + δs = 5.53 inches**

**<u>Calculate settlement and consolidation due to Fill placement above the MMR for the Proposed Grading Plan:</u>**

Notes:
1. Initial void ratios are from the final void ratios in the calculation above.
2. Soil properties and calculations are the same as used above.

| | | 2020 (settled) | | | Grading Plan | | | | | | | | 2020 to Grading Plan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_1$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs |
| RWF (added) | 125 | | | | 13.0 | 0 | 94 | - | - | - | - | - | - | - |
| | | | | | 11.5 | 188 | | | | | | | | |
| F | 120 | 11.5 | 0 | 650 | 11.5 | 188 | 838 | - | - | - | - | 740000 | 0.03 | - |
| | | 0.7 | 1301 | | 0.7 | 1488 | | | | | | | | |
| F(bgw) | 57.6 | 0.7 | 1301 | 1505 | 0.7 | 1488 | 1692 | - | - | - | - | 740000 | 0.02 | - |
| | | -6.4 | 1709 | | -6.4 | 1897 | | | | | | | | |
| O1 | 32.6 | -6.4 | 1709 | 1753 | -6.4 | 1897 | 1940 | 56 | 1.580 | 0.610 | 0.030 | - | 0.34 | 0.082 |
| | | -9.1 | 1797 | | -9.1 | 1984 | | | | | | | | |
| O2 | 32.6 | -9.1 | 1797 | 1840 | -9.1 | 1984 | 2028 | 56 | 1.587 | 0.612 | 0.031 | - | 0.32 | 0.082 |
| | | -11.8 | 1884 | | -11.8 | 2071 | | | | | | | | |
| O3 | 32.6 | -11.8 | 1884 | 1928 | -11.8 | 2071 | 2115 | 56 | 1.592 | 0.614 | 0.031 | - | 0.31 | 0.082 |
| | | -14.5 | 1971 | | -14.5 | 2159 | | | | | | | | |
| O4 | 32.6 | -14.5 | 1971 | 2015 | -14.5 | 2159 | 2202 | 57 | 1.597 | 0.615 | 0.031 | - | 0.29 | 0.082 |
| | | -17.2 | 2059 | | -17.2 | 2246 | | | | | | | | |
| S-1 | 57.6 | -17.2 | 2059 | 2429 | -17.2 | 2246 | 2616 | - | - | - | - | 740000 | 0.04 | - |
| | | -30.0 | 2799 | | -30.0 | 2986 | | | | | | | | |
| S-2 | 65.6 | -30.0 | 2799 | 3028 | -30.0 | 2986 | 3216 | - | - | - | - | 740000 | 0.02 | - |
| | | -37.0 | 3258 | | -37.0 | 3445 | | | | | | | | |
| S-3 | 62.6 | -37.0 | 3258 | 3571 | -37.0 | 3445 | 3758 | - | - | - | - | 740000 | 0.03 | - |
| | | -47.0 | 3884 | | -47.0 | 4071 | | | | | | | | |

Immediate Settlement, δi = 0.15 inches
Consolidation Settlement, δc = 1.26 inches
Secondary Settlement, δs = 0.328 inches

**Total = δi + δc + δs = 1.73 inches**

Resulting settlement is < 2-inches and is therefore acceptable.

**<u>Calculate Overburden on MMC:</u>**

Estimated Existing Overburden Pressure on MMC = 300 psf
Estimated Overburden Pressure on MMC at Proposed Grade = 488 psf < 800 psf (Load Limitation Zone C)

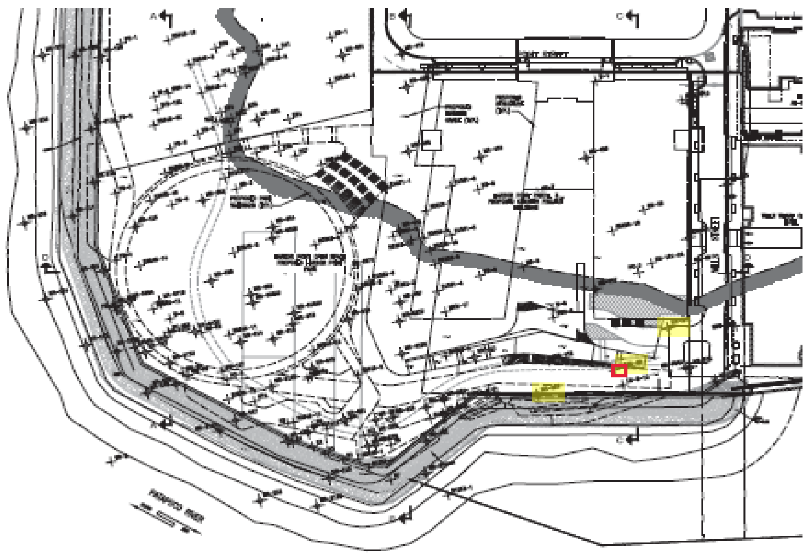
**MUESER RUTLEDGE CONSULTING ENGINEERS PLLC**

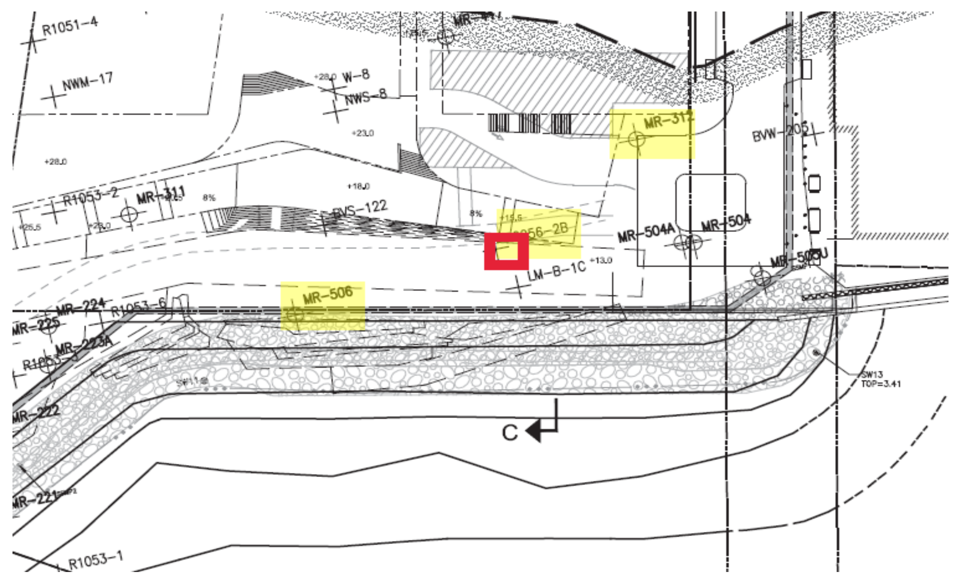
SHEET NO.: 1 OF 2
FILE NO.: 13921
MADE BY: PED DATE: 4/14/2021
CHECKED BY: FTF DATE: 4/20/2021

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-7

**Location:** As shown below: From Dwg CDP G-100.00, dated 12/22/2020.

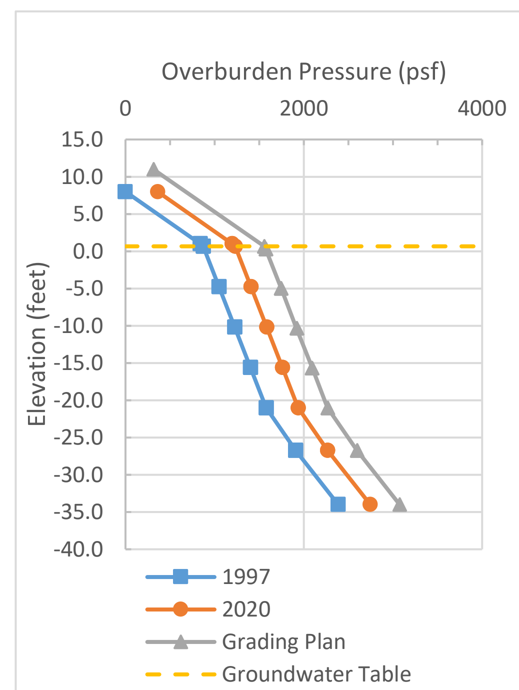




**Stratigraphy and Soil Properties:**

Boring logs used: R0256-2B, MR-312, MR-506

| | 1993 | | 2020 | | | | 2020 (settled) | | Grading Plan | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) | **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) |
| F or RWF | 8.0 | 1.0 | 11.0 | 1.0 | 120 | F | 11.0 | 0.66 | 13.5 | 0.66 | 120 / 125 |
| O (AGW) | 1.0 | 0.66 | 1.00 | 0.66 | 95 | F (BGW) | 0.66 | 0.3 | 0.66 | 0.3 | 57.6 |
| O (BGW) | 0.66 | -21.0 | 0.66 | -21.0 | 32.6 | O | 0.3 | -21.0 | 0.3 | -21.0 | 32.6 |
| S-1 | -21.0 | -26.7 | -21.0 | -26.7 | 57.6 | S-1 | -21.0 | -26.7 | -21.0 | -26.7 | 57.6 |
| S-2 | -26.7 | -34.0 | -26.7 | -34.0 | 65.6 | S-2 | -26.7 | -34.0 | -26.7 | -34.0 | 65.6 |
| S-3 | -34.0 | -38.0 | -34.0 | -38.0 | 62.6 | S-3 | -34.0 | -38.0 | -34.0 | -38.0 | 62.6 |
| M | -38.0 | -52.8 | -38.0 | -52.8 | - | M | -38.0 | -52.8 | -38.0 | -52.8 | - |




Notes:
1. Groundwater table at Elev. +0.66.
2. Change in height of Stratum O in 2020 (settled) is a reflection of the calculated settlement and consolidation from 1997 to 2020 below.

**Calculate settlement and consolidation due to Fill placement from the MMR construction in 1997:**

Settlement is initially calculated from 1997 to 2020 to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMR construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

Parameters:

| | | |
|---|---|---|
| Avg. Water Content for Stratum O, $w_n$ = | 60 % | Average from water content from boring MR-801 who's conditions most closely resemble the current state soils. |
| Initial Void Ration, $e_0$ = | $0.233*w_n + 0.2948$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Compression Index, Cc = | $0.0094*w_n + 0.083$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Young's Modulus of Sands, Ei = | 740000 psf | Used for Stratums F, S-1, and S-2, from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Secondary Compression Ratio, Cα ≈ | Cc*0.05 ± 0.01 | Mesri and Godlewski (1977) |

Calculations:

| | | |
|---|---|---|
| Immediate Settlement, δi = | $\sum \Delta\sigma i \frac{Hi * I}{Ei}$ | Influence Factor, I = 1.0, for 1-D Loading |
| Consolidation Settlement, δs = | $\sum \frac{H_i}{1+e_{0i}} C_{ci} \log_{10} \frac{\sigma'_{vf}}{\sigma'_{vi}}$ | Assume only virgin compression occurs ($\sigma'_{vi} = p'_c$) |
| Secondary Settlement, Ss = | $\sum H_i C_{\alpha i} \log_{10} \frac{\Delta t}{t_p}$ | Assume Δt/tp = 10; from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Final Void Ration, $e_1$ = | $e_0 + \frac{\Delta H}{H*(1+e_0)}$ | |

| **M U E S E R R U T L E D G E C O N S U L T I N G E N G I N E E R S PLLC** | |
|---|---|
| SHEET NO.: 2 OF 2 | FILE NO.: 13921 |
| MADE BY: PED | DATE: 4/14/2021 |
| CHECKED BY: FTF | DATE: 4/20/2021 |

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-7

| | | 1997 | | | 2020 | | | | | | | | 1997 to 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_0$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs | $e_1$ |
| F (added) | 120 | | | | 11.0 | 0 | 180 | - | - | - | - | - | - | - | - |
| | | | | | 8.0 | 360 | | | | | | | | | |
| F | 120 | 8.0 | 0 | 420 | 8.0 | 360 | 780 | - | - | - | - | 740000 | 0.04 | - | - |
| | | 1.0 | 840 | | 1.0 | 1200 | | | | | | | | | |
| O (AGW) | 95 | 1.0 | 840 | 856 | 1.0 | 1200 | 1216 | 60 | 1.693 | 0.647 | 0.032 | - | 0.15 | 0.011 | 1.587 |
| | | 0.7 | 872 | | 0.7 | 1232 | | | | | | | | | |
| O1 | 32.6 | 0.7 | 872 | 961 | 0.7 | 1232 | 1321 | 60 | 1.693 | 0.647 | 0.032 | - | 2.16 | 0.175 | 1.596 |
| | | -4.8 | 1049 | | -4.8 | 1409 | | | | | | | | | |
| O2 | 32.6 | -4.8 | 1049 | 1137 | -4.8 | 1409 | 1497 | 60 | 1.693 | 0.647 | 0.032 | - | 1.86 | 0.175 | 1.608 |
| | | -10.2 | 1225 | | -10.2 | 1585 | | | | | | | | | |
| O3 | 32.6 | -10.2 | 1225 | 1314 | -10.2 | 1585 | 1674 | 60 | 1.693 | 0.647 | 0.032 | - | 1.64 | 0.175 | 1.617 |
| | | -15.6 | 1402 | | -15.6 | 1762 | | | | | | | | | |
| O4 | 32.6 | -15.6 | 1402 | 1490 | -15.6 | 1762 | 1850 | 60 | 1.693 | 0.647 | 0.032 | - | 1.47 | 0.175 | 1.625 |
| | | -21.0 | 1578 | | -21.0 | 1938 | | | | | | | | | |
| S-1 | 57.6 | -21.0 | 1578 | 1743 | -21.0 | 1938 | 2103 | - | - | - | - | 740000 | 0.03 | - | - |
| | | -26.7 | 1907 | | -26.7 | 2267 | | | | | | | | | |
| S-2 | 65.6 | -26.7 | 1907 | 2146 | -26.7 | 2267 | 2506 | - | - | - | - | 740000 | 0.04 | - | - |
| | | -34.0 | 2386 | | -34.0 | 2746 | | | | | | | | | |
| S-3 | 62.6 | -34.0 | 2386 | 2511 | -34.0 | 2746 | 2871 | - | - | - | - | 740000 | 0.02 | - | - |
| | | -38.0 | 2636 | | -38.0 | 2996 | | | | | | | | | |

Immediate Settlement, δi = 0.14 inches
Consolidation Settlement, δc = 7.28 inches
Secondary Settlement, δs = 0.712 inches

**Total = δi + δc + δs = 8.13 inches**

**<u>Calculate settlement and consolidation due to Fill placement above the MMR for the Proposed Grading Plan:</u>**

Notes:
1. Initial void ratios are from the final void ratios in the calculation above.
2. Soil properties and calculations are the same as used above.

| | | 2020 (settled) | | | Grading Plan | | | | | | | | 2020 to Grading Plan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_1$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs |
| RWF (added) | 125 | | | | 13.5 | 0 | 156 | - | - | - | - | - | - | - |
| | | | | | 11.0 | 313 | | | | | | | | |
| F | 120 | 11.0 | 0 | 620 | 11.0 | 313 | 933 | - | - | - | - | 740000 | 0.05 | - |
| | | 0.66 | 1241 | | 0.66 | 1553 | | | | | | | | |
| F (BGW) | 57.6 | 0.66 | 1241 | 1250 | 0.66 | 1553 | 1563 | 56 | 1.587 | 0.612 | 0.031 | - | 0.09 | 0.01 |
| | | 0.3 | 1260 | | 0.3 | 1572 | | | | | | | | |
| O1 | 32.6 | 0.3 | 1260 | 1347 | 0.3 | 1572 | 1659 | 57 | 1.596 | 0.615 | 0.031 | - | 1.37 | 0.16 |
| | | -5.0 | 1433 | | -5.0 | 1746 | | | | | | | | |
| O2 | 32.6 | -5.0 | 1433 | 1520 | -5.0 | 1746 | 1833 | 57 | 1.608 | 0.619 | 0.031 | - | 1.23 | 0.17 |
| | | -10.3 | 1607 | | -10.3 | 1920 | | | | | | | | |
| O3 | 32.6 | -10.3 | 1607 | 1694 | -10.3 | 1920 | 2007 | 57 | 1.617 | 0.622 | 0.031 | - | 1.12 | 0.17 |
| | | -15.7 | 1781 | | -15.7 | 2094 | | | | | | | | |
| O4 | 32.6 | -15.7 | 1781 | 1868 | -15.7 | 2094 | 2181 | 58 | 1.625 | 0.624 | 0.031 | - | 1.02 | 0.17 |
| | | -21.0 | 1955 | | -21.0 | 2268 | | | | | | | | |
| S-1 | 57.6 | -21.0 | 1955 | 2119 | -21.0 | 2268 | 2432 | - | - | - | - | 740000 | 0.03 | - |
| | | -26.7 | 2283 | | -26.7 | 2596 | | | | | | | | |
| S-2 | 65.6 | -26.7 | 2283 | 2523 | -26.7 | 2596 | 2835 | - | - | - | - | 740000 | 0.04 | - |
| | | -34.0 | 2762 | | -34.0 | 3075 | | | | | | | | |
| S-3 | 62.6 | -34.0 | 2762 | 2887 | -34.0 | 3075 | 3200 | - | - | - | - | 740000 | 0.02 | - |
| | | -38.0 | 3013 | | -38.0 | 3325 | | | | | | | | |

Immediate Settlement, δi = 0.14 inches
Consolidation Settlement, δc = 4.84 inches
Secondary Settlement, δs = 0.67 inches

**Total = δi + δc + δs = 5.65 inches**

Resultant settlement is > 2-inches and therefore may cause unacceptable differential settlement and extension of the Geomembrane. Check for replacement of regular weight fill with light weight fill; see Calcultion 'Settlement and Consolidation Calculation for Location S-2 with Over-Excavation and Light Weight Fill Placement.'

**<u>Calculate Overburden on MMC:</u>**

Estimated Existing Overburden Pressure on MMC = 300 psf
Estimated Overburden Pressure on MMC at Proposed Grade = 613 psf > 500 psf (Load Limitation Zone D), not acceptable.

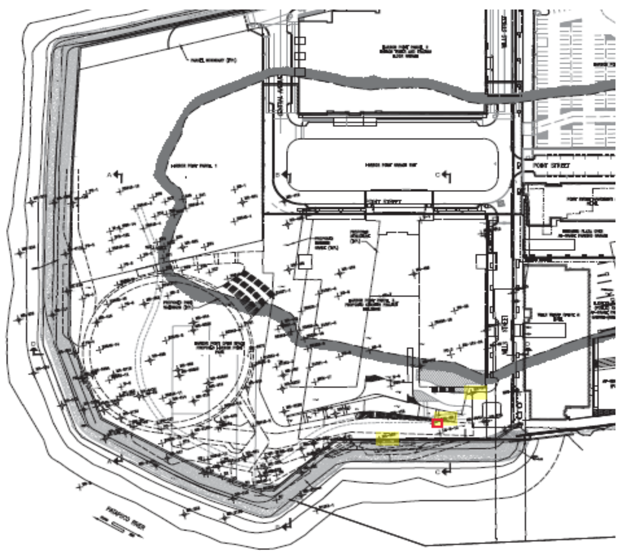
**MUESER RUTLEDGE CONSULTING ENGINEERS PLLC**

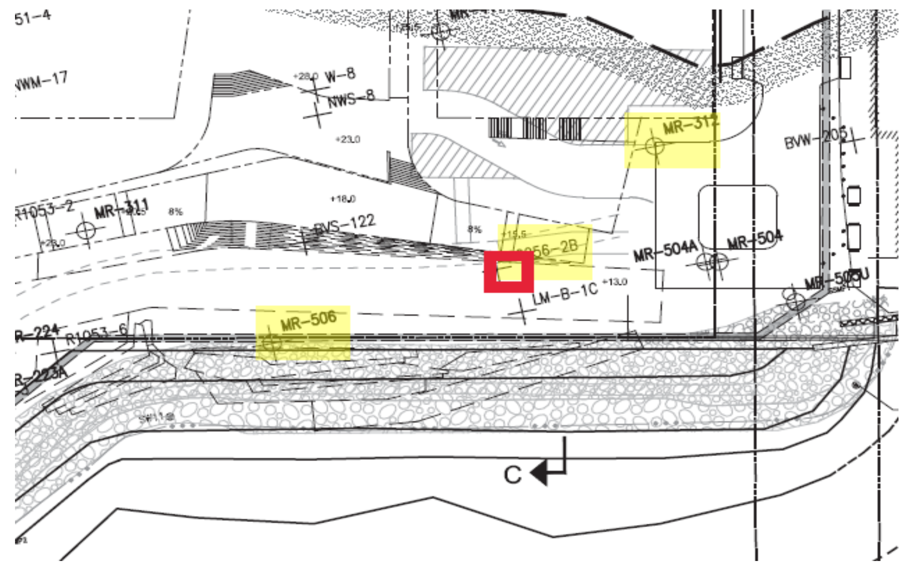
SHEET NO.: 1 OF 2
FILE NO.: 13921
MADE BY: PED DATE: 4/14/2021
CHECKED BY: FTF DATE: 4/20/2021

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-7 with Over-Excavation and Light Weight Fill Placement

**Location:** As shown below: From Dwg CDP G-100.00, dated 12/22/2020.

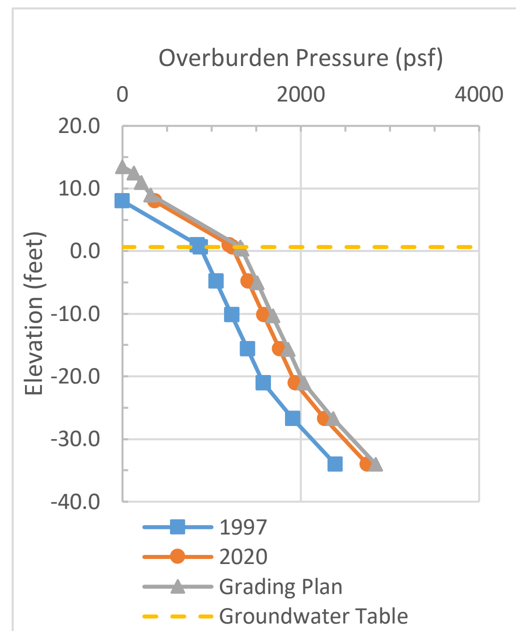





**Stratigraphy and Soil Properties:**

Boring logs used: R0256-2B, MR-312, MR-506

| Stratum | 1993 | | 2020 | | | Stratum | 2020 (settled) | | Grading Plan | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) | **Stratum** | Elevs: Top / Bottom | | Elevs: Top / Bottom | | γ' (pcf) |
| | | | | | | RWF | | | 13.50 | 12.5 | 125 |
| | | | | | | LWF | | | 12.5 | 9.00 | 55 |
| F | 8.0 | 1.00 | 11.0 | 1.00 | 120.0 | F | 11.0 | 0.66 | 9.0 | 0.66 | 120.0 |
| O (AGW) | 1.00 | 0.66 | 1.00 | 0.66 | 95.0 | F (BGW) | 0.66 | 0.3 | 0.66 | 0.3 | 57.6 |
| O (BGW) | 0.66 | -21.0 | 0.66 | -21.0 | 32.6 | O | 0.3 | -21.0 | 0.3 | -21.0 | 32.6 |
| S-1 | -21.0 | -26.7 | -21.0 | -26.7 | 57.6 | S-1 | -21.0 | -26.7 | -21.0 | -26.7 | 57.6 |
| S-2 | -26.7 | -34.0 | -26.7 | -34.0 | 65.6 | S-2 | -26.7 | -34.0 | -26.7 | -34.0 | 65.6 |
| S-3 | -34.0 | -38.0 | -34.0 | -38.0 | 62.6 | S-3 | -34.0 | -38.0 | -34.0 | -38.0 | 62.6 |
| M | -38.0 | -52.8 | -38.0 | -52.8 | - | M | -38.0 | -52.8 | -38.0 | -52.8 | - |




Notes:
1. Groundwater table at Elev. +0.66.
2. Change in height of Stratum O in Grading Plan is a reflection of the calculated settlement and consolidation from 1997 to 2020 below.

**Calculate settlement and consolidation due to Fill placement from the MMR construction in 1997:**

Settlement is initially calculated from 1997 to 2020 to account for changes and differentials in the compressibility parameters of Stratum O which occurred due to the MMR construction and placement of fill after the last series of borings were conducted, from which much of the laboratory data was used to develop the original parameters.

Parameters:

| | | |
|---|---|---|
| Avg. Water Content for Stratum O, $w_n$ = | 60 % | Average from water content from boring MR-801 who's conditions most closely resemble the current state soils. |
| Initial Void Ration, $e_0$ = | $0.233*w_n + 0.2948$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Compression Index, Cc = | $0.0094*w_n + 0.083$ | Formula from Figure 4 in MRCE's Dec. 31, 2020 Geotechnical Report. |
| Young's Modulus of Sands, Ei = | 740000 psf | Used for Stratums F, S-1, and S-2, from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Secondary Compression Ratio, Cα ≈ | Cc*0.05 ± 0.01 | Mesri and Godlewski (1977) |

Calculations:

| | | |
|---|---|---|
| Immediate Settlement, δi = | $\sum \Delta\sigma i \frac{Hi * I}{Ei}$ | Influence Factor, I = 1.0, for 1-D Loading |
| Consolidation Settlement, δs = | $\sum \frac{H_i}{1+e_{0i}} C_{ci} \log_{10}\frac{\sigma'_{vf}}{\sigma'_{vi}}$ | Assume only virgin compression occurs ($\sigma'_{vi} = p'_c$) |
| Secondary Settlement, Ss = | $\sum H_i C_{\alpha i} \log_{10}\frac{\Delta t}{t_p}$ | Assume Δt/tp = 10; from MRCE's EE Memo 1, Dec. 2013 for Exelon Building. |
| Final Void Ration, $e_1$ = | $e_0 + \frac{\Delta H}{H*(1+e_0)}$ | |

FOR: Harbor Point - Parcel 3 DDP

SUBJECT: Settlement and Consolidation Calculation for Location S-7 with Over-Excavation and Light Weight Fill Placement

| | | 1997 | | | 2020 | | | | | | | | 1997 to 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_0$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs | $e_1$ |
| F (added) | 120 | | | | 11.0 | 0 | 180 | - | - | - | - | - | - | - | - |
| | | | | | 8.0 | 360 | | | | | | | | | |
| F | 120 | 8.0 | 0 | 420 | 8.0 | 360 | 780 | - | - | - | - | 740000 | 0.04 | - | - |
| | | 1.0 | 840 | | 1.0 | 1200 | | | | | | | | | |
| O (AGW) | 95.0 | 1.0 | 840 | 856 | 1.0 | 1200 | 1216 | 60 | 1.693 | 0.647 | 0.032 | - | 0.15 | 0.011 | 1.587 |
| | | 0.7 | 872 | | 0.7 | 1232 | | | | | | | | | |
| O1 | 32.6 | 0.7 | 872 | 961 | 0.7 | 1232 | 1321 | 60 | 1.693 | 0.647 | 0.032 | - | 2.16 | 0.175 | 1.596 |
| | | -4.8 | 1049 | | -4.8 | 1409 | | | | | | | | | |
| O2 | 32.6 | -4.8 | 1049 | 1137 | -4.8 | 1409 | 1497 | 60 | 1.693 | 0.647 | 0.032 | - | 1.86 | 0.175 | 1.608 |
| | | -10.2 | 1225 | | -10.2 | 1585 | | | | | | | | | |
| O3 | 32.6 | -10.2 | 1225 | 1314 | -10.2 | 1585 | 1674 | 60 | 1.693 | 0.647 | 0.032 | - | 1.64 | 0.175 | 1.617 |
| | | -15.6 | 1402 | | -15.6 | 1762 | | | | | | | | | |
| O4 | 32.6 | -15.6 | 1402 | 1490 | -15.6 | 1762 | 1850 | 60 | 1.693 | 0.647 | 0.032 | - | 1.47 | 0.175 | 1.625 |
| | | -21.0 | 1578 | | -21.0 | 1938 | | | | | | | | | |
| S-1 | 57.6 | -21.0 | 1578 | 1743 | -21.0 | 1938 | 2103 | - | - | - | - | 740000 | 0.03 | - | - |
| | | -26.7 | 1907 | | -26.7 | 2267 | | | | | | | | | |
| S-2 | 65.6 | -26.7 | 1907 | 2146 | -26.7 | 2267 | 2506 | - | - | - | - | 740000 | 0.04 | - | - |
| | | -34.0 | 2386 | | -34.0 | 2746 | | | | | | | | | |
| S-3 | 62.6 | -34.0 | 2386 | 2511 | -34.0 | 2746 | 2871 | - | - | - | - | 740000 | 0.02 | - | - |
| | | -38.0 | 2636 | | -38.0 | 2996 | | | | | | | | | |

Immediate Settlement, δi = 0.14 inches
Consolidation Settlement, δc = 7.28 inches
Secondary Settlement, δs = 0.712 inches
**Total = δi + δc + δs = 8.13 inches**

**Calculate settlement and consolidation due to Fill placement above the MMR for the Proposed Grading Plan:**

Notes:
1. Initial void ratios are from the final void ratios in the calculation above.
2. Soil properties and calculations are the same as used above.

| | | 2020 (settled) | | | Grading Plan | | | | | | | | 2020 to Grading Plan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | γ (pcf) | Elev | σ' (psf) | Avg σ' (psf) | Elev | σ' (psf) | Avg σ' (psf) | $w_n$ (%) | $e_1$ | Cc | $C_\alpha$ | Ei (psf) | δi or δc | δs |
| RWF | 125 | | | | 13.5 | 0 | - | - | - | - | - | - | - | - |
| | | | | | 12.5 | 125 | | | | | | | | |
| LWF | 55 | | | | 12.5 | 125 | 166 | - | - | - | - | - | - | - |
| | | | | | 11.0 | 208 | | | | | | | | |
| LWF | 55 | | | | 11.0 | 208 | 763 | - | - | - | - | 740000 | 0.02 | - |
| | | | | | 9.0 | 318 | | | | | | | | |
| F | 120 | 11.0 | 0 | 620 | 9.0 | 318 | | - | - | - | - | | | - |
| | | 0.66 | 1241 | | 0.66 | 1318 | | | | | | | | |
| F (BGW) | 57.6 | 0.66 | 1241 | 1250 | 0.66 | 1318 | 1328 | 56 | 1.587 | 0.612 | 0.031 | - | 0.02 | 0.01 |
| | | 0.3 | 1260 | | 0.3 | 1337 | | | | | | | | |
| O1 | 32.6 | 0.3 | 1260 | 1347 | 0.3 | 1337 | 1424 | 57 | 1.596 | 0.615 | 0.031 | - | 0.37 | 0.16 |
| | | -5.0 | 1433 | | -5.0 | 1511 | | | | | | | | |
| O2 | 32.6 | -5.0 | 1433 | 1520 | -5.0 | 1511 | 1598 | 57 | 1.608 | 0.619 | 0.031 | - | 0.33 | 0.17 |
| | | -10.3 | 1607 | | -10.3 | 1685 | | | | | | | | |
| O3 | 32.6 | -10.3 | 1607 | 1694 | -10.3 | 1685 | 1772 | 57 | 1.617 | 0.622 | 0.031 | - | 0.30 | 0.17 |
| | | -15.7 | 1781 | | -15.7 | 1859 | | | | | | | | |
| O4 | 32.6 | -15.7 | 1781 | 1868 | -15.7 | 1859 | 1946 | 58 | 1.625 | 0.624 | 0.031 | - | 0.27 | 0.17 |
| | | -21.0 | 1955 | | -21.0 | 2033 | | | | | | | | |
| S-1 | 57.6 | -21.0 | 1955 | 2119 | -21.0 | 2033 | 2197 | - | - | - | - | 740000 | 0.01 | - |
| | | -26.7 | 2283 | | -26.7 | 2361 | | | | | | | | |
| S-2 | 65.6 | -26.7 | 2283 | 2523 | -26.7 | 2361 | 2600 | - | - | - | - | 740000 | 0.01 | - |
| | | -34.0 | 2762 | | -34.0 | 2840 | | | | | | | | |
| S-3 | 62.6 | -34.0 | 2762 | 2887 | -34.0 | 2840 | 2965 | - | - | - | - | 740000 | 0.01 | - |
| | | -38.0 | 3013 | | -38.0 | 3090 | | | | | | | | |

Immediate Settlement, δi = 0.05 inches
Consolidation Settlement, δc = 1.28 inches
Secondary Settlement, δs = 0.67 inches
**Total = δi + δc + δs = 2.00 inches**

Settlement of approximately 2-inches is acceptable.

