APPENDIX B

STABILITY ANALYSES

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SLOPE STABILITY ANALYSES

1.0 INTRODUCTION

This appendix presents the slope stability analyses performed for the proposed Corrective Action Management Unit (CAMU) at the Chevron Perth Amboy Facility (Facility) in New Jersey. Static and pseudo-static stability analyses were performed for representative cross sections of the CAMU and the perimeter berm. The representative cross sections were selected to analyze the different conditions based on the proposed CAMU configuration and the surrounding topographical features. The failure modes analyzed included base stability failure and/or failure along the bottom liner system. The appendix discusses the analysis method, design criteria, slope configurations, subsurface stratigraphy, and the parameters used in the slope stability analyses and presents the analyses results.

2.0 ANALYSIS METHOD

The slope stability analyses were performed using Slope/W (Version 2007) software. Slope/W is a limit equilibrium stability analysis software developed by GEO-SLOPE International Ltd. Spencer method was used in the stability analyses. The method performs limit equilibrium analysis using the method of slices to compute a factor of safety against slope failure that satisfies both force and moment equilibrium.

3.0 DESIGN CRITERIA

3.1 Factor of Safety

Static and pseudo-static stability analyses were performed for representative cross sections of the CAMU and the perimeter berm. For static stability analyses, a minimum factor of safety of 1.5 was targeted for the critical shear surfaces based on the requirements in New Jersey Department of Environmental Protection (NJDEP) Chapter 26 Subchapter 2A. For the pseudo-static stability analyses, a factor of safety of 1.0 was considered acceptable under the seismic loading based on Resource Conservation and Recovery Act (RCRA) Subtitle D (258) guidance document EPA/600/R-95/051.

3.2 Seismic Loading

A site-specific ground motion study was performed for the North Field Basin (NFB) and the Surge Pond at the Facility. The NFB is immediately north of the CAMU and the Surge Pond is east of the CAMU area. The study was performed by Mueser Rutledge Consulting Engineers (MRCE) in 2003 to determine the seismic coefficient (k_s) for use in stability analysis of landfills since the Surge Pond was developed into an on-site landfill to dispose sludge excavated from the NFB wetlands. The study is summarized in a report by MRCE titled *Site-Specific Ground Motion Analysis and Seismic Coefficient (k_s), North Field Basin and Surge Pond, Chevron Texaco, Perth Amboy, New Jersey*, October 2003. A copy of the

complete report is included on the CD in Attachment A-1. The relevant sections of the report are included in Attachment B-1.

The study used U.S. Geological Survey (USGS) seismic hazard maps published in 2002 (included in Attachment B-1) for the peak ground acceleration at bedrock (PGA_r). The PGA_r corresponded to an event with 2 percent probability of exceedance in 50 years. Two site-specific profiles were analyzed using SHAKE2000 to evaluate the site factor (F), where $F = PGA_s / PGA_r$ and PGA_s is the peak acceleration at ground surface. Based on the analysis performed, F of 1.4 was recommended in the report.

The USGS seismic hazard map updated in 2008 (Rev. III, Jan 2010) is also included in Attachment B-1. The revised map indicates that the PGA_r with 2 percent probability of exceedance in 50 years for Perth Amboy ranges from 0.09g to 0.12g. Hence, PGA_r of 0.12g was used to compute k_s.

In accordance with 40 CFR Part 258, k_s can be taken as half of PGA_s, which implies

$$k_s = ½\ PGA_s = ½\ (F \times PGA_r) = ½\ (1.4 \times 0.12g) = 0.084g$$

A horizontal acceleration of 0.084g was used in the pseudo-static analyses performed for the CAMU side slopes and the perimeter berm.

4.0 CROSS SECTIONS ANALYZED

Stability analyses were performed for two failure modes, base failure and failure along the bottom liner system. The base failure represents a deep-seated failure extending below the toe of slope and through the foundation soils. The failure along the bottom liner system represents slip surfaces along the interfaces between the geosynthetics or between geosynthetics and soils proposed as part of the bottom liner system. For the CAMU side slopes, factors of safety against base failure and failure along the bottom liner system were evaluated. For the perimeter berm, only factor of safety against base failure was applicable.

4.1 CAMU Side Slopes – Base Failure

To analyze stability of the CAMU side slopes against deep-seated base failure, stability analyses were performed for 4 cross sections that represent different configurations based upon the proposed CAMU design as well as the surrounding topographical features. The locations of these cross sections are presented in Figure B-1. It is noted that similar conditions in different parts of the proposed CAMU are represented by the same cross section.

Section 1 was selected to represent the conditions on north side of Cell 3. The NFB wetlands is a low lying area (with approximate basin EL. 3 feet, NGVD) that is located immediately north of the Cell 3 and a part of Cell 2. Section 1 was analyzed to model the low lying NFB wetlands area in the stability analyses. Section 1 configuration with CAMU raised to full height is presented in Figure B-2.

Section 2 was selected to represent two intermediate conditions during the phased development of the CAMU. The CAMU consists of 3 cells and only one cell will be constructed at a time. The CAMU will be developed in phases from the west end of the footprint (starting with Cell 1) towards the east end (with Cell 3 as the last cell to be constructed during the phased development of the CAMU). Section 2 models the conditions along the intercell berm when (i) only Cell 1 has been raised to full height and Cells 2 and 3 have not been developed and (ii) Cells 1and 2 have been raised to full height and Cell 3 has not been developed. Section 2 configuration with CAMU (in the previous cell) raised to full height is presented in Figure B-3.

Section 3 was selected to represent the existing conditions on north and west sides of Cell 1, and east side of Cell 3. The ground surface on these sides extends beyond the existing perimeter berm at relatively high elevation (EL. 15 feet, NGVD approximately). Section 3 was analyzed to model the high ground extending beyond the existing perimeter berm in the stability analyses. Section 3 configuration with CAMU raised to full height is presented in Figure B-4.

Section 4 was selected to represent the conditions on south side of the cells (Cells 1, 2, and 3). The elevation of the basin area beyond the southern limit of the CAMU ranges from EL. 7 to EL. 10 feet (NGVD). No berm exists on south side of the cells at present. The south-side perimeter berm will be constructed as part of each cell construction. Section 4 was analyzed to model the proposed perimeter berm and the south-side basin area in the stability analyses. Section 4 configuration with CAMU raised to full height is presented in Figure B-5.

As noted in Figure B-1, a reinforced concrete tank pad exists in the center of each of the three CAMU cells. These concrete pads served as the foundation for the tanks that existed previously in these basins (the tanks were demolished but the footings were left in place). Each concrete tank pad is approximately 125-foot in diameter and 1.5-foot in thickness. Each tank pad is supported by more than 600 timber piles that are located on a 4.5-foot by 4.5-foot grid pattern. The design capacity of these plies was 30 tons and the post-installation computed capacity typically ranged from 40 to 60 tons. The existing pile-supported concrete tank pad in each cell will remain in place and will not be removed during cell construction.

Figures B-2 through B-5 indicate the location of these tank pads in Sections 1 through 4, respectively. These tank pads will stay in place and will not be removed during cell construction. The cells will be graded by filling above the elevation of these tank pads, which is approximately EL. 9 feet (NGVD). It is recognized that these tank pads will enhance the stability of the CAMU slopes. However, the concrete tank pads and their founding timber piles were ignored (i.e., assumed to not exist) in the stability analyses because their condition could not be assessed and limited as-built information is available for them. .

4.2 CAMU Side Slope – Failure Along Liner System

The stability analyses for the CAMU side slope failure along the bottom liner system were performed for two cross sections. The first cross section analyzed the proposed bottom liner configuration along the

north-south alignment within the CAMU cells. The second cross section analyzed the bottom liner configuration along the east-west alignment within the CAMU cells. The stability analyses were performed to back-calculate the minimum interface friction angle (assuming no adhesion) between the geosynthetics or between geosynthetics and soils proposed as part of the bottom liner system that will be needed to meet the design criteria.

4.3 Perimeter Berm

In addition to analyzing the stability of the CAMU side slopes, stability analyses were also performed for the perimeter berm. The stability of the downstream or outside slope of the perimeter berms was analyzed against deep-seated base failure. Two perimeter berm sections were analyzed for stability. The first section modeled the existing perimeter berm on the north side of Cell 3, between the CAMU and the NFB wetlands, as indicated in Section 1 in Figure B-2. The second section modeled the proposed perimeter berm on south side of the CAMU cells as indicated in Section 4 in Figure B-5.

5.0 SUBSURFACE STRATIGRAPHY

5.1 Subsurface Strata

The subsurface stratigraphy in CAMU area was discussed in Appendix A. As discussed in Appendix A, the stratigraphy in CAMU area consists of (from top to bottom) fill layer (Stratum 1), peat / organic silt and clay (Stratum 3/4), red brown silt and clay (Stratum 6), red brown sands and gravel (Stratum 5), tan/gray sands (Stratum 8), gray green clays (Stratum 7), and weathered bedrock. Figures B-2 through B-5 present the subsurface stratigraphy used in Sections 1 through 4, respectively. As noted, only Strata 1, 3/4, 6, and 5 were modeled in stability analyses. The remaining strata were too deep and did not influence the stability of the sections analyzed.

Stratum 1 thickness was varied from 9 to 11 feet in the sections modeled in stability analyses based on the profiles presented in Appendix A. Strata 3 and 4 were encountered intermixed in the field and were modeled as a single layer. Stratum 3/4 thickness was considered to be 8 feet on the north side of the CAMU footprint and 4 feet on the south side (see discussion in Section 4.1 of Appendix A). Stratum 6 was modeled as a 10-ft thick layer and the underlying Stratum 5 was modeled as a 20-ft thick layer.

5.2 Groundwater Elevation

Based on the groundwater monitoring performed in the CAMU area over the years, the groundwater has been observed to be within few feet of the existing ground surface in the tank basins. As a result, the groundwater was modeled to be 2 feet below the existing ground surface (at EL. 7 feet, NGVD) within the CAMU footprint. The NFB wetlands (on north side of the CAMU area) are tidally influenced. The groundwater elevation was modeled at EL. 3 feet (NGVD), which approximately corresponds to the mean high water elevation in the NFB wetlands.

6.0 CASES ANALYZED

6.1 CAMU Stages

The CAMU area is underlain by Stratum 3/4 (peat / organic silt and clay). Stratum 3/4 is characteristically a low shear strength layer that is susceptible to relatively large settlement under loading. As stabilized soils/waste are disposed in the CAMU cells, the effective stresses in the underlying strata will increase due to the loading. Stratum 3/4 will consolidate under the imposed loads and gain strength. To model the increase in strength of Stratum 3/4 soils with increase in effective stresses with disposal of stabilized soils/waste in the cells, a staged construction approach was utilized in the stability analyses. The development of each cell (from end of construction through raising to full height) was divided into 4 stages, Stages 1 through 4.

Stage 1 represented the existing conditions or conditions at the end of construction (prior to disposal of stabilized soils/waste in the cells). Stage 2 represented the conditions with stabilized soils/waste raised to top of perimeter berm (EL. 17 feet, NGVD), corresponding to a stabilized soils/waste height of approximately 8 feet (as the existing ground surface elevation in the tank basins/cells is approximately EL. 9 feet, NGVD). Stage 3 represented the conditions with stabilized soils/waste raised to EL. 30 feet (NGVD), corresponding to a stabilized soils/waste height of approximately 20 feet. Stage 4 represented the post-closure conditions (cell raised to full height and after installation of final cover), corresponding to a stabilized soils/waste height of approximately 30 feet. The strength of Stratum 3/4 for each stage of construction is discussed in Section 7.0 below.

It is noted that only Stages 3 and 4 represent conditions with stabilized soils/waste slope above the elevation of the perimeter berm. As a result, stability analyses were performed for CAMU side slopes for Stages 3 and 4 only.

6.2 Failure Surfaces

The stability analyses were performed using both circular and non-circular (or block) shear surfaces. However, Stratum 3/4 was the weakest layer in the stratigraphy that predominantly controlled the factor of safety against failure. The thickness of Stratum 3/4 varied from 4 to 8 feet in the CAMU footprint as discussed above. Due to the relatively small thickness of the controlling layer (Stratum 3/4), the non-circular shear surfaces represented the critical failure surfaces with the lowest factor of safety. As a result, only results for non-circular shear surfaces are included in this appendix.

7.0 SOIL PROPERTIES

The strength parameters for the various materials modeled in the stability analyses are summarized in Table B-1. The strength parameters used in stability analyses for Strata 1, 5, and 6 were same as those discussed in Appendix A (see Table A-13). The strength parameters for Stratum 3/4 and some of the other materials modeled in stability analyses (that were not discussed in Appendix A) are presented below.

Stability analyses were performed using undrained shear strength (S_u) as well as drained strength (or effective stress) parameters for Strata 3/4 and 6. The strength parameters used in stability analyses for Stratum 3/4 are discussed below. The strength parameters for Stratum 6 were same as those discussed in Appendix A (see Table A-13).

7.1 Stratum 3/4 – Undrained Strength Parameters

The undrained shear strength (S_u) of Stratum 3/4 was increased along with the increase in effective vertical stress (σ'_v) due to disposal of stabilized soils/waste in the CAMU cells. As discussed in Section 6.1 above, a staged construction approach was utilized to model the increase in S_u of Stratum 3/4 soils with increase in σ'_v. Based on the information presented in Appendix A, the existing S_u of Stratum 3/4 soils was assumed to be 300 pounds per square foot (psf) and a Su/σ'_v ratio of 0.25 was used to compute the increase in S_u with σ'_v (see Table A-13 and Figure A-5 in Appendix A, which are also included in Attachment B-2 for ready reference). The methodology used to compute S_u for each stage (Stage 1 through Stage 4) is presented in Attachment B-2. It includes the change in effective stresses for each stage of construction and the resulting increase in S_u.

In the laboratory tests performed to evaluate the S_u of Stratum 3/4, the peak S_u was typically measured at strain exceeding 10 percent. For strain compatibility with adjacent strata, the strain in Stratum 3/4 was restricted to 5 percent. An evaluation of the laboratory test results indicated that the S_u at 5 percent strain corresponded to approximately 80 percent of the peak S_u on average. As a result, only 80 percent of the peak S_u computed in Attachment B-2 were used in the stability analyses. It is noted that only Stages 3 and 4 represented conditions where the stabilized soils/waste slopes were above the elevation of the perimeter berm for which stability analyses could be performed. As a result, 80 percent reduction was applied only to peak S_u computed for Stages 3 and 4.

As noted in Attachment B-2, the S_u for Stratum 3/4 increased from 300 psf for Stage 1 (existing conditions) to 900 psf for Stage 4 (stabilized soils/waste raised to full height). The Stratum 3/4 layer modeled in the stability analyses was divided into multiple zones such that each zone corresponded to one of the stages evaluated in Attachment B-2. Each zone was assigned a S_u depending on the stage(s) it corresponded to. Figures B-2 through B-5 present the Stratum 3/4 zones modeled in the stability analyses. Table B-1 summarizes the S_u for the Stratum 3/4 zones modeled.

Stratum 3/4 zone under the proposed berms (the intercell berms in Section 2 and the perimeter berm on south side of the cells in Section 4) corresponded to Stage 2. As a result, S_u of 450 psf, corresponding to S_u evaluated for Stage 2, was assigned to this zone (Stratum 3/4 zone under the proposed berms) as well. Stratum 3/4 zone under the existing perimeter berms (on east, north, and west sides of the CAMU footprint in Sections 1 and 3) exhibited a relatively higher S_u based on the correlation to the measured Standard Penetration Test (SPT) blow counts. As a result, a slightly higher S_u of 500 psf was assigned to Stratum 3/4 zone under the existing perimeter berms.

7.2 Stratum 3/4 – Drained Strength Parameters

For the drained strength or effective stress parameters, two strength envelopes were selected for use in CAMU design and analyses in Appendix A (see Table A-13). The first strength envelop corresponded to an effective friction angle (ϕ') of 11° with effective cohesion (c') of 550 psf. The second strength envelop corresponded to ϕ' of 18° with no cohesion. The stability analyses were performed using both the strength envelopes. Due to the relatively low height of the CAMU, the analyses with ϕ' of 18° and no cohesion resulted in lower factors of safety. Therefore, stability analyses results only for drained strength corresponding to ϕ' of 18° with no cohesion are included in this appendix.

7.3 Other Materials

In addition to the subsurface strata soils discussed above, two other materials were also modeled in the stability analyses. These materials included the stabilized soils/waste and the fill materials for the existing perimeter berms. The stabilized soils and intermixed debris that will be disposed in the CAMU cells as waste will essentially consist of the Stratum 1 fill materials. As a result, the stabilized soils/waste materials were assigned the same strength parameters as Stratum 1 soils. The existing perimeter berms (on east, north, and west sides of the CAMU footprint modeled in Sections 1 and 3) were predominantly constructed using clayey soils from on-site borrow area(s). As a result, the existing perimeter berm soils were assigned the same strength parameters as Stratum 6 clays.

8.0 STABILITY ANALYSES RESULTS

8.1 CAMU Side Slope – Base Failure

The stability analyses results for CAMU side slopes in base failure mode are summarized in Table B-2 and Figures B-6 through B-9. Figures B-6 through B-9 present the stability analyses results for the various scenarios analyzed for Sections 1 through 4, respectively. The results of static stability analyses performed using undrained strength parameters for Stage 3 of Sections 1 through 4 are presented in Figures B-6a through B-9a, respectively (see summary in Table B-2). The results of static stability analyses performed using undrained and drained strength parameters for Stage 4 of Sections 1 through 4 are presented in Figures B-6b through B-9b, respectively. The results of pseudo-static stability analyses performed using undrained and drained strength parameters for Stage 4 of Sections 1 through 4 are

presented in Figures B-6c through B-9c, respectively. The computed factors of safety met the design criteria for all scenarios analyzed.

Based on the stability analyses results, the top of final cover side slope in Cell 3 was limited to EL. 38 feet (NGVD), which is 4 feet lower than the top of slope elevation in the other two cells. The top of final cover side slope in Cells 1 and 2 corresponds to EL. 42 feet (NGVD). To meet the design criteria, a slightly lower elevation was required in Cell 3 primarily due to the low lying NFB wetlands area on north side of the cell.

8.2 CAMU Side Slope – Failure Along Liner System

The stability analyses for the CAMU side slope failure along the bottom liner system were performed for two cross sections. The first cross section analyzed the proposed bottom liner configuration along the north-south alignment within the CAMU cells. The second cross section analyzed the bottom liner configuration along the east-west alignment within the CAMU cells. The stability analyses were performed to back-calculate the interface friction angle (assuming no adhesion) needed to meet the design criteria.

The results of the stability analyses are presented in Figures B-10 and B-11. Figure B-10 presents the static and pseudo-static analyses results for the north-south alignment. Figure B-11 presents the static and pseudo-static analyses results for the east-west alignment. As noted, an interface friction angle (ϕ) of 14.5° was needed to meet the design criteria for the north-south alignment and ϕ of 13° was needed for the east-west alignment.

Based on the analyses results, a minimum strength envelop corresponding to ϕ of 14.5° with no adhesion will be specified for the interfaces between the geosynthetics or between the geosynthetics and soils that will be used in the bottom liner system. Based on the published literature, the strength envelop for the geosynthetics proposed in the bottom liner system typically exceed this requirement (see Table B-3).

8.3 Perimeter Berms Stability

Stability analyses were performed for base failure mode for an existing perimeter berm and a proposed perimeter berm. For the existing perimeter berm, stability analyses were performed for the berm on the north side of Cell 3 that is between the CAMU and the NFB wetlands as indicated in Section 1. Static and pseudo-static stability analyses were performed using undrained as well as the drained strength parameters. The analyses results are summarized in Table B-4 and Figures B-12 and B-13. Figure B-12 presents the static stability analyses results and Figure B-13 presents the pseudo-static stability analyses results. As noted, the computed factors of safety exceeded the design criteria.