**Calculate Overburden on MMC:**

Estimated Existing Overburden Pressure on MMC = 300 psf
Estimated Overburden Pressure on MMC at Proposed Grade = 508 psf ≈ 500 psf (Load Limitation Zone D)

FILE 13921/13922

**MUESER RUTLEDGE CONSULTING ENGINEERS**

MADE BY FTF DATE 7/8/2021

PROJECT Area 1, Phase 2, Parcel 3

CHECKED BY AMD DATE 7/9/2021

SUBJECT EE Memo 3 Settlement Calculations, Covered Slip Stress State

Covered Slip at Building 23 Foundations

Purpose: Show that all load placed over the Covered Slip where the Building 23 Foundations exist is supported by the Foundations and does not load the Covered Slip

Assumptions

1. Existing Piles have an allowable capacity of 20 Tons each (reduced from 30 tons indicated on design drawings)
2. Load is shed to the Building 23 foundations

Definitions

$\sigma_F$ = unit weight of Fill = 125 psf

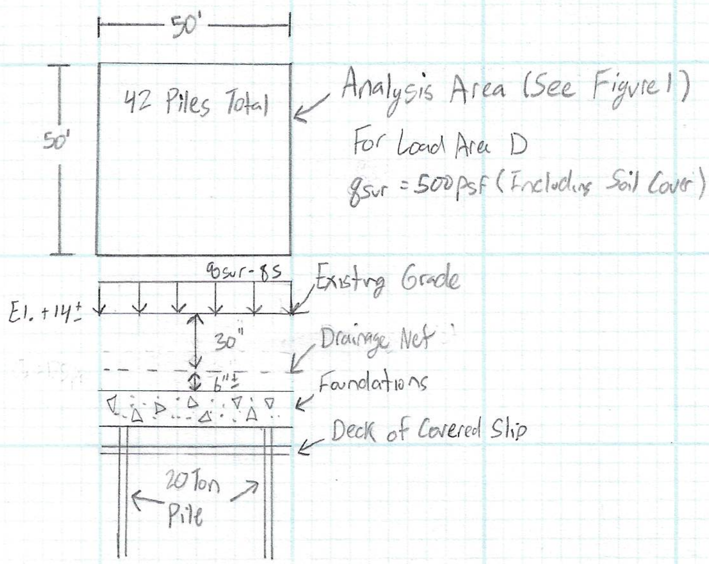
$q_{sur}$ = Allowable Surcharge

$Q_T$ = Total Surcharge Load ($q_{sur}$ + $q_s$)

$q_s$ = Soil Surcharge

C = Pile Capacity

$C_T$ = Total Pile Capacity in Analysis Area




$C_T = C \cdot 42 = 20 \text{ tons} \cdot 42 = 840 \text{ tons}$

$Q_T = q_{sur} \cdot 50\text{ft} \cdot 50\text{ft} = 500\text{psf} \cdot 2500\text{sf} = 625 \text{ tons}$

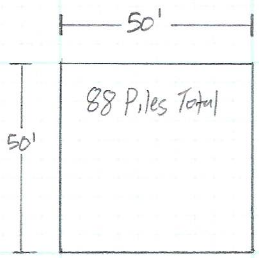
$C_T > Q_T$ ✓

**MUESER RUTLEDGE CONSULTING ENGINEERS**

MADE BY FTF DATE 7/8/2021
CHECKED BY AMD DATE 7/9/2021

PROJECT Area 1 Phase 2, Parcel 3

SUBJECT EE Memo 3 Settlement Calculations, Covered Slip Stress State




For Load Area B (See Figure 1)

$q_{sur}$ = 1250 psf (Including Soil cover)

$C_T = C \cdot 88 = 1{,}760$ tons

$Q_T = 1250 \text{ psf} \cdot 50 \cdot 50 = 1{,}562$ tons

$C_T > Q_T$

**MUESER RUTLEDGE CONSULTING ENGINEERS**

PROJECT Area 1, Phase 2, Parcel 3

MADE BY FTF DATE 7/8/2021
CHECKED BY AMD DATE 7/9/2021

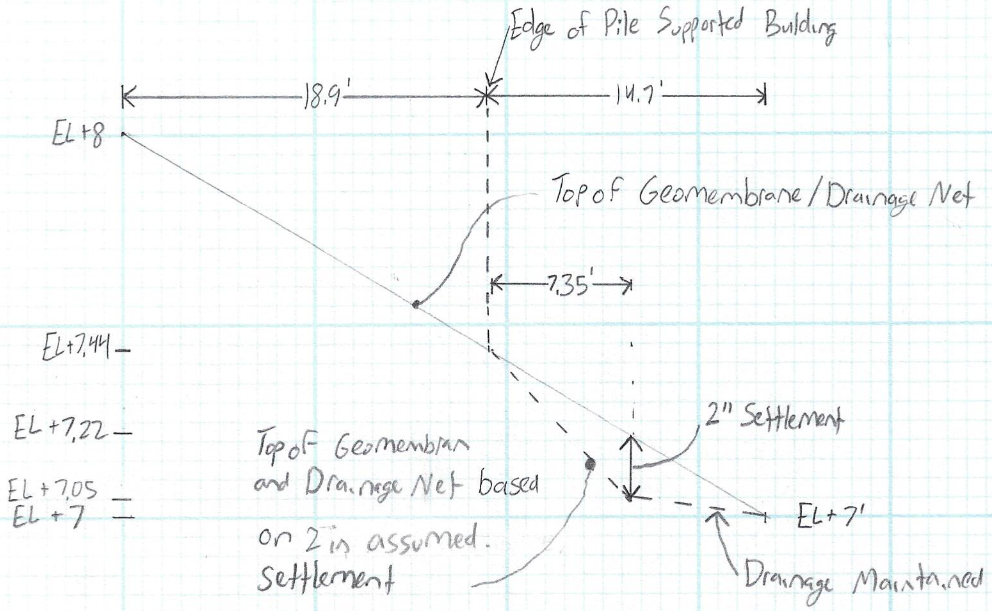
SUBJECT EE Memo Settlement Calculations, Drainage Net

Purpose: Show that positive drainage is maintained for the drainage net with 2 inches of differential Settlement

Assumptions

1. Slope of Geomembrane has not changed since the initial Survey, as Shown on Drawing F0.103, Geomembrane Contours Plan
2. 2" of settlement occurs halfway between edge of Pile supported building and +7 Ft Contour of Top of Geomembrane (Worst possible case across site)

For Plan Location see Figure 3



# EE Memo 4 Construction Vehicle Load Spreading Analysis and Road Layout

MRCE
built on firm foundations

## MEMORANDUM

**Date:** November 9, 2021

**To:** Office

**From:** Adam M. Dyer

**Re:** EE Memo 4 - Construction Vehicle Load Spreading Analysis and Road Layout

**File:** Area 1, Phase 2, Parcel 3, Baltimore, MD
File # 13921/13922

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MRCE has reviewed available information for the Harbor Point Development project and static and dynamic construction loads at the Multimedia Cap (MMC) synthetic layers. The purpose of this evaluation is to determine if these loads cause instability or excessive pressure at the synthetic layers, or if additional fill or other protection is needed to protect the MMC synthetic layers.

### EXHIBITS

| | |
|---|---|
| Attachment 1 (EE Memo 4) | Drawing No. I-1 - "Criteria for Interim Use Harbor Point Site Area 1 West of Wills St." Dated: September 10, 2003. |
| Attachment 2 (EE Memo 4) | WINSTRESS Runs – Existing Conditions:<br>• Static Load Spreading of Design Truck<br>• Static & Dynamic Load Spreading of Design Truck<br>• Static Load Spreading of Wheel Loader<br>• Static & Dynamic Load Spreading of Wheel Loader<br>• Static Load Spreading of 16,380 Gallon Double-Wall Tank<br>• Static Load Spreading of 25 Yard Roll-off Box with Aluminum Hard Top |
| Attachment 3 (EE Memo 4) | JCB Wheel Loader 457 ZX |
| Attachment 4 (EE Memo 4) | Adler 16,380 Gallon Double Wall Tank |
| Attachment 5 (EE Memo 4) | Adler 25 Yard Roll-off Box with Aluminum Hard Top |
| Attachment 6 (EE Memo 4) | WINSTRESS Runs – Asphalt:<br>• Static Load Spreading of Design Truck<br>• Static & Dynamic Load Spreading of Design Truck<br>• Static Load Spreading of Wheel Loader<br>• Static & Dynamic Load Spreading of Wheel Loader |
| Attachment 7 (EE Memo 4) | Assessment of Proposed Laydown and Stockpile Areas |
| Attachment 8 (EE Memo 4) | Link Belt LS 518 Cut Sheet |
| Calculation 1 (EE Memo 4) | Static, Dynamic, and Soil Load Application Calculations |
| Calculation 2 (EE Memo 4) | Water and Soil Containers Applied Load Calculations |
| Calculation 3 (EE Memo 4) | MMC Bearing Capacity under Design Truck |
| Calculation 4 (EE Memo 4) | Load on Drainage Net from Modu-Tanks |

Calculation 5 (EE Memo 4) Crane Mat Bearing Pressure

## AVAILABLE INFORMATION

1. Drawing No. FO.107

## REFERENCES


1. Black and Veatch Harbor Point Project Memorandum from Christian Lavallee, P.E., to Gary Snyder, P.E. “Response to Requested Design Criteria for the Multimedia Cap and Hydraulic Barrier”, dated January 30, 2004.
2. “Wheel Loading 15cy Concrete Truck” - NYC Transit Authority Field Design Standards, pp. DS-8, dated December 1986.
3. American Association of State Highway and Transportation Officials. *AASHTO LRFD Bridge Design Specifications*. p. 3-24 to 3-25, 3-31 © AASHTO 2012, Washington, D.C.
4. Holtz, Robert D., and Kovacs, William D. An Introduction to Geotechnical Engineering. p. 342-343. © 1981 Prentice Hall, Upper Saddle River, NJ.
5. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*. 5th Edition. p. 18-43 © AASHTO 2004, Washington, D.C.
6. American Association of State Highway and Transportation Officials. *AASHTO Guide for Design of Pavement Structures 1993*. p. II-12, II-69 to II-79 © AASHTO, Washington, D.C.
7. P/T Enterprises, Inc. *Hot Mix Asphalt Pavement Design Guide, 10th Ed*. © 2008 The Maryland Asphalt Association, Inc.
8. Coduto, Donald P. *Foundation Design – Principles and Practices*. 2nd Ed. p. 176-179. © January 2001 Prentice-Hall, Upper Saddle River, NJ.
9. Maryland Department of Transportation – State Highway Administration. *Maryland Motor Carrier Handbook*. pp. 81-95. May 2012.
10. Mueser Rutledge Consulting Engineers. *Existing Subsurface Structures Review and Documentations* 1992.


## MULTIMEDIA CAP AND UNDERLYING MATERIALS

The Cover Soil present at Area 1 is 30 inches above the MMC synthetic layers. This thickness of soil was assumed to exist across the site. The top 6 inches are a crushed stone (CR-6) and the underlying materials are sand and gravel aggregates (Cover Soil). The Geomembrane is protected by a Drainage Net and Cover Geotextile above, and by a GCL and Cushion Geotextile below. The synthetic layers are underlain with compacted crushed stone and controlled fill. The primary concern of the operation of construction access roads is the transmission of construction loads through the Cover Soil, crushing the MMC synthetic layers, thereby reducing water transmissivity of the Drainage Net. Additional concerns include the bearing capacity of Cover Soil, and road serviceability and rutting due to frequent construction vehicle use.

## PREVIOUS EVALUATION

In 2003, MRCE provided Interim Use Notes for Site Development of Harbor Point Area 1, which restricted the allowable applied bearing stress at the MMC synthetic layers to 2 kips per square foot (ksf) (Attachment 1 (EE Memo 4)). Laboratory compression test data for the Drainage Net indicates its ability to convey water is compromised above a bearing stress of 2 ksf (Ref. 1).

MRCE’s Interim Use Notes limited vehicles to a fully loaded 15 cubic yard (cy) concrete truck (will be referred as the “Design Truck”); highway permitted HS-20 trucks weigh less than that maximum (Ref. 3). This allowance was based on the distribution of wheel loads to stresses below 2 ksf at the 30 inch depth of the synthetic layers.

## LOAD SPREADING ANALYSIS

Calculations of bearing stress at the Drainage Net were performed using WINSTRESS Version 1.0, released in September 2001 by Prototype Engineering, Inc. WINSTRESS is an elastic stress analysis program which applies surface loads on a semi-infinite mass. Output from this program is similar to an application of the 2:1 method of load approximation with depth (Ref. 4).

## BEARING STRESSES AT MMC SYNTHETIC LAYERS

### Design Truck

The Design Truck has contact with the ground with one single wheel 20 kip axle, 14 feet from two dual wheel 40 kip axles spaced 4.5 feet apart, for a total fully loaded weight of 100 kips (Ref. 2). Each wheel has a contact area with the ground of 128 square inches, for a contact pressure under static load of 78 pounds per square inch (psi) (11.25 ksf). Dynamic loading adds an additional 33% of static loading for a total of 103 psi (14.96 ksf) (Calculation 1 (EE Memo 4)). The bearing stress felt at the Drainage Net under static and static plus dynamic loading is 1.15 and 1.53 ksf, less than the limit of 2 ksf (using WINSTRESS – Attachment 2 (EE Memo 4)).

### Wheel Loader

The Wheel Loader (JCB Wheel Loader 457 ZX- Attachment 3 (EE Memo 4)) will subject the MMC synthetic layers to heavy loads when unloading delivery vehicles and at soil stockpile areas. The Wheel Loader has contact with the MMC with a two – two single wheel rubber tire axles. When combined with a maximum payload of 12 kips, the front axle carries 30.6 kips. These wheels each have a static contact pressure of 62.7 psi (9.02 ksf). With an additional dynamic load of 33%, contact pressure increases to 83.3 psi (12.0 ksf). The bearing stress at the Drainage Net under these loads is 1.05 and 1.39 ksf, each less than 2 ksf (Attachment 2 (EE Memo 4)).

### Clean Soil Stockpile Area

A typical earth fill weighs 125 pounds per cubic foot (pcf). Approximately 16 feet of earth fill will apply 2 kips per square foot (ksf). Given the 30 inches of Cover Soil now in place, earth fill should be limited to 13.5 feet. The maximum earth fill load is at the cover soil stockpile, see Drawing FO.107. Soil stockpile in this area should be limited to 13.5 feet above existing grade.

### Track Cranes

Large track cranes will be used for pile driving. The toe pressure of the crane tracks under load must be spread by timber mats to an area load which will introduce no more than 2 ksf stress at the synthetic layers. Toe pressure and mat sizes must be determined before track cranes operate on the site. The crane used for the pile load test program was a Link Belt LS 518 using a Delmag D46-32 hammer. Calculations of bearing pressure indicate a maximum pressure of approximately 436 psf, well below the 2 ksf maximum (see Calculation 5 (EE Memo 4)).

### Stormwater Storage Modu-Tanks

As described in EE Memo 1, stormwater pumped from excavations will be stored in Modu-tanks roughly 4 feet deep and 50 feet square capable of storing up to 100,000 gallons of impacted water. The Modu-tanks will have an approximately uniform bearing pressure at the drainage net of approximately 0.226 ksf which is less than the 2 ksf allowable, as shown on Calculation 4 (EE Memo 4).

### Water and Soil Container Load Spreading

Water will be temporarily stored in 16,380 Gallon Double-Wall Tanks, which have contact with the ground by four 4 inch wide skids in both transverse and longitudinal directions (Attachment 4 (EE Memo 4)), with a fully loaded capacity of 175,000 lbs (Calculation 2(EE Memo 4)). The bearing pressure was assumed to be uniform along the skids. The skids have a contact area with the ground of 6464 square inches, for a contact pressure of 27.1 psi (3.90 ksf). The tanks will remain in place and are emptied and lifted to a single axle for moving.

Contaminated soil may be stored in 25 Yard Roll-off Box with Aluminum Hard Top, which has contact with the ground by four 8 inch x 10 inch wheels and two 2 inch wide, 22 foot long skids (Attachment 5 (EE Memo 4)). The approximate weight at capacity is 90,000 lbs (Calculation 2 (EE Memo 4)). The assumption was made that load will be distributed evenly by the skids and wheels. The skids and wheels have a contact area with the ground of 1200 square inches, for a contact pressure of 75 psi (10.80 ksf).

The stress felt at the Drainage Net from the bearing pressure of the water tank and soil box are 0.74 and 0.53 ksf, respectively. These loads are less than that of the Design Truck. Each of these stresses is less than the limiting value of 2 ksf. The container exerts a high bearing stress on the MMC surface when the container is hoisted onto the truck carriage. The CR-6 surface may rut under these high bearing pressures. Ruts should be regarded and the MMC surface should be compacted to repair ruts. Asphalt, concrete pavement, or mats should be used where loaded containers are stored and frequently transferred to/from the truck carriage. Both containers should be located where settlement of compressible strata is not a concern.

## BEARING CAPACITY AT MMC SYNTHETIC LAYERS

A bearing capacity analysis was performed of the Design Truck's wheel load (static plus dynamic) (Calculation 3 (EE Memo 4)), considered more critical than the Wheel Loader. The Cover Soil has a safety factor of 8.3 against bearing capacity failure at the depth of the MMC synthetic layers. The MMC provides a stable environment for supporting the synthetic layers under the planned construction equipment loads.

## CONSTRUCTION ROAD LAYOUT

A layout of construction access roads, Drawing F0.107, has been generated to provide a materials delivery loop and stabilized access to all future pile locations. Construction roads should have a minimum turn radius of 48 feet for truck turns (Ref. 3, 5). Proposed locations for material laydown and soil stockpiles are assessed on Attachment 7 (EE Memo 4). Settlement of the materials stockpile areas is not a concern as these areas are underlain by either a pile supported slab (abandoned foundation of former industrial building) or are inboard of the former shoreline and are not underlain by compressible soil. Therefore, material stockpile locations are limited to a maximum bearing of 2,000 psf to prevent compression of the MMC drainage net only.

Construction vehicles will access the site through an existing gate at the intersection of Dock Street and Central Avenue and travel along a 20 foot wide construction road. Deliveries should be made to the materials laydown and soil stockpile areas. Concrete barriers should be used to prevent vehicle damage to existing site infrastructure.

Vehicle speeds should be limited to 15 miles per hour to limit dynamic load application to the MMC synthetic layers.

## CONSTRUCTION ROAD PAVEMENT DESIGN

### Equivalent Single Axle Loads

Major concerns for a construction road are serviceability and protection against rutting and erosion, in addition to wheel loads (Ref. 6). If an 18-kip single axle is used as a basis for construction road design, the estimated number of equivalent single axle loads (ESAL's) that will pass along this route is 10 per hour, considering all types of construction and personal vehicles. Assuming a site work schedule of 10 hour work days, 6 days per week, and 52 weeks per year, 31,200 ESAL's can be expected to pass along a section of construction road each year. The construction road can be considered a low-volume industrial road (Ref. 7).

### Asphalt Construction Access Roads

In order to mitigate dust and reduce maintenance from the frequent passage of construction vehicles, asphalt should be used as a wearing surface for construction roads. Due to the presence of CR-6 as a good existing subgrade (CBR> 20), a compacted 5 inches minimum of asphalt should be used. The asphalt should be comprised of single lifts of compacted 2 inches minimum of 12.5 MM (0.5 inch) Superpave as surface course and compacted 3 inches minimum of 19 MM (0.75 inch) Superpave as base course, separated by tack coat. MM refers to the maximum size aggregate that can be used. The road should be crowned with a minimum slope of 1.5% per foot and toward the perimeter of the site, limiting sheet flow run-on from flowing into the site. Hot mix asphalt shall be designed, mixed, and constructed in accordance with Maryland State Highway Administration Standard Specifications for Construction and Materials. No stipulations for drainage are recommended, but may be required should ponding become an issue (See EE Memo 1 – Construction Storm Water Management).

With the addition of 5 inches of asphalt, bearing stress at the MMC synthetic layers due to static and static plus dynamic loading drops, as shown in Attachment 2 (EE Memo 4) and Attachment 6 (EE Memo 4); summarized below in Tables 1 and 2.

| Bearing Stress at Drainage Net (ksf) | Limit | Static | Static + Dynamic |
|---|---|---|---|
| Existing Conditions (30 inches Cover Soil ) | 2.0 | 1.15 | 1.53 |
| 30 inches Cover Soil plus 5 inches Asphalt | 2.0 | 0.99 | 1.30 |

**Table 1** – Bearing Stress at Drainage Net under Design Truck with and without Asphalt

| Bearing Stress at Drainage Net (ksf) | Limit | Static | Static + Dynamic |
|---|---|---|---|
| Existing Conditions (30 inches Cover Soil) | 2.0 | 1.05 | 1.39 |
| 30 inches Cover Soil plus 5 inches Asphalt | 2.0 | 0.86 | 1.12 |

**Table 2** – Bearing Stress at Drainage Net under Wheel Loader with and without Asphalt

**CONCLUSIONS**

- The Drainage Net's flow capacity is compromised above a bearing stress of 2 ksf.
- All construction access roads should be composed of 5 inch asphalt to support concentrated loads from construction vehicles.
- Clean soil stockpiles should be limited to no higher than 13.5 feet above existing grade.
- Bearing stress applied by construction activities is limited to 2,000 psf at the MMC synthetic layers.
- Water and soil containers should be located on asphalt, concrete pad, or mats where they may be lifted up or removed.

# EXHIBITS

**ATTACHMENTS**

**EE MEMO 4**

ADDED DECEMBER 2013



MUESER RUTLEDGE CONSULTING ENGINEERS

File: 11896

Made By: SY Date: 11/11/13

FOR: EXELON

Checked By: AMD Date: 11/11/13

SUBJECT: BEARING PRESSURE CALCULATION

**Equipment : Link Belt LS518; DELMAG D46-32 Hammer**

Weight of Machine with **20.5 kip counterweight** $W := 189\text{kip}$ see page 3 of attached crane literature

Weight on Each Crawler $P := \frac{W}{2}$ $P = 94.5\ \text{kip}$

Crawler Contact Length $L_c := 21\text{ft}$ Crawler Contact Width $W_c := 4\text{ft}$

Crawler rests on 12 inch Timber mats, conservatively assuming 1H:1V Distributon through the timber thickness, Area of contact,

Length of Contact Area $L_{soil} := L_c + 12\text{in} \cdot 1 \cdot 2$ $L_{soil} = 23\ \text{ft}$

Width of Contact Area $W_{soil} := W_c + 12\text{in} \cdot 1 \cdot 2$ $W_{soil} = 6\ \text{ft}$

Membrane rests under 30 inches of soil cover, $D_{soil} := 30\text{in}$

Assuming 1H:2V distribution through the cover soil, Area of membrane influenced by crane loading,

$L_m := L_{soil} + 30\text{in} \cdot 1$ $L_m = 25.5\ \text{ft}$ $W_m := W_{soil} + 30\text{in} \cdot 1$ $W_m = 8.5\ \text{ft}$

Area $A_m := L_m \cdot W_m$ $A_m = 216.75\ \text{ft}^2$

Estimated bearing pressure on membrane $\sigma_b := \frac{P}{A_m}$ $\sigma_b = 436\ \text{psf}$ << 2000 psf allowable

MUESER RUTLEDGE CONSULTING ENGINEERS

File: 11896

Made By: SY Date: 11/11/13

FOR: EXELON

Checked By: AMD Date: 11/11/13

SUBJECT: BEARING PRESSURE CALCULATION

**Equipment : Link Belt LS518; DELMAG D46-32 Hammer**

Weight of Machine with **90 kip counterweight** $W := 259\text{kip}$ see page 3 of attached crane literature

Weight on Each Crawler $P := \frac{W}{2}$ $P = 129.5\,\text{kip}$

Crawler Contact Length $L_c := 21\,\text{ft}$ Crawler Contact Width $W_c := 4\,\text{ft}$ See Page 4 of Attached Crane Literature

Crawler rests on 12 inch Timber mats, conservatively assuming 1H:1V Distributon through the timber thickness, Area of contact,

Length of Contact Area $L_{soil} := L_c + 12\text{in}\cdot 1\cdot 2$ $L_{soil} = 23\,\text{ft}$

Width of Contact Area $W_{soil} := W_c + 12\text{in}\cdot 1\cdot 2$ $W_{soil} = 6\,\text{ft}$

Membrane rests under 30 inches of soil cover, $D_{soil} := 30\text{in}$

Assuming 1H:2V distribution through the cover soil, Area of membrane influenced by crane loading,

$L_m := L_{soil} + 30\text{in}\cdot 1$ $L_m = 25.5\,\text{ft}$ $W_m := W_{soil} + 30\text{in}\cdot 1$ $W_m = 8.5\,\text{ft}$

Area $A_m := L_m \cdot W_m$ $A_m = 216.75\,\text{ft}^2$

**Estimated bearing pressure on membrane** $\sigma_b := \frac{P}{A_m}$ $\sigma_b = 597\,\text{psf}$ << 2000 psf allowable

Attachment 1: Drawing No. I-1 - "Criteria for Interim Use Harbor Point Site Area 1 West of Wills St."

Dated: September 10, 2003.


## INTERIM USE NOTES FOR PROTECTION OF EXISTING SITE INFRASTRUCTURE

1. **Physical Protection:**

   Areas and items below are to be physically protected against damage. Protection will be by traffic barriers, concrete block, self-contained free-standing planters, or similar items:

   - HMS vaults which extend above ground surface
   - Gas Vent
   - Lightweight geofoam fill area over Covered Slip outboard of former Building 23.

   Protection by means other than physical barriers are required for the following:

   - Covers to wells and equipment at all locations, shall be locked or tightly bolted closed to protect against tampering.
   - Place 4" parking blocks along edge of pavement to keep vehicular traffic on paved surface. Emergency vehicle access shall not be impeded.

2. **Allowable Applied Load Intensity**

   The maximum allowable applied load intensity (static or dynamic) on the multimedia cap is 2,000 psf. For traffic limitation, see Note 8.

3. **Preservation Of Site Sampling And Monitoring Points**

   Maintain availability of site monitoring locations, sampling locations and survey points. Interim use construction and paving over survey points is prohibited, unless replaced in kind or extended through the paving, as approved by Honeywell. Survey monitoring point elevations immediately before and after replacement.

### INTERIM SITE IMPROVEMENTS

4. **Shallow Trenching and Excavations**

   Shallow trenches or local excavations within the cover soil are permitted for installing drainage chases, water lines, utilities, or constructing slabs flush with the pavement surface, etc. All trenching and excavation shall be approved by Honeywell. Excavations over the Multimedia Cap shall be limited in depth to twelve inches below the bottom of the crushed stone cover, or shallower if the visual barrier is encountered. The visual barrier shall not be penetrated. All excavations shall be inspected, and documented in depth and extent and transmitted to Honeywell.

   - Excavations are to be performed by smooth bucket equipment (no plate welded across teeth), under the direct observation of a person approved by Honeywell or designated representative.
   - Remove the stone cover down to the geotextile. Cut and fold back the geotextile. Replace geotextile upon completion.
   - Excavation spoils shall be stockpiled on heavy duty plastic tarps, and removed from the site, or returned to the excavation and compacted to 95% Standard Proctor maximum density.

5. **Paving Site Areas**

   Parking areas and access roads shall be paved. Concrete and asphalt pavement may be placed directly on the crushed stone surface. The paved areas shall be designed to provide storm drainage by sheet flow off cap without causing erosion of cover materials. Crushed stone or concrete water flow diffusers shall be located in area of erosion as needed. Manholes, other flush mounted access openings, settlement plates and equipment shall be raised with the asphalt pavement as approved by Honeywell. Surveys shall be performed before and after raising settlement plates and resets shall be indicated in the O & M records. All well covers in paved areas shall be designed to accommodate the design traffic load and exclude surface water.

6. **Lights**

   Light poles may be installed on the cap provided the limitations on excavation and bearing intensity are met, and the light poles are stable. Light poles may be fixed to concrete blocks, or flush mounted slabs as desired. Foundation designs for poles shall be approved by Honeywell.

7. **Waterfront Improvements**

   Not applicable for interim use.

### USE LIMITATIONS

8. Vehicles shall typically operate on paved areas. Occasional use on unpaved areas is permitted. Vehicles are limited to a fully loaded 15 cubic yard capacity concrete truck. Highway permitted HS 20 trucks weigh less than that maximum, and are therefore permitted. Concrete trucks shall not clean out or wash down equipment on Area 1, 2, or 3 Cap. Crane pads shall be supported on mats to limit loads in accordance with Note 2.

9. Plants, bushes, trees, etc. shall be set in planters with sides and bottoms impenetrable to roots.

10. Permanent and semi-permanent generators or other motorized equipment requiring refueling shall be placed on pre-cast or cast-in-place concrete pads with a perimeter lip to retain spilled fuel. During refueling, temporary equipment on asphalt shall be surrounded by a sorbent coil appropriate for the type of fuel used. Temporary equipment requiring refueling on unpaved areas shall be placed on a temporary petroleum resistant plastic or concrete containment with perimeter lip, during refueling. Should a spill of any measurable quantity occur, the spill shall be fully cleaned using sorbent towels and other measures as necessary. Honeywell shall be notified of spills. Used sorbent materials shall be disposed of properly. Fuel containers shall be stored on paved areas with containment berms. LPG bottles have no storage or use limitations.

11. Stakes or spikes which will be driven into the ground shall be no longer than 12 inches. Fence posts shall not be driven into the ground, but must be supported by concrete block bases or other

12. Periodic inspections shall be made by Honeywell or designated representative to verify compliance with these criteria.

## LEGEND

- MULTIMEDIA CAP
- DOUBLE - LAYER SYNTHETIC DRAINAGE COMPOSITE
- INFILTRATION TRENCH
- METHANE GAS VENT
- MP3 SETTLEMENT PLATE
- TOE DRAIN COLLECTION PIPING
- RIP-RAP
- SOIL-BENTONITE BARRIER
- SETBACK FROM SOIL/BENTONITE AND HMS COMPONENTS
- PIEZOMETER SYSTEM
- MJ2 EL 12.16 MANHOLE JUNCTION
- VJ3 EL. 11.48 VAULT JUNCTION WITH PUMPING WELL
- APPROX. LIMIT OF BUILDINGS
- CAP COVER SOIL SAMPLING LOCATION
- DRAINAGE LAYER SAMPLING LOCATION
- 4" PARKING BLOCKS
- EXISTING UNPAVED SERVICE ROAD
- PROPOSED PAVED PARKING/ROAD WAY
- APPROX. LIMIT OF AREAS OF KNOWN OR POTENTIAL SETTLEMENT CONCERN
- APPROX. LIMIT OF AREAS OF DREDGED CHANNEL
- PROPERTY BOUNDARY
- FENCE LINE

GENERAL NOTES:

1. Base drawing provided from available information compiled by Parsons Engineering Science, Inc., acting for Honeywell International Inc.
2. Site use areas shown provide clearance for minor discrepancies in actual locations of buried utilities. Locations of visible utilities shall be confirmed for protection before site work commences.

GRAPHIC SCALE

80' 40' 0 80' 160'

HARBOR POINT
(FORMER HONEYWELL BALTIMORE WORKS)
BALTIMORE MARYLAND

STRUEVER BROTHERS
ECCLES & ROUSE, INC.
BALTIMORE MARYLAND

MUESER RUTLEDGE CONSULTING ENGINEERS
14 PENN PLAZA – 225 W. 34TH STREET, NY, NY 10122

| SCALE | MADE BY I.Y. | DATE 9–10–03 | FILE NO. |
|---|---|---|---|
| GRAPHIC | CH'KD BY P.W.D. | DATE 9–10–03 | 9487 |

CRITERIA FOR INTERIM USE
HARBOR POINT SITE AREA 1
WEST OF WILLS ST.