For the proposed perimeter berm, stability analyses were performed for the berm on south side of the CAMU cells as indicated in Section 4. Static and pseudo-static stability analyses were performed using

undrained as well as the drained strength parameters. The analyses results are summarized in Table B-4 and Figures B-14 and B-15. Figure B-14 presents the static stability analyses results and Figure B-15 presents the pseudo-static stability analyses results. As noted, the computed factors of safety exceeded the design criteria.

The input and output reports for representative stability analyses performed for the CAMU side slopes and the perimeter berm are included in Attachment B-3.

9.0 REFERENCES

- GEO-SLOPE International Ltd., *"Stability Modeling with SLOPE/W 2007 Version, An Engineering Methodology"*, Fourth Edition, November 2008.

- Gregory N. Richardson, Edward Kavazanjian and Neven Matasovi, "*Resource Conservation and Recovery Act (RCRA) Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities"*, EPA /600/R-95/051, Office of Research and Development, United States Environmental Protection Agency (USEPA), Cincinnati, Ohio, April 1995.

- Mueser Rutledge Consulting Engineers, *"Site-Specific Ground Motion Analysis and Seismic Coefficient ks, North Field Basin and Surge Pond, Chevron Texaco, Perth Amboy, New Jersey"*, October 17, 2003.

- New Jersey Department of Environmental Protection (NJDEP), "*Additional, Specific Disposal Regulations for Sanitary Landfills"*, Chapter 26 (Solid Waste) Subchapter 2A, updated February 2009.

APPENDIX B

TABLES

Table B-1

STRENGTH PARAMETERS USED IN STABILITY ANALYSES
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

			Undrained (Total)	Drained (Effective)	
Stratum #	**Description**	**Total Unit Wt. (γ_t) (pcf)**	**Shear Strength (S_u) (psf)**	**Cohesion (c') (psf)**	**Friction Angle (ø') (degrees)**
	Stabilized Soils/Waste	120	-	0	30
	Existing Perimeter Berm Soils	125	1,000	0	22
	Proposed Berm Soils	120	-	0	30
Stratum 1	Fill	120	-	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85 (70-95)		0	18
	Stage 4 strength		900		
	Stage 3/4 strength		800		
	Stage 3 strength		700		
	Stage 2/3 strength		575		
	Strength Under berm (Existing)		500		
	Strength CAMU north, east and West		500		
	Strength under berm (Proposed)		450		
	Strength CAMU existing conditions		300		
	Strength in NFB wetlands		300		
	Strength CAMU south		300		
Stratum 5	Red Brown Sand and Gravel	120	-	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	0	22

Table B-2

STABILITY ANALYSES RESULTS FOR SECTIONS 1 THROUGH 4
FOR BASE FAILURE MODE
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Stage	Analysis Description	Factor of Safety (FOS)				Corresponding Figure No.
		Section 1	Section 2	Section 3	Section 4	
Undrained Analyses						
Stage 3 (Top of waste EL. 30')	Static - Undrained	1.7	1.8	2.8	1.9	Figs. B-6a to B-9a
Stage 4 [1]	Static - Undrained	1.5	1.5	1.9	1.6	Figs. B-6b to B-9b
Stage 4 [1]	Pseudo Static - Undrained	1.0	1.1	1.3	1.1	Figs. B-6c to B-9c
Drained Analyses						
Stage 4 [1]	Static - Drained	1.7	1.8	2.3	1.8	Figs. B-6b to B-9b
Stage 4 [1]	Pseudo Static - Drained	1.1	1.2	1.6	1.3	Figs. B-6c to B-9c

Notes:

1. Stage 4 analyzed top of final cover side slope at EL. 38' for Section 1 and at EL. 42' for Sections 2 through 4.
2. All elevations are in feet, NGVD.

Table B-3

SUMMARY OF DOCUMENTED INTERFACE FRICTION VALUES

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

GEOSYNTHETIC / GEOSYNTHETIC	δ (degrees)
Smooth HDPE / Nonwoven Geotextile	6 to 12
Textured HDPE / Nonwoven Geotextile	25 to 35
Smooth HDPE / Geonet	8 to 15
Textured HDPE / Geonet	8 to 15
Textured HDPE / Geocomposite Drainage Layer	17 to 29
Geonet / Nonwoven Geotextile	14 to 22
Smooth HDPE / GCL (hydrated)	5 to 12
Textured HDPE / GCL (hydrated)	18 to 37
GEOSYNTHETIC / SOIL	**tan δ / tan ϕ'**
Smooth HDPE / Clay	0.4 to 0.7
Textured HDPE / Clay	0.8 to 0.9
Smooth HDPE / Sand	0.5 to 0.6
Textured HDPE / Sand	0.7 to 0.8
Needlepunched Geotextile / Sand	0.8 to 1.0
Needlepunched Geotextile / Angular Gravel	0.7 to 0.9
Needlepunched Geotextile / Rounded Gravel	0.6 to 0.8
Needlepunched Geotextile / Silty Sands	0.96
Geogrid / Soil	1
GCL / Sand	δ = 17 to 35 degrees

Notes:

1. δ = interface friction angle; ϕ' = soil internal friction angle.
2. Adapted from tests by Martin et al. (1984), Williams and Houlihan (1986), Koerner et al. (1986), manufacturers literature, and unpublished results from GeoSyntec Consultants.

Table B-4

STABILITY ANALYSES RESULTS FOR PERIMETER BERMS

BASE FAILURE MODE

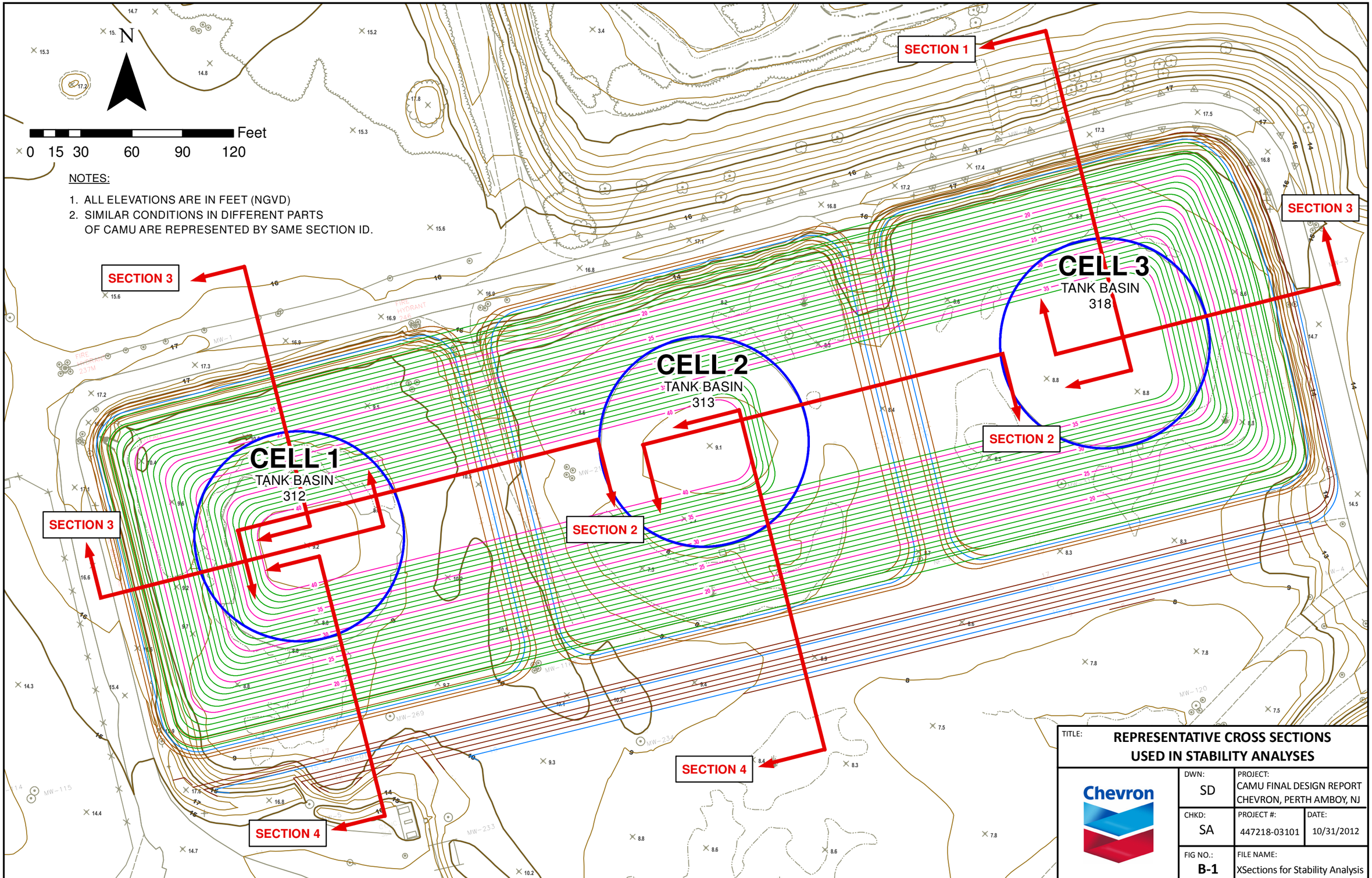
CAMU Final Design Report

Chevron Perth Amboy Facility, NJ

Analysis Description	**Factor of Safety (FOS)**		**Corresponding Figure No.**
	Existing Perimeter Berm (Section 1)	**Proposed Perimeter Berm (Section 4)**	
Undrained Analyses			
Static - Undrained	2.5	2.4	Figs. B-12 & B-14
Pseudo Static - Undrained	1.7	1.6	Figs. B-13 & B-15
Drained Analyses			
Static - Drained	1.5	2.4	Figs. B-12 & B-14
Pseudo Static - Drained	1.0	1.7	Figs. B-13 & B-15

APPENDIX B

FIGURES

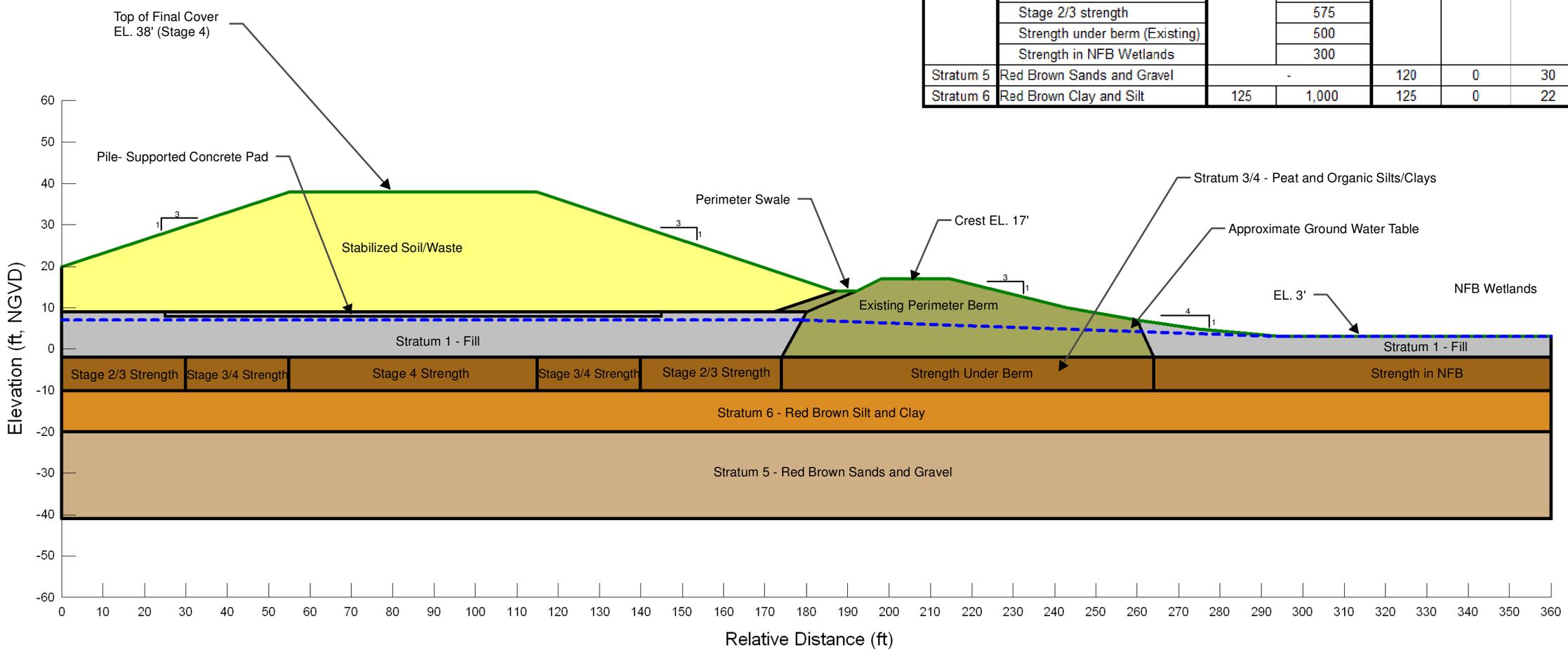


TITLE: **REPRESENTATIVE CROSS SECTIONS USED IN STABILITY ANALYSES**

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: **B-1**	FILE NAME: XSections for Stability Analysis	

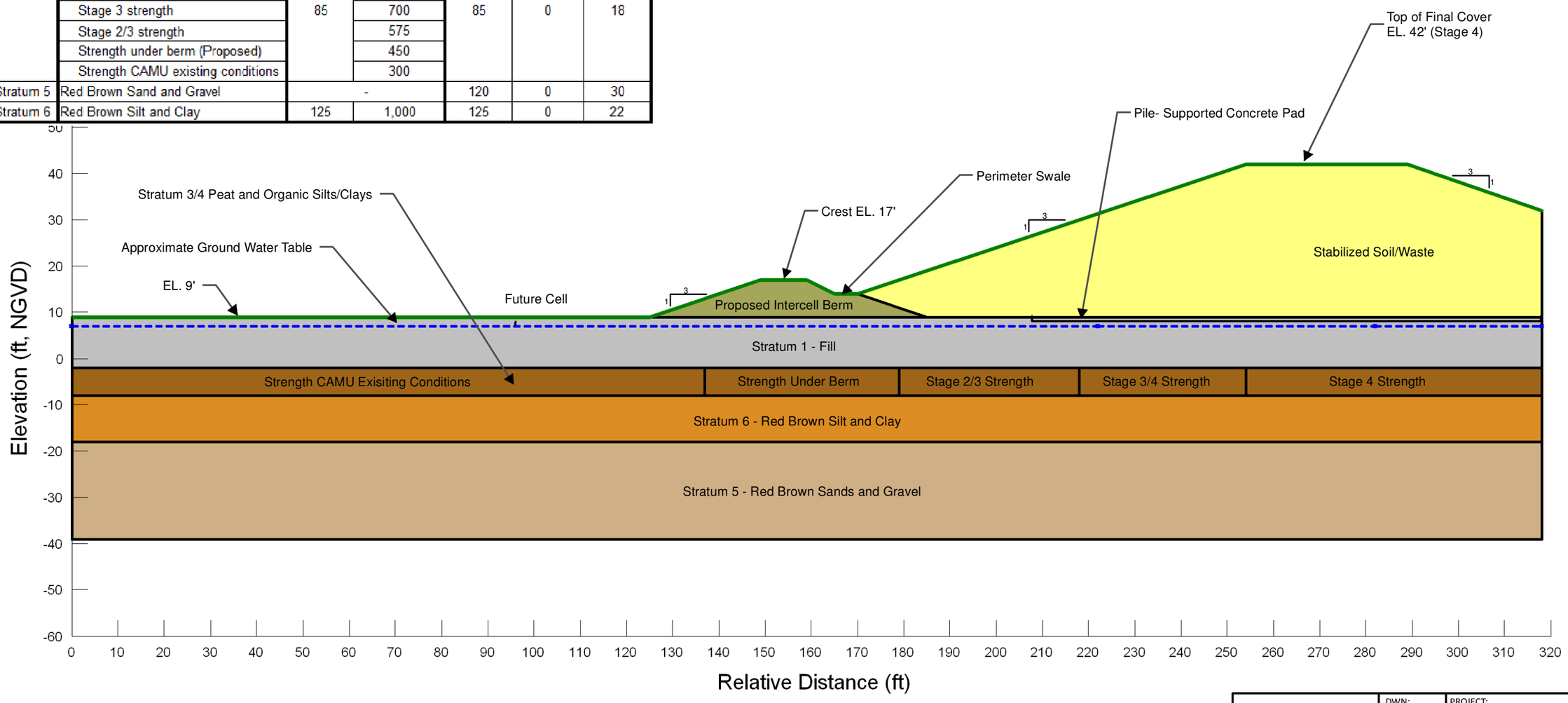
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength in NFB Wetlands		300			
Stratum 5	Red Brown Sands and Gravel	-		120	0	30
Stratum 6	Red Brown Clay and Silt	125	1,000	125	0	22



SECTION 1 CONFIGURATION AND SUBSURFACE STRATIGRAPHY

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-2	FILE NAME: Sec 1 Config & Subsurface

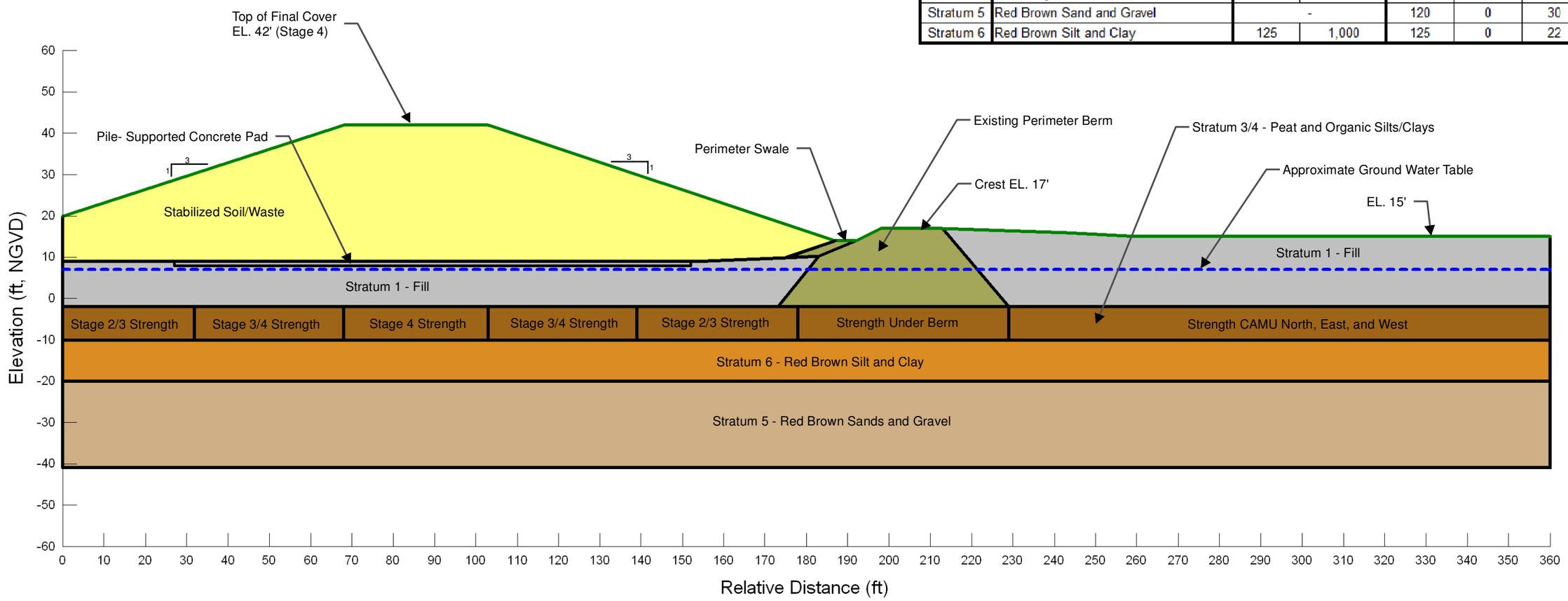
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU existing conditions		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