DRAWING NO. I–1

# Attachment 2 EE MEMO 4

Static Load Spreading of Design Truck
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : 15 yd3 Concrete Truck
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 X1(ft) | Corner Point P1 Y1(ft) | Corner Point P2 X2(ft) | Corner Point P2 Y2(ft) | Load (Ksf) |
|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.66 | 1.33 | 11.250 |
| 2 | 1.33 | 0.00 | 2.00 | 1.33 | 11.250 |
| 3 | 6.00 | 0.00 | 6.66 | 1.33 | 11.250 |
| 4 | 7.33 | 0.00 | 8.00 | 1.33 | 11.250 |
| 5 | 0.00 | 4.50 | 0.66 | 5.83 | 11.250 |
| 6 | 1.33 | 4.50 | 2.00 | 5.83 | 11.250 |
| 7 | 6.00 | 4.50 | 6.66 | 5.83 | 11.250 |
| 8 | 7.33 | 4.50 | 8.00 | 5.83 | 11.250 |

INCREMENT OF STRESS FOR
X = 0.33(ft) Y = 0.66(ft) Z = 2.50(ft)

| Vert. Dsz (Ksf) |
|---|
| 1.15 |

Static and Dynamic Load Spreading of Design Truck
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : 15 yd3 Concrete Truck
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 | | Corner Point P2 | | Load |
|---|---|---|---|---|---|
| | X1(ft) | Y1(ft) | X2(ft) | Y2(ft) | (Ksf) |
| 1 | 0.00 | 0.00 | 0.66 | 1.33 | 14.960 |
| 2 | 1.33 | 0.00 | 2.00 | 1.33 | 14.960 |
| 3 | 6.00 | 0.00 | 6.66 | 1.33 | 14.960 |
| 4 | 7.33 | 0.00 | 8.00 | 1.33 | 14.960 |
| 5 | 0.00 | 4.50 | 0.66 | 5.83 | 14.960 |
| 6 | 1.33 | 4.50 | 2.00 | 5.83 | 14.960 |
| 7 | 6.00 | 4.50 | 6.66 | 5.83 | 14.960 |
| 8 | 7.33 | 4.50 | 8.00 | 5.83 | 14.960 |

INCREMENT OF STRESS FOR
X = 0.33(ft) Y = 0.66(ft) Z = 2.50(ft)

Vert. Dsz
(Ksf)

1.53

Static Load Spreading of Wheel Loader
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : Wheel Loader
Date : 6/27/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 | | Corner Point P2 | | Load |
|---|---|---|---|---|---|
| | X1(ft) | Y1(ft) | X2(ft) | Y2(ft) | (Ksf) |
| 1 | 0.00 | 0.00 | 1.60 | 1.06 | 9.020 |
| 2 | 0.00 | 10.83 | 1.60 | 11.89 | 9.020 |
| 3 | 6.83 | 10.83 | 8.43 | 11.89 | 9.020 |
| 4 | 6.83 | 0.00 | 8.43 | 1.06 | 9.020 |

INCREMENT OF STRESS FOR
X = 0.80(ft) Y = 0.53(ft) Z = 2.50(ft)

Vert. Dsz
(Ksf)

1.05

Static and Dynamic Load Spreading of Wheel Loader
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : Wheel Loader
Date : 6/27/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 X1(ft) | Corner Point P1 Y1(ft) | Corner Point P2 X2(ft) | Corner Point P2 Y2(ft) | Load (Ksf) |
|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 1.60 | 1.06 | 12.000 |
| 2 | 0.00 | 10.83 | 1.60 | 11.89 | 12.000 |
| 3 | 6.83 | 10.83 | 8.43 | 11.89 | 12.000 |
| 4 | 6.83 | 0.00 | 8.43 | 1.06 | 12.000 |

INCREMENT OF STRESS FOR
X = 0.80(ft) Y = 0.53(ft) Z = 2.50(ft)

| Vert. Dsz (Ksf) |
|---|
| 1.39 |

16,380 Gallon Double-Wall Tank
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : 16380 Gallon Tank
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 X1(ft) | Corner Point P1 Y1(ft) | Corner Point P2 X2(ft) | Corner Point P2 Y2(ft) | Load (Ksf) |
|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.33 | 27.33 | 3.900 |
| 2 | 2.00 | 0.00 | 2.33 | 27.33 | 3.900 |
| 3 | 6.00 | 0.00 | 6.33 | 27.33 | 3.900 |
| 4 | 8.00 | 0.00 | 8.33 | 27.33 | 3.900 |
| 5 | 0.33 | 0.00 | 2.00 | 0.33 | 3.900 |
| 6 | 0.33 | 9.00 | 2.00 | 9.33 | 3.900 |
| 7 | 0.33 | 18.00 | 2.00 | 18.33 | 3.900 |
| 8 | 0.33 | 27.00 | 2.00 | 27.33 | 3.900 |
| 9 | 2.33 | 0.00 | 6.00 | 0.33 | 3.900 |
| 10 | 2.33 | 9.00 | 6.00 | 9.33 | 3.900 |
| 11 | 2.33 | 18.00 | 6.00 | 18.33 | 3.900 |
| 12 | 2.33 | 27.00 | 6.00 | 27.33 | 3.900 |
| 13 | 6.33 | 0.00 | 8.00 | 0.33 | 3.900 |
| 14 | 6.33 | 9.00 | 8.00 | 9.33 | 3.900 |
| 15 | 6.33 | 18.00 | 8.00 | 18.33 | 3.900 |
| 16 | 6.33 | 27.00 | 8.00 | 27.33 | 3.900 |

INCREMENT OF STRESS FOR
X = 2.17(ft) Y = 9.17(ft) Z = 2.50(ft)

Vert. Dsz
(Ksf)

0.74

25 Yard Roll-off Box with Aluminum Hard Top
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : 25 yd Roll-off Box
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 X1(ft) | Corner Point P1 Y1(ft) | Corner Point P2 X2(ft) | Corner Point P2 Y2(ft) | Load (Ksf) |
|---|---|---|---|---|---|
| 1 | 0.00 | 0.34 | 0.50 | 0.84 | 10.800 |
| 2 | 0.00 | 19.42 | 0.50 | 19.92 | 10.800 |
| 3 | 7.05 | 0.34 | 7.55 | 0.84 | 10.800 |
| 4 | 7.05 | 19.42 | 7.55 | 19.92 | 10.800 |
| 5 | 2.00 | 0.00 | 2.17 | 22.00 | 10.800 |
| 6 | 5.38 | 0.00 | 5.55 | 22.00 | 10.800 |

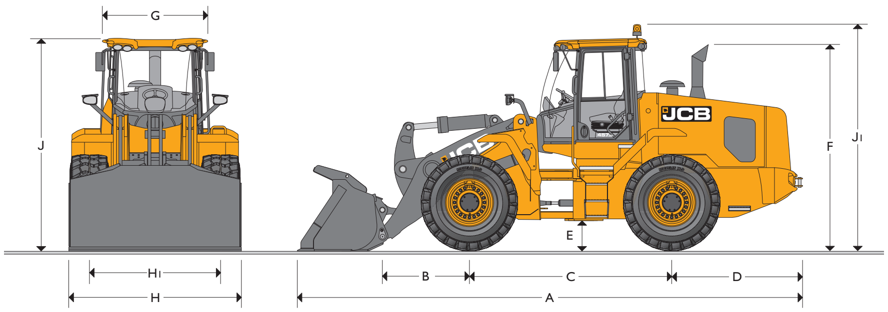
INCREMENT OF STRESS FOR
X = 2.08(ft) Y = 11.00(ft) Z = 2.50(ft)

Vert. Dsz
(Ksf)

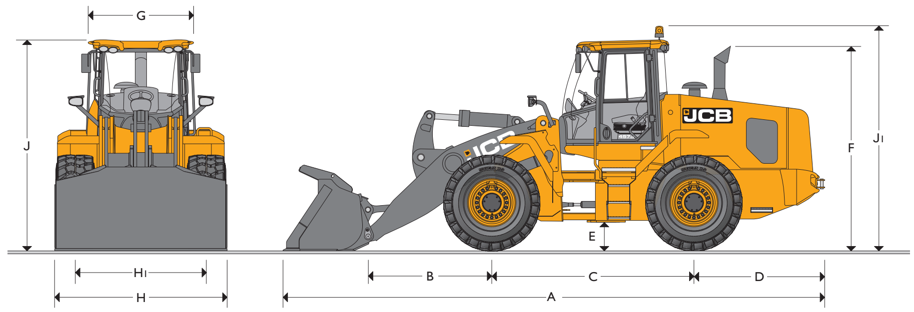
0.53

# Attachment 3 EE MEMO 4

## STATIC DIMENSIONS – Standard height arm




## STATIC DIMENSIONS – High lift arm




## STATIC DIMENSIONS – Standard height arm

| | | | ft-in (mm) |
|---|---|---|---|
| A | Overall length with standard bucket | | 26-2 (7964) |
| B | Axle to pivot pin | | 5-4 (1622) |
| C | Wheel base | | 10-10 (3300) |
| D | Axle to counterweight face | | 6-6 (1974) |
| E | Minimum ground clearance | | 1-7 (470) |
| F | Height over exhaust | | 10-11 (3318) |
| G | Width over cab | | 4-7 (1400) |
| H | Width over tires | | 8-10 (2702) |
| H1 | Wheel track | | 6-10 (2100) |
| J | Height over cab | | 11-1 (3370) |
| J1 | Overall height (to top of fixed beacon) | | 12-2 (3714) |
| Pin height (maximum) | | | 13-5 (4107) |
| Overall operating height | | | 18-3 (5571) |
| Front axle weight | | lb (kg) | 17,921 (8129) |
| Rear axle weight | | lb (kg) | 24,368 (11,053) |
| Total weight | | lb (kg) | 42,289 (19,182) |
| Inside radius | | | 10-5 (3182) |
| Maximum radius | | | 21-6 (6554) |
| Articulation angle | | degrees | ±40° |

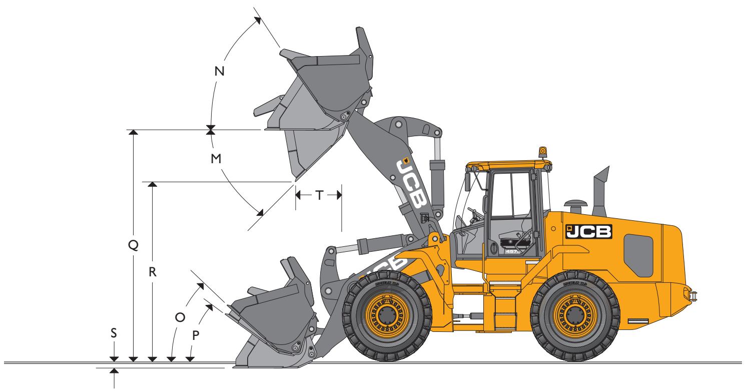
Data based on machine equipped with a 4.3yd³ bucket with bolt-on toeplates and 23.5 R25 Michelin XHA (L3) radial tires.

## STATIC DIMENSIONS – High lift arm

| | | | ft-in (mm) |
|---|---|---|---|
| A | Overall length with standard bucket | | 28-0 (8524) |
| B | Axle to pivot pin | | 7-2 (2182) |
| C | Wheel Base | | 10-10 (3300) |
| D | Axle to counterweight face | | 6-6 (1974) |
| E | Minimum ground clearance | | 1-7 (470) |
| F | Height over exhaust | | 10-11 (3318) |
| G | Width over cab | | 4-7 (1400) |
| H | Width over tires | | 8-10 (2702) |
| H1 | Wheel track | | 6-10 (2100) |
| J | Height over cab | | 11-1 (3370) |
| J1 | Overall height (to top of fixed beacon) | | 12-2 (3714) |
| Pin height (maximum) | | | 15-4 (4677) |
| Overall operating height | | | 20-2 (6140) |
| Front axle weight | | lb (kg) | 18,576 (8,426) |
| Rear axle weight | | lb (kg) | 24,619 (11,167) |
| Total weight | | lb (kg) | 43,195 (19,593) |
| Inside radius | | | 10-5 (3182) |
| Maximum radius over shovel | | | 22-2 (6770) |
| Articulation angle | | degrees | ±40° |

Data based on machine equipped with a 4.3yd³ bucket with bolt-on toeplates and 23.5 R25 Michelin XHA (L3) radial tires.

## LOADER DIMENSIONS – Standard height arm




## CHANGES TO OPERATING PERFORMANCE AND DIMENSIONS

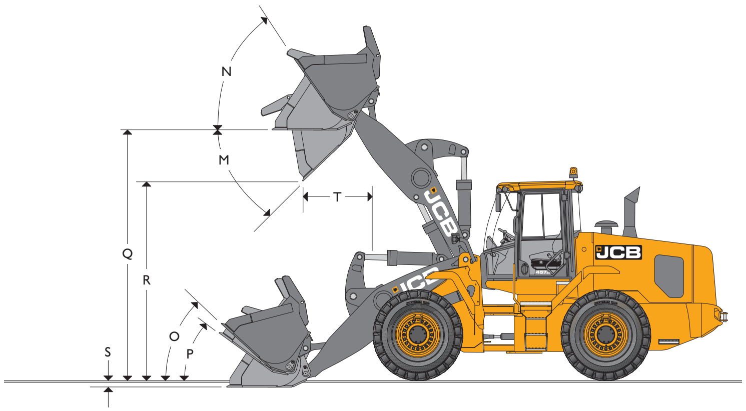
| Tire size | Manufacturer | Type | Rating | Op. weight lb (kg) | Tipping loads Straight lb (kg) | Tipping loads Full turn lb (kg) | Dimensions Vertical in (mm) | Dimensions Width in (mm) |
|---|---|---|---|---|---|---|---|---|
| 23.5R25 (radial) | Michelin | XTLA | L2 | -220 (-100) | -156 (-71) | -134 (-61) | -0.08 (-2) | 0 |
| 23.5R25 (radial) | Goodyear | TL-3A+ | L3 | 714 (324) | 506 (230) | 433 (196) | 0.75 (19) | 0 |
| 23.5R25 (radial) | Goodyear | RT-3B | L3 | 388 (176) | 275 (125) | 235 (107) | 0.39 (10) | 0 |
| 23.5–25 (crossply) | Goodyear | HRL-3A | L3 | -220 (-100) | -156 (-71) | -134 (-61) | 0.59 (15) | 0 |
| 23.5–25 (crossply) | Earthmover | 20ply | L3 | -335 (-152) | -237 (-108) | -203 (-92) | 0.24 (6) | 0 |
| 23.5R25 (radial) | Earthmover | | L3 | 0 | 0 | 0 | 0.16 (4) | 0 |
| 23.5R25 (radial) | Goodyear | GP-48 | L4 | 838 (380) | 593 (269) | 508 (230) | 1.38 (35) | 0 |
| 23.5R25 (radial) | Michelin | XLDD2A | L5 | 1261 (572) | 893 (405) | 764 (347) | 1.42 (36) | 0 |
| 23.5R25 (radial) | Michelin | XMINED2 | L5 | 1781 (808) | 1262 (572) | 1079 (490) | 1.42 (36) | 0 |
| 23.5R25 (radial) | Goodyear | RL-5K | L5 | 1552 (704) | 1099 (499) | 941 (427) | 1.42 (36) | 0 |
| 23.5-25 (solid cushion)* | SG Revolution | SE | - | 6887 (3124) | 1030 (467) | 882 (400) | 1.18 (30) | 0 |
| 23.5-25 (solid cushion)* | SG Revolution | DWL | - | 6887 (3124) | 1030 (467) | 882 (400) | 1.18 (30) | 0 |
| Deduct optional extra counterweight | – | | – | -1764 (-800) | -3407 (-1546) | -2812 (-1275) | 0 | 0 |

*Optional extra counterweights is not available when solid tires are fitted.

Assumes the fitment of Michelin 23.5R25 XHA (L3) tires.

| | | |  | | |  | |  | |  | |  | |  | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bucket mounting | | Direct | Direct | Direct | Direct | Direct | Direct | Direct | Quickhitch | Quickhitch | Quickhitch | Quickhitch | Quickhitch | Quickhitch |
| | Bucket type | | General Purpose | General Purpose | Penetration | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose |
| | Bucket equipment | | Tipped teeth | Tipped teeth | Tipped teeth | Reversible toeplate | Reversible toeplate | Tipped teeth & toeplate segments | Tipped teeth & toeplate segments | Tipped teeth | Tipped teeth | Reversible toeplate | Reversible toeplate | Tipped teeth & toeplate segments | Tipped teeth & toeplate segments |
| | Bucket capacity (SAE heaped) | $yd^3$ ($m^3$) | 4.1 (3.1) | 4.3 (3.3) | 4.1 (3.1) | 4.3 (3.3) | 4.6 (3.5) | 4.3 (3.3) | 4.6 (3.5) | 4.1 (3.1) | 4.3 (3.3) | 4.3 (3.3) | 4.6 (3.5) | 4.3 (3.3) | 4.6 (3.5) |
| | Bucket capacity (struck) | $yd^3$ ($m^3$) | 3.651 (2.791) | 3.912 (2.991) | 3.651 (2.791) | 3.836 (2.933) | 4.103 (3.137) | 3.836 (2.933) | 4.103 (3.137) | 3.266 (2.497) | 3.515 (2.687) | 3.464 (2.648) | 3.720 (2.844) | 3.464 (2.648) | 3.720 (2.844) |
| | Bucket width | ft-in (mm) | 9-4 (2837) | 9-4 (2837) | 9-3 (2811) | 9-2 (2800) | 9-2 (2800) | 9-2 (2800) | 9-2 (2800) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) |
| | Bucket weight with wearparts | lb (kg) | 3532 (1602) | 3627 (1645) | 3554 (1612) | 3797 (1722) | 3892 (1765) | 3797 (1722) | 3892 (1765) | 3043 (1380) | 3122 (1416) | 3296 (1495) | 3376 (1531) | 3296 (1495) | 3376 (1531) |
| | Maximum material density | $lb/yd^3$ ($kg/m^3$) | 3594 (2132) | 3352 (1989) | 3589 (2129) | 3343 (1983) | 3129 (1856) | 3343 (1983) | 3129 (1856) | 3263 (1936) | 3044 (1806) | 3035 (1801) | 2840 (1685) | 3035 (1801) | 2840 (1685) |
| | Tipping load straight | lb (kg) | 38,342 (17,392) | 38,103 (17,284) | 38,292 (17,369) | 38,048 (17,259) | 37,809 (17,150) | 38,048 (17,259) | 37,809 (17,150) | 35,233 (15,982) | 35,017 (15,884) | 34,965 (15,860) | 34,748 (15,762) | 34,965 (15,860) | 34,748 (15,762) |
| | Tipping load full turn | lb (kg) | 31,956 (14,494) | 31,741 (14,397) | 31,908 (14,473) | 31,671 (14,365) | 31,455 (14,267) | 31,671 (14,365) | 31,455 (14,267) | 29,275 (13,278) | 29,079 (13,190) | 29,015 (13,161) | 28,817 (13,071) | 29,015 (13,161) | 28,817 (13,071) |
| | Payload at 50% FTTL | lb (kg) | 15,978 (7247) | 15,871 (7199) | 15,954 (7237) | 15,836 (7183) | 15,728 (7134) | 15,836 (7183) | 15,728 (7134) | 14,638 (6639) | 14,540 (6595) | 13,102 (5943) | 13,003 (5898) | 13,102 (5943) | 13,003 (5898) |
| | Maximum break out force | lbf (kN) | 38,666 (172) | 37,092 (165) | 38,666 (172) | 36,193 (161) | 34,619 (154) | 36,193 (161) | 34,619 (154) | 34,394 (153) | 33,046 (147) | 32,146 (143) | 30,798 (137) | 32,146 (143) | 30,798 (137) |
| M | Dump angle maximum | degrees | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° |
| N | Roll back angle at full height | degrees | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° | 67° |
| O | Roll back at carry | degrees | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° |
| P | Roll back at ground level | degrees | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° | 39° |
| Q | Load over height | ft-in (mm) | 12-6 (3822) | 12-6 (3822) | 12-3 (3856) | 12-6 (3831) | 12-6 (3831) | 12-6 (3822) | 12-6 (3822) | 12-6 (3822) | 12-2 (3702) | 12-6 (3822) | 12-2 (3702) | 12-6 (3822) | 12-2 (3702) |
| R | Dump height (45° dump) | ft-in (mm) | 9-0 (2741) | 8-10 (2699) | 9-1 (2765) | 9-6 (2887) | 9-4 (2845) | 9-0 (2741) | 8-10 (2699) | 8-7 (2621) | 8-5 (2559) | 9-1 (2767) | 8-11 (2725) | 8-7 (2621) | 8-5 (2559) |
| S | Dig depth | ft-in (mm) | 0-3 (74) | 0-3 (74) | 0-3 (74) | 0-4 (91) | 0-4 (91) | 0-4 (109) | 0-4 (109) | 0-3 (74) | 0-3 (74) | 0-4 (91) | 0-4 (91) | 0-4 (91) | 0-4 (91) |
| T | Reach at dump height | ft-in (mm) | 3-11 (1183) | 3-9 (1135) | 4-0 (1207) | 3-7 (1085) | 3-5 (1039) | 3-11 (1183) | 3-9 (1135) | 4-3 (1301) | 4-1 (1255) | 3-11 (1205) | 3-10 (1159) | 4-3 (1301) | 4-1 (1255) |
| | Reach maximum (45° dump) | ft-in (mm) | 7-0 (2140) | 7-2 (2182) | 7-1 (2164) | 6-8 (2032) | 6-10 (2074) | 7-0 (2140) | 7-2 (2182) | 7-5 (2260) | 7-7 (2302) | 7-1 (2152) | 7-2 (2194) | 7-5 (2260) | 7-7 (2302) |
| | Operating weight (includes 176lb operator and full fuel tank) | lb (kg) | 43,945 (19,933) | 44,053 (19,982) | 43,967 (19,943) | 44,210 (20,053) | 44,318 (20,102) | 44,210 (20,053) | 44,318 (20,102) | 44,659 (20,257) | 44,767 (20,306) | 44,924 (20,377) | 45,032 (20,426) | 44,924 (20,377) | 45,032 (20,426) |

## LOADER DIMENSIONS – High lift arm




## CHANGES TO OPERATING PERFORMANCE AND DIMENSIONS

| Tire size | Manufacturer | Type | Rating | Op. weight lb (kg) | Tipping loads Straight lb (kg) | Tipping loads Full turn lb (kg) | Dimensions Vertical in (mm) | Dimensions Width in (mm) |
|---|---|---|---|---|---|---|---|---|
| 23.5R25 (radial) | Michelin | XLTA | L2 | -220 (-100) | -129 (-58) | -110 (-50) | -0.08 (-2) | 0 |
| 23.5R25 (radial) | Goodyear | TL-3A+ | L3 | 714 (324) | 417 (189) | 357 (162) | 0.75 (19) | 0 |
| 23.5R25 (radial) | Goodyear | RT-3B | L3 | 388 (176) | 227 (103) | 194 (88) | 0.39 (10) | 0 |
| 23.5–25 (crossply) | Goodyear | HRL-3A | L3 | -220 (-100) | -129 (-58) | -110 (-50) | 0.59 (15) | 0 |
| 23.5–25 (crossply) | Earthmover | 20ply | L3 | -335 (-152) | -196 (-89) | -167 (-76) | 0.24 (6) | 0 |
| 23.5R25 (radial) | Earthmover | | L3 | 0 | 0 | 0 | 0.16 (4) | 0 |
| 23.5R25 (radial) | Goodyear | GP-48 | L4 | 838 (380) | 489 (222) | 418 (190) | 1.38 (35) | 0 |
| 23.5R25 (radial) | Michelin | XLDD2A | L5 | 1261 (572) | 736 (334) | 630 (286) | 1.42 (36) | 0 |
| 23.5R25 (radial) | Michelin | XMINED2 | L5 | 1781 (808) | 1040 (472) | 890 (404) | 1.42 (36) | 0 |
| 23.5R25 (radial) | Goodyear | RL-5K | L5 | 1552 (704) | 906 (411) | 775 (352) | 1.42 (36) | 0 |
| 23.5-25 (solid cushion)* | SG Revolution | SE | - | 6887 (3124) | 4021 (1824) | 3440 (1560) | 1.18 (30) | 0 |
| 23.5-25 (solid cushion)* | SG Revolution | DWL | - | 6887 (3124) | 4021 (1824) | 3440 (1560) | 1.18 (30) | 0 |
| Deduct optional extra counterweight | – | – | | -1764 (-800) | -2808 (-1274) | -2317 (-1051) | 0 | 0 |

*Optional extra counterweights is not available when solid tires are fitted.

| Assumes the fitment of Michelin 23.5R25 XHA (L3) tires. |  | | |  | |  | |  | |  | |  | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bucket mounting | Direct | Direct | Direct | Direct | Direct | Direct | Direct | Quickhitch | Quickhitch | Quickhitch | Quickhitch | Quickhitch | Quickhitch |
| Bucket type | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose | General Purpose |
| Bucket equipment | Tipped teeth | Tipped teeth | Tipped teeth | Reversible t/plate | Reversible t/plate & t/plate segments | Reversible t/plate & t/plate segments | Reversible t/plate | Tipped teeth | Tipped teeth | Reversible t/plate | Reversible t/plate & t/plate segments | Reversible t/plate & t/plate segments | Reversible t/plate & t/plate segments |
| Bucket capacity (SAE heaped) $yd^3$ ($m^3$) | 3.7 (2.8) | 4.1 (3.1) | 4.3 (3.3) | 4.3 (3.3) | 4.6 (3.5) | 4.3 (3.3) | 4.6 (3.5) | 4.1 (3.1) | 4.3 (3.3) | 4.3 (3.3) | 4.6 (3.5) | 4.3 (3.3) | 4.6 (3.5) |
| Bucket capacity (struck) $yd^3$ ($m^3$) | 3.266 (2.497) | 3.651 (2.791) | 3.912 (2.991) | 3.836 (2.933) | 4.103 (3.137) | 3.836 (2.933) | 4.103 (3.137) | 3.266 (2.497) | 3.515 (2.687) | 3.464 (2.648) | 3.720 (2.844) | 3.464 (2.648) | 3.720 (2.844) |
| Bucket width ft-in (mm) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-2 (2800) | 9-2 (2800) | 9-2 (2800) | 9-2 (2800) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) | 9-4 (2837) |
| Bucket weight with wearparts lb (kg) | 3371 (1529) | 3532 (1602) | 3627 (1645) | 3797 (1722) | 3892 (1765) | 3797 (1722) | 3892 (1765) | 3043 (1380) | 3122 (1416) | 3296 (1495) | 3376 (1531) | 3296 (1495) | 3376 (1531) |
| Maximum material density $lb/yd^3$ ($kg/m^3$) | 2983 (1770) | 2681 (1591) | 2500 (1483) | 2493 (1479) | 2333 (1384) | 2493 (1479) | 2333 (1384) | 2455 (1457) | 2290 (1358) | 2284 (1355) | 2138 (1269) | 2284 (1355) | 2138 (1269) |
| Tipping load straight lb (kg) | 29,210 (13,250) | 29,080 (13,191) | 28,898 (13,108) | 28,857 (13,089) | 28,679 (13,009) | 28,857 (13,089) | 28,679 (13,009) | 26,978 (12,237) | 26,812 (12,162) | 26,775 (12,145) | 26,611 (12,071) | 26,775 (12,145) | 26,611 (12,071) |
| Tipping load full turn lb (kg) | 24,164 (10,961) | 24,057 (10,912) | 23,897 (10,840) | 23,845 (10,816) | 23,683 (10,743) | 23,845 (10,816) | 23,683 (10,743) | 22,230 (10,084) | 22,085 (10,017) | 22,037 (9996) | 21,889 (9929) | 22,037 (9996) | 21,889 (9929) |
| Payload at 50% FTTL lb (kg) | 12,082 (5481) | 12,029 (5456) | 11,949 (5420) | 11,923 (5408) | 11,842 (5372) | 11,923 (5408) | 11,842 (5372) | 11,115 (5042) | 11,043 (5009) | 11,019 (4998) | 10,945 (4965) | 11,019 (4998) | 10,945 (4965) |
| Maximum break out force lbf (kN) | 36,867 (164) | 33,945 (151) | 32,596 (145) | 31,922 (142) | 30,573 (136) | 31,922 (142) | 30,573 (136) | 30,123 (134) | 28,999 (129) | 28,325 (126) | 27,201 (121) | 28,325 (126) | 27,201 (121) |
| M Dump angle maximum degrees | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° | 45° |
| N Roll back angle at full height degrees | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° | 53° |
| O Roll back at carry degrees | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° | 52° |
| P Roll back at ground level degrees | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° |
| Q Load over height ft-in (mm) | 14-5 (4393) | 14-5 (4393) | 14-5 (4393) | 14-5 (4402) | 14-5 (4402) | 14-5 (4393) | 14-5 (4393) | 14-5 (4393) | 14-0 (4273) | 14-5 (4393) | 14-1 (4282) | 14-5 (4393) | 14-0 (4273) |
| R Dump height (45° dump) ft-in (mm) | 11-1 (3376) | 10-10 (3312) | 10-9 (3270) | 11-4 (3458) | 11-2 (3416) | 10-10 (3312) | 10-9 (3270) | 10-6 (3192) | 10-3 (3130) | 10-11 (3338) | 10-10 (3296) | 10-6 (3192) | 10-3 (3130) |
| S Dig depth ft-in (mm) | 0-3 (75) | 0-3 (75) | 0-3 (75) | 0-4 (101) | 0-4 (101) | 0-4 (101) | 0-4 (101) | 0-3 (75) | 0-3 (75) | 0-4 (101) | 0-4 (101) | 0-4 (101) | 0-4 (101) |
| T Reach at dump height ft-in (mm) | 3-7 (1099) | 4-2 (1259) | 4-0 (1213) | 3-10 (1162) | 3-8 (1117) | 4-2 (1259) | 4-0 (1213) | 4-6 (1379) | 4-5 (1333) | 4-3 (1283) | 4-1 (1237) | 4-6 (1379) | 4-5 (1333) |
| Reach maximum (45° dump) ft-in (mm) | 8-5 (2553) | 8-7 (2617) | 8-9 (2659) | 8-3 (2509) | 8-4 (2551) | 8-7 (2617) | 8-9 (2659) | 9-0 (2737) | 9-1 (2779) | 8-8 (2629) | 8-9 (2617) | 9-0 (2737) | 9-1 (2779) |
| Operating weight (includes 176lb operator and full fuel tank) lb (kg) | 44,690 (20,271) | 44,851 (20,344) | 44,959 (20,393) | 45,116 (20,464) | 45,224 (20,513) | 45,116 (20,464) | 45,224 (20,513) | 45,563 (20,667) | 45,673 (20,717) | 45,830 (20,788) | 45,938 (20,837) | 45,830 (20,788) | 45,938 (20,837) |

## LOADER

Heavy duty three cylinder geometry provides high breakout forces with excellent loading characteristics. The pin, bush and sealing design on all pivot points provide extended maintenance intervals.

## ENGINE

6-cylinder variable geometry turbo-charged and charge air cooled 8.9l diesel engine. High pressure common rail fuel injection, cooled exhaust gas recirculation and a diesel particulate filter combine to reduce emissions and optimise fuel efficiency. Selectable Power or Economy modes.

| | | |
|---|---|---|
| Manufacturer | | Cummins |
| Model | | QSL9 |
| Displacement | in³ (ltr) | 543 (8.9) |
| Bore | in (mm) | 4.49 (114) |
| Stroke | in (mm) | 5.69 (145) |
| Aspiration | | Variable Geometry Turbocharger |
| No. of Cylinders | | 6 |
| Max. Gross Power to SAE J1995/ISO 14396 | hp (kW) @ 1800rpm | 250 (186) |
| Rated Gross Power to SAE J1995/ISO 14396 | hp (kW) @ 2200rpm | 250 (186) |
| Net Power to SAE J1349 | hp (kW) @ 2100rpm | 247 (184) |
| Gross Torque at 1400rpm | lbf-ft (Nm) @1500rpm | 800 (1085) |
| Economy Working Range | rpm | 800 - 1800 |
| Torque Rise | % | 34.1 |
| Valves per Cylinder | | 4 |
| Wet Weight | lbs (kg) | 1560 (708) |
| Air Cleaner | | Cyclonic pre filter with scavenge system |
| Fan Drive Type | | Hydraulic |
| Emissions | | US EPA Tier 4i, EU Stage IIIB |

## TRANSMISSION

4 wheel drive, automatic 4 speed transmission. "Power-Inch" intelligent clutch cut off technology as standard . Optional 5 speed transmission with auto-locking torque converter available for even more speed and efficiency.

| Type | | 4 speed non-lock up converter | 5 speed with lock up torque converter |
|---|---|---|---|
| Make | | ZF | ZF |
| Model | | 4WG210 (standard) | 5WG210 with lock-up (option) |
| Forward speed 1 | mph (kph) | 4.3 (7.0) | 4.4 (7.1) |
| Forward speed 2 | mph (kph) | 8.5 (13.7) | 7.8 (12.6) |
| Forward speed 3 | mph (kph) | 16.2 (26.1) | 11.9 (19.1) |
| Forward speed 4 | mph (kph) | 25.8 (41.5) | 18.1 (29.1) |
| Forward speed 5 | mph (kph) | | 26.6 (42.7) |
| Reverse 1 | mph (kph) | 4.6 (7.3) | 4.7 (7.5) |
| Reverse 2 | mph (kph) | 9.0 (14.4) | 8.3 (13.3) |
| Reverse 3 | mph (kph) | 17.0 (27.4) | 19.0 (30.6) |

## AXLES

3 axles options available; Torque proportioning differentials, Limited slip differentials or Open differentials with automatic differential locking. All axle options feature wheel speed braking for lower heat build up and longer service life.

| Type | Open Differential | Limited Slip Differential | Open Differential with auto-locking front |
|---|---|---|---|
| Make and Model | ZF MT-L 3095 MK 2 (front and rear) | ZF MT-L 3095 MK 2 (front and rear) | ZF MT-L 3095 MK 2 (front and rear) |
| Overall Axle ratio | 23.334:1 | 23.334:1 | 23.334:1 |
| Rear Axle Oscillation | ±12.5° | ±12.5° | ±12.5° |

## ELECTRICAL SYSTEM

24 volt negative ground system, 70 Amp alternator with 2 x 110 Amp hour low maintenance batteries. Isolator located in rear of machine. Ignition key start/stop and pre-heat cold start. Primary fuse box. Other electrical equipment includes quartz halogen, twin filament working lights, front/rear wash/wipe, heated rear screen, full roading lights, clock, gauge and warning light monitoring. Connectors to IP67 standard.

| | | |
|---|---|---|
| System voltage | Volt | 24 |
| Alternator output | Amp hour | 70 |
| Battery capacity | Amp hour | 2 x 110 |

## STEERING

Priority steer hydraulic system with emergency steering. Piston pump meters flow through steer valve to provide smooth low effort response. Steering angle ± 40°. Steering cylinders fitted with end rod damping to provide cushioned steering at full articulation. Adjustable steering column.

## BRAKES

Hydraulic power braking on all wheels, operating pressure 1160psi (80 bar). Dual circuit with accumulator back-up provide maximum safety under all conditions. Hub mounted, oil immersed, multi-plate disc brakes with sintered linings reduce heat build up. Wheel speed braking improves performance and reduce wear. Parking brake, electro-hydraulic disc type operating on transmission output shaft.

## SERVICE FILL CAPACITIES

| | gal (liters) |
|---|---|
| Hydraulic system | 35.7 (135) |
| Fuel system | 81.6 (309) |
| Engine oil (includes filter) | 5.0 (19) |
| Engine coolant | 10.6 (40) |
| Axles | 9.0 (34) |
| Transmission | 10.8 (41) |

## CAB

Resiliently mounted ROPS/FOPS structure (tested in accordance with EN3471:2008/EN3449: 2008 (Level 2). Entry/exit is via a large rear hinged door, grab handles giving 3 points of contact and and anti-slip inclined steps. Forward visibility through a curved, laminated windscreen with lower glazed quarter panels, two interior mirror and heated exterior mirrors. Instrumentation analogue/digital display gauges along with full color LCD screen including selectable machine and operator menus along with service and diagnostic screens. Heating/ventilation provides balanced and filtered air distribution throughout the cab via a powerful 27,300 BTU capacity heater, with air conditioning and climate control system as options. Provision of speakers and antenna for radio fitment (radio/CD not included). The cab environment is positively pressurised preventing the ingress of dust including in-cab recirculation filter. Fabric mechanical suspension seat as standard with various options including vinyl material, air suspension, heating and deluxe Grammer Actimo XXL air suspension seat with headrest, twin armrests, lumbar support, backrest extension, heating and full adjustment. Coat hook, cup holder and additional storage space. Fuse box positioned at rear for access to fuses, relays and diagnostic connectors.

## TIRES

A variety of tire options are available including:
23.5R25 XTLA (L2), 23.5R25 XHA (L3), 23.5R25 TL-3A+ (L3), 23.5R25 RT-3B (L3), 23.5x25x20 ply HRL (L3), 23.5x25x20 ply (L3), 23.5R25 JCB (L3), 23.5R25 XMINE (L5), 23.5R25 XLDD2 (L5), 23.5R25 RL-5K (L5), 23.5R25 DWL (Solid Cushion), 23.5R25 SE (Solid Cushion)

## ATTACHMENTS

An extensive range of attachments are available to fit directly or via the JCB quickhitch mounting.

## LOADER HYDRAULICS

Twin variable displacement piston pumps feed a “load sensing” system providing a fuel efficient and responsive distribution of power as required. Main services are servo actuated from a single lever (joystick) loader control. Auxiliary circuits controlled via additional lever or joystick mounted electrical buttons. Accumulator back-up is available to control loader in the event of loss of pump pressure.

| | | |
|---|---|---|
| Pump type | | Twin variable displacement piston pumps |
| Pump 1 max. flow | gal/min (l/min) | 43 (163) |
| Pump 1 max. pressure | PSI (bar) | 3625 (250) |
| Pump 2 max. flow | gal/min (l/min) | 43 (163) |
| Pump 2 max. pressure | PSI (bar) | 2320 (160) |
| **Hydraulic cycle times at full engine revs** | | **seconds** |
| Arms raise (full bucket) | | 5.8 |
| Bucket dump (full bucket) | | 1.2 |
| Arms lower (empty bucket) | | 4.1 |
| Total cycle | | 11.1 |

| Ram dimensions | | Bore | Rod | Closed centers | Stroke |
|---|---|---|---|---|---|
| Bucket ram x2 | in (mm) | 7.1 (180) | 3.0 (90) | 42.5 (1080) | 22.4 (570) |
| Lift ram x2 | in (mm) | 6.3 (160) | 3.1 (80) | 50.8 (1290) | 29.3 (744) |
| Steer ram x2 | in (mm) | 3.5 (90) | 2.0 (50) | 24.4 (621) | 12.3 (312) |

## STANDARD EQUIPMENT

**Loader:** Bucket reset mechanism (selectable), loader arm kickout mechanism (selectable), loader control isolator, single lever or multi lever servo control, high breakout forces with excellent loading characteristics, safety strut.

**Engine:** Air cleaner – cyclonic pre filter with scavenge system. Variable geometry turbocharger, cooled exhaust gas recirculation, diesel particulate filter, isolated cooling package with hydraulically driven cooling fan. Selectable ECO mode (217hp)

**Transmission:** Single lever shift control, neutral start, 'Power-Inch' Intelligent clutch cut off on footbrake (selectable), direction changes and kickdown on gear selector and loader control lever.

**Axles:** Epicyclic wheel hub reduction, fixed front, oscillating rear.

**Brakes:** Mulit-plate wet disc brakes, sintered brake pads, dual circuit hydraulic power, wheel speed braking. Parking disc brake on transmission output shaft.