SECTION 2 CONFIGURATION AND SUBSURFACE STRATIGRAPHY

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-3	FILE NAME: Sec 2 Config & Subsurface

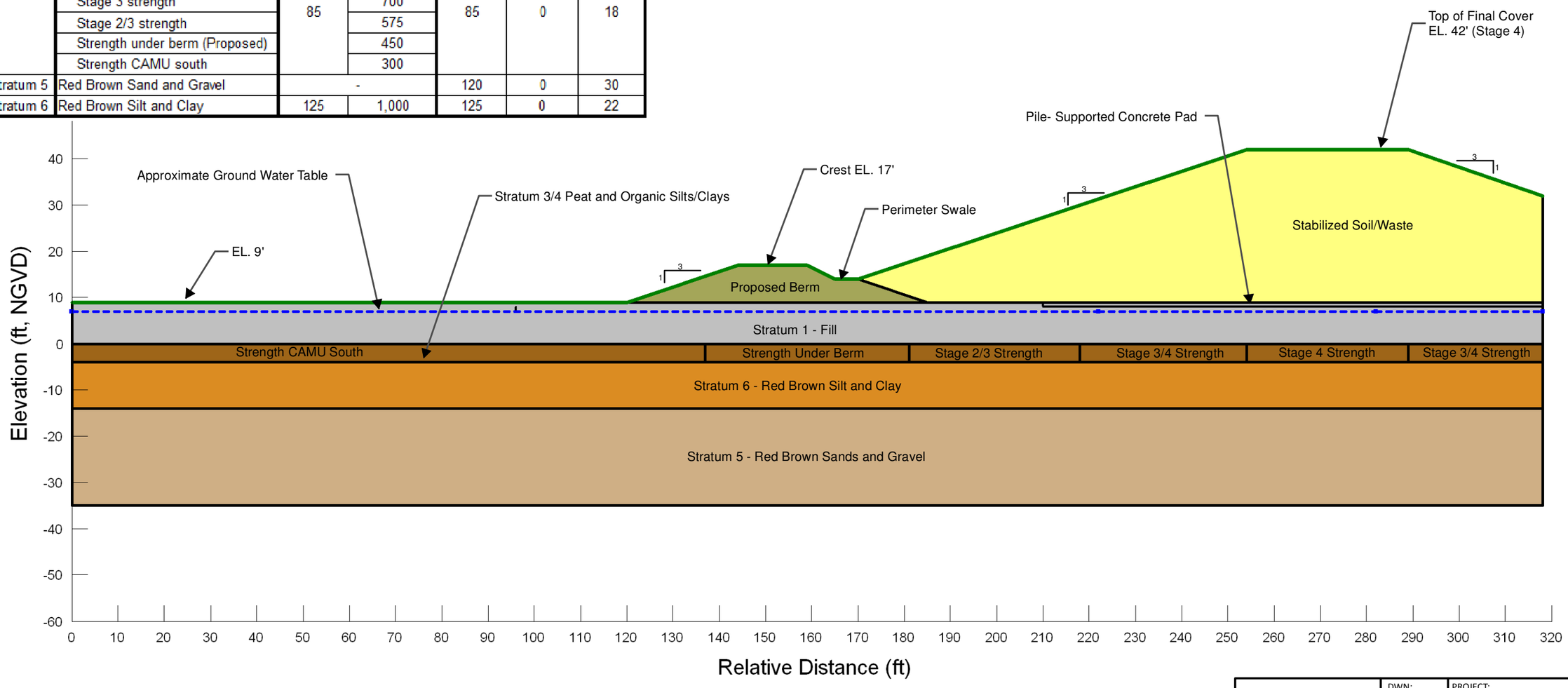
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	120	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



SECTION 3 CONFIGURATION AND SUBSURFACE STRATIGRAPHY

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-4	FILE NAME: Sec 3 Config & Subsurface

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays					
	Stage 4 strength	85	900	85	0	18
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU south		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

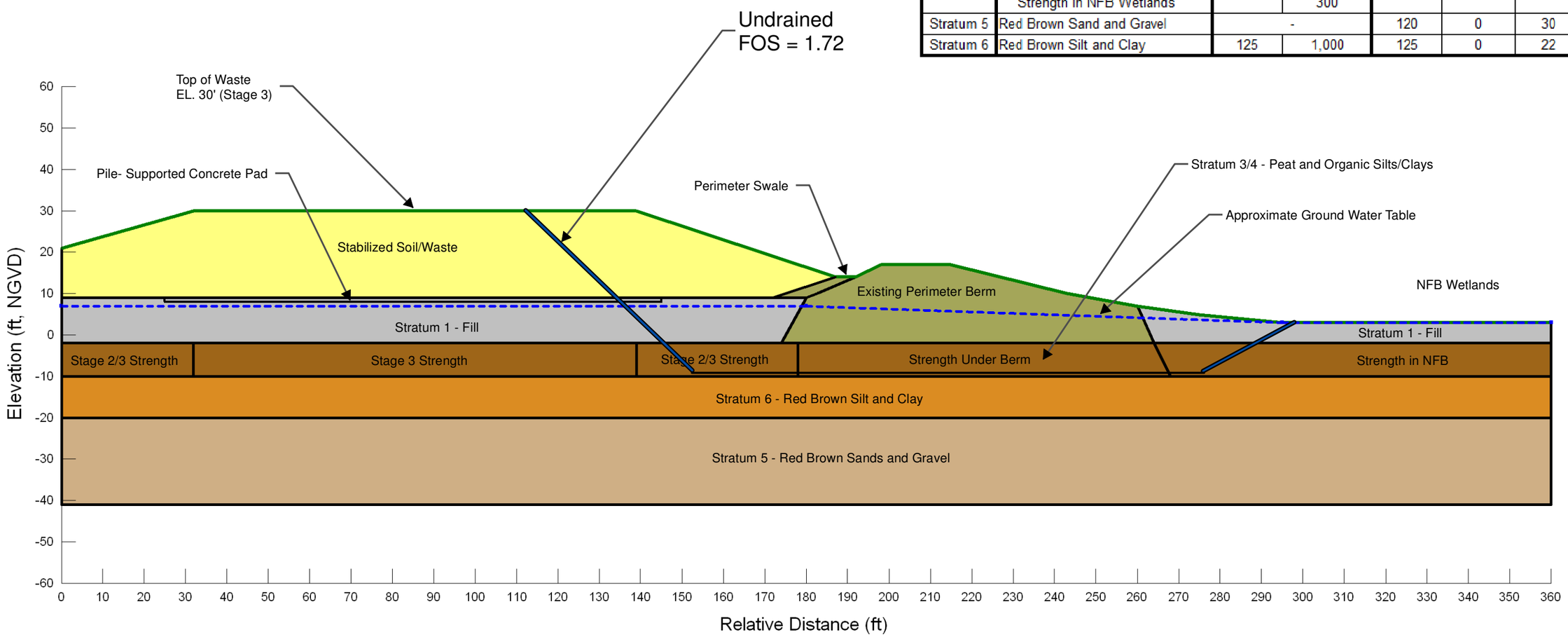


SECTION 4 CONFIGURATION AND SUBSURFACE STRATIGRAPHY

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: B-5	FILE NAME: Sec 4 Config & Subsurface	

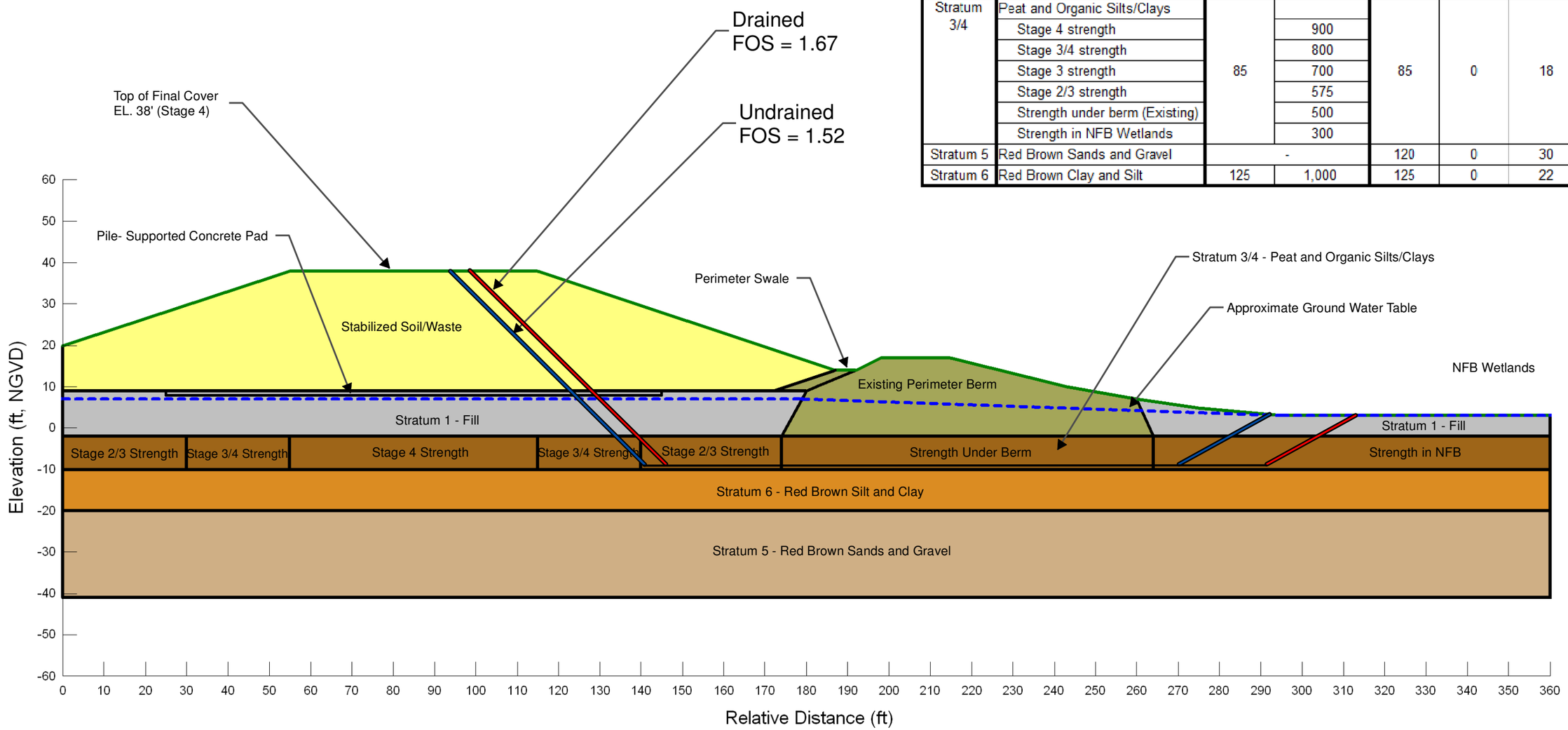
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		120	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength in NFB Wetlands		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