**Hydraulics:** Twin piston pumps with priority steer, emergency steer back-up, 2 spool loader circuit with accumulator support, 3rd spool auxiliary hydraulic circuit, 4th spool optional.

**Steering:** Adjustable steering column, "soft feel" steering wheel, 5 turns lock to lock, resilient stops on max lock.

**Cab:** ROPS/FOPS safety structure, interior light, center mounted master warning light. Electronic monitoring panel with full color LCD display. Two speed intermittent front windscreen wipe/wash and self park, single speed rear windscreen wipe/wash and self park. 3 speed heater/demisting with replaceable air filter, RH opening windows, sun visor, internal rear view mirror, heated external mirrors, adjustable suspension seat with belt and headrest, operator storage, laminated windscreen, heated rear screen, loader control isolator, horn, adjustable armrest.

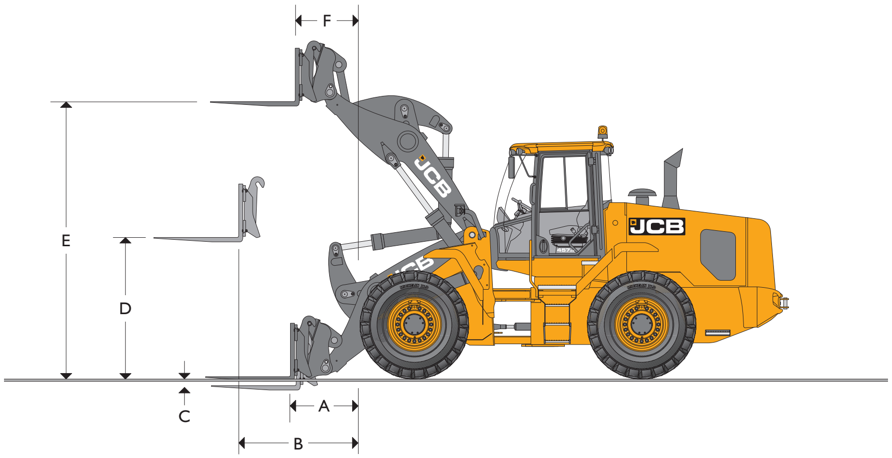
**Electrical:** Road lights front and rear, parking lights, front and rear working lights, reverse alarm and light, rear fog light, battery isolator, radio wiring and speakers, 70 amp alternator, rotating beacon.

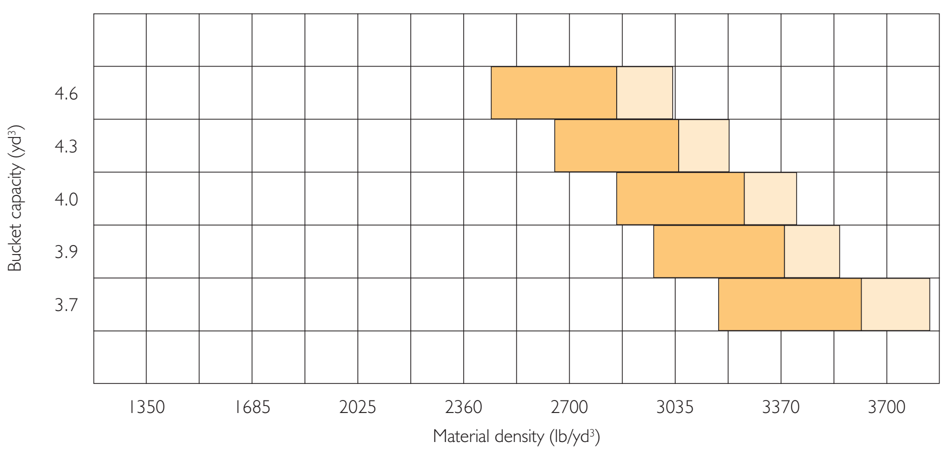
**Bodywork:** Front and rear fenders, side and rear access panels, mesh air intake screens, flexible bottom step, full width rear counterweight, recovery hitch, lifting lugs, belly guards.

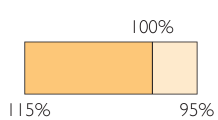
## OPTIONAL EQUIPMENT

**Loader:** High lift loader end, Smoothride system (SRS), hydraulic quickhitch with in-cab pin isolation, replaceable bucket wear parts.
**Engine:** Widecore radiator, epoxy coated radiator / coolers, automatically reversing cooling fan, engine block heater
**Transmission:** 5 speed transmission with Lock-up torque converter, transmission cooler bypass
**Axles:** Limited slip differentials front and rear, Open differential with automatic differential locking -100% (front axle only)
**Hydraulics:** ARV kit, 4th hydraulic spool
**Cab:** Canopy cab, wastemaster cab, air conditioning, Climate control, joystick or multi-lever hydraulic controls, auxiliary hydraulic control on separate lever or joystick mounted (proportional), 24V to 12V in cab converter, cab screen guards, heated air suspension seat, Grammer Actimo XXL seat, front and rear blinds, P3 cab air filter, Carbon cab air filter
**Electrical:** Reversing camera (color), additional front and rear work lights, sealed electrics, non-heated mirrors
**Bodywork:** Full rear fenders, light guards, number plate light kit, white noise reverse alarm, smart reverse alarm.
**Miscellaneous options:** Automatic greasing system, Biodegradable hydraulic oil, fire extinguisher, grease gun and cartridge
Wastemaster package: Includes front and rear light guards, widecore radiator, carbon cab air filter, front screen guard, full belly guarding, Wastemaster decal.

## 457 HT – LOADER DIMENSIONS – FORK FRAME WITH FORKS



Bucket fill factors

## LOADER DIMENSIONS – FORK FRAME WITH FORKS

| | Assumes the fitment of Michelin 23.5R25 XHA (L3) tires | | Standard arm | High lift arm |
|---|---|---|---|---|
| | Fork carriage width | ft-in (mm) | 4-11 (1500) | 4-11 (1500) |
| | Length of tines | ft-in (mm) | 4-0 (1220) | 4-0 (1220) |
| A | Reach at ground level | ft-in (mm) | 3-7 (1084) | 5-5 (1644) |
| B | Reach at arms horizontal | ft-in (mm) | 5-7 (1695) | 7-2 (2172) |
| C | Below ground level | ft-in (mm) | 0-1 (16) | 0-1 (16) |
| D | Arms, horizontal height | ft-in (mm) | 6-6 (1975) | 6-6 (1975) |
| E | Arms, maximum height | ft-in (mm) | 13-1 (3997) | 15-0 (4567) |
| F | Reach at maximum height | ft-in (mm) | 2-5 (735) | 2-8 (813) |
| | Payload* | lb (kg) | 17,951 (8142) | 13,391 (6074) |
| | Tipping load straight | lb (kg) | 26,900 (12,202) | 20,228 (9175) |
| | Tipping load full turn (40°) | lb (kg) | 22,439 (10,178) | 16,741 (7594) |
| | Attachment weight | lb (kg) | 1301 (590) | 1301 (590) |

*At the center-of-gravity distance 24in (600mm). Based on 80% of full turn tipping load as defined by ISO 8313.
Manual fork spacings at 2in (50mm) increments. Class 4A Fork section 6in x 2.4in (150mm x 60mm).

## BUCKET SELECTOR

| | Loose density | | Fill factor |
|---|---|---|---|
| Material | lb/yd³ | kg/m³ | % |
| Snow (fresh) | 337 | 200 | 110 |
| Peat (dry) | 674 | 400 | 100 |
| Sugar beet | 894 | 530 | 100 |
| Coke (loose) | 961 | 570 | 85 |
| Barley | 1012 | 600 | 85 |
| Petroleum coke | 1146 | 680 | 85 |
| Wheat | 1231 | 730 | 85 |
| Coal bitumous | 1290 | 765 | 100 |
| Fertilizer (mixed) | 1737 | 1030 | 85 |
| Coal anthracite | 1764 | 1046 | 100 |
| Earth (dry) (loose) | 1939 | 1150 | 100 |
| Nitrate fertilizer | 2180 | 1250 | 85 |
| Sodium chloride (dry) (salt) | 2192 | 1300 | 85 |
| Cement Portland | 2428 | 1440 | 100 |
| Limestone (crushed) | 2580 | 1530 | 100 |
| Sand (dry) | 2613 | 1550 | 100 |
| Asphalt | 2698 | 1600 | 100 |
| Gravel (dry) | 2782 | 1650 | 85 |
| Clay (wet) | 2832 | 1680 | 110 |
| Sand (wet) | 3187 | 1890 | 110 |
| Fire clay | 3507 | 2080 | 100 |
| Copper (concentrate) | 3878 | 2300 | 85 |
| Slate | 4721 | 2800 | 100 |
| Magnetite | 5402 | 3204 | 100 |

## A GLOBAL COMMITMENT TO QUALITY

JCB's total commitment to its products and customers has helped it grow from a one-man business into one of the world's largest manufacturers of backhoe loaders, crawler excavators, wheeled excavators, telescopic handlers, wheeled loaders, dump trucks, rough terrain fork lifts, industrial fork lifts, mini/midi excavators, skid steer loaders and tractors.

By making constant and massive investments in the latest production technology, the JCB factories have become some of the most advanced in the world.

By leading the field in innovative research and design, extensive testing and stringent quality control, JCB machines have become renowned all over the world for performance, value and reliability.

And with an extensive dealer sales and service network in over 150 countries, we aim to deliver the best customer support in the industry.

Through setting the standards by which others are judged, JCB has become one of the world's most impressive success stories.

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DWUSA 3243 05/13

ADLER TANK RENTALS

# Attachment 4 EE MEMO 4

*Easy-to-clean, smooth-wall interior*


## 16,380 Gallon
## Double-Wall Tank

Capacity: 16,380 gal (390 bbl)
Height: 9' 8"
Width: 8' 6"
Length: 46'
Tare Weight: 38,000 lbs

*All sizes are approximate*

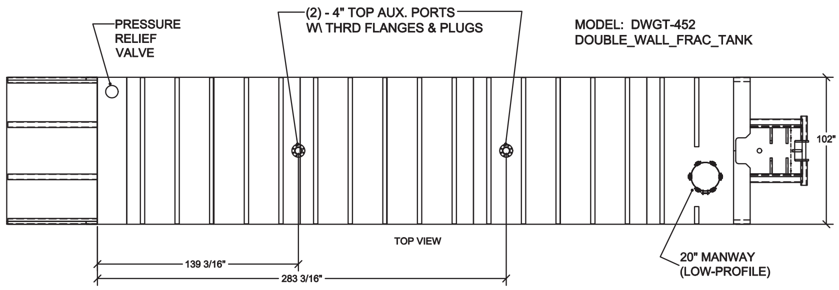
At Adler Tank Rentals, we are committed to providing safe and reliable containment solutions for all types of applications where performance matters.

Providing maximum protection against potentially hazardous spill risk and environmental contamination, the 16,380 Gallon Double-Wall Tank ensures full secondary containment of both hazardous vapors and the tank's liquid contents.

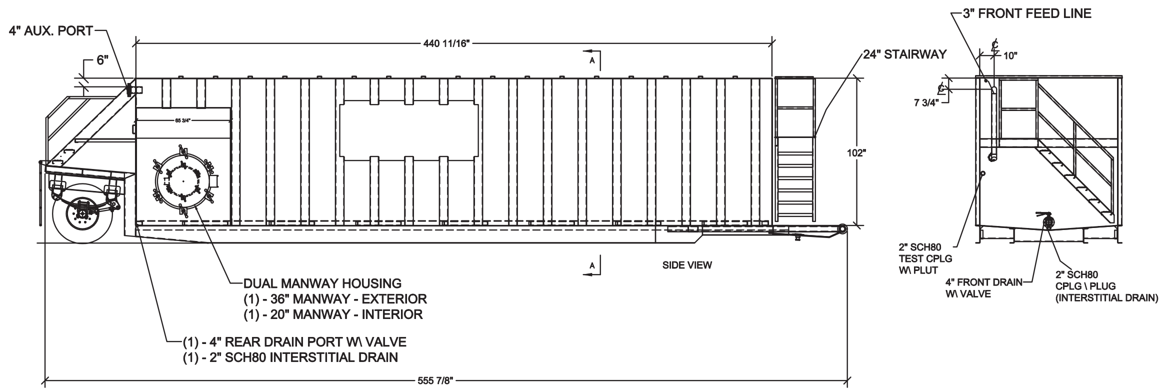
### Mechanical Features

- Epoxy-coated interior
- 3" fill line
- Two (2) standard 20" side-hinged manways
- Two (2) 4" valved floor-level fill/drain ports valves for low point drain out
- 36" manway access to interstitial space
- 4" vent with 1 lb pressure/ 4 oz vacuum pressure relief valve
- Sloped and V bottom for quicker drain out and easier cleaning
- Easy-to-clean design with smooth-wall interior, no corrugations and no internal rods
- Two (2) 4" threaded and plugged auxiliary ports on roof
- Front-mounted ladderwell for top access
- Fixed rear axle for increased maneuverability
- Nose rail cut-out for easy access when installing hose and fittings on the front/bottom of tank
- 100% secondary containment; literally a tank built within a tank for storage of risk-potential materials in environmentally sensitive areas
- One (1) 2" interstitial space drain below 4" total drain

# 16,380 Gallon Double-Wall Tank








*Tank configurations may vary in selected markets*

## Safety Features

- Non-slip step materials on ladderwells and catwalks
- "Safety yellow" rails and catwalks for high visibility
- Safe operation reminder decals

## Options

- Bare steel interior
- Steam coils
- Audible alarms, strobes and level gauges (digital and mechanical)

## Comprehensive Service

Adler Tank Rentals provides containment solutions for hazardous and non-hazardous liquids and solids. We offer 24-hour emergency service, expert planning assistance, transportation, repair and cleaning services. All of our rental equipment is serviced by experienced Adler technicians and tested to exceed even the most stringent industry standards.

ADLER TANK RENTALS

800-421-7471 www.adlertankrentals.com

Attachment 5 **EE MEMO 4**

# 25 YARD ROLL-OFF BOX WITH ALUMINUM HARD TOP


In Select Markets

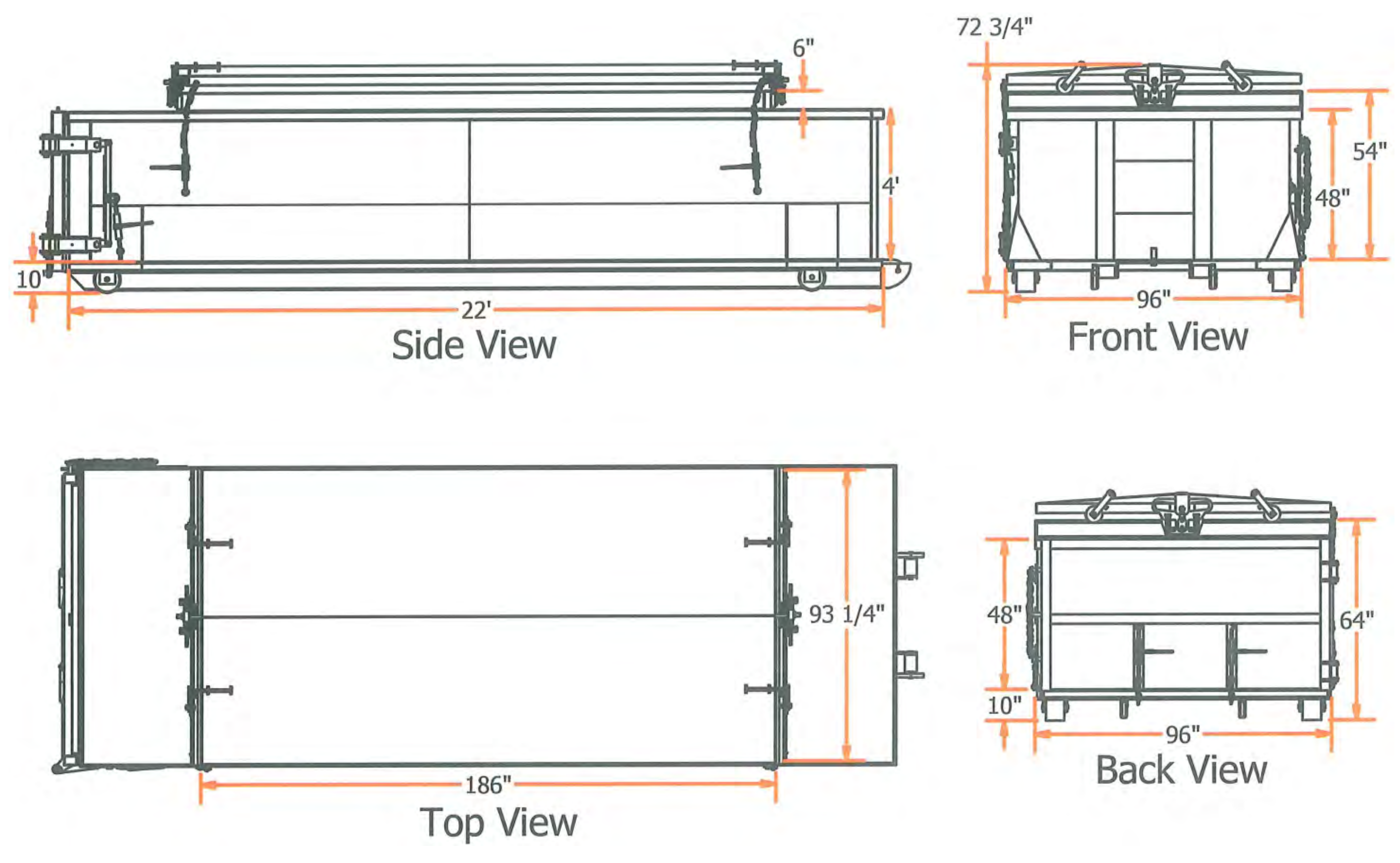
Capacity: 25 yd
Height: 6′
Width: 8′
Length: 23′

*All sizes are approximate*

Mechanical features:

- Rolling aluminum lid equipped with ratcheting binders to lock in place
- Plastic liners available upon request
- Compatible with standard roll-off frame truck

25 Yard Roll-Off Box With Aluminum Hard Top



# Attachment 6 **EE MEMO 4**

Static Load Spreading of Design Truck with Asphalt
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : 15 yd3 Concrete Truck
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 | | Corner Point P2 | | Load |
|---|---|---|---|---|---|
| | X1(ft) | Y1(ft) | X2(ft) | Y2(ft) | (Ksf) |
| 1 | 0.00 | 0.00 | 0.66 | 1.33 | 11.250 |
| 2 | 1.33 | 0.00 | 2.00 | 1.33 | 11.250 |
| 3 | 6.00 | 0.00 | 6.66 | 1.33 | 11.250 |
| 4 | 7.33 | 0.00 | 8.00 | 1.33 | 11.250 |
| 5 | 0.00 | 4.50 | 0.66 | 5.83 | 11.250 |
| 6 | 1.33 | 4.50 | 2.00 | 5.83 | 11.250 |
| 7 | 6.00 | 4.50 | 6.66 | 5.83 | 11.250 |
| 8 | 7.33 | 4.50 | 8.00 | 5.83 | 11.250 |

INCREMENT OF STRESS FOR
X = 0.33(ft) Y = 0.66(ft) Z = 2.92(ft)

Vert. Dsz
(Ksf)

0.93

Vert. Dsz + Asphalt Weight = 0.93 + (145pcf)*(0.42ft) = 0.99 ksf

Static and Dynamic Load Spreading of Design Truck with Asphalt

RECTANGULAR LOADS

UNIFORM VERTICAL

Project Name: Exelon
Client : 15 yd3 Concrete Truck
Date : 6/24/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 X1(ft) | Corner Point P1 Y1(ft) | Corner Point P2 X2(ft) | Corner Point P2 Y2(ft) | Load (Ksf) |
|---|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.66 | 1.33 | 14.960 |
| 2 | 1.33 | 0.00 | 2.00 | 1.33 | 14.960 |
| 3 | 6.00 | 0.00 | 6.66 | 1.33 | 14.960 |
| 4 | 7.33 | 0.00 | 8.00 | 1.33 | 14.960 |
| 5 | 0.00 | 4.50 | 0.66 | 5.83 | 14.960 |
| 6 | 1.33 | 4.50 | 2.00 | 5.83 | 14.960 |
| 7 | 6.00 | 4.50 | 6.66 | 5.83 | 14.960 |
| 8 | 7.33 | 4.50 | 8.00 | 5.83 | 14.960 |

INCREMENT OF STRESS FOR

X = 0.33(ft) Y = 0.66(ft) Z = 2.92(ft)

Vert. Dsz
(Ksf)

1.24

Vert. Dsz + Asphalt Weight = 1.24 + (145pcf)*(0.42ft) = 1.30 ksf

Static Load Spreading of Wheel Loader with Asphalt
RECTANGULAR LOADS
UNIFORM VERTICAL

Project Name: Exelon
Client : Wheel Loader
Date : 6/27/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 | | Corner Point P2 | | Load |
|---|---|---|---|---|---|
| | X1(ft) | Y1(ft) | X2(ft) | Y2(ft) | (Ksf) |
| 1 | 0.00 | 0.00 | 1.60 | 1.06 | 9.020 |
| 2 | 0.00 | 10.83 | 1.60 | 11.89 | 9.020 |
| 3 | 6.83 | 10.83 | 8.43 | 11.89 | 9.020 |
| 4 | 6.83 | 0.00 | 8.43 | 1.06 | 9.020 |

INCREMENT OF STRESS FOR
X = 0.80(ft) Y = 0.53(ft) Z = 2.92(ft)

Vert. Dsz
(Ksf)

0.80

Vert. Dsz + Asphalt Weight = 0.80 + (145pcf)*(0.42ft) = 0.86 ksf

Static and Dynamic Load Spreading of Wheel Loader with Asphalt

RECTANGULAR LOADS

UNIFORM VERTICAL

Project Name: Exelon
Client : Wheel Loader
Date : 6/27/2013

Project Number : 11896A
Project Manager: GS
Computed by : DJG

| Footing # | Corner Point P1 | | Corner Point P2 | | Load |
|---|---|---|---|---|---|
| | X1(ft) | Y1(ft) | X2(ft) | Y2(ft) | (Ksf) |
| 1 | 0.00 | 0.00 | 1.60 | 1.06 | 12.000 |
| 2 | 0.00 | 10.83 | 1.60 | 11.89 | 12.000 |
| 3 | 6.83 | 10.83 | 8.43 | 11.89 | 12.000 |
| 4 | 6.83 | 0.00 | 8.43 | 1.06 | 12.000 |

INCREMENT OF STRESS FOR

X = 0.80(ft) Y = 0.53(ft) Z = 2.92(ft)

Vert. Dsz
(Ksf)

1.06

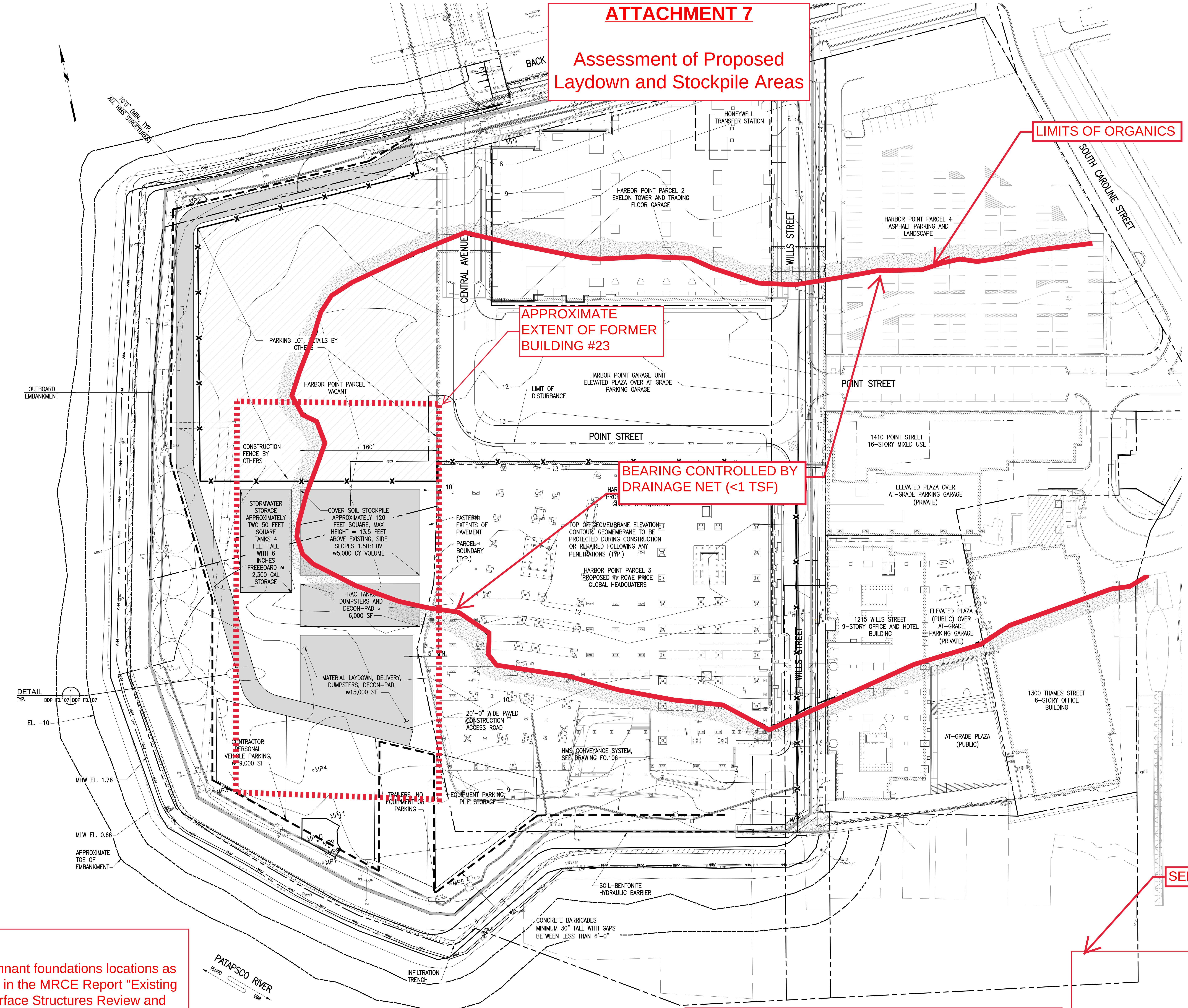
Vert. Dsz + Asphalt Weight = 1.06 + (145pcf)*(0.42ft) = 1.12 ksf

# ATTACHMENT 7

## Assessment of Proposed Laydown and Stockpile Areas

**NOTES:**

1. For general notes, see Drawing DDP FO.001.
2. Layout depicted hereon is approximate and is for general site logistics of Phase 1 construction only.




PLAN
SCALE: NOT TO SCALE

Notes:

1. Remnant foundations locations as shown in the MRCE Report "Existing Subsurface Structures Review and Documentation." Dated June 29, 1992, see "Appendix E" from report attached.

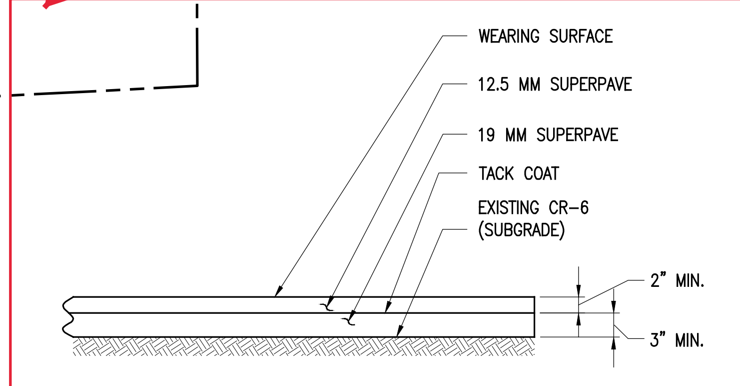
2. Base Drawing from FO.107, for legibility, see Base Drawing.

From Appendix E:

Building #23: Pile Supported or Shallow Bearing, Soil Bearing to 1tsf Therefore, Drainage Net Controls

Proposed Stockpile and Laydown Areas are Typically within Load Limitation Area B (1250 psf load permitted on the MMC Geosynthetic Layers), see Drawing FO.102.

Materials laydown within the shaded areas limited to 0.5 tsf.




DETAIL 1: TYPICAL ASPHALT SECTION
SCALE: NOT TO SCALE

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1307 POINT STREET
BALTIMORE, MARYLAND 21231

IN PROGRESS

01/13/2021 - 100% SCHEMATIC DESIGN
05/03/2021 - 100% DESIGN DEVELOPMENT

title
CONSTRUCTION SITE LOGISTICS PLAN

drawn by: F.T.F.
checked by: A.M.D.
scale: AS INDICATED
project number: 13922

ATTACHMENT 7
EE MEMO 4

Appendix E

Table 1
Foundation Support Summary

| BUILDING | | | | |
|---|---|---|---|---|
| NO. | NAME | FOUNDATION TYPE | ESTIMATED CAPACITY* (TONS) | AREA** (SQ.FT.) |
| 1 | Chromic Acid Tank Farm | Seven Tanks<br>Timber Pile Support (44 piles)<br>12" R/C Cap/Slab<br>TOS Elev. + 12.6 | | 1,430 |
| 2 | Acid Storage Tanks | Two Tanks<br>Timber Pile Support (91-15 ton Raymond Step Taper Concrete Piles)<br>21" R/C Cap/Slab<br>TOS Elev. + 7.6 | 1365T | 1,070 |
| 3 | Chromic Acid Solution Storage Tanks | Four Tanks<br>(Two Large/Two Small)<br>Shallow Support<br>15" Slab | | 1,650 |
| 5 | House Fire Pump Solution Tank (1949) | 30' I.D. - 160,000 gal. capacity<br>Shallow Support<br>18" Perimeter Footing<br>12" R/C Slab | | 650 |
| 6 | Solution Storage Tank Farm | One Tank<br>Pile Support (24 Piles)<br>9" - 12" Slab Above 2'x 2' Concrete Framing Beams<br>TOS Elev. + 6.1 | | 990 |
| 8 | Shipping Station Wash Pad | Part Pile Support<br>Part Shallow Support | | 2,600 |
| 9 | 750,000 gal Waste Water Tank | One Tank<br>Timber Pile Support (222 Piles)<br>12" R/C Cap/Slab<br>TOS Elev. + 9.6 | | 3,200 |
| 10 | Fuel Oil Pump House and Storage Tank | Pump House<br>Shallow Support (2 ft perimeter footing, 12" R/C Slab)<br>TOS Elev. + 7.35'<br>Storage Tank<br>Pile Supported (67-30 ton Raymond Step Taper Concrete Piles)<br>TOS Elev. +6.5 | 2010T | 2,700 |
| 11 | Acid Storage Tank | One Tank<br>Timber Pile Support (8 Piles)<br>2' x 2' - 4" Framing Beams | | |

Note: * Estimated Capacity based on design capacity of piles without any degradation multiplied by number of piles.