SECTION 1 STAGE 3 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-6a	FILE NAME: CAMU FDR Sec 1 Stg 3 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength in NFB Wetlands		300			
Stratum 5	Red Brown Sands and Gravel	-		120	0	30
Stratum 6	Red Brown Clay and Silt	125	1,000	125	0	22

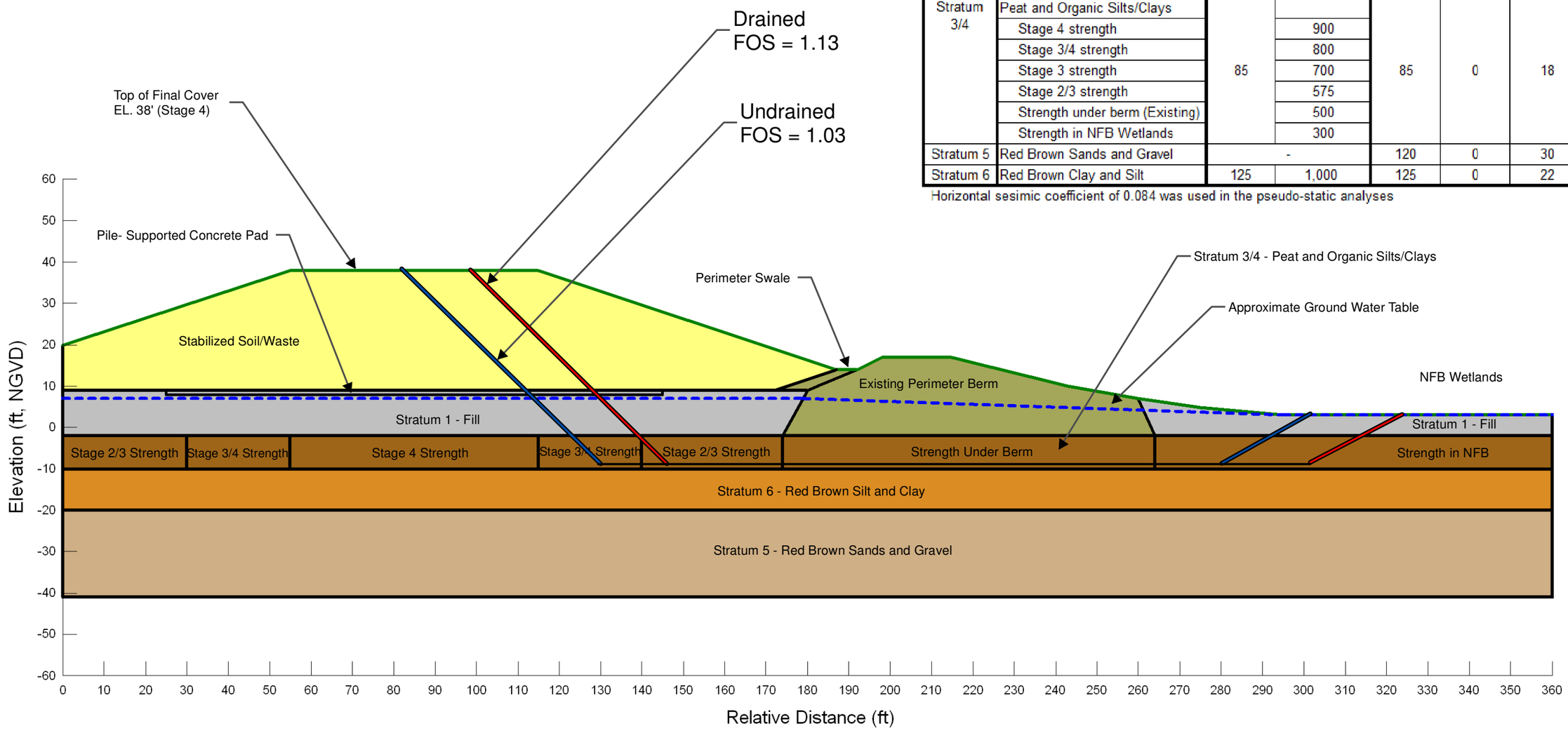


SECTION 1 STAGE 4 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-6b	FILE NAME: CAMU FDR Sec 1 Stg 4 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength in NFB Wetlands		300			
Stratum 5	Red Brown Sands and Gravel	-		120	0	30
Stratum 6	Red Brown Clay and Silt	125	1,000	125	0	22

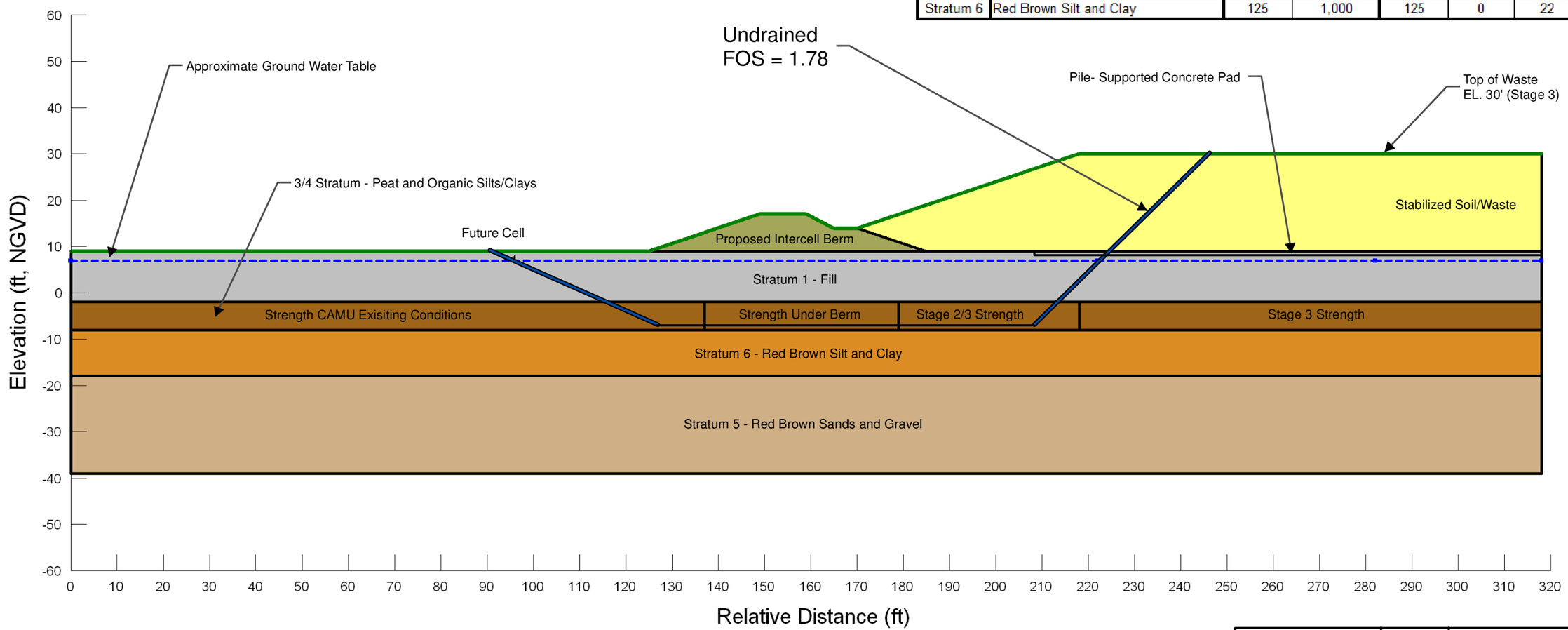
Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses



SECTION 1 STAGE 4 SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-6c	FILE NAME: CAMU FDR Sec 1 Stg 4 Seismic