** Area of footprint for building.

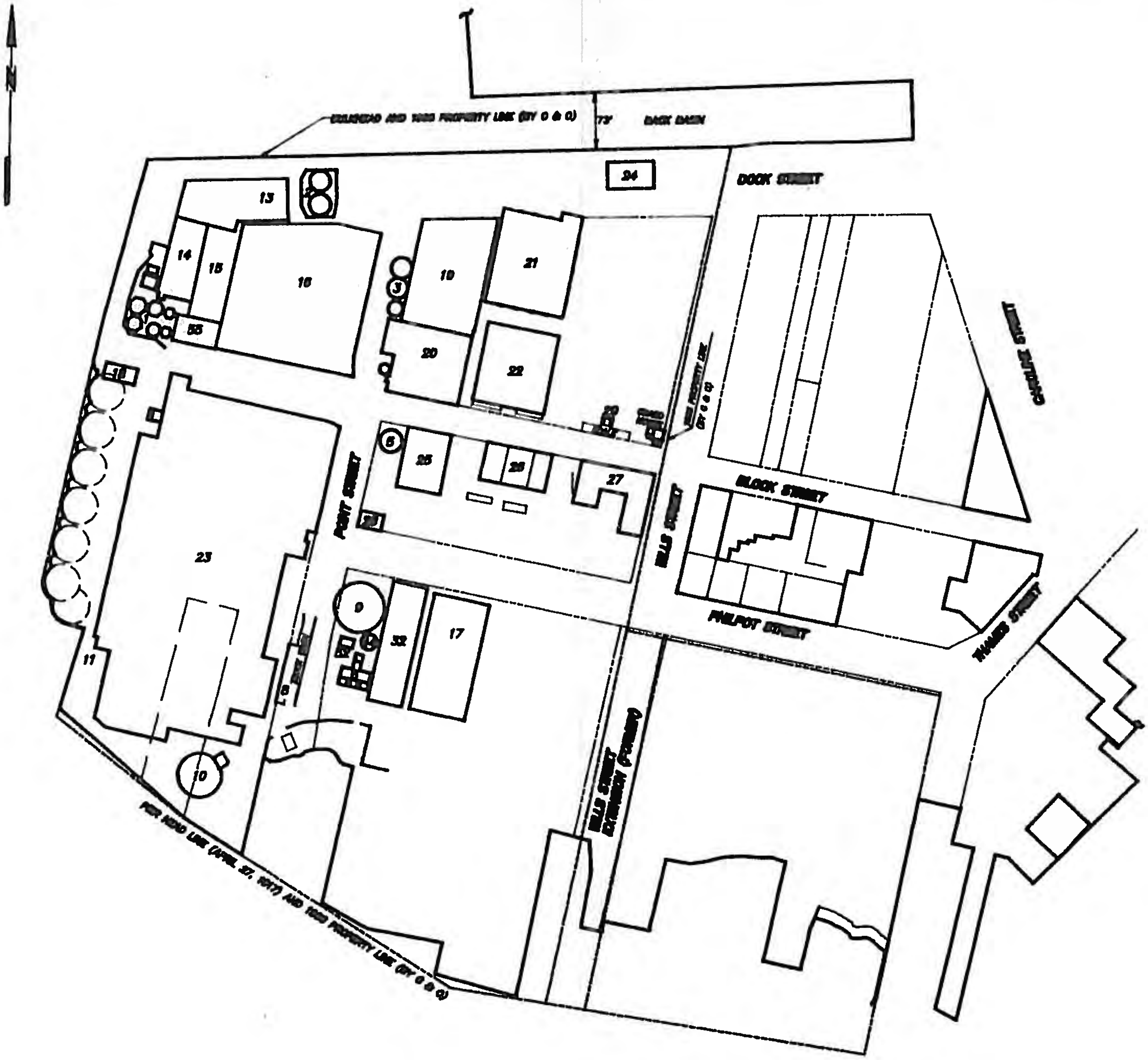
Table 1
Foundation Support Summary (Continued)

| BUILDING | | | | |
|---|---|---|---|---|
| NO. | NAME | FOUNDATION TYPE/SUPPORT | ESTIMATED CAPACITY | AREA (SQ.FT.) |
| 13 | Potash and Korean Plant (1948 - Steel Frame Corrugated Metal Siding) | Processing Building<br>Part Pile Supported<br>Part Shallow Support<br>(Clusters of 2 to 5 Piles/Cap; 6" slab 82-15 ton Unknown Type Composite Piles)<br>Above Framing Beams<br>TOS Elev +. 6.6 | 1230T | 7,300 |
| 14 | Sodium Chromate Plant (1936 - Steel Frame Corrugated Metal Siding) | N/A | | 4,400 |
| 15 | Repack Warehouse (1930 - Hollow Tile Corrugated Metal Siding) | Shallow Support<br>6" R/C Slab<br>TOS Elev. + 9.6 | | 5,200 |
| 16 | Soda Building (1921) | Pile Supported<br>(123-16" sq. Giant Patented R/C Piles, unknown capacity) | | 31,100 |
| 16 | Secondary Products (1959 - Hollow Tile) | Modifications to original Soda Building Added Shallow Support (Soil Bearing 1 TSF) | 328T | 31,100 |
| 17 | Storage Waste Water (1977 - pre engr. Metal Building) | One Tank<br>Timber Pile Supported<br>(45 Vertical/44 Battered)<br>8" R/C Slab | | 4,200 |
| 18 | Boat House | Shallow Support<br>6" R/C Slab on Grade | | 840 |
| 19 | Container Warehouse (1916 - concrete block) (1955 - alterations) | Shallow Support<br>East Wall Alterations 1955: Continuous R/C grade beam on 2' wide ftg; 8 column footings - 4'-0" x 3'-6" | | 12,000 |
| 20 | Boiler House (1936 - brick) | N/A<br>20" Brick Exterior Walls | N/A | 9,500 |
| 21 | Stores Building (1955 - Brick Veneer) | Shallow Support (12" Wide Continuous Perimeter Footing with 2'x 2' Spread Footings 4'x 4' Interior Column Footings<br>6" R/C Slab<br>TOS Elev. + 10.72 | N/A | 12,300 |
| 22 | Engineering Cafeteria (1955 - Brick Veneer) | Shallow Support<br>13" Wide Continuous Perimeter Footing with 3'- 3" Square Spread Footings N/S, and 5'- 6" Square Spread Footings E/W (3.5 KSF)<br>6" R/C Slab<br>TOS Elev. + 11.35' | N/A | 9,500 |

Table 1
Foundation Support Summary (Continued)

| | | B U I L D I N G | | |
|---|---|---|---|---|
| NO. | NAME | FOUNDATION TYPE/SUPPORT | ESTIMATED CAPACITY | AREA |
| 23 | Sodium Bichromate (1949 - Steel Frame, Corrugated Asbestos Siding) | Processing Plant<br>Part Pile Support<br>Part Shallow Support<br>(1700 30 ton Raymond Step-Taper Concrete Piles with Framing Beams)<br>6" to 12" Slab<br>TOS 1.2' to 7.6' | 51,000T | 96,800 |
| 24 | Car Wash (1971 - Steel Frame Metal Siding) | Likely, Concrete Slab on Grade | | 500 |
| 25 | Locker Building (1937 - Brick Veneer) | Shallow Support (25" Perimeter Footing and Square Footings at Interior Columns | | 4,300 |
| 26 | Locker Medical (1900 - Brick Veneer) | | | 4,200 |
| 27 | Main Office and Laboratory (1900 two-story Brick Veneer) | Shallow Support (13" Wide Perimeter Footing on top of 2'- 6" Square Spread Footings. 4' Square Interior Column Footings. | | 5,200 |
| 28 | Maintenance Shop (1945 - Wood Frame) | Shallow Support<br>Perimeter Wall Footing<br>6" R/C Slab | | 640 |
| 29 | Truck Scale | Shallow Support<br>8" R/C Walls for 4.5 Ft Deep Vault | | 610 |
| 32 | Bowie Smith Building (Purchased 1955 -Brick) | N/A | | 6,800 |
| 44 | Wastewater Discharge | Storage Tank<br>Timber Pile Support (17 Piles)<br>9-12" R/C Cap/Slab<br>TOS Elev. + 7.85 | | 310 |
| 52 | Solution Shipping (1956 - Brick Veneer) | Shallow Support<br>30" Perimeter Wall Footing<br>4" Slab<br>TOS Elev. + 103.0 | | 190 |
| 55 | Chromic Acid Plant (1959 - Steel Frame Corrugated Asbestos Siding) | Pile Support<br>23 Open Ended Pipe Piles<br>22" x 2' - 6" Framing Beams<br>6" R/C Slab<br>TOS Elev. +10.1 | | 1,900 |

END OF TABLE




DRAFT

ALLIED-SIGNAL INC.

MORRISTOWN NEW JERSEY

BALTIMORE WORKS REMEDIATION

MUESER RUTLEDGE CONSULTING ENGINEERS

708 THIRD AVENUE, NEW YORK, N.Y. 10017

| SCALE | MADE BY | DATE | FILE NO. |
|---|---|---|---|
| NONE | H.B. | 6/23/92 | 6909 |
| | CHKD BY G.L.B. | DATE 6/23/92 | |

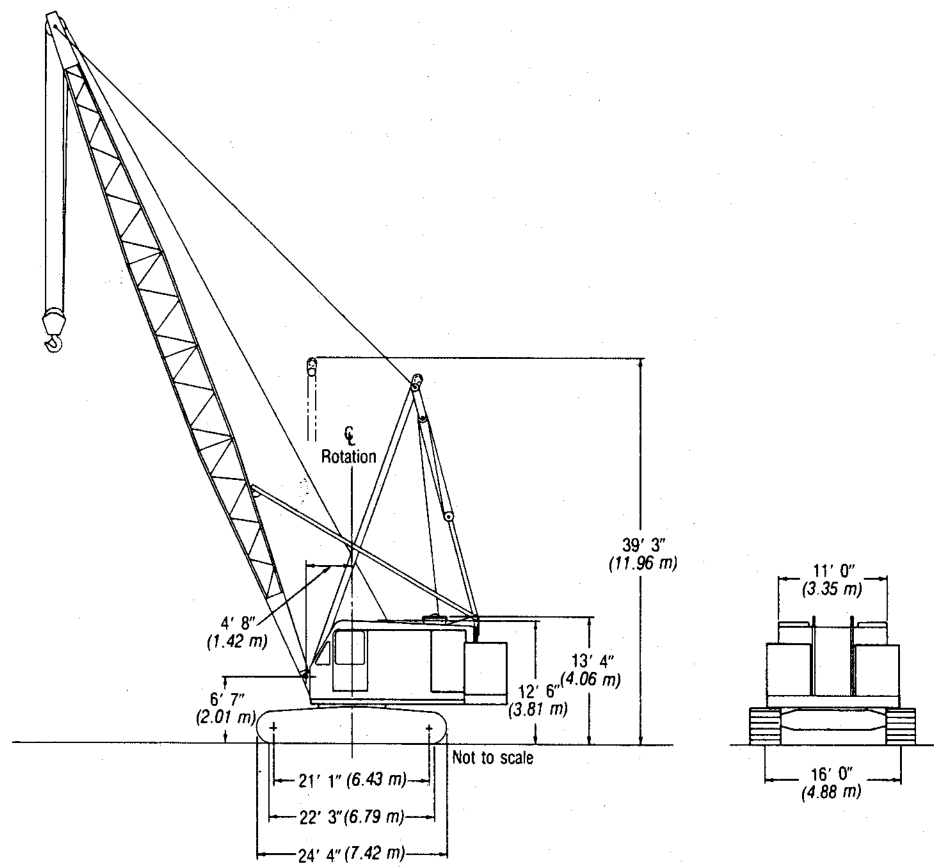
| | DRAWING NO. |
|---|---|
| KEY PLAN FOR TABLE 1 | E-1 |

# General Specifications

## Link-Belt® 150-ton *(136.05 metric ton)*

## Wire rope crawler excavator/crane

# LS-518

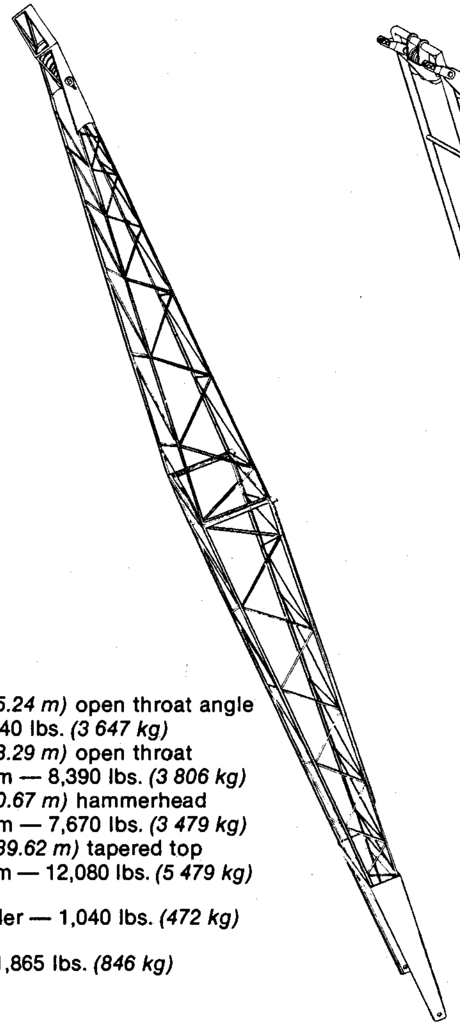


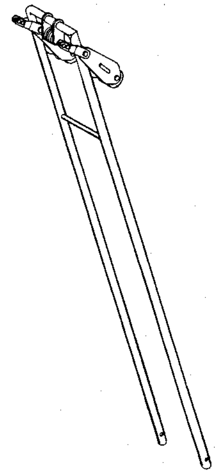

| General dimensions | Feet | *meters* |
|---|---|---|
| Overall width for transport less side frames | — | — |
| and catwalks; axles in line with upper | 11' 0" | 3.35 |
| Overall width of counterweight | 17' 0" | 5.25 |
| Width of cab less catwalks | 11' 0" | 3.35 |
| Width of cab with catwalks both sides | 16' 10" | 5.13 |
| Tailswing of counterweight "A" or "AB" | 17' 3" | 5.26 |
| Overall height for transport — basic machine | — | — |
| less crawler side frames | 11' 11" | 3.63 |
| Overall height, live boom mast with 60' | — | — |
| *(18.29)* boom horizontal | 25' 6" | 7.77 |

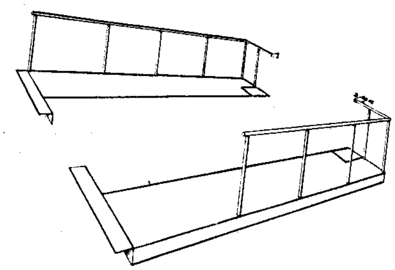
| General dimensions | Feet | *meters* |
|---|---|---|
| Basic angle boom length | 50' 0" | 15.24 |
| Basic tubular boom lengths: | — | — |
| — Open throat | 60' 0" | 18.29 |
| — Hammerhead | 35' 0" | 10.67 |
| — Tapered top | 130' 0" | 39.62 |
| Overall width with 44" *(1.12 m)* track shoes | 19' 8" | 5.99 |
| Minimum ground clearance | 1' 5" | 0.43 |
| Clearance under counterweight "A" or "AB" | 4' 3" | 1.30 |
| Clearance width less crawler side frames, | — | — |
| counterweight, and catwalks | 17' 7" | 5.36 |

**GENERAL INFORMATION ONLY**

# Weight deductions for transporting — approximate

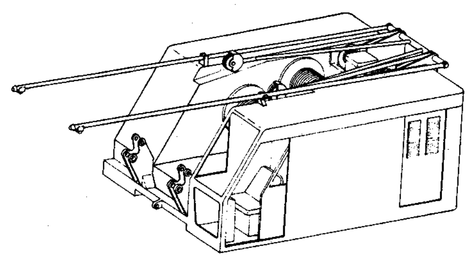






Catwalks — 1,600 lbs. *(726 kg)*

Boom live mast —
5,620 lbs. *(2 549 kg)*

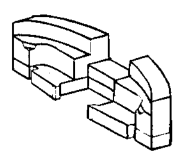


Basic 50′ *(15.24 m)* open throat angle boom — 8,040 lbs. *(3 647 kg)*
Basic 60′ *(18.29 m)* open throat tubular boom — 8,390 lbs. *(3 806 kg)*
Basic 35′ *(10.67 m)* hammerhead tubular boom — 7,670 lbs. *(3 479 kg)*
Basic 130′ *(39.62 m)* tapered top tubular boom — 12,080 lbs. *(5 479 kg)*

Tagline winder — 1,040 lbs. *(472 kg)*

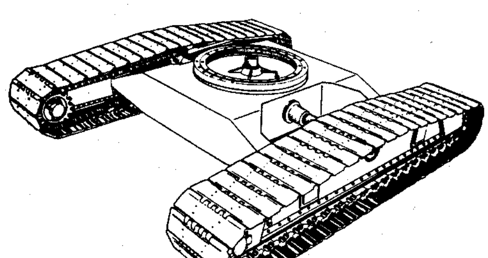
Fairlead — 1,865 lbs. *(846 kg)*

Basic revolving upperstructure less counterweight — 65,700 lbs.
*(29 802 kg)*

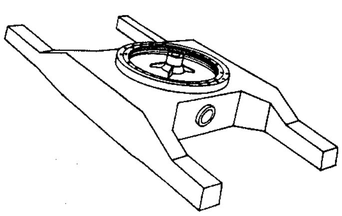


Counterweight "A" —
20,500 lbs. *(9 299 kg)*

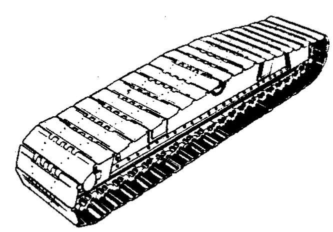
Counterweight "B" —
69,500 lbs. *(31,525 kg)*



Complete crawler mounting with turntable bearing — 88,775 lbs.
*(40 268 kg)*

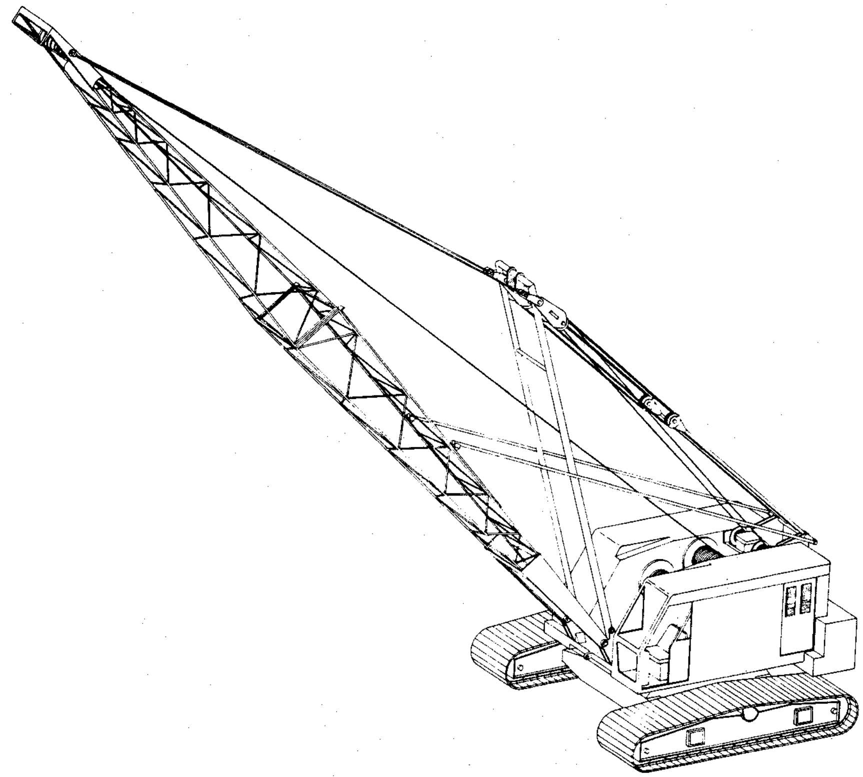


Lower frame with turntable bearing — 29,395 lbs.
*(13 336 kg)*



One side frame with 44″ *(1.12 m)* track shoes — 29,690 lbs. *(13 647 kg)*

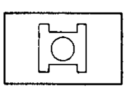
# Machine working weights — approximate



| Complete basic machine with GM 8V-71N diesel engine and single stage Allison torque converter, turntable bearing, independent boomhoist, swing brake, independent swing and travel, extended front and rear drum shafts, front and rear drum laggings, catwalks and railings along both sides, counterweight lowering mechanism, 44″ *(1.12 m)* wide track shoes, and 60′ *(18.29 m)* tubular boom. | Pounds | *kilograms* |
|---|---|---|
| — with 20,500 lb. *(9 299 kg)* counterweight "A" | 189,025 | *85 472* |
| — with 90,000 *(40 824 kg)* counterweight "AB" | 258,525 | *117 267* |

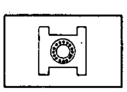
# General specifications

## Mounting — crawler



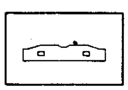
**Lower frame**

All-welded, stress relieved, precision machined; lined bored for traction shaft. Machined surface provided for mounting turntable bearing.



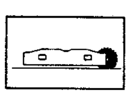
**Turntable bearing**

Inner race with internal swing gear bolted to lower frame.



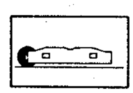
**Crawler side frames**

All-welded, stress relieved, precision machined. Removable; positioned on cross axles by patented dowel and key arrangement and held in place with two patented, adjustable wedgepacks per side frame.



*Track drive sprockets*

Cast steel, heat treated, involute splined to shafts which are mounted on bronze bushings. One-piece track/chain drive sprocket assembly mounted on bronze bushings, chain driven from sprocket on outer traction shaft; one per side frame. Track drive sprocket lugs mesh with shoe lugs; axle adjusted for chain take-up.



*Track idler wheels*

Cast steel heat treated; mounted on bronze bushings. One track idler wheel per side frame. Axle adjusted for track take-up.

*Track carrier rollers*

Heat treated, mounted on bronze bushings; two rollers per side frame.

*Track rollers*

Heat treated, mounted on bronze bushings; fourteen per side frame.

*Tracks*

Heat treated, self-cleaning, multiple hinged track shoes joined by one-piece full floating pins. 52 shoes per side frame, 44" *(1.12 m)* wide.

*Track/chain adjustment* — Track drive chains adjusted by shimming axles of chain drive sprockets. Track adjusted with threaded adjusting bolts attached to track idler (wheel) axles.

**Independent travel**

*Standard.* Three-piece traction shaft joined with involute splined couplings; inner traction shaft mounted on bronze bushings in precision bored lower frame. Outer traction shaft engages splines in chain drive sprockets which are mounted on bronze bushings in side frames. Powered by bevel gear drive enclosed in oil within lower frame.

*Travel speed — Standard:* 1.0 m.p.h. *(1.61 km/h)*. Optional high speed planetary: 1.65 m.p.h. *(2.65 km/h)*.

**Gradeability** — 30% based on machine equipped with "AB" counterweight, basic 60′ *(18.29 m)* long, 62" *(1.57 m)* deep tubular boom, and boom live mast.

**Steering** — Power hydraulic. Travel/steer jaw clutches hydraulically engaged, spring released. Spring applied, hydraulically released travel/steer/digging/parking external contracting band brakes simultaneously released by interconnecting mechanical linkage. Brakes automatically set when steer levers are in neutral. Two 24" *(0.61 m)* diameter by 5" *(0.13 m)* wide brake bands; effective lining area 281 square inches *(1 813 cm²)* per brake.

Ground contact area and ground bearing pressure — based on machine equipped with boom live mast and basic 60′ *(18.29 m)* long, 62" *(1.57 m)* deep tubular boom.

| Counterweight | Track shoes | | Ground contact area | | Ground bearing pressure | |
|---|---|---|---|---|---|---|
| | Inches | *meters* | Square inches | *cm²* | P.s.i. | *kPa* |
| "A" 20,500 lbs. *(9 299 kg)* | 44 | *1.12* | 22,940 | *148 036* | 8.2 | *56.54* |
| "AB" 90,000 lbs. *(40 824 kg)* | 44 | *1.12* | 22,940 | *148 036* | 11.3 | *77.91* |

## Revolving upperstructure

**Frame**

All-welded, stress relieved, precision machined; machinery side housings welded integral with frame.

**Turntable bearing**

Outer race of bearing bolted to machined surface on under side of frame.

**Engines**

Full pressure lubrication, oil filter, oil cooler, air cleaner, fuel filter, hour meter and hand throttle. Optional hand throttle (lever type on swing control lever) and foot throttle available. Manual control shutdown for GM engines; electrical shutdown for Cummins engine.

*Auxiliary governor control — Optional;* for use with GM8V-71N and Cummins NT 855 engines only. Provides approximately 50% greater pinion r.p.m. Recommended for lifting crane service only.

**Fuel tank**

85 gallon *(322 L)* capacity; equipped with fuel sight level gauge, flame arrester, and filler pipe cap with locking eye for padlock.

## Power train

**Transmission**

FMC quadruple roller chain enclosed in chain case and running in oil. Pump driven oil stream lubrication with independent sump.

**Machinery gear train**

"Full Function" design, two-directional power available to all operating shafts; shafts mounted on anti-friction bearings in precision bored machinery side housings. All load hoist, swing, and boomhoist functions independent of one another. Components such as gears, pinions, chain wheels, brake drums and clutch spiders involute splined to shafts. Drum gear/clutch drum assemblies bolted together and mounted on shafts on anti-friction bearings. Machine-cut teeth on drum gears, pinions, spur gears, and chain wheel.

| Engine specifications | GM 8V-71N with single-stage torque converter ① | GM 8V-71N with three-stage torque converter ② | Cummins NT 855-P310 with three-stage torque converter ② |
|---|---|---|---|
| Number of cylinders | 8 | 8 | 6 |
| Bore and stroke — inches | 4¼ x 5 | 4¼ x 5 | 5½ x 6 |
| — *(mm)* | *(108 x 127)* | *(108 x 127)* | *(140 x 152)* |
| Piston displacement — cu. in. | 568 | 568 | 855 |
| — *(cm³)* | *(9 310)* | *(9 310)* | *(14 013)* |
| High idle speed — r.p.m. | 2,250 | 2,250 | 2,350 |
| Engine r.p.m. at full load speed | 2,100 | 2,100 | 2,100 |
| Net engine h.p. at full load speed | 245 *(183 kW)* | 260 *(194 kW)* | 279 *(208 kW)* |
| Peak torque — ft. lbs. | 710 | 749 | 890 |
| — *(joules)* | *(963)* | *(1 016)* | *(1 207)* |
| — r.p.m. | 1,200 | 1,200 | 1,500 |
| Electrical system | 12-volt | 12-volt | 12-volt |
| Batteries | Two 12-volt | Two 12-volt | Two 12-volt |
| Clutch or power takeoff | Disconnect between engine and converter | Disconnect between engine and converter | Disconnect between engine and converter |
| Transmission — | | | |
| Number chain wheel teeth | 164 | 164 | 164 |
| Number engine pinion teeth | 30 | 36 | 33 |

① 2.54:1 ratio Allison TCDOA-565 single-stage converter with output shaft governor.
② Twin Disc Co-10066-TC1 three-stage converter with output shaft governor.

# Principal operating functions

## Control System

Speed-o-Matic® power hydraulic control system requiring no bleeding. Variable operating pressure transmitted to all two-shoe clutch cylinders as required. System includes constant displacement, engine driven, vane type hydraulic pump to provide flow of oil; accumulator to maintain system operating pressure, unloader valve to control pressure in accumulator, relief valve to limit maximum pressure buildup in system, full-flow filter with 40 micron disposable filter element, and variable pressure control valves to control drum clutches and other operating cylinders.

## Load hoisting and lowering

Wire rope drum gear train (front and rear main, and optional third, operating drums) spur gear driven, powered by chain transmission from engine.

## Load hoist drums

Front and rear main operating drums — Two-piece, removable, smooth or grooved laggings bolted to adapter which is splined to drum shaft. Extended length shafts permit installation of optional power load lowering clutches; special length shaft required for, and furnished with, optional planetary drive unit for rear drum.

— Lifting crane applications: 19⅛" *(0.49 m)* front and 27" *(0.69 m)* rear smooth drum laggings.
— Clamshell or magnet applications: 27" *(0.69 m)* front and rear grooved drum laggings.
— Dragline application: 24⅜" *(0.62 m)* front and 27" *(0.69 m)* rear grooved drum laggings.

*Third operating drum – Optional;* mounts forward of front main operating drum. Two-piece removable 13¼" *(0.34 m)* root diameter smooth drum lagging bolted to brake drum. Brake drum splined to shaft.

**Note** — Third drum limits:
— Lifting crane application: to prevent front drum hoist rope interference with third drum, front drum operation limited to certain boom radii and requires special investigation.
— Use of fairlead: third drum is over-winding requiring use of auxiliary third drum lagging flange and deflector roller to deflect wire rope downward and horizontally toward fairleader.

## *Drum clutches*

Speed-o-Matic power hydraulic two-shoe clutches; internal expanding, lined shoes. Clutch spiders splined to shafts; clutch drums bolted to drum spur gears and mounted on shafts on anti-friction bearings.

*Load hoist clutches* — Speed-o-Matic power hydraulic two-shoe clutches. Front and rear main operating drum clutches: 37" *(0.94 m)* diameter, 5½" *(0.14 m)* face width; effective lining area 501 square inches *(3 233 cm²)*. Optional third drum clutch: 20" *(0.51 m)* diameter, 5" *(0.13 m)* face width; effective lining area 215 square inches *(1 387 cm²)*.

**Two-speed rear drum** — *Optional.* An added spur gear, mounted between left swing clutch and standard spur gear, powers idler pinion mounted on outer end of extended reduction shaft. Idler pinion powers large spur gear and clutch drum that is normally the rear drum lowering clutch. Through this gear arrangement, the rear drum shaft is powered in the same direction as the standard hoist clutch, but at 80% higher than standard speed. Control is by pulling the hoist drum lever for standard speed, pushing for high speed. All gears machine cut. **Note:** Two-speed rear drum not available on machines equipped with optional power load lowering clutch or auxiliary brake on rear drum.

**Drum planetary drive unit** — *Optional*; available for load hoist on rear main operating drum to allow increase of standard load hoist line speed. Planetary unit mounts on extended drum shaft between drum spur gear and two-shoe clutch drum. Two-shoe clutch controls standard line speeds. Planetary drive unit controlled by external contracting band brake through push button located on clutch control lever.

*Load lowering clutches — Optional*; Speed-o-Matic power hydraulic two-shoe clutches. Front and/or rear main operating drum clutches: 30″ *(0.76 m)* diameter, 6½″ *(0.17 m)* face width. **Note:** Load lowering clutch not available on rear drum equipped with optional two-speed hoist or auxiliary rear drum brake.

*Drum brakes*

Three piece, external contracting band; brake drum involute splined to shaft. Mechanically foot pedal operated; foot pedal equipped with latch to permit locking brake in applied position.

*Front and rear main drums* — Brakes 44″ *(1.12 m)* diameter, 5½″ *(0.14 m)* face width; effective lining area 651 square inches *(4 201 cm²)*.

*Optional third drum* — Brake 27″ *(0.69 m)* diameter, 4″ *(0.10 m)* face width; effective lining area 268 square inches *(1 729 cm²)*.

**Auxiliary rear drum brake** — *Optional.* Increases brake lining contact area by 651 square inches *(4 201 cm²)*; 44″ *(1.12 m)* diameter, 5½″ *(0.14 m)* face width. Pressure on mechanical brake pedal applies the standard rear drum brake band and the auxiliary rear drum brake band simultaneously; linkage divides braking effort equally between standard and auxiliary brakes. Mounts in load lowering clutch location. **Note:** Auxiliary rear drum brake not available on rear drum equipped with optional load lowering clutch or two-speed hoist.

*Drum rotation indicators*

Standard for front and rear main operating drums. Two rotating dials mounted on control stand; dials actuated by flexible shaft drive from front or rear main operating drum.

Swing system

Spur gear driven; single bevel gears (enclosed and running in oil) on horizontal swing shaft and vertical shaft. Swing pinion, involute splined to vertical swing shaft, meshes with internal teeth of swing gear integral with outer race of turntable.

*Swing clutches*

Speed-o-Matic power hydraulic internal expanding two-shoe clutches. 30″ *(0.76 m)* diameter, 6½″ *(0.15 m)* face width; lined shoes.

*Swing brake* — External contracting band; spring applied, hydraulically released by operator controlled lever. Brake drum involute splined to vertical swing shaft. Brake 18″ *(0.46 m)* diameter, 5″ *(0.13 m)* face width; effective lining area 212 square inches *(1 368 cm²)*.

*Swing lock* — Mechanically controlled pawl engages with internal teeth of turntable bearing swing (ring) gear.

*Maximum swing speed* — 3.0 r.p.m.

Boom hoist/ lowering system

Independent, worm gear driven. Boom hoist/lowering assembly mounted on platform at cab roof level. Precision control boom hoisting and lowering through power hydraulic two-shoe clutches.

**Boomhoist drum**

Dual laggings involute splined to shaft; 10½″ *(0.27 m)* root diameter grooved.

*Boomhoist drum locking pawl*

Operator controlled; mechanically applied and released.

*Boom hoist/ lowering clutches*

Speed-o-Matic power hydraulic two-shoe clutches; one each for boom hoisting and boom lowering. Clutches 17½″ *(0.44 m)* diameter, 4″ *(0.10 m)* face width; effective lining area 121 square inches *(781 cm²)*.

*Boom hoist brake*

One external contracting band brake; spring applied, hydraulically released. Brake drum involute splined to worm shaft. Brake 12″ *(0.80 m)* diameter, 4″ *(0.10 m)* face width; effective lining area 120 square inches *(774 cm²)*.

*Boomhoist limiting device* — Provided to restrict hoisting boom beyond recommended minimum radius; located on exterior right hand side of operator's cab.

Electrical system

Battery, 12 volt, 225 ampere hour; two batteries. *Optional:* battery lighting system, including two sealed beam automotive type adjustable headlights located on cab front roof, one interior cab light and automotive type wiring. *Optional:* additional 50 watt sealed beam automotive type headlight mounted on boom (three maximum quantity recommended). *Optional:* Onan independent light plant with single cylinder, four cycle, air cooled diesel engine with remote electrical starting, 3,000 watt, 120-volt, three-wire, single phase, 60 cycles A.C. including wiring in conduit, three interior cab lights, trouble lamp with cord, two 300 watt adjustable flood lights on cab front roof and necessary cab extensions. *Optional:* additional 300 watt flood lights available for mounting on cab and boom.

**Operator's cab**

Full vision, equipped with safety glass panels. Operator's door is hinged; front window slides on ball bearing rollers. Standard equipment includes dry chemical fire extinguisher, machinery guards. *Optional:* electrical windshield wiper, cab heater, defroster fan, and sound reduction material.

**Elevated operator's cab**

*Optional.* 18′ *(5.49 m)* higher than standard operator's cab (25′ — *7.62 m* — eye level). Catwalk is included along operator's side. Sound reduction material is not available, and cab heater and defroster fan are not recommended for elevated cab.

**Machinery cab**

Equipped with warning horn, right rear side door hinged, sliding doors (two at rear, one at left rear side, and one at right front side) for machinery access, roof-top access ladder, and skid-resistant finish on roof.

**Catwalks**

Standard for both sides of machinery cab. Channel and floor plate construction with hand railings.

**Gantry**

Fixed low, mounted to revolving upperstructure frame to support boom suspension system.

*Gantry bail*

Mounted to gantry headshaft. Contains eight 12" *(0.30 m)* root diameter sheaves mounted on bronze bushings for 18-part boomhoist wire rope reeving.

**Counterweight**

Removable; held in place by "T" bolts.
— Counterweight "A" 20,500 lbs. *(9 299 kg)*.
— Counterweight "AB" (standard): 90,000 lbs. *(40 824 kg)* available for lifting crane service only; three-piece allowing for reduction to weight "A". (Refer to counterweight requirement instructions with lifting capacity charts).

*Counterweight removal device — Standard.* Counterweight can be raised or lowered with rope mechanism. Rope is anchored to and wound on special drum cast integrally with rear brake drum and lowered against rear drum brake.

## Booms and jibs

**Angle boom**

Two-piece basic boom 50' *(15.24 m)* long with open throat top section; 60" *(1.52 m)* wide, 54" *(13.7 m)* deep at connections. Alloy steel chord angles 4" x 4" x ½" *(102 x 102 x 13 mm)*.

*Base section* — 25' *(7.62 m)* long; boomfeet 2¾" *(78 mm)* wide on 54½" *(0.86 m)* centers.

*Boom extensions* — Available in 10', 20' and 30' *(3.05, 6.10 and 9.14 m)* lengths with appropriate length pendants.

*Boom connections* — Pin connected.

*Boom top section* — Open throat; 25' *(7.62 m)* long.

*Boompoint machinery*. Five 21" *(0.53 m)* root diameter sheaves mounted on anti-friction bearings for lifting crane application; two 21" *(0.53 m)* root diameter sheaves for dragline application.

*Boom midpoint suspension pendants* — Required on boom lengths exceeding 180' *(54.86 m)*. **Note:** Boom must have a joint 85' *(25.91 m)* from boom foot pins to allow attachment of midpoints.

**Angle jib**

Two-piece basic jib 20' *(6.10 m)* long; 24" *(0.61 m)* wide, 20" *(0.51 m)* deep at connections. Alloy steel main chord angles 2½" x 2½" x 5/16" *(64 x 64 x 8 mm)*.

*Base section* — 10' *(3.05 m)* long; mounted to bracket welded on end boom top section.

*Jib extensions* — Available in 10' and 15' *(3.05 and 4.57 m)* lengths; maximum jib length permitted — 40' *(12.19 m)*.

*Jib connections* — Bolted

*Jib tip section* — 10' *(3.05 m)* long; single peak sheave 15⅞" *(4.57 m)* root diameter mounted on anti-friction bearings.

*Jib mast*

10' *(3.05 m)* high, mounted on jib base section. One deflector sheave mounted on anti-friction bearings, mounted within mast to guide jib load hoist line. Three equalizer sheaves mounted on top of mast — one for jib frontstay line, two for jib backstay line.