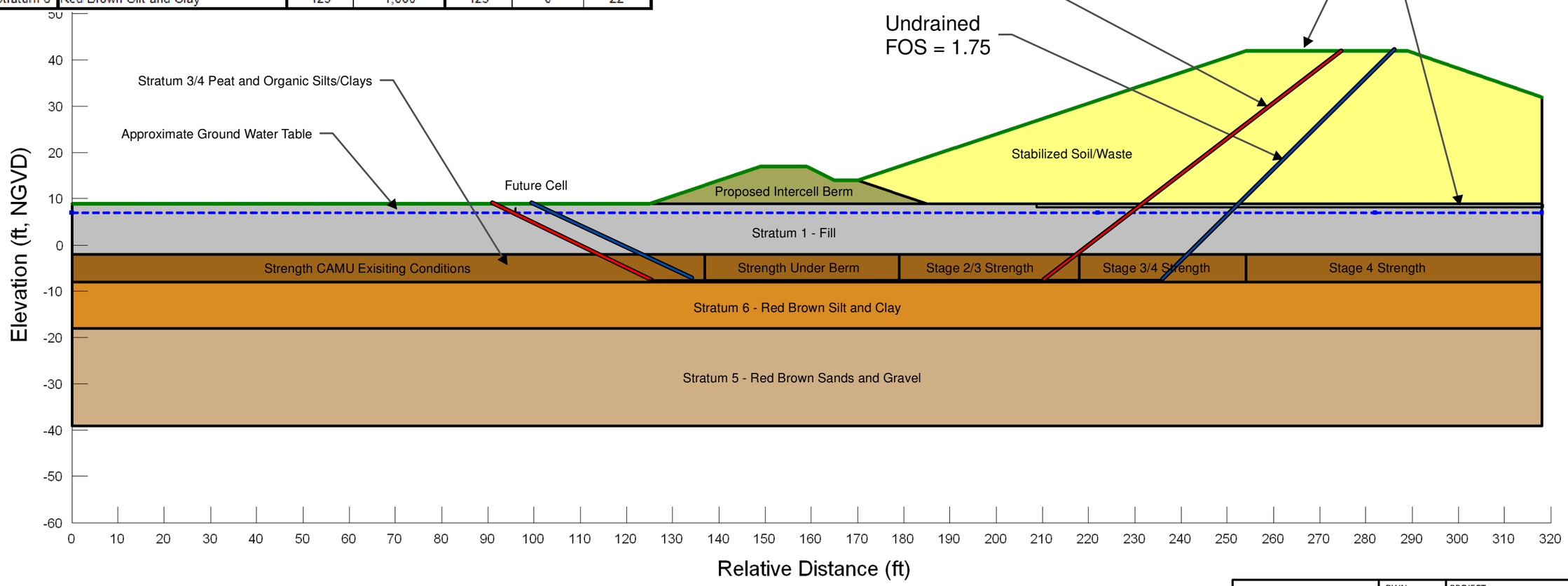
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		125	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU existing conditions		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



SECTION 2 STAGE 3 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-7a	FILE NAME: CAMU FDR Sec 2 Stg 3 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays					
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength	85	700	85	0	18
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU existing conditions		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

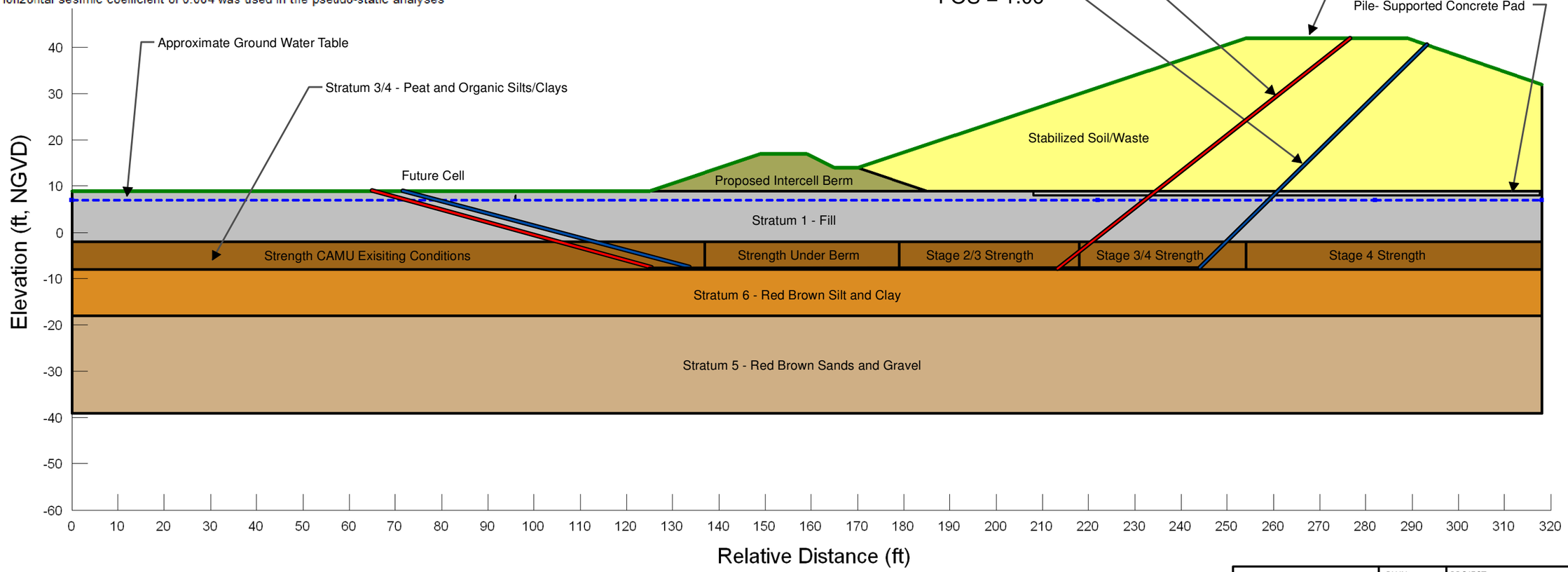


SECTION 2 STAGE 4 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-7b	FILE NAME: CAMU FDR Sec 2 Stg 4 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU existing conditions		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

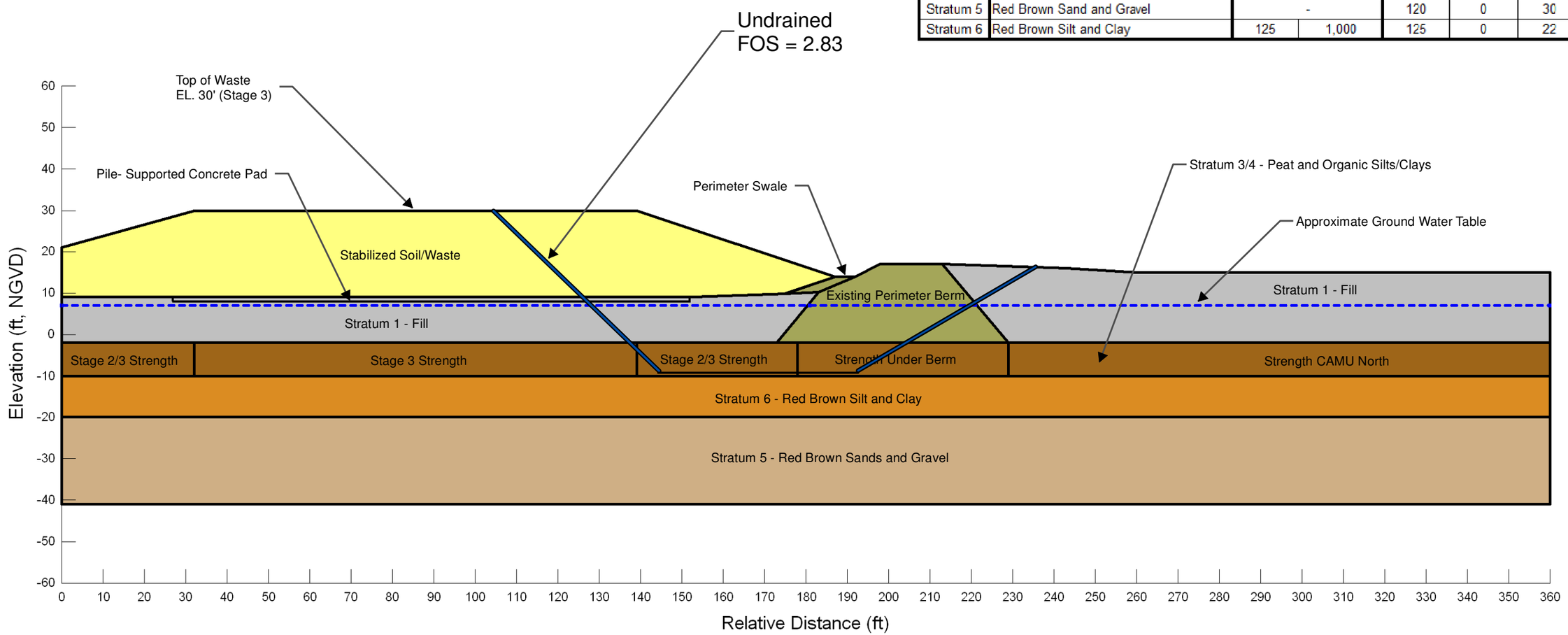
Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses



SECTION 2 STAGE 4 SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-7c	FILE NAME: CAMU FDR Sec 2 Stg 4 Seismic

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	120	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