**Tubular boom**

Two-piece basic boom 60' *(18.29 m)* long with open throat top section; 35' *(10.67 m)* long with hammerhead top section. Boom 70" *(1.77 m)* wide, 62" *(1.57 m)* deep at connections. Alloy steel round tubular chords 4" *(0.10 m)* outside diameter.

*Base section* — 30' *(9.14 m)* long; boomfeet 2¾" *(70 mm)* wide on 54½ *(1.37 m)* centers.

*Boom extensions* — Available in 10', 20', 30', and 40' *(3.05, 6.10, 9.14 and 12.19 m)* lengths (chord wall thickness "F") with appropriate length pendants. Available in 10' and 20' *(3.05 and 6.10 m)* lengths (chord wall thickness "J") with appropriate length pendants for boom with hammerhead top section only. **Note:** The 40' *(12.19 m)* of hammerhead boom extensions immediately above boom base section **must** consist of 10' or 20' *(3.05 or 6.10 m)* extensions with chord wall thickness "J".

*Boom connections* — In-line pin connections.

*Boom top section* — Open throat; 30' *(9.14 m)* long.

— *Boompoint machinery.* Five 21" *(0.53 m)* root diameter sheaves mounted on anti-friction bearings for lifting crane applications; two 26¼" *(0.67 m)* root diameter sheaves for dragline applications.

*Boom top section* — Hammerhead; 5' *(1.52 m)* long.

— *Boompoint machinery.* Five 21" *(0.53 m)* root diameter head sheaves mounted on anti-friction bearings for lifting crane applications.
Boom midpoint suspension pendants — Required on boom lengths exceeding 180' *(54.86 m)*.
**Note:** Boom must have a joint 110' *(33.53 m)* from boom foot pins to allow attachment of midpoints.

**Tubular jib**

Two-piece basic jib 30' *(9.14 m)* long; 36" *(0.91 m)* wide, 30" *(0.76 m)* deep at connections. Alloy steel tubular chords 2¼" *(57 mm)* outside diameter.

*Base section* — 15' *(4.57 m)* long; mounted to boom headshaft hubs.

*Jib extensions* — Available in 10', 15', 20', 30', and 40' *(3.05, 4.57, 6.10, 9.14, and 12.19 m)* lengths; maximum jib length permitted — 70' *(21.34 m)*.

*Jib connections* — In-line pin connections.

Jib tip section — 15' *(4.57 m)* long; single peak sheave 21" *(0.53 m)* root diameter mounted on anti-friction bearings.

*Jib mast*

12′ 7⅝″ *(6.85 m)* high, mounted on jib base section. One deflector sheave, mounted on anti-friction bearings, mounted within mast to guide jib load hoist line. Jib frontstay line and jib backstay line pin at top of jib mast.

**Tubular boom**

Three-piece basic boom 130′ *(39.62 m)* long with tapered top section; 80″ *(2.03 m)* wide, 68″ *(1.73 m)* deep at connections. Alloy steel round tubular chords 4¼″ *(0.10 m)* outside diameter.

*Base section* — 35′ *(10.67 m)* long; boomfeet 2¾″ *(10 mm)* wide on 54½″ *(1.37 m)* centers.

*Transition section* — Tapered, 50′ *(15.24 m)* tapered from 80″ *(2.03 m)* wide, 68″ *(1.73 m)* deep at lower end to 55″ *(1.40 m)* wide, 41″ *(1.04 m)* deep at top end.

*Boom extensions* — Available in 10′, 20′, 30′, 40′ and 50′ *(3.05, 6.10, 9.14, 12.19, and 15.24 m)* lengths with appropriate length pendants.

*Boom connections* — In-line pin connections.

*Boom top section* — Tapered, 45′ *(13.72 m)* long; tapered from 55″ *(1.40 m)* wide, 41″ *(1.04 m)* deep at lower end to 32″ *(0.81 m)* wide, 17″ *(0.43 m)* deep at top end.

*Boompoint machinery* — Two 28⅜″ *(0.72 m)* root diameter head sheaves, mounted on anti-friction bearings.

*Boom midpoint suspension pendants* — Required on boom lengths greater than 200′ *(60.96 m)*. **Note:** Boom must have a joint 115′ *(35.05 m)* from boom foot pins to allow attachment of midpoints.

**Tubular jib**

Two-piece basic jib 30′ *(9.14 m)* long; 36″ *(0.91 m)* wide, 30″ *(0.76 m)* deep at connections. Alloy steel tubular chords 2¼″ *(57 mm)* outside diameter.

*Base section* — 15′ *(4.57 m)* long; mounted to boom headshaft hubs.

*Jib extensions* — Available in 20′ *(6.10 m)* lengths; maximum jib length permitted — 70′ *(21.34 m)*.

*Jib connections* — In-line pin connected.

*Jib tip section* — 15′ *(4.57 m)* long; single peak sheave 15⅞″ *(0.40 m)* root diameter mounted on anti-friction bearings.

*Jib mast*

12′7⅝″ *(6.85 m)* high, mounted on jib base section. Two deflector sheaves, mounted on anti-friction bearings, mounted within mast to guide jib load hoist line. Jib frontstay line and jib backstay line pin at top of jib mast.

## Items applicable to both tubular or angle booms and jibs

**Boom stops**

Dual rail, retractable tubular type; spring-loaded bumper ends, Also serve as mast stops when live mast is used as short boom.

*Boom stop warning indicator* — Mounts on boom base section; visually warns operator that boom is near minimum radius and boom stops are approaching seating condition. When boom stop disengages, indicator is spring released to original position.

**Boomhoist bridle**

Serves as connection between boom pendants and boomhoist reeving. Bridle contains eight 12″ *(0.30 m)* root diameter head sheaves, mounted on bronze bushings, for eighteen-part boomhoist reeving with boom live mast.

*Spreader bar* — Installed at end of first 30′ *(9.14 m)* pendant which is connected directly to boom head shaft. Required on boom lengths 150′ *(45.72 m)* and over, with or without jib.

**Boom live mast**

Required for all boom lengths; reduces boom compression loadings. 30′ *(9.14 m)* long from center of head shaft to mounting pin; mounts on front of upper frame near boomfeet. Supports boomhoist bridle and boom midpoint suspension pendants. Mast may be used for machine assembly/disassembly, but is not intended for general crane service. **Note:** Refer to Performance Specifications for boom live mast lifting capacities.

*Auxiliary load hoist sheaves* — Two 13″ *(0.33 m)* root diameter sheaves mounted on bronze bushings, grooved for ¾″ *(19 mm)* diameter wire rope. For use of boom live mast as short boom.

*Live mast stops* — When using mast as short boom, main boom stops must be attached to cab for live mast backstops to function properly. Live mast backstops must be manually positioned.

**Boompoint sheave guards** — Standard for open throat crane/clamshell/magnet/dragline service. Upper sheave guard: single tubular guard bolted to top side of boom head. Lower sheave guards: tubular roller guards mounted on anti-friction bearings; five for crane service, three for clamshell/magnet/dragline service. Rigid guards for hammerhead and tapered top booms.

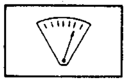
**Deflector rollers** — Deflect main or third drum hoist line off boom to avoid chafing; rollers mounted an anti-friction bearings. Angle boom: none on base section, two mounted on top section, and one on each boom extension. Tubular boom: open throat — none on base section, two mounted on top section, and one on each boom extension; hammerhead — none on base section, one mounted on each boom section; tapered top — none on base section, three mounted on top section, two on 40′ and 50′ *(12.19 and 15.24 m)* extensions, and one on remaining extensions.

**Jib mast stops** — Telescoping type; pinned from jib mast to boom top section and from mast to jib base section.

**Jib staylines** — Back staylines attached between top of jib mast and base of boom top section. Front staylines attached between top of jib mast and peak of jib.

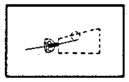
**Boom carrying equipment** — For carrying boom in horizontal position with live mast at approximate 15′ *(4.57 m)* overall clearance height from ground. May be used with angle or tubular booms 50′ through 120′ *(15.24 through 36.28 m)*. **Note:** Tapered top boom cannot be carried with live mast in lowered position. Boom suspension system uses two links, one at each end of the 10′ *(3.05 m)* pendant portion of basic pendants. The free ends of the links are pinned together shortening overall pendant length, lowering live mast relative to the boom. Booms cannot be used to handle loads with reduced mast height.

# Auxiliary equipment



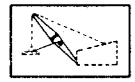
**Boom angle indicator**

Standard with all crane booms. Pendulum type, mounted on boom base section.



**Fairlead**

*Optional.* Full revolving type with barrel, sheaves, and guide rollers mounted on anti-friction bearings.



**Tagline**

*Optional.* Spring wound drum type mounted on crane boom. Rud-O-Matic® model 1848, triple barrel with 30" *(0.76 m)* reel for booms not exceeding 100' *(30.48 m)*; for use with 4 to 5 cubic yard *(3.06 to 3.82 m³)* clamshell buckets.

GENERAL INFORMATION ONLY

# Link-Belt® LS-518 Performance Specifications

## **Boom live mast** — lifting capacities when used as short boom ①

| Boom live mast radius ②③ | | Capacities | |
|---|---|---|---|
| Feet | *meters* | Pounds | *kilograms* |
| 13 to 20* | *3.96 to 6.10** | 47,000 | *21 319* |
| 25* | *7.62** | 30,000 | *13 608* |
| 28* | *8.53** | 23,000 | *10 433* |

* Based on factors other than that which would cause a tipping condition.
① Requires 4 parts of ¾" *(19 mm)* Type "N" wire rope.
② Boom live mast stops must be in proper working condition and operative. Use of live mast as short boom is intended for machine assembly or disassembly only. It should not be used for general crane service.
③ Live mast must not be operated at radius less than 13' *(3.96 m)*.

## Wire rope and drum data

### **Main load hoist wire rope length** — for open throat ① hammerhead ② and tapered top ③ booms using 1⅛" *(28 mm)* diameter wire rope

| Parts of line | Boom lengths | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50' *(15.24 m)* | | 60' *(18.29 m)* | | 70' *(21.34 m)* | | 80' *(24.38 m)* | | 90' *(27.43 m)* | | 100' *(30.48 m)* | | 110' *(33.53 m)* | | 120' *(36.58 m)* | |
| | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* |
| 1 | 120 | *36.58* | 140 | *42.67* | 160 | *48.77* | 180 | *54.86* | 200 | *60.96* | 220 | *67.06* | 240 | *73.15* | 260 | *79.25* |
| 2 | 180 | *54.86* | 210 | *64.01* | 240 | *73.15* | 270 | *82.30* | 300 | *91.44* | 330 | *100.58* | 360 | *109.73* | 390 | *118.87* |
| 3 | 240 | *73.15* | 280 | *85.34* | 320 | *97.54* | 360 | *109.73* | 400 | *121.92* | 440 | *134.11* | 480 | *146.30* | 520 | *158.50* |
| 4 | 300 | *91.44* | 350 | *106.68* | 400 | *121.92* | 450 | *137.16* | 500 | *152.40* | 550 | *167.64* | 600 | *182.88* | 650 | *198.12* |
| 5 | 360 | *109.73* | 420 | *128.02* | 480 | *146.30* | 540 | *164.59* | 600 | *182.88* | 660 | *201.17* | 720 | *219.46* | 780 | *237.74* |
| 6 | 420 | *128.02* | 490 | *149.35* | 560 | *170.69* | 630 | *192.02* | 700 | *213.36* | 770 | *234.70* | 840 | *256.03* | 910 | *277.37* |
| 7 | 480 | *146.30* | 560 | *170.69* | 640 | *195.07* | 720 | *219.46* | 800 | *243.84* | 880 | *268.22* | 960 | *292.61* | 1,040 | *316.99* |
| 8 | 540 | *164.59* | 630 | *192.02* | 720 | *219.46* | 810 | *246.89* | 900 | *274.32* | 990 | *301.75* | 1,080 | *329.18* | 1,170 | *356.62* |
| 9 | 600 | *182.88* | 700 | *213.36* | 800 | *243.84* | 900 | *274.32* | 1,000 | *304.80* | 1,100 | *335.28* | 1,200 | *365.76* | 1,300 | *396.24* |
| 10 | 660 | *201.17* | 770 | *234.70* | 880 | *268.22* | 990 | *301.75* | 1,100 | *335.28* | 1,210 | *368.81* | 1,320 | *402.34* | 1,430 | *435.86* |

| Parts of line | Boom lengths | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 130' *(39.62 m)* | | 140' *(42.67 m)* | | 150' *(45.72 m)* | | 160' *(48.77 m)* | | 170' *(51.82 m)* | | 180' *(54.86 m)* | | 190' *(57.91 m)* | | 200' *(60.96 m)* | |
| | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* |
| 1 | 280 | *85.34* | 300 | *91.44* | 320 | *97.54* | 340 | *103.63* | 360 | *109.73* | 380 | *115.82* | 400 | *121.92* | 420 | *128.02* |
| 2 | 420 | *128.02* | 450 | *137.16* | 480 | *146.30* | 510 | *155.45* | 540 | *164.59* | 570 | *173.74* | 600 | *182.88* | 630 | *192.02* |
| 3 | 560 | *170.69* | 600 | *182.88* | 640 | *195.07* | 680 | *207.26* | 720 | *219.46* | 760 | *231.65* | 800 | *243.84* | 840 | *256.03* |
| 4 | 700 | *213.36* | 750 | *228.60* | 800 | *243.84* | 850 | *259.08* | 900 | *274.32* | 950 | *289.56* | 1,000 | *304.80* | 1,050 | *320.04* |
| 5 | 840 | *256.03* | 900 | *274.32* | 960 | *292.61* | 1,020 | *310.90* | 1,080 | *329.18* | 1,140 | *347.47* | 1,200 | *365.76* | 1,260 | *384.05* |
| 6 | 980 | *298.70* | 1,050 | *320.04* | 1,120 | *341.38* | 1,190 | *362.71* | 1,260 | *384.05* | 1,330 | *405.38* | 1,400 | *426.72* | 1,470 | *448.06* |
| 7 | 1,120 | *341.38* | 1,200 | *365.76* | 1,280 | *390.14* | 1,360 | *414.53* | 1,440 | *438.91* | 1,520 | *463.30* | 1,600 | *487.68* | 1,680 | *512.06* |
| 8 | 1,260 | *384.05* | 1,350 | *411.48* | 1,440 | *438.91* | 1,530 | *466.34* | 1,620 | *493.78* | 1,710 | *521.21* | 1,800 | *548.64* | 1,890 | *576.07* |
| 9 | 1,400 | *426.72* | 1,500 | *457.20* | 1,600 | *487.68* | 1,700 | *518.16* | 1,800 | *548.64* | 1,900 | *579.12* | 2,000 | *609.60* | 2,100 | *640.08* |
| 10 | 1,540 | *469.39* | 1,650 | *502.92* | 1,760 | *536.45* | 1,870 | *569.98* | 1,980 | *603.50* | 2,090 | *637.03* | 2,200 | *670.56* | 2,310 | *704.09* |

| Parts of line | Boom lengths | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 210' *(64.01 m)* | | 220' *(67.06 m)* | | 230' *(70.10 m)* | | 240' *(73.15 m)* | | 250' *(75.20 m)* | | 260' *(79.25 m)* | | 270' *(82.30 m)* | | 280' *(85.34 m)* | |
| | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* | Feet | *meters* |
| 1 | 440 | *134.11* | 460 | *140.21* | 480 | *146.30* | 500 | *152.40* | 520 | *158.50* | 540 | *164.59* | 560 | *170.69* | 580 | *176.78* |
| 2 | 660 | *201.17* | 690 | *210.31* | 720 | *219.46* | 750 | *288.60* | 780 | *237.74* | 810 | *246.89* | 840 | *256.03* | 870 | *265.18* |
| 3 | 880 | *268.22* | 920 | *280.42* | 960 | *292.61* | 1,000 | *304.80* | 1,040 | *316.99* | 1,080 | *329.18* | 1,120 | *341.38* | 1,160 | *353.57* |
| 4 | 1,100 | *335.28* | 1,150 | *350.52* | 1,200 | *365.76* | 1,250 | *381.00* | 1,300 | *396.24* | 1,350 | *411.48* | 1,400 | *426.72* | 1,450 | *441.96* |
| 5 | 1,320 | *402.34* | 1,380 | *420.62* | 1,440 | *438.91* | 1,500 | *457.20* | 1,560 | *475.49* | | | | | | |
| 6 | 1,540 | *469.39* | 1,610 | *490.73* | 1,680 | *512.06* | 1,750 | *533.40* | 1,820 | *554.74* | | | | | | |
| 7 | 1,760 | *536.45* | 1,840 | *560.83* | 1,920 | *585.22* | 2,000 | *609.60* | 2,080 | *633.98* | | | | | | |
| 8 | 1,980 | *603.50* | 2,070 | *630.94* | 2,160 | *658.37* | 2,250 | *685.80* | 2,340 | *713.23* | | | | | | |
| 9 | 2,200 | *670.56* | 2,300 | *701.04* | | | | | | | | | | | | |

| Parts of line | Boom lengths | |
|---|---|---|
| | 290' *(88.39 m)* | |
| | Feet | *meters* |
| 1 | 600 | *182.88* |
| 2 | 900 | *274.32* |
| 3 | 1,200 | *365.76* |
| 4 | 1,500 | *457.20* |

① Open throat 54" x 60" *(1.37 x 1.52 m)* angle boom lengths: 50' *(15.24 m)* through 210' *(64.01 m)*.
Open throat 62" x 70" *(1.57 x 1.77 m)* tubular boom lengths: 60' *(18.29 m)* through 250' *(76.20 m)*.
② Hammerhead 62" x 70" *(1.57 x 1.77 m)* tubular boom lengths: 35' *(10.67 m)* through 245' *(74.68 m)*.
③ Tapered top 80" x 68" *(2.03 x 1.73 m)* tubular boom lengths: 130' *(39.62 m)* through 290' *(88.39 m)*.

# LS-518 performance specifications

## Wire rope and drum data — (continued)

### Jib load hoist rope lengths (whipline) — using 7/8″ *(22 mm)* diameter wire rope

| Jib length | Parts of line | Boom lengths 50′ *(15.24 m)* | | 60′ *(18.29 m)* | | 70′ *(21.34 m)* | | 80′ *(24.38 m)* | | 90′ *(27.43 m)* | | 100′ *(30.48 m)* | | 110′ *(33.53 m)* | | 120′ *(36.58 m)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters |
| 20′ ① *(6.10 m)* | 1 | 160 | *48.77* | 180 | *54.86* | 200 | *60.96* | 220 | *67.06* | 240 | *73.15* | 260 | *79.25* | 280 | *85.34* | 300 | *91.44* |
| | 2 | 235 | *71.63* | 265 | *80.77* | 295 | *89.92* | 325 | *99.06* | 355 | *108.20* | 385 | *117.35* | 415 | *126.49* | 445 | *135.64* |
| 30′ *(9.14 m)* | 1 | 180 | *54.86* | 200 | *60.96* | 220 | *67.06* | 240 | *73.15* | 260 | *79.25* | 280 | *85.34* | 300 | *91.44* | 320 | *97.54* |
| | 2 | 265 | *80.77* | 295 | *89.92* | 325 | *99.06* | 355 | *108.20* | 385 | *117.35* | 415 | *126.49* | 445 | *135.64* | 475 | *144.78* |
| 50′ ② *(15.24 m)* | 1 | Not applicable | | 240 | *73.15* | 260 | *79.25* | 280 | *85.34* | 300 | *91.44* | 320 | *97.54* | 340 | *103.63* | 360 | *109.73* |
| | 2 | | | 355 | *108.20* | 385 | *117.35* | 415 | *126.49* | 445 | *135.64* | 475 | *144.78* | 505 | *153.92* | 535 | *163.07* |
| 70′ ② *(21.34 m)* | 1 | | | 280 | *85.34* | 300 | *91.44* | 320 | *97.54* | 340 | *103.63* | 360 | *109.73* | 380 | *115.82* | 400 | *121.92* |
| | 2 | | | 415 | *126.49* | 445 | *135.64* | 475 | *144.78* | 505 | *153.92* | 535 | *163.07* | 565 | *172.21* | 595 | *181.36* |

| Jib length | Parts of line | Boom lengths 130′ *(39.62 m)* | | 140′ *(42.67 m)* | | 150′ *(45.72 m)* | | 160′ *(48.72 m)* | | 170′ *(51.82 m)* | | 180′ *(54.86 m)* | | 190′ *(57.91 m)*③ | | 200′ *(60.96 m)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters |
| 20′ ① *(6.10 m)* | 1 | 320 | *97.54* | 340 | *103.63* | 360 | *109.73* | 380 | *115.82* | 400 | *121.92* | 420 | *128.02* | 440 | *134.11* | Not applicable | |
| | 2 | 475 | *144.78* | 505 | *153.92* | 535 | *163.07* | 565 | *172.21* | 595 | *181.36* | 625 | *190.50* | 635 | *193.55* | | |
| 30′ *(9.14 m)* | 1 | 340 | *103.63* | 360 | *109.73* | 380 | *115.82* | 400 | *121.92* | 420 | *128.02* | 440 | *134.11* | 460 | *140.21* | 480 | *146.30* |
| | 2 | 505 | *153.92* | 535 | *163.07* | 565 | *172.21* | 595 | *181.36* | 625 | *190.50* | 655 | *199.64* | 685 | *208.79* | 715 | *217.93* |
| 50′ ② *(15.24 m)* | 1 | 380 | *115.82* | 400 | *121.92* | 420 | *128.02* | 440 | *134.11* | 460 | *140.21* | 480 | *146.30* | 500 | *152.40* | 520 | *158.50* |
| | 2 | 565 | *172.21* | 595 | *181.36* | 625 | *190.50* | 655 | *199.64* | 685 | *208.79* | 715 | *217.93* | 745 | *227.08* | 775 | *236.22* |
| 70′ ② *(21.34 m)* | 1 | 420 | *128.02* | 440 | *134.11* | 460 | *140.21* | 480 | *146.30* | 500 | *152.40* | 520 | *158.50* | 540 | *164.59* | 560 | *170.69* |
| | 2 | 625 | *190.50* | 655 | *199.64* | 685 | *208.79* | 715 | *217.93* | 745 | *227.08* | 775 | *236.22* | 805 | *245.36* | 835 | *254.51* |

| Jib length | Parts of line | Boom lengths 210′ *(64.01 m)* | | 220′ *(67.06 m)* | | 230′ *(70.10 m)*④ | | 240′ *(73.15 m)*④ | | 250′ *(75.20 m)*④ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters |
| 20′ ① (6.10m) | 1 | ← Not applicable → | | | | | | | | | |
| | 2 | | | | | | | | | | |
| 30′ *(9.14 m)* | 1 | 500 | *152.40* | 520 | *158.50* | 540 | *164.59* | 560 | *170.69* | 580 | *176.78* |
| | 2 | 745 | *227.08* | 775 | *236.22* | 805 | *245.36* | 835 | *254.51* | 865 | *263.65* |
| 50′ ② *(15.24 m)* | 1 | 540 | *164.59* | 560 | *170.69* | 580 | *176.78* | 600 | *182.88* | 620 | *188.98* |
| | 2 | 805 | *245.36* | 835 | *254.51* | 865 | *263.65* | 895 | *272.80* | 925 | *281.94* |
| 70′ ② *(21.34 m)* | 1 | 580 | *176.78* | 600 | *182.88* | 620 | *188.98* | 640 | *195.07* | 660 | *201.17* |
| | 2 | 865 | *263.65* | 895 | *272.80* | 925 | *281.94* | 955 | *291.08* | 985 | *300.23* |

① Angle jibs only.
② Tubular jibs only.
③ Maximum angle boom length on which jib can be mounted is 190′ *(57.91 m)*.
④ Maximum tubular boom lengths on which jibs can be mounted: open throat — 230′ *(70.10 m)*; hammerhead — 225′ *(68.58 m)*; tapered top — 250′ *(75.20 m)*.

### Clamshell or dragline wire rope lengths using one part wire rope

| Attachment | Function | Boom lengths 50′ *(15.24 m)* | | 60′ *(18.29 m)* | | 70′ *(21.34 m)* | | 80′ *(24.38 m)* | | 90′ *(27.43 m)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feet | meters | Feet | meters | Feet | meters | Feet | meters | Feet | meters |
| Clamshell | Holding | 130 | *39.62* | 150 | *45.72* | 170 | *51.82* | 190 | *57.91* | 210 | *64.01* |
| | Closing | 180 | *54.86* | 200 | *60.96* | 220 | *67.06* | 240 | *73.15* | 260 | *79.25* |
| Dragline | Hoist | 130 | *39.62* | 150 | *45.72* | 170 | *51.82* | 190 | *57.91* | 210 | *64.01* |
| | Inhaul | 75 | *22.86* | 85 | *25.91* | 95 | *28.96* | 105 | *32.00* | 115 | *35.05* |

### Boom hoist wire rope length — 640′ *(195.07 m)*

# LS-518 performance specifications

## Drum wire rope capacities

| Wire rope layer | Front or rear drum — 19⅛" *(0.48 m)* root diameter smooth lagging, 1⅛" *(28 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* | Front or rear drum — 27" *(0.69 m)* root diameter smooth lagging, 1⅛" *(28 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* | Boomhoist drum — 10½" *(0.27 m)* root diameter grooved lagging, ¾" *(19 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 75 | *22.86* | 75 | *22.86* | 103 | *31.39* | 103 | *31.39* | 29 | *8.84* | 29 | *8.84* |
| 2 | 90 | *27.43* | 165 | *50.29* | 118 | *35.97* | 221 | *67.36* | 40 | *12.19* | 69 | *21.03* |
| 3 | 99 | *30.18* | 264 | *80.47* | 126 | *38.40* | 347 | *105.77* | 45 | *13.72* | 114 | *34.75* |
| 4 | 109 | *33.22* | 373 | *113.69* | 132 | *40.23* | 479 | *146.00* | 49 | *14.94* | 163 | *49.68* |
| 5 | 117 | *35.66* | 490 | *149.35* | | | | | 54 | *16.46* | 217 | *66.14* |
| 6 | 126 | *38.40* | 616 | *187.76* | | | | | 59 | *17.98* | 276 | *84.12* |
| 7 | 135 | *41.15* | 751 | *228.90* | | | | | | | | |
| 8 | 144 | *43.89* | 895 | *272.80* | | | | | | | | |

| Wire rope layer | Front drum (inhaul) — 24⅜" *(0.62 m)* root diameter grooved lagging, 1⅛" *(28 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* | Front or rear drum — 27" *(0.69 m)* root diameter grooved lagging, ⅞" *(22 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* | Third drum — 13¼" *(0.34 m)* root diameter smooth lagging, ⅞" *(22 mm)* wire rope: Rope per layer, Feet | Rope per layer, *meters* | Total wire rope, Feet | Total wire rope, *meters* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 89 | *27.13* | 89 | *27.13* | 110 | *33.53* | 110 | *33.53* | 69 | *21.03* | 69 | *21.03* |
| 2 | 111 | *33.83* | 200 | *60.86* | 154 | *46.94* | 264 | *80.47* | 151 | *46.02* | 220 | *67.06* |
| 3 | 120 | *36.58* | 320 | *97.54* | 162 | *49.38* | 426 | *129.84* | 242 | *73.76* | 462 | *140.82* |
| 4 | 129 | *39.32* | 449 | *136.86* | 171 | *52.12* | 597 | *181.97* | 342 | *104.24* | 804 | *245.06* |
| 5 | 138 | *42.06* | 587 | *178.92* | 180 | *54.86* | 777 | *236.83* | 451 | *137.46* | 1,255 | *382.52* |
| 6 | 147 | *44.81* | 734 | *223.72* | 189 | *57.61* | 966 | *294.44* | | | | |

## Available line speed and line pull① — based on Cummins N855-P310 ② diesel engine with three stage Twin Disc torque converter developing maximum net horsepower as developed by P.C.S.A. Standard No. 1

| Attachment | Front or rear drum: Root diameter | Wire rope diameter, Inches | Wire rope diameter, *mm* | Line speed first layer, F.p.m. | Line speed first layer, *m/min* | Line pull first layer, Pounds | Line pull first layer, *kilograms* | Third drum: Root diameter | Wire rope diameter, Inches | Wire rope diameter, *mm* | Line speed first layer, F.p.m. | Line speed first layer, *m/min* | Line pull first layer, Pounds | Line pull first layer, *kilograms* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crane | 19⅛" *(0.49 m)* | ⅞ | *22* | 101 | *30.78* | 61,400 | *27 851* | 13¼" *(0.34 m)* | ⅞ | 22 | 117 | *35.66* | 29,800 | *13 517* |
| | | 1 | *26* | 102 | *31.09* | 61,000 | *27 670* | | | | | | | |
| | | 1⅛ | *28* | 103 | *31.39* | 60,700 | *27 534* | | | | | | | |
| Crane | 27" *(0.69 m)* | ⅞ | *22* | 142 | *43.28* | 44,100 | *20 004* | | | | | | | |
| | | 1 | *26* | 142 | *43.28* | 43,800 | *19 868* | | | | | | | |
| | | 1⅛ | *28* | 143 | *43.59* | 43,500 | *19 732* | | | | | | | |
| Clamshell hoist and closing or dragline hoist | 27" *(0.69 m)* | ⅞ | *22* | 142 | *43.28* | 44,100 | *20 004* | | | | | | | |
| | | 1 | *26* | 142 | *43.28* | 43,800 | *19 868* | | | | | | | |
| Dragline inhaul | 24⅜" *(0.62 m)* | 1 | *26* | 129 | *39.32* | 47,000 | *21 319* | | | | | | | |
| | | 1⅛ | *28* | 130 | *39.62* | 46,700 | *21 183* | | | | | | | |

## Permissible line speed and pull① — based on Type "N" wire rope strength, single part line

| Attachment | Front or rear drum: Root diameter | Wire rope diameter, Inches | Wire rope diameter, *mm* | Line speed first layer, F.p.m. | Line speed first layer, *m/min* | Line pull first layer, Pounds | Line pull first layer, *kilograms* | Third drum: Root diameter | Wire rope diameter, Inches | Wire rope diameter, *mm* | Line speed first layer, F.p.m. | Line speed first layer, *m/min* | Line pull first layer, Pounds | Line pull first layer, *kilograms* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crane | 19⅛" *(0.49 m)* | ⅞ | *22* | 101 | *30.78* | 22,700 | *10 297* | 13¼" *(0.34 m)* | ⅞ | 22 | 117 | *35.66* | 22,700 | *10 297* |
| | | 1 | *26* | 102 | *31.09* | 29,500 | *13 381* | | | | | | | |
| | | 1⅛ | *28* | 103 | *31.39* | 37,100 | *16 829* | | | | | | | |
| Crane | 27" *(0.69 m)* | ⅞ | *22* | 142 | *43.28* | 22,700 | *10 297* | | | | | | | |
| | | 1 | *26* | 142 | *43.28* | 29,500 | *13 381* | | | | | | | |
| | | 1⅛ | *28* | 143 | *43.59* | 37,100 | *16 829* | | | | | | | |
| Clamshell hoist and closing, or dragline hoist | 27" *(0.69 m)* | ⅞ | *22* | 142 | *43.28* | 22,700 | *10 297* | | | | | | | |
| | | 1 | *26* | 142 | *43.28* | 29,500 | *13 381* | | | | | | | |
| Dragline inhaul | 24⅜" *(0.62 m)* | 1 | *26* | 129 | *39.32* | 29,500 | *13 381* | | | | | | | |
| | | 1⅛ | *28* | 130 | *39.62* | 37,100 | *16 829* | | | | | | | |

① Maximum permissible load on single part of line for Type "N" wire rope: ¾"*(19 mm)* — 16,800 lbs. *(7 620 kg)*; ⅞" *(22 mm)* — 22,700 lbs. *(10 297 kg)*; 1" *(26 mm)* — 29,600 lbs. *(13 427 kg)*; 1⅛" *(28 mm)* — 37,100 lbs. *(16 829 kg)*. Maximum permissible load for ⅞" *(22 mm)* Type "P" wire rope — 14,800 lbs. *(6 713 kg)*.
② Data applicable only to Cummins NT855-P310 engine package. If required, similar data for other engine packages available from Sales Office.

# LS-518 performance specifications

**Load hoisting performance** ① — line speeds are maximum for full throttle operation (2,100 r.p.m. full load speed) with Cummins NT855-P310 diesel engine equipped with three stage Twin Disc torque converter and auxiliary governor control

| Single line load ② | | Front or rear drum — 19⅛" *(0.48 m)* root diameter using 1⅛" *(28 mm)* diameter wire rope | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Line speed | | | | | | | | | | | |
| | | First layer rope | | | | Fifth layer rope | | | | Eighth layer rope | | | |
| | | Standard | | High speed ③ | | Standard | | High speed ③ | | Standard | | High speed ③ | |
| Pounds | *kilograms* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* |
| 5,000 | *2 268* | 199 | *60.66* | 337 | *102.72* | 279 | *85.04* | 471 | *143.56* | 339 | *103.33* | 561 | *170.99* |
| 10,000 | *4 536* | 191 | *58.22* | 310 | *94.49* | 260 | *79.25* | 406 | *123.75* | 306 | *93.27* | 452 | *137.77* |
| 15,000 | *6 804* | 180 | *54.86* | 276 | *84.12* | 241 | *73.46* | 335 | *102.11* | 278 | *84.73* | 368 | *112.17* |
| 20,000 | *9 072* | 170 | *51.82* | 244 | *74.37* | 222 | *67.67* | 283 | *86.26* | 250 | *76.20* | 297 | *90.53* |
| 25,000 | *11 340* | 159 | *48.46* | 215 | *65.53* | 199 | *60.66* | 237 | *72.24* | 221 | *67.36* | 236 | *71.93* |
| 30,000 | *13 608* | 151 | *46.02* | 191 | *58.22* | 180 | *54.86* | 198 | *60.35* | 198 | *60.35* | | |
| 35,000 | *15 876* | 143 | *43.59* | 170 | *51.82* | 165 | *50.29* | 168 | *51.21* | 179 | *54.56* | | |
| 40,000* | *18 144** | 132* | *40.23** | 148* | *45.11** | 152* | *46.33** | | | 160* | *48.77** | | |
| 45,000* | *20 412** | 122* | *37.19** | 132* | *40.23** | 140* | *42.67** | | | 141* | *42.98** | | |
| 50,000* | *22 680** | 117* | *35.66** | | | 126* | *38.40** | | | 127* | *38.71** | | |
| 55,000* | *24 948** | 109* | *33.22** | | | 115* | *35.05** | | | | | | |
| 60,000* | *27 216** | 103* | *31.39** | | | 107* | *32.61** | | | | | | |

| Single line load ② | | Front or rear drum — 27" *(0.69 m)* root diameter using ⅞" *(22 mm)* wire rope | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Line speed | | | | | | | | | | | |
| | | First layer rope | | | | Fourth layer rope | | | | Sixth layer rope | | | |
| | | Standard | | High speed ③ | | Standard | | High speed ③ | | Standard | | High speed ③ | |
| Pounds | *kilograms* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* | F.p.m. | *m/min* |
| 5,000 | *2 268* | 267 | *81.38* | 447 | *136.25* | 314 | *95.71* | 520 | *158.50* | 345 | *105.16* | 566 | *172.52* |
| 10,000 | *4 536* | 251 | *76.50* | 389 | *118.57* | 292 | *89.00* | 434 | *132.28* | 317 | *96.62* | 460 | *140.21* |
| 15,000 | *6 804* | 235 | *71.63* | 329 | *100.28* | 266 | *81.08* | 355 | *108.20* | 285 | *86.87* | 366 | *111.56* |
| 20,000 | *9 072* | 215 | *65.53* | 276 | *84.12* | 240 | *73.15* | 292 | *89.00* | 253 | *77.11* | 297 | *90.53* |
| [illegible]00* | *11 340** | 197* | *60.05** | 236* | *71.93** | 215* | *65.53** | 241* | *73.46** | 224* | *68.28** | 240* | *73.15** |
| [illegible]00* | *13 608** | 180* | *54.87** | 201* | *61.26** | 192* | *58.52** | 200* | *60.96** | 199* | *60.66** | | |
| [illegible],000* | *15 876** | 164* | *49.99** | 171* | *52.12** | 174* | *53.04** | | | 178* | *54.25** | | |
| 40,000* | *18 144** | 150* | *45.72** | | | 157* | *47.85** | | | 159* | *48.46** | | |
| 45,000* | *20 412** | 138* | *42.06** | | | 142* | *43.28** | | | 142* | *43.28** | | |
| 50,000* | *22 680** | 127* | *38.71** | | | 127* | *38.71** | | | | | | |
| 55,000* | *24 948** | 116* | *35.36** | | | | | | | | | | |
| 60,000* | *27 216** | 106* | *32.31** | | | | | | | | | | |

*Based on factors other than allowable strength of single line of wire rope.
① Data applicable only to Cummins NT855-P310 engine package as described above. If required, similar data for other engine packages available from Sales Office.
② Maximum permissible load on single part of line for Type "N" wire rope: ⅞" *(22 mm)* — 22,700 lbs. *(10 297 kg)*; 1⅛" *(28 mm)* — 37,100 lbs. *(16 829 kg)*. Maximum permissible load for ⅞" *(22 mm)* Type "P" wire rope; 14,800 lbs. *(6 713 kg)*.
③ Machine equipped with optional high speed planetary drum drive unit.

## Rope size and type

| Wire rope application | Size and type used |
|---|---|
| Boomhoist | ¾" *(19 mm)* diameter, Type "W" |
| Main load hoist | 1⅛" *(28 mm)* diameter, Type "N" |
| Jib load hoist (1-part) | ⅞" *(22 mm)* diameter, Type "P" |
| Jib load hoist (2-part) | ⅞" *(22 mm)* diameter, Type "N" |
| Third drum | ⅞" *(22 mm)* diameter, Type "N" |
| Clamshell holding (hoist) or closing | ⅞" *(22 mm)* diameter, Type "M" |
| Dragline hoist | ⅞" *(22 mm)* diameter, Type "M" |
| Dragline inhaul | 1⅛" *(28 mm)* diameter, Type "G" |
| Boom pendants | 1⅜" *(35 mm)* diameter, Type "N" |
| Boom midpoint suspension pendants ④ | ⅞" *(22 mm)* diameter, Type "N" |
| Jib frontstay line | ¾" *(19 mm)* diameter, Type "N" |
| Jib backstay line | ¾" *(19 mm)* diameter, Type "N" |

④ Required on boom lengths exceeding 180′ *(54.86 m)*.

| Wire rope types |
|---|
| Type "M" — 6 x 25 (6 x 19 class), filler wire, extra improved plow steel, preformed, independent wire rope center, right lay, lang lay. |
| Type "N" — 6 x 25 (6 x 19 class), filler wire, extra improved plow steel, preformed, independent wire rope center, right lay, regular lay. |
| Type "P" — 19 x 7 non-rotating, extra improved plow steel, preformed, wire strand core. |
| Type "G" — 6 x 30 flattened strand, extra improved plow steel, preformed, independent wire rope center, right lay, lang lay. |
| Type "W" — 6 x 26 (6 x 19 class), extra improved plow steel, preformed, independent wire rope center, right lay, alternate lay. |

We are constantly improving our products and therefore reserve the right to change designs and specifications.

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# CALCULATIONS
# EE MEMO 4

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/24/2013

FOR: Exelon Checked By: AMD Date: 6/28/2013

SUBJECT: Calculation 1: Static, Dynamic, and Asphalt Load Application Calculations

### Static Applied Stress Calculation - Design Truck (See Ref. 2 for axle/wheel layout):

$w := 0.667ft$ $l := 1.333ft$ Dimensions of Contact with Ground of a Single Wheel (8" x 16")

$A := w \cdot l$ $A = 0.89\,ft^2$ Contact Area of a Single Wheel

$P := 10kip$ Applied Load per Wheel

$\sigma_s := \frac{P}{A}$ $\sigma_s = 11.25\,ksf$ Bearing Stress at Grade per Wheel

### Dynamic Applied Stress Calculation - Design Truck (Ref. 3):

$D_E := 0$ Embedment Depth of Applied Load

$IM := 33 \cdot (1 - 0.125 \cdot D_E)$ Dynamic Load Allowance for Drainage Net (Additional Percentage of Static Response Applied at Grade)

$IM = 33$

$\sigma_d := \frac{IM}{100} \cdot \sigma_s$ Additional Allowable Dynamic Load

$\sigma_d = 3.71\,ksf$

$\sigma_T := \sigma_s + \sigma_d$ Static plus Dynamic Applied Load at Grade from the Design Truck

$\sigma_T = 14.96\,ksf$

### Asphalt Applied Stress Calculation:

$\gamma_{asp} := 145pcf$ Assumed Unit Weight of Asphalt

$D_{asp} := 5in$ Recommended Height for Asphalt for Construction Roads (as per Ref. 7)

$\sigma_{asp} := \gamma_{asp} \cdot D_{asp}$

$\sigma_{asp} = 0.06\,ksf$ Additional CR-6 Applied Stress due to Construction Roads

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/24/2013

FOR: Exelon Checked By: AMD Date: 6/28/2013

SUBJECT: Calculation 1: Static, Dynamic, and Asphalt Load Application Calculations

### Static Applied Stress Calculation - Wheel Loader (See Attachment 3):

$W_o := 43195lb$ Wheel Loader Operating Weight

$W_f := 18576lb$ Front Axle Weight

$W_r := 24619lb$ Rear Axle Weight

$W_p := 12082lb$ Payload

$W_{front} := W_f + W_p$

$W_{front} = 30658\,lb$ Maximum Load on Front Axle

$P := \frac{W_{front}}{2}$ $P = 15329\,lb$ Maximum Load per Wheel on Front Axle

$w := \frac{P}{0.8}$ $w = 1.597\,ft$ Width of Contact Area of Wheel (Ref. 3)

$\gamma := 1.50$ Load Factor (Ref. 3)

$$l := 6.4\gamma \cdot \left(1in + \frac{IM}{100}\right)$$

$l = 1.06\,ft$ Length of Contact Area of Wheel (Ref. 3)

$A := w \cdot l$ $A = 1.699\,ft^2$ Contact Area of a Single Wheel

$P = 15329\,lb$ Applied Load per Wheel

$\sigma_s := \frac{P}{A}$ $\sigma_s := 9.02ksf$ Bearing Stress at Grade per Wheel

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/24/2013

FOR: Exelon Checked By: AMD Date: 6/28/2013

SUBJECT: Calculation 1: Static, Dynamic, and Asphalt Load Application Calculations

### Dynamic Applied Stress Calculation - Wheel Loader (Ref. 3):

$D_E := 0$ Embedment Depth of Applied Load

$IM := 33 \cdot (1 - 0.125 \cdot D_E)$

$IM = 33$ Dynamic Load Allowance for Drainage Net (Additional Percentage of Static Response Applied at Grade)

$\sigma_d := \frac{IM}{100} \cdot \sigma_s$

$\sigma_d = 2.98\,ksf$ Additional Allowable Dynamic Load

$\sigma_T := \sigma_s + \sigma_d$

$\sigma_T = 12\,ksf$ Static plus Dynamic Applied Load at Grade from the Wheel Loader

SUBJECT CALCULATION 2: WATER AND SOIL CONTAINERS APPLIED LOAD CALCULATIONS

1. 16380 GALLON DOUBLE-WALL TANK (SEE ATTACHMENT 4)

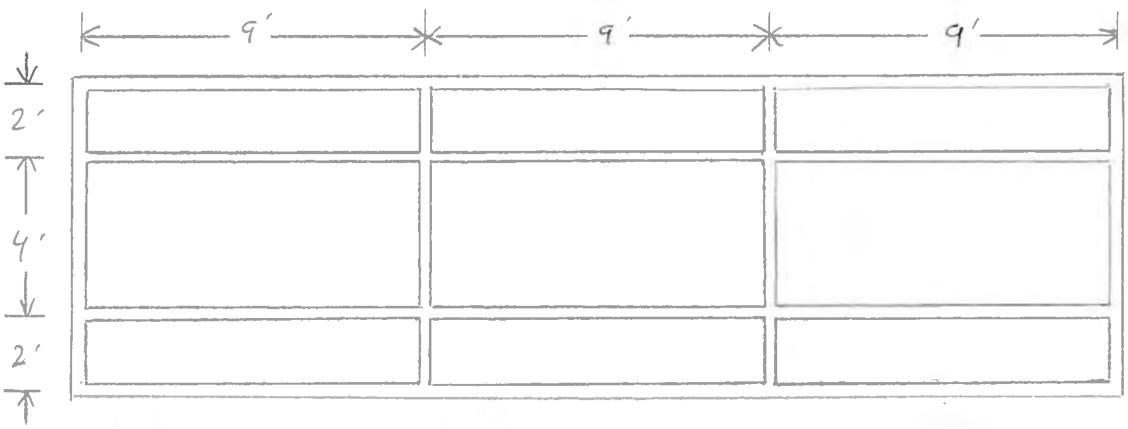
LOADS

- TANK BEARS ON FRAMEWORK OF 4" WIDE STEEL SKIDS (SHOWN BELOW) AND IS ASSUMED FILLED TO CAPACITY WITH WATER.
- TARE WEIGHT: 38000 lbs
- PAYLOAD

$$16380 \text{ gal} \left(\frac{8.35 \text{ lb}}{1 \text{ gal}}\right) = 136773 \text{ lbs}$$

- TOTAL MAXIMUM WEIGHT = 38000 + 136773 = 174773 lbs ≈ 175000 lbs

LAYOUT




GROUND CONTACT AREA OF DOUBLE-WALL TANK

PLAN VIEW

AREA

LONGITUDINAL: $(9'+9'+9')(4'')(4 \text{ SKIDS})(12\text{in}/1\text{ft}) = 5184 \text{ in}^2$

TRANSVERSE: $[(2'+4'+2')(4'')(12\text{in}/1\text{ft}) - 4 \text{ SKIDS}(4'' \times 4'')] 4 \text{ SKIDS}$
$= 1280 \text{ in}^2$

TOTAL $= 5184 + 1280 = 6464 \text{ in}^2$

BEARING STRESS $= \dfrac{175000 \text{ lb}}{6464 \text{ in}^2} = 27.1 \text{ psi} = 3.90 \text{ ksf}$ (ASSUMED UNIFORM)

→ ACCORDING TO WINSTRESS, MAXIMUM BEARING STRESS AT DRAINAGE NET IS 0.74 KSF < 2.0 KSF ∴ NO REINFORCEMENT REQUIRED.

SUBJECT CALCULATION 2: WATER AND SOIL CONTAINERS APPLIED LOAD CALCULATIONS

2. 25 YARD ROLL-OFF BOX WITH ALUMINUM HARD-TOP (SEE ATTACHMENT 5)

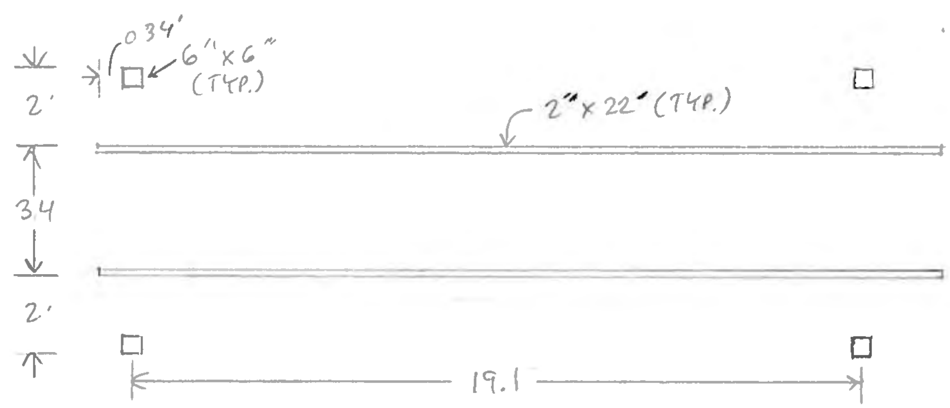
LOADS

- BOX BEARS ON FOUR 8"×10" WHEELS (ASSUMED 6"×10" CONTACT AREA) AND ASSUMED TO ALSO BEAR ON TWO 2" WIDE, 22' LONG SKIDS,
- BOX IS ASSUMED TO BE FILLED TO CAPACITY WITH SOIL, DEBRIS, WATER, CONCRETE FRAGMENTS, VOID SPACE, ETC ~ 125 PCF.
- TARE WEIGHT = 5000 lbs
- PAYLOAD:

(CAPACITY)(UNIT WEIGHT OF CONTENTS) = $(25 yd^3)(125 pcf)(27 ft^3/yd^3)$
= 84375 lbs

- TOTAL MAXIMUM WEIGHT = 5000 + 84375 = 89375 ≈ 90000 lbs

LAYOUT




GROUND CONTACT AREA OF ROLL-OFF BOX

PLAN VIEW

AREA

WHEELS: (6"×6")(4 WHEELS) = 144 $in^2$

SKIDS: (22')(12in/1Ft)(2")(2 SKIDS) = 1056 $in^2$

TOTAL: 144 + 1056 = 1200 $in^2$

BEARING STRESS: $\frac{90000 \text{ lbs}}{1200 \text{ in}^2}$ = 75 psi = 10.80 ksf

→ ACCORDING TO WINSTRESS, MAXIMUM BEARING STRESS AT DRAINAGE NET IS 0.53 KSF < 2.0KSF ∴ NO REINFORCEMENT REQUIRED.

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File: 11896A

Made By: DJG Date: 6/25/2013

FOR: Exelon Checked By: AMD Date: 6/27/2013

SUBJECT: Calculation 3: MMC Bearing Capacity under Design Truck

**Determine the Bearing Capacity of the MMC Soil Cover under wheel contact area of the Design Truck using Terzaghi's Bearing Capacity Formula (p. 177, Ref. 8):**

$c := 0psf$ — Cohesion of Soil Cover

$N_c := 52.6$ $N_q := 36.5$ $N_\gamma := 39.6$ — Terzaghi Bearing Capacity Factors for $\phi$ = 34 degrees

$z := 2.5ft$ — Depth to top of Drainage Net

$\gamma := 125pcf$ — Assumed Unit Weight for Soil Cover (No standing water within Soil Cover)

$\sigma_{zD} := \gamma \cdot z$

$\sigma_{zD} = 312.5\ psf$ — Vertical Effective Stress at top of Drainage Net

$B := 8in$ — Width of Design Truck Tire Contact Area with Ground

$q_{ult} := 1.3c \cdot N_c + \sigma_{zD} \cdot N_q + 0.4 \cdot \gamma \cdot B \cdot N_\gamma$

$q_{ult} = 12726.25\ psf$ $q_{ult} = 12.73\ ksf$ — MMC Ultimate Bearing Capacity - Bearing Stress Necessary to Cause Bearing Capacity Failure at Drainage Net

$q_{DT} := 1.53ksf$ — Applied Bearing Stress to Drainage Net of Design Truck under Static and Dynamic Loading

$FS := \frac{q_{ult}}{q_{DT}}$ $FS = 8.32$ — Factor of Safety Against Bearing Capacity Failure of MMC Soil Cover

MUESER RUTLEDGE CONSULTING ENGINEERS
CALCULATION #4

SHEET 1 OF 1
FILE: 118964-40
MADE BY: AMD 7/15/13
CHK'D BY: DJG 7/16/13

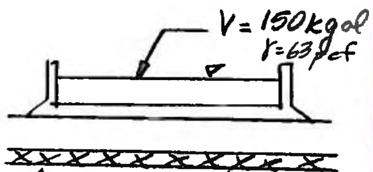
PROJECT: EXELON TOWER & TF GARAGE

SUBJECT: LOAD ON DRAINAGE NET FROM MODU-TANKS

Modutank @ Site will be similar in construction to image @ center.

SIZE: 75 x 75 ft

CAPACITY: 150K gal LIQUID STORAGE FOR CONTAMINATED WATER: $\gamma = 8.42\ \text{lbs/gal}$




$q_{ALL} = 1\ \text{tsf}$

$$q_{APP} = \frac{150\text{kgal} \cdot 8.42\ \text{lb/gal}}{75^2\ \text{sf}}$$

$$= \frac{2000 \cdot 8.42\ \text{lb}}{75\ \text{sf}}$$

$$= 225\ \text{psf} = 0.113\ \text{tsf}$$

$0.113\ \text{tsf} < 1.0\ \text{tsf}$ ∴ **$q_{APP}$ IS OK.**

# EE Memo 5 Slab-on-Grade Development Cap at Garage Level

## MEMORANDUM

**Date:** November 9, 2021

**To:** Office

**From:** Adam M. Dyer

**Re:** EE Memo 5 – Slab-on-Grade Development Cap at Garage Level

**File:** Area 1, Phase 2, Parcel 3, Baltimore, MD
File # 13921/13922

Garage Level grades call for replacement of the Cover Soil (min. 30 inch thickness) with a concrete slab-on-grade, underlain by sufficient Cover Soil to obtain the desired top of slab elevation. The finished slab will be exposed to the environment and will support automobile parking. Styrofoam insulation will be placed below the slab to provide equal or better thermal protection of the MMC synthetic layers. The concrete slab will spread vehicle loads to protect the synthetic layers.

### EXHIBITS

| | |
|---|---|
| Attachment 1 (EE Memo 5) | Vulcan 810 Intruder |
| Calculation 1 (EE Memo 5) | Thickness of Thermal Insulation at Garage Level |
| Calculation 2 (EE Memo 5) | Vehicular Load Spreading on Slab-on-Grade |

### REFERENCES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3. United States American Concrete Institute (ACI). Guide to Thermal Properties of Concrete and Masonry Systems: ACI 122R-02. American Concrete Institute, 2002.
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5. EPRI Soil and Rock Classification for the Design of Ground-Coupled Heat Pump Systems – Field Manual - Cu-6600, Table 3-1.
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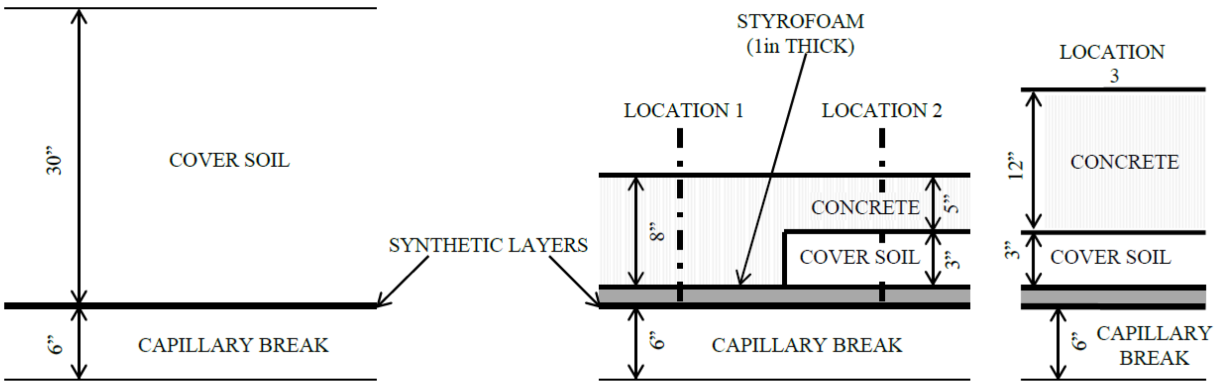
## THERMAL PROTECTION ANALYSIS AND ASSUMPTIONS

Thermal Resistance (R-Value) is a measure of the ability of a homogeneous material of unit thickness to resist a temperature difference of one degree Fahrenheit across a unit area (Ref. 3). R-Values are expressed in terms of ($ft^2$*h*°F) / Btu. The assumed R-Values for Cover Soil, Styrofoam, or concrete are (Ref. 4, 5, 6):

- Concrete: $R_{conc}$ = 0.10 per inch
- Cover Soil (sand and gravel): $R_{soil}$ = 0.189 per inch
- Styrofoam: $R_{foam}$ = 5.0 per inch

Existing and future conditions analyzed are shown in Figures 1a and 1b. Thermal resistance analysis was performed for 30 inch minimum Cover Soil (assumed sand and gravel) (Figure 1a) and two future cases as shown in Figure 1b. Steel reinforcement was neglected for this analysis, the concrete slab was assumed to be normal weight concrete (150 pounds per cubic foot (pcf)). Additional Cover Soil will be left below the Styrofoam, though no additional Cover Soil was assumed for this analysis.




**1a** **1b**

**Figure 1a and 1b –** (a) Existing Conditions, (b) Future Slab-on-Grade

## FINDINGS

The controlling factor to thermal performance is the thickness of Styrofoam used, as its R-Value is high compared to that of Cover Soil or concrete. The existing 30 inches of Cover Soil provides an overall R-Value of 5.67. Both future conditions were analyzed by adding the resistance of each material, assuming the heat has only one path through each system. Analysis performed at Location 1 in Figure 1b at the future Garage Level Slab haunch resulted in an overall R-Value of 5.80. Similar analysis at Locations 2 and 3 in Figure 1b through the Garage Level Slab-on-grade resulted in an overall R-Values of 6.07 and 6.77, respectively (See Table 1). Supporting calculations are provided in Calculation 1 (EE Memo 5).

| | | EXISTING CONDITIONS | | LOCATION 1 | | LOCATION 2 | | LOCATION 3 | |
|---|---|---|---|---|---|---|---|---|---|
| R-Value Parameter / Material | Unit R-Value | Layer Thickness | Equivalent R-Value | Layer Thickness | Equivalent R-Value | Layer Thickness | Equivalent R-Value | Layer Thickness | Equivalent R-Value |
| | $\frac{ft^2*h*°F}{Btu*in}$ | Inch | $\frac{ft^2*h*°F}{Btu*in}$ | Inch | $\frac{ft^2*h*°F}{Btu*in}$ | Inch | $\frac{ft^2*h*°F}{Btu*in}$ | Inch | $\frac{ft^2*h*°F}{Btu*in}$ |
| **Concrete (Ref 4)** | 0.10 | 0 | 0 | 8 | 0.8 | 5 | 0.5 | 12 | 1.2 |
| **Cover Soil (Sand and Gravel) (Ref 5)** | 0.189 | 30 | 5.67 | 0 | 0 | 3 | 0.507 | 3 | 0.567 |
| **Styrofoam (Ref 6)** | 5.0 | 0 | 0 | 1 | 5 | 1 | 5 | 1 | 5 |
| ***TOTAL:*** | | | **5.67** | | **5.80** | | **6.07** | | **6.77** |

**Table 1 –** R-Value Summary

## LOAD SPREAD ANALYSIS

The bearing stress on the Drainage Net at Locations 1a and 1b was analyzed for the most extreme load conditions beneath the Design Truck, Wheel Loader, and Tow Truck. As discussed in EE Memo 4, bearing stress on the MMC synthetic layers should not exceed 2 kips per square foot (ksf), as any higher stress will compromise the flow of the Drainage Net.

The 5-inch thick concrete slab on grade will include steel reinforcing bars, intended to distribute wheel loads even with cracking, facilitating its rehabilitation under a regular repairing cycle.

### Design Truck and Wheel Loader

The Design Truck and Wheel Loader were evaluated for bearing stresses to determine if they can be allowed to drive on the finished Garage Level Slab (while construction is on-going). They have contact areas with the ground of 8 inches x 16 inches and 19.2 inches x 12.7 inches, respectively for a single wheel. Applied static plus dynamic loads are 26.6 kips for the Design Truck under a dual wheel and 20.4 kips for the Wheel Loader under a single wheel. Assuming concrete spreads load at a 1:1 ratio and soil spreads load at a 2:1 ratio (Ref. 7), it was determined that neither the Design Truck, nor the Wheel Loader should be permitted to drive on the finished Garage Level Slab (See Calculation 2 (EE Memo 5) and Table 2).

### Tow Truck

An extreme expected loading condition within the future Garage Level was assumed to be the rear axle of a tow truck under static plus dynamic loading while pulling a vehicle, given that emergency vehicle dimensions are bigger than the allowable clearance at the garage. The “Tow Truck” (see Attachment 1 (EE Memo 5)) has a maximum operating weight (which includes vehicle and cargo) of 14,500 lbs, with the rear axle supporting 10,000 lbs. The towing hydraulic system has a lift capacity of 4000 lbs. With inclusion of dynamic applied load and lift capacity, the maximum applied load on the rear axle is 18,620 lbs, for a wheel load of 4,655 lbs (four wheels support rear axle). Under this load and using a dual wheel contact area of 15.64 inches x 12.7 inches (Calculation 2 (EE Memo 5)), it was determined that the Tow Truck will impose bearing pressures on the MMC synthetic layers of 1.47 ksf and 1.82 ksf at Locations 1 and 2, respectively, each less than 2 ksf (Table 2), not causing undue harm to the MMC synthetic layers.

Under similar loading conditions regarding contact areas, a load of 10.25 kips was calculated as the maximum dynamic impact load for a dual wheel condition, similar to the Tow Truck, which should be permitted to drive on the finished Garage Level Slab**.**

| Location | Limit | Design Truck | Wheel Loader | Tow Truck |
|---|---|---|---|---|
| | (*ksf*) | (*ksf*) | (*ksf*) | (*ksf*) |
| **Haunch (1)** | **2.0** | 2.99 | 2.9 | 1.47 |
| **Slab-on-Grade (2)** | **2.0** | 3.57 | 3.54 | 1.82 |

**Table 2 –** Active Vehicle Load Spreading; Bearing Stress at Drainage Net

## CONCLUSIONS

- The future Plaza Garage will provide sufficient resistance to thermal changes of expansion and contraction and protect the MMC's synthetic layers with 1 inch of Styrofoam insulation.
- Neither the Design Truck, nor the Wheel Loader should be allowed to drive on the slab for the Garage Level, based on the load imposed over the MMC synthetic layers.
- Vehicles driving on the Garage Level Slab should be limited in weight to no more than that of an active vehicle Tow Truck, please refer to Drawing No. FO.107.

# EXHIBITS

**ATTACHMENT 1**
**EE MEMO 5**

Vulcan

# 810 Intruder

Attachment 1 EE MEMO 2


## *The Superior Solution to Auto Load Wheel Lifts*

The Vulcan 810 Intruder has been specifically designed to fill the needs of private impounders and professional repossessors. The low-profile boom and low-mount planetary winch provide a sleek appearance and superior visibility. The modular design body is adjustable from 88 inch to 94 inch, eliminating the need for fender flares, and includes spacious driver and passenger side tool compartments to provide ample storage for your additional equipment. The proven hydraulic auto load wheel lift system provides for quick and easy operation, even when hooking up parallel parked vehicles. Contact your local Vulcan Distributor for more information on the sleek and stylish Vulcan 810 Intruder.

**Innovative. Durable.**
**Brutally Tough.**

# Innovative. Durable. Brutally Tough.

## Specifications

**BOOM**

Recovery Boom (at boom end swivel) .................... 8,000 lbs.
Maximum Lift Angle .................................... 21°
Winch (Planetary) ..................................... 8,000 lbs.
Cable ................................................. 3/8" x 100'

**UNDERLIFT**

Lift Capacity Extended ................................ 4,000 lbs.
Tow Rating ............................................ 7,500 lbs.
Maximum Reach ......................................... 73"
Optional Power Tilt ................................... 30° Arc

**CHASSIS RECOMMENDATIONS**

Minimum C.A. (Cab to Axle) ............................ 60"
Maximum C.A. (With Tunnel Tool Box) ................... 84"
Suggested GVWR ........................................ 14,500 lbs.

## Standard Features

- 60" C.A. Steel Modular Body
- Adjustable Body Width, 88" or 94"
- Auto Load Wheel Lift System
- 180° Pivoting Crossbar
- Self Centering Crossbar
- Tailboard Safety Chain Pockets
- Safety Chains
- Safety Chain Pocket Guards
- Wheel Lift Ratchets & Straps
- Driver & Passenger Side Tool Compartments
- In Cab Wheel Lift & Winch Controls
- 8,000 lb. Planetary Winch with 100' of 3/8" Cable
- Junction Box and Wiring Harness
- Mud Flaps
- Federal Standard 108 Lighting
- Tire Spacers (Flat Tires)

## Optional Fea-

- Aluminum or Composite Modular Body
- Power Tilt
- Power Tilt with Adjustable limiter switches on elevation & tilt functions
- Steel Light Pylon
- Aluminum Tubular Light Pylon
- 24" Tunnel Tool Box (Steel, Aluminum or Composite)
- Trailer Hitch Attachment
- Motorcycle Attachment
- Dress Up Packages
- Emergency Lighting
- Dollies & Mounting Options
- Clutch Pump or Pump/PTO


The Optional Power Tilt feature on the Intruder allows the wheel lift to operate through a 30-degree arc, which provides easier hook-ups on driveways or sloped roads.

All ratings are based on structural factors only, not vehicle capacities or capabilities. Specifications shown are approximations and may vary depending on chassis selected. Miller Industries Towing Equipment Inc. reserves the right to change or modify product and or specifications without notice or obligation. Some equipment shown is optional.

Miller INDUSTRIES



Vulcan

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**CALCULATION 1**
**EE MEMO 2**

SUBJECT: Calculation 1: Thickness of Thermal Insulation at Garage Level

Thermal protection of synthetic layers is currently provided by a minimum of 30 inches of Cover Soil. Cover Soil is assumed composed of sand and gravel. Analysis below compares thermal resistance of existing Cover Soil with future Garage Level Slab at Locations 1, 2, and 3.

Future Garage Level at Location 1 (see Figure 1b) encounters an 8 inch concrete haunch ($t_{haunch}$), underlain by molded polystyrene (Styrofoam) ($t_{sty}$).

Future Garage Level at Location 2 (see Figure 1b) encounters a 5 inch concrete slab on grade ($t_{conc}$) underlain by a minimum of 3 inches of Cover Soil ($t_{soil}$) and Styrofoam ($t_{sty}$).

Future Garage Level at Location 3 (see Figure 1b) encounters a 12 inch concrete slab on grade ($t_{conc}$) underlain by a minimum of 3 inches of Cover Soil ($t_{soil}$) and Styrofoam ($t_{sty}$).

**EXISTING MMC:**

$R_{soil} = k_{soil}^{-1} * \frac{1 \text{ ft}}{12 \text{ in}}$ Thermal Resistance of Sand and Gravel Per Inch Thickness (Ref. 5)

Where: $k_{soil} = 0.44 \frac{\text{Btu}}{\text{ft} * \text{h} * °\text{F}}$ Thermal Conductivity of Sand and Gravel

$R_{soil} = \frac{1}{k_{soil} * 12 \text{ in}} = 0.189 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Sand and Gravel per Inch

$R_{soil} * 30 \text{ in. Cover Soil} = 5.67 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Minimum Cover Soil

**GARAGE LEVEL SLAB:**

Component Thermal Resistance:

$R_{haunch} = 0.10 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Haunch (concrete) Per Inch Thickness (Ref. 4)

$R_{conc} = 0.10 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Concrete Per Inch Thickness (Ref. 4)

$R_{soil} = 0.189 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Sand and Gravel Per Inch Thickness

$R_{sty} = 5.0 \frac{\text{ft}^2 * \text{h} * °\text{F}}{\text{Btu} * \text{in}}$ Thermal Resistance of Styrofoam Per Inch Thickness (Ref. 6)

SUBJECT: Calculation 1: Thickness of Thermal Insulation at Garage Level

Total Thermal Resistance at Location 1:

$$R_t = R_{haunch} * t_{haunch} + R_{sty} * t_{sty} = (0.10)*(8\text{ in}) + (5.0)*(1\text{ in}) = 5.80 \quad \frac{ft^2 * h * °F}{Btu}$$

Total Thermal Resistance at Location 2:

$$R_t = R_{conc} * t_{conc} + R_{soil} * t_{soil} + R_{sty} * t_{sty} = (0.10)*(5\text{ in}) + (0.189)*(3\text{ in}) + (5.0)*(1\text{ in}) = 6.07 \quad \frac{ft^2 * h * °F}{Btu}$$

Total Thermal Resistance at Location 3:

$$R_t = R_{conc} * t_{conc} + R_{soil} * t_{soil} + R_{sty} * t_{sty} = (0.10)*(12\text{ in}) + (0.189)*(3\text{ in}) + (5.0)*(1\text{ in}) = 6.77 \quad \frac{ft^2 * h * °F}{Btu}$$

| | | |
|---|---|---|
| **Location 1** | **5.80** | **> 5.67** |
| **Location 2** | **6.07** | **> 5.67** |
| **Location 3** | **6.77** | **> 5.67** |

Analysis at Locations 1, 2, and 3 shows the future Garage Level Slab will provide sufficient resistance to thermal changes of expansion and contraction and protect the MMC's synthetic layers with 1 inch Styrofoam insulation.

**CALCULATION 2**
**EE MEMO 2**

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/28/2013

FOR: Exelon Checked By: FL Date: 7/25/2013

SUBJECT: Calculation 2: Vehicular Load Spreading on Slab-on-Grade

**Determine if Design Truck, Wheel Loader, and/or Tow Truck are allowed to drive on Plaza Garage Slab-on-Grade (See EE Memo 7 for calculation of Static and Dynamic Loads, wheel/axle layout and Contact Areas):**

$\sigma_{MMC} := 2ksf$ Maximum Allowable Bearing Pressure on MMC Synthetic Layers

***Location 1 (See Figure 1b):*** 8" Concrete, 0" Cover Soil, 1" Styrofoam = 9" depth to MMC synthetic layers.
***Location 2 (See Figure 1b):*** 5" Concrete, 3" min Cover Soil, 1" Styrofoam = 9" depth to MMC synthetic layers.

***Design Truck:***

$w_{DT} := 24in$ $l_{DT} := 16in$ Dimensions of Contact with Slab of a Dual Wheel (8" x 16" each, 8" apart)

$A_{DT} := w_{DT} \cdot l_{DT}$ $A_{DT} = 2.67\,ft^2$ Contact Area of a DualWheel

$P_{DT} := 1.33 \cdot 20kip$ $P_{DT} = 26.6\,kip$ Maximum Applied Static plus Dynamic Load per Wheel

***Wheel Loader:***

$w_{WL} := 1.60ft$ $l_{WL} := 1.06ft$ Dimensions of Contact with Slab of a Single Wheel (19.2" x 12.7")

$A_{WL} := w_{WL} \cdot l_{WL}$ $A_{WL} = 1.7\,ft^2$ Contact Area of a Single Wheel

$P_{WL} := 20.38kip$ Maximum Applied Static plus Dynamic Load per Wheel

Assume a 45 degree, 60 degree, and 90 degree load spreading through concrete slab, Cover Soil, and 1" Styrofoam, respectively (Ref. 7).

***Load Contact Areas - Design Truck:***

*Location 1:*

$A_{c1DT} := A_{DT}$ $A_{c1DT} = 2.67\,ft^2$ Contact Area of a Dual Wheel on Slab

$A_{sty1DT} := (w_{DT} + 2 \cdot 8in) \cdot (l_{DT} + 2 \cdot 8in)$ Contact Area of a Dual Wheel on Styrofoam

$A_{sty1DT} = 8.89\,ft^2$ Contact Area of a Dual Wheel on MMC Synthetic Layers

***Load Contact Areas - Design Truck (cont'd):***

*Location 2:*

$A_{c2DT} := A_{DT}$ $A_{c2DT} = 2.67\,ft^2$ Contact Area of a Dual Wheel on Slab

$A_{cs2DT} := (w_{DT} + 2 \cdot 5in) \cdot (l_{DT} + 2 \cdot 5in)$ $A_{cs2DT} = 6.14\,ft^2$ Contact Area of a Dual Wheel on Cover Soil

$A_{sty2DT} := (w_{DT} + 2 \cdot 5in + 2 \cdot 1.5in) \cdot (l_{DT} + 2 \cdot 5in + 2 \cdot 1.5in)$ Contact Area of a Dual Wheel on Styrofoam

$A_{sty2DT} = 7.45\,ft^2$ Contact Area of a Dual Wheel on MMC Synthetic Layers

***Load Contact Areas - Wheel Loader:***

*Location 1:*

$A_{c1WL} := A_{WL}$ $A_{c1WL} = 1.7\,ft^2$ Contact Area of a Single Wheel on Slab

$A_{sty1WL} := (w_{WL} + 2 \cdot 8in) \cdot (l_{WL} + 2 \cdot 8in)$ Contact Area of a Single Wheel on Styrofoam

$A_{sty1WL} = 7.02\,ft^2$ Contact Area of a Single Wheel on MMC Synthetic Layers

*Location 2:*

$A_{c2WL} := A_{WL}$ $A_{c1WL} = 1.7\,ft^2$ Contact Area of a Single Wheel on Slab

$A_{cs2WL} := (w_{WL} + 2 \cdot 5in) \cdot (l_{WL} + 2 \cdot 5in)$ $A_{cs2WL} = 4.61\,ft^2$ Contact Area of a Single Wheel on Cover Soil

$A_{sty2WL} := (w_{WL} + 2 \cdot 5in + 2 \cdot 1.5in) \cdot (l_{WL} + 2 \cdot 5in + 2 \cdot 1.5in)$ Contact Area of a Single Wheel on Styrofoam

$A_{sty2WL} = 5.75\,ft^2$ Contact Area of a Single Wheel on MMC Synthetic Layers

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File: 11896A

Made By: DJG Date: 6/28/2013

FOR: Exelon Checked By: FL Date: 7/25/2013

SUBJECT: Calculation 2: Vehicular Load Spreading on Slab-on-Grade

### *Bearing Pressures at MMC Synthetic Layers - Design Truck:*

*Location 1:*

$P_{DT} = 26.6\,\text{kip}$

$\sigma_{1DT} := \dfrac{P_{DT}}{A_{sty1DT}}$ $\sigma_{1DT} = 2.99\,\text{ksf}$ $2.99\text{ksf} > 2\text{ksf}$

Therefore, Design Truck not allowed at Location 1 - Bearing pressure exceeds 2 ksf at MMC Synthetic Layers.

*Location 2:*

$P_{DT} = 26.6\,\text{kip}$

$\sigma_{2DT} := \dfrac{P_{DT}}{A_{sty2DT}}$ $\sigma_{2DT} = 3.57\,\text{ksf}$ $3.57\text{ksf} > 2\text{ksf}$

Therefore, Design Truck not allowed at Location 2 - Bearing pressure exceeds 2 ksf at MMC Synthetic Layers.

### *Bearing Pressures at MMC Synthetic Layers - Wheel Loader:*

*Location 1:*

$P_{WL} = 20.38\,\text{kip}$

$\sigma_{1WL} := \dfrac{P_{WL}}{A_{sty1WL}}$ $\sigma_{1WL} = 2.9\,\text{ksf}$ $2.9\text{ksf} > 2\text{ksf}$

Therefore, Wheel Loader not allowed at Location 1 - Bearing pressure exceeds 2 ksf at MMC Synthetic Layers.

*Location 2:*

$P_{WL} = 20.38\,\text{kip}$

$\sigma_{2WL} := \dfrac{P_{WL}}{A_{sty2WL}}$ $\sigma_{2WL} = 3.54\,\text{ksf}$ $3.54\text{ksf} > 2\text{ksf}$

Therefore, Wheel Loader not allowed at Location 2 - Bearing pressure exceeds 2 ksf at MMC Synthetic Layers.

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/28/2013

FOR: Exelon Checked By: FL Date: 7/25/2013

SUBJECT: Calculation 2: Vehicular Load Spreading on Slab-on-Grade

**Tow Truck - See EE Memo 7 text for wheel/axle layout:**

$W_o := 14500lbf$ Tow Truck Operating Weight

$W_f := 4500lbf$ Front Axle Weight

$W_r := 10000lbf$ Rear Axle Weight

$W_p := 4000lbf$ Maximum Lift Capacity - Extended

$W_{rear} := W_r + W_p$

$W_{rear} = 14\,kip$ Maximum Static Load on Rear Axle

***Dynamic Applied Stress Calculation - Tow Truck (Ref. 8):***

$D_E := 0$ Embedment Depth of Applied Load

$IM := 33 \cdot (1 - 0.125 \cdot D_E)$ Dynamic Load Allowance for Drainage Net (Additional Percentage of Static Response Applied at Grade)

$IM = 33$

$$W_{dTT} := \frac{IM}{100} \cdot W_{rear}$$

$W_{dTT} = 4.62\,kip$ Additional Allowable Dynamic Load

$W_{TT} := W_{rear} + W_{dTT}$

$W_{TT} = 18.62\,kip$ Static plus Dynamic Applied Load at Grade from the Tow Truck

$P_{TT} := \frac{W_{TT}}{4}$ $P_{TT} = 4.66\,kip$ Maximum Load per Wheel on Dual Wheel Rear Axle (4 wheels total)

$$w_{TT} := \frac{P_{TT}}{0.8\frac{kip}{in}}$$

Width of Contact Area of Wheel (Ref. 8)

$w_{TT} = 0.485\,ft$

$\gamma := 1.50$ Load Factor (Ref. 8)

$$l_{TT} := 6.4\gamma \cdot \left(1in + \frac{IM \cdot 1in}{100}\right)$$

$l_{TT} = 1.06\,ft$ Length of Contact Area of Wheel (Ref. 8)

**MUESER RUTLEDGE CONSULTING ENGINEERS** File: 11896A

Made By: DJG Date: 6/28/2013

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SUBJECT: Calculation 2: Vehicular Load Spreading on Slab-on-Grade

### *Dynamic Applied Stress Calculation - Tow Truck (cont'd):*

$A_{TT} := (2w_{TT} + 4in) \cdot l_{TT}$ $A_{TT} = 1.39\ ft^2$ Contact Area of a Dual Wheel, Considering 4" of Separation Between Wheels

$P_{TT2} := 2 \cdot P_{TT}$ $P_{TT2} = 9.31\ kip$ Maximum Applied Load

### *Load Contact Areas - Tow Truck:*

*Location 1:*

$A_{c1TT} := A_{TT}$ $A_{c1TT} = 1.39\ ft^2$ Contact Area of a Single Wheel on Slab

$A_{sty1TT} := (2w_{TT} + 4in + 2 \cdot 8in) \cdot (l_{TT} + 2 \cdot 8in)$ Contact Area of a Single Wheel on Styrofoam

$A_{sty1TT} = 6.32\ ft^2$ Contact Area of a Single Wheel on MMC Synthetic Layers

*Location 2:*

$A_{c2TT} := A_{TT}$ $A_{c2TT} = 1.39\ ft^2$ Contact Area of a Single Wheel on Slab

$A_{cs2TT} := (2w_{TT} + 4in + 2 \cdot 5in) \cdot (l_{TT} + 2 \cdot 5in)$ Contact Area of a Single Wheel on Cover Soil

$A_{cs2TT} = 4.05\ ft^2$

$A_{sty2TT} := (2w_{TT} + 4in + 2 \cdot 5in + 2 \cdot 1.5in) \cdot (l_{TT} + 2 \cdot 5in + 2 \cdot 1.5in)$ Contact Area of a Single Wheel on Styrofoam

$A_{sty2TT} = 5.12\ ft^2$ Contact Area of a Single Wheel on MMC Synthetic Layers

**MUESER RUTLEDGE CONSULTING ENGINEERS**

File: 11896A

Made By: DJG Date: 6/28/2013

FOR: Exelon Checked By: FL Date: 7/25/2013

SUBJECT: Calculation 2: Vehicular Load Spreading on Slab-on-Grade

***Bearing Pressures at MMC Synthetic Layers - Tow Truck:***

*Location 1:*

$P_{TT2} = 9.31\,kip$

$\sigma_{1TT} := \frac{P_{TT2}}{A_{sty1TT}}$ $\sigma_{1TT} = 1.47\,ksf$ $1.47ksf < 2ksf$

Therefore, Tow Truck is allowed at Location 1 - Bearing pressure is less than 2 ksf at MMC Synthetic Layers.

*Location 2:*

$P_{TT2} = 9.31\,kip$

$\sigma_{2TT} := \frac{P_{TT2}}{A_{sty2TT}}$ $\sigma_{2TT} = 1.82\,ksf$ $1.82ksf < 2ksf$

Therefore, Tow Truck is allowed at Location 2 - Bearing pressure is less than 2 ksf at MMC Synthetic Layers.

**The Maximum Allowable Load over the slab, if considering similar loading areas to the Tow Truck will be:**

*Location 1:* $P_{max1} := 2ksf \cdot A_{sty1TT}$ $P_{max1} = 12.64\,kip$

*Location 2:* $P_{max2} := 2ksf \cdot A_{sty2TT}$ $P_{max2} = 10.25\,kip$

# EE Memo 6 Evaluation of Existing Covered Slip and Type J Platform

MRCE
built on firm foundations

## MEMORANDUM

**Date:** January 14, 2022

**To:** Office

**From:** Adam M. Dyer

**Re:** EE Memo 6 – Evaluation of Existing Covered Slip and Type J Platform

**File:** Area 1, Phase 2, Parcel 3 Development, Baltimore, MD
File # 13922

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This memorandum summarizes the assessment of the existing conditions of the Covered Slip and Type J Platform to determine if improvements will be required during construction of foundations for the Area 1, Phase 2, Parcel 3 development, park features, and utilities supporting them.

### EXHIBITS

| | |
|---|---|
| Figure 1 (EE Memo 6) | Covered Slip Assessment |
| Figure 2 (EE Memo 6) | Type J Platform Assessment |
| Calculation Set 1 (EE Memo 6) | South Slip Site Surcharge over Type J Platform |

### AVAILABLE INFORMATION

1. Drawing FO.101 – Subsurface Features Plan
2. Drawing FO.103 – Geomembrane Contour Plan

### REFERENCES

1. "Corrective Measures Implementation Construction Completion Report, Phase I: Soil-Bentonite Hydraulic Barrier Wall, Phase II: Final Remedial Construction" prepared by Black and Veatch, Volumes I and II, February 2000.
2. "Existing Subsurface Structures Review and Documentation" prepared by Mueser Rutledge Consulting Engineers, June 29, 1992.
3. "Condition Survey of Waterfront Structures" prepared by Mueser Rutledge Consulting Engineers, May 4, 1990.

### PROPOSED DEVELOPMENT

The proposed development in the area of the Covered Slip and the Type J Platform consists of a public park with concrete, paver, and gravel walkways with trees, grass, and plantings.

### ASSESSMENT OF BURIED STRUCTURES

The southern shoreline of the site includes several abandoned subsurface structures. The condition of these structures was last documented in Reference 1 after completion of the Environmental Remediation System (ERS). After construction of the Head Maintenance System (HMS) water levels in the site vary minimally and the Multimedia Cap (MMC) restricts oxygen exchange below the Geomembrane which will slow the decay of underlying timber piles. The Covered Slip and Type J Platform are abandoned timber platforms which require assessment prior to altering the finished condition at grade.

**Covered Slip**

This area is an abandoned slip for docking vessels delivering materials to the former timber and ice storage facilities prior to 1948. The platform is approximately 72 feet long along the south face and consists of a low level timber deck and timber pile caps supported by timber piles. Pile caps are oriented generally parallel to the outboard face. Timber sheet pile bulkheads along the east and west faces of the slip support the soil beyond. Voids of unknown size exist below the timber deck. Attempts were made during the demolition of on-Site structures to fill the void space with grout, but were incomplete. Portions of the Covered Slip have collapsed.

An assessment was done to determine the suitability of the timber platform to carry existing MMC loads and if site improvements are feasible. Figure 1 (EE Memo 6) depicts five (5) areas of differing conditions for the existing Covered Slip:

A. Building 23 Foundations – Covered Slip is shielded from MMC loads by abandoned pile caps and pile supported structural slab by the Former Building 23 foundations. The MMC is not at risk from collapse of the underlying Covered Slip. We identify this area as the “Protected Covered Slip”.

B. L-Shaped Area – Covered Slip is minimally shielded from MMC load by widely spaced abandoned pile caps by the former Building 23 shed. MMC is at risk from collapse of underlying Covered Slip in current condition. We identify this area as the “Unprotected Covered Slip”.

C. Fuel Oil Tank – Covered Slip is shielded from MMC loads by the abandoned tank slab in discrete area, areas immediately adjacent to slab are minimally shielded. MMC is not at risk in this localized area, however, portions of the Covered Slip around the area have already collapsed. We identify this area as part of the “Collapsed Covered Slip”.

D. EPS Geofoam – Covered Slip collapsed in 1997 from construction of original MMC. MMC is not at risk if current condition is maintained with minimal alteration. We identify this area as part of the “Collapsed Covered Slip”.

E. Embankment Collapse – Covered Slip collapsed in early 1990s during construction of the Outboard Embankment. MMC is not at risk if current condition is maintained with minimal alteration. We identify this area as part of the “Collapsed Covered Slip”.

**Type J Platform**

This structure, along the west side of the South Slip adjacent to the Bowie Smith Pier, is a low-level timber relieving platform constructed circa 1948. The platform is about 250 to 265 feet long, varies in width from about 30 to 40 feet, and consists of two 3 inch thick timber deck layers, just above mean low water (MLW), supported by timber pile caps and timber piles. Pile caps are oriented in the east-west direction. Pile and pile cap spacing is typically about 4 feet on center. A concrete headwall at the outboard face and a timber sheet pile bulkhead along the inboard edge retain the soil above the platform and to the west, respectively. A void exists below the southern half of the platform up to about 11 feet deep.

An assessment was done to determine the suitability of the timber platform to carry the existing MMC loads and if site improvements are feasible. Figure 2 (EE Memo 6) depicts three (3) areas of differing conditions of the existing Type J Platform:

A. Building 23 Foundations – Type J Platform is shielded from MMC loads by abandoned pile caps and pile supported structural slab by the Former Building 23. MMC is not at risk from collapse of underlying Covered Slip.

B. Unprotected – Type J Platform is minimally shielded or un-shielded from MMC load by widely spaced abandoned pile caps by the former Building 23 or un-improved ground. MMC is at low risk from collapse of Type J Platform underlying Covered Slip in current condition.

C. South Slip Surcharging - Type J Platform was partially surcharged in the mid-1990s when the adjacent South Slip was effectively surcharged to about Elev. +13 as the majority of the platform was covered by the slope of the surcharge pile, see Calculation 1 (EE Memo 6). MMC is not at risk if load on Drainage Net does not exceed 600 psf.

## SUMMARY

Site improvements can be constructed with the below restrictions:

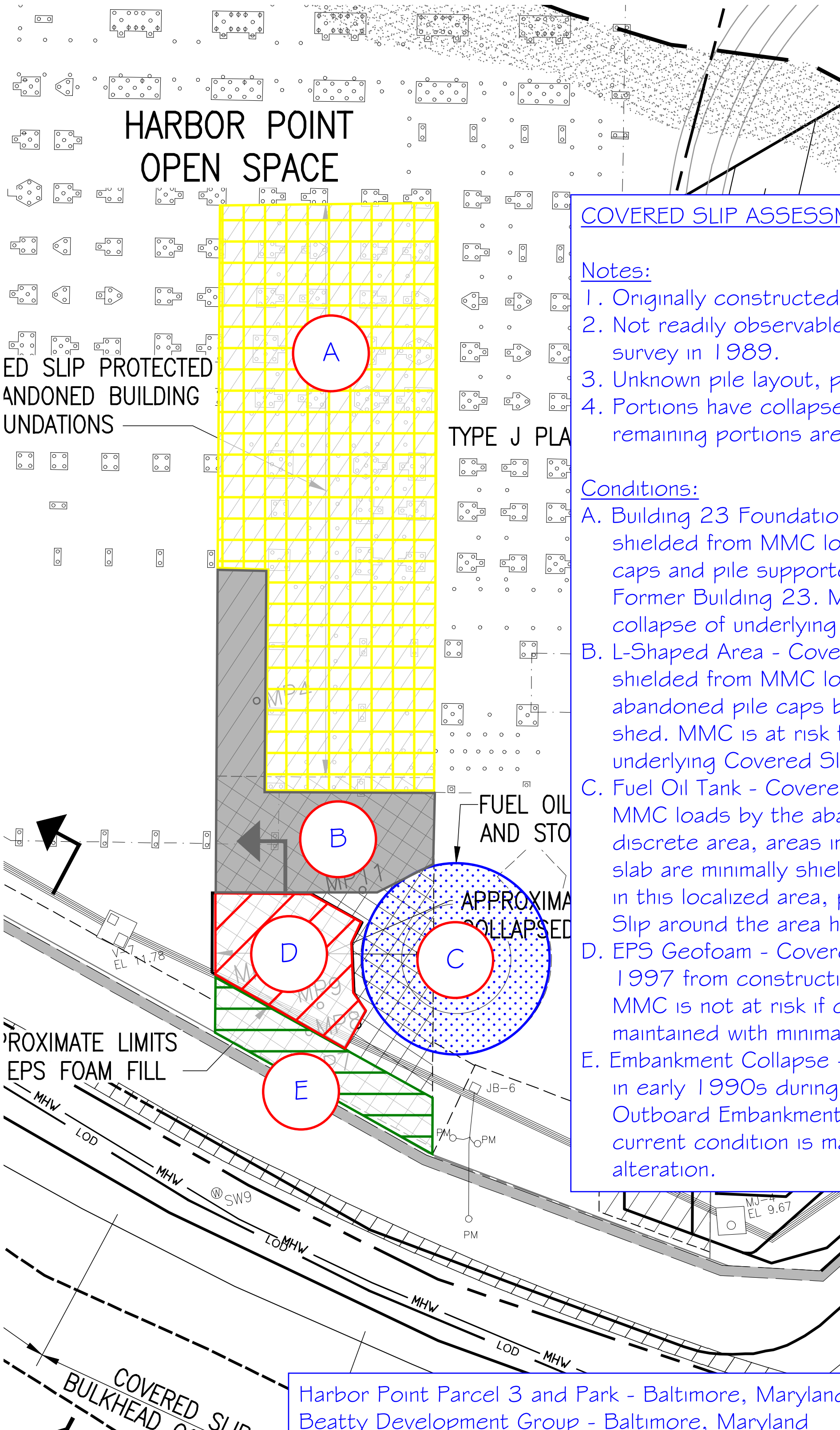
**Covered Slip**

1. Below Building 23 Foundations – as assessed in EE Memo 3.
2. L-Shaped – construct a pile supported relieving platform to mitigate concerns of collapse and restore MMC to existing grades above platform.
3. Fuel Oil Tank, EPS Geofoam, and Embankment Collapse – together these should be referred to as the "Collapsed Section", surface improvements should not change final grade, should be restricted to removal of up to 12 inches of existing fill and replacement with top-soil and plantings. Access to this area should not be promoted.

**Type J Platform**

1. Building 23 Foundations, Unprotected, and South Slip Surcharging – site improvements should be limited to 600 psf static and dynamic loads on the Drainage Net.

# EXHIBITS




COVERED SLIP ASSESSMENT OF RISK TO MMC:

Notes:

1. Originally constructed in early 1900s.
2. Not readily observable during last condition survey in 1989.
3. Unknown pile layout, platform construction.
4. Portions have collapsed in the past and remaining portions are at risk of collapse.

Conditions:

A. Building 23 Foundations - Covered Slip is shielded from MMC loads by abandoned pile caps and pile supported structural slab by the Former Building 23. MMC is not at risk from collapse of underlying Covered Slip.

B. L-Shaped Area - Covered Slip is minimally shielded from MMC load by widely spaced abandoned pile caps by the former Building 23 shed. MMC is at risk from collapse of underlying Covered Slip in current condition.

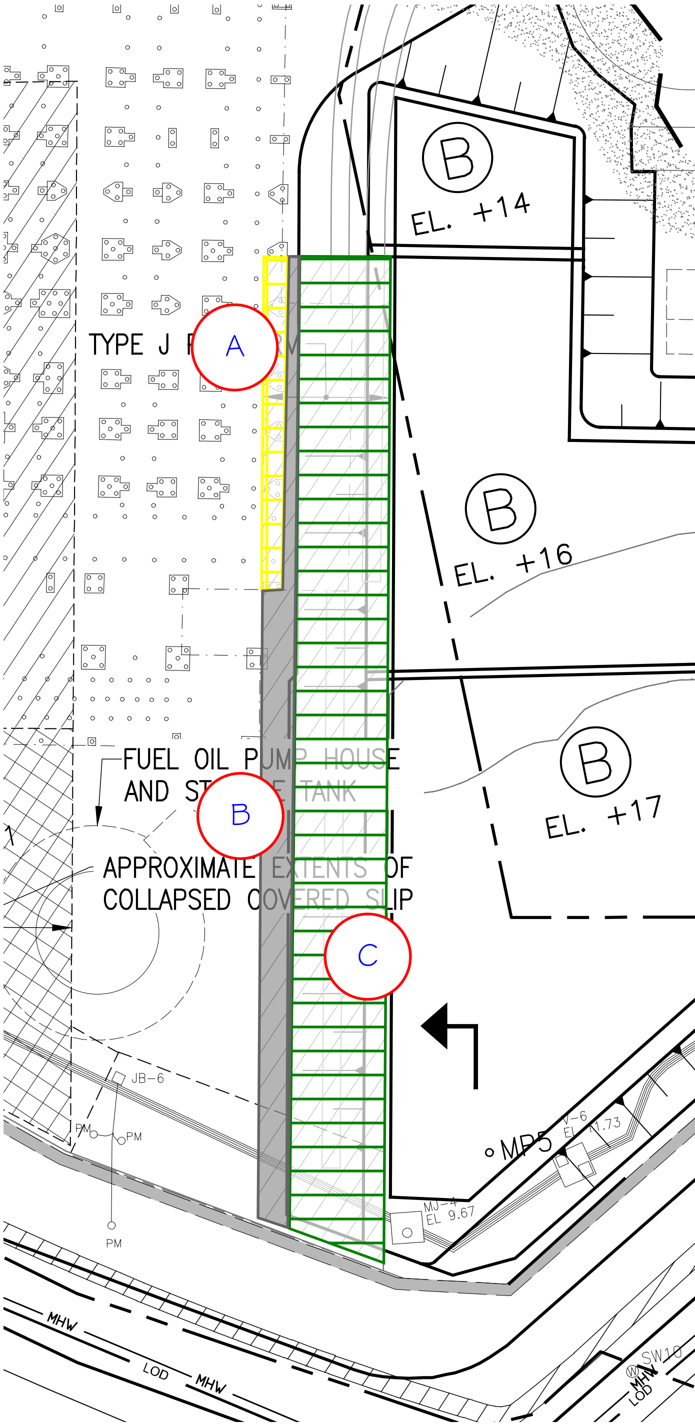
C. Fuel Oil Tank - Covered Slip is shielded from MMC loads by the abandoned tank slab in discrete area, areas immediately adjacent to slab are minimally shielded. MMC is not at risk in this localized area, portions of the Covered Slip around the area have already collapsed.

D. EPS Geofoam - Covered Slip collapsed in 1997 from construction of original MMC. MMC is not at risk if current condition is maintained with minimal alteration.

E. Embankment Collapse - Covered Slip collapsed in early 1990s during construction of the Outboard Embankment. MMC is not at risk if current condition is maintained with minimal alteration.

Harbor Point Parcel 3 and Park - Baltimore, Maryland
Beatty Development Group - Baltimore, Maryland
Mueser Rutledge Consulting Engineers, PLLC - New York, New York
EE Memo 6: Evaluation of Existing Covered Slip and TYpe J Platform
Job No.: 13922; Made By: A.M.D.; Date: 2021-07-09

# FIGURE 1 (EE MEMO 6) - COVERED SLIP ASSESSMENT




TYPE J PLATFORM ASSESSMENT OF RISK TO MMC:

Notes:

1. Originally constructed circa 1945.
2. Readily observable during last condition survey in 1989. Piles and deck were in good condition.
3. Pile layout and platform construction are known and documented.
4. No subsidence has been observed in the area of the platform and the platform remained intact during construction of the remedy.

Conditions:

A. Building 23 Foundations - Type J Platform is shielded from MMC loads by abandoned pile caps and pile supported structural slab by the Former Building 23. MMC is not at risk from collapse of underlying Covered Slip.

B. Unprotected - Type J Platform is minimally shielded or un-shielded from MMC load by widely spaced abandoned pile caps by the former Building 23 or un-improved ground. MMC is at low risk from collapse of Type J Platform underlying Covered Slip in current condition.

C. South Slip Surcharging - Type J Platform was partially surcharged in the mid-1990s when the adjacent South Slip was effectively surcharged to about Elev. +13 as the majority of the platform was covered by the slope of the surcharge pile, see Calculation 1. MMC is not at risk if load on Drainage Net does not exceed 600 psf.

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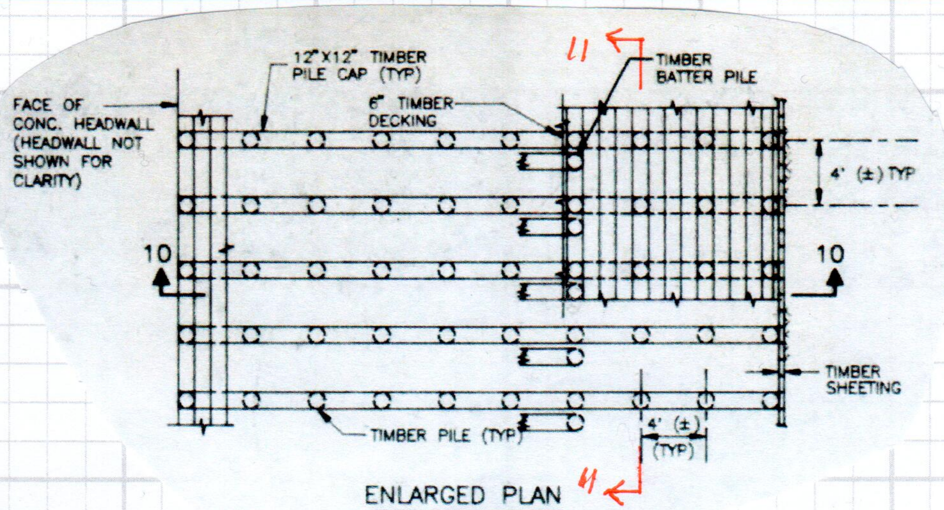
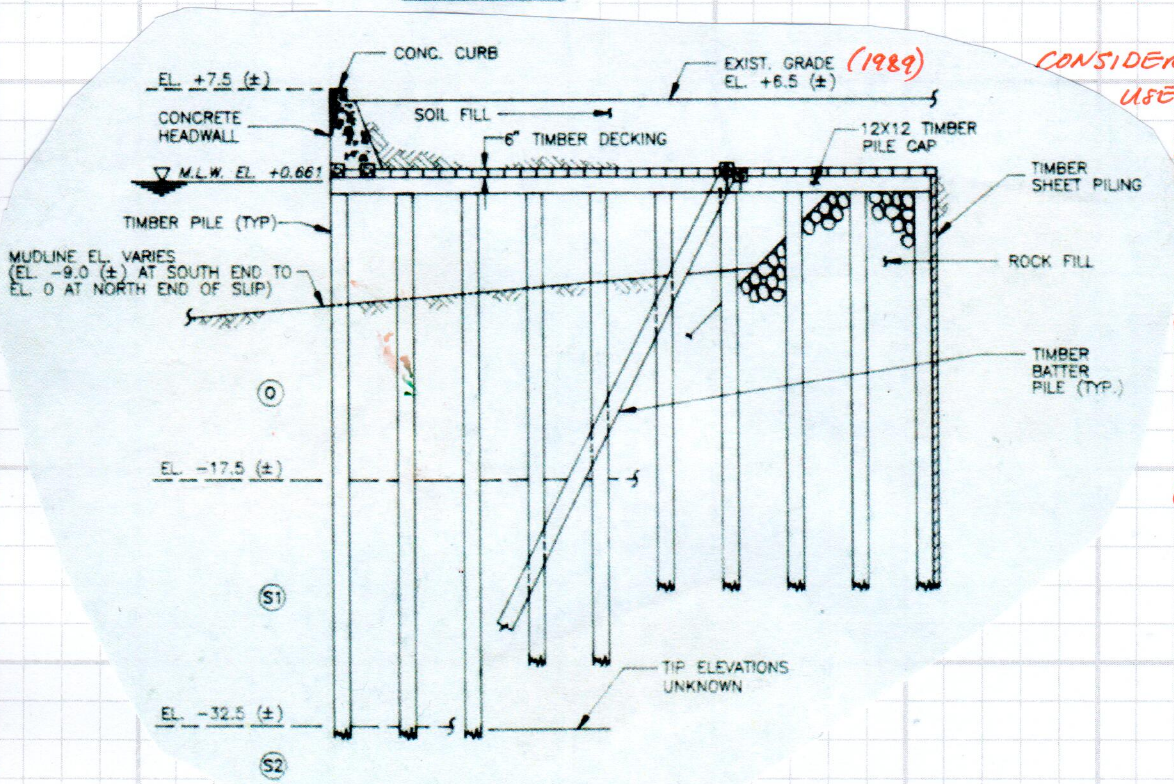
Job No.: 13922; Made By: A.M.D.; Date: 2021-07-09

# FIGURE 2 (EE MEMO 6)- TYPE J PLATFORM ASSESSMENT




ENLARGED PLAN
PLATFORM TYPE J

0 5' 10'




SECTION 10

BASED ON SITE SURCHARGE TO ELEV. +13 TYPE J PLATFORM HAS BEEN LOADED TO ~:

ELEV. +13 TO ELEV. +1 @ 125 psf

= 12 · 125 psf = 1,750 psf

~~WITHOUT~~ FOR GEOMEMBRANE AT ELEV. +8.5

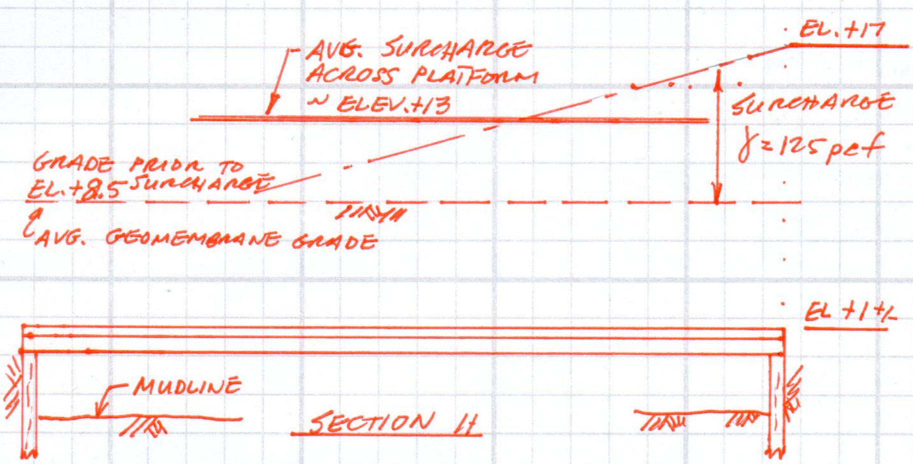
ELEV. +13 TO ELEV. +8.5 @ 125 psf

= 4.5 · 125 psf = 562.5 psf

CONSIDERING EQUIPMENT USED TO PLACE AND REMOVE SURCHARGE PILE OF 5 psi MINIMUM ∴

USE 600 psf ALLOWABLE ABOVE DRAINAGE NET.

STATIC & DYNAMIC




| | |
|---|---|
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| BALTIMORE | MARYLAND |
| BEATTY DEVELOPMENT GROUP | |
| BALTIMORE | MARYLAND |

**MUESER RUTLEDGE CONSULTING ENGINEERS**
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| SCALE | MADE BY | DATE | FILE NO. |
|---|---|---|---|
| N/A | AMD | 07/09/21 | 13922 |
| | CH'KD BY | DATE | |

| | |
|---|---|
| SOUTH SLIP SITE SURCHARGE OVER TYPE J PLATFORM | ~~DRAWING NO.~~ CALCULATION 1 |