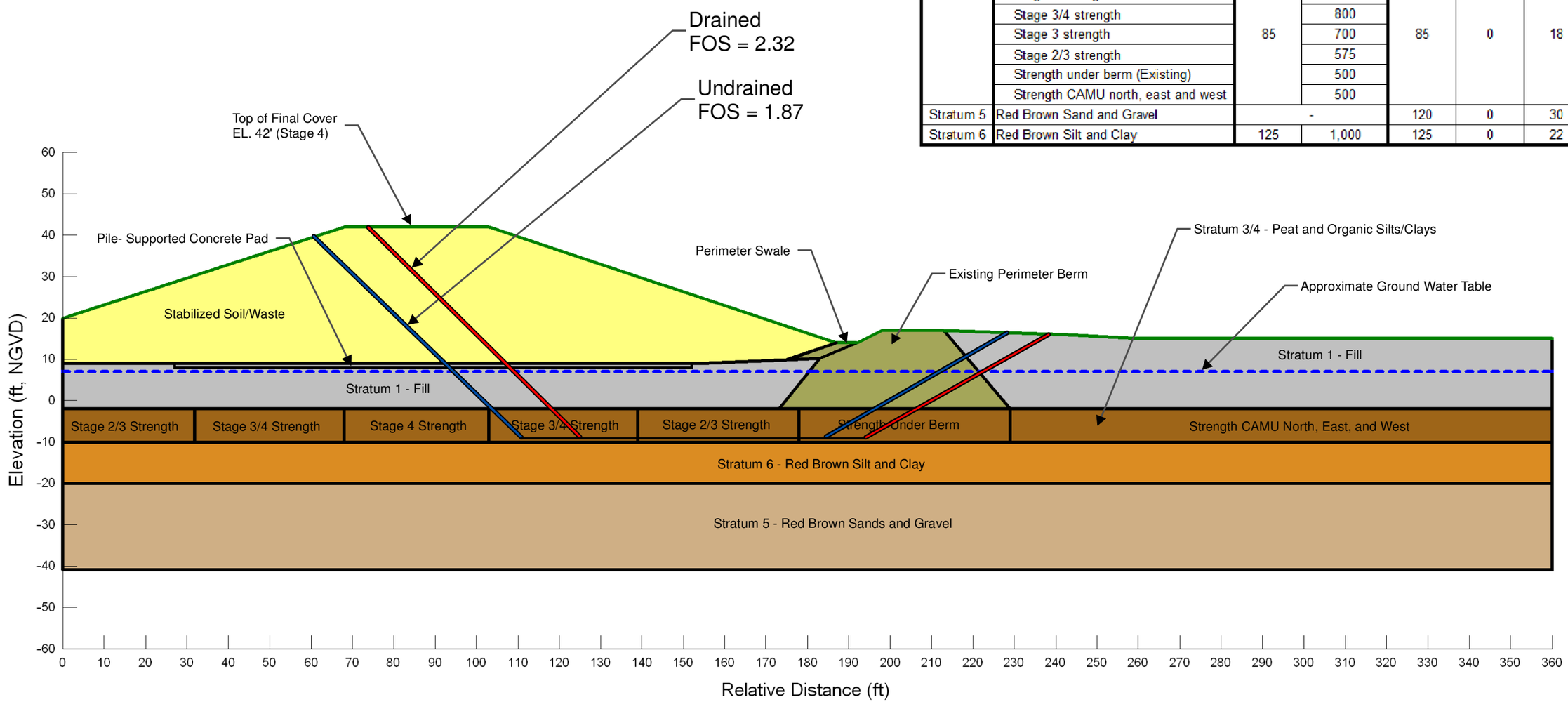


SECTION 3 STAGE 3 STATIC STABILITY ANALYSIS RESULTS

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: B-8a	FILE NAME: CAMU FDR Sec 3 Stg 3 Static	

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	120	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



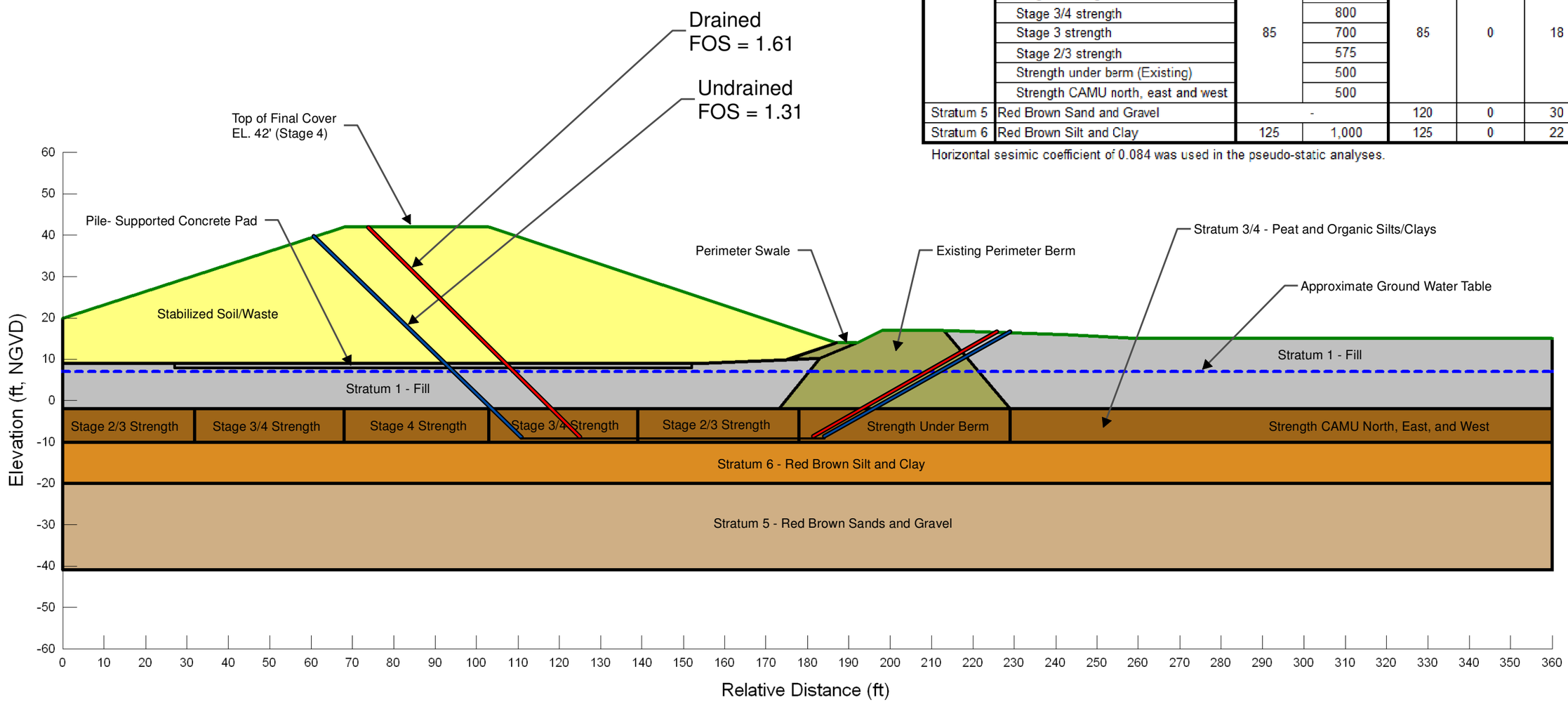
SECTION 3 STAGE 4 STATIC STABILITY ANALYSIS RESULTS

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: B-8b	FILE NAME: CAMU FDR Sec 3 Stg 4 Static	

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Exisiting Perimeter Berm Soils	125	1,000	120	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

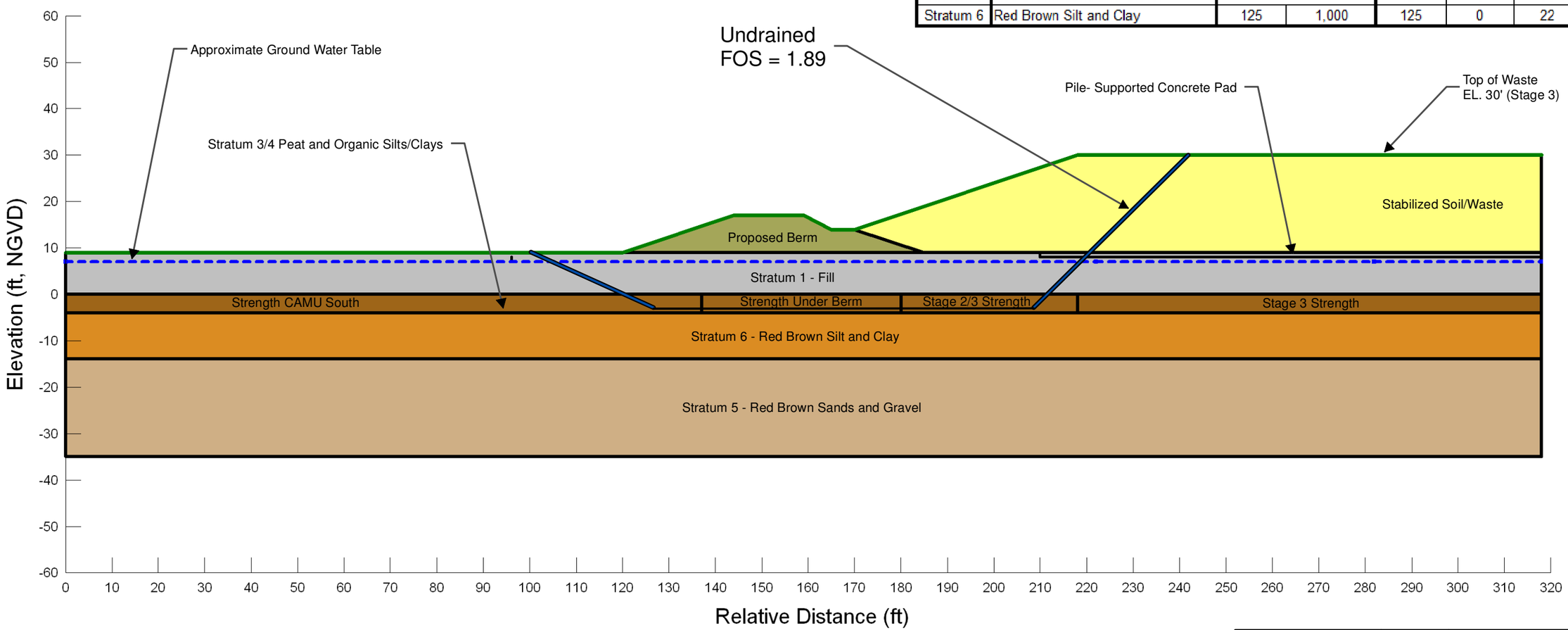
Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.



SECTION 3 STAGE 4 SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-8c	FILE NAME: CAMU FDR Sec 3 Stg 4 Seismic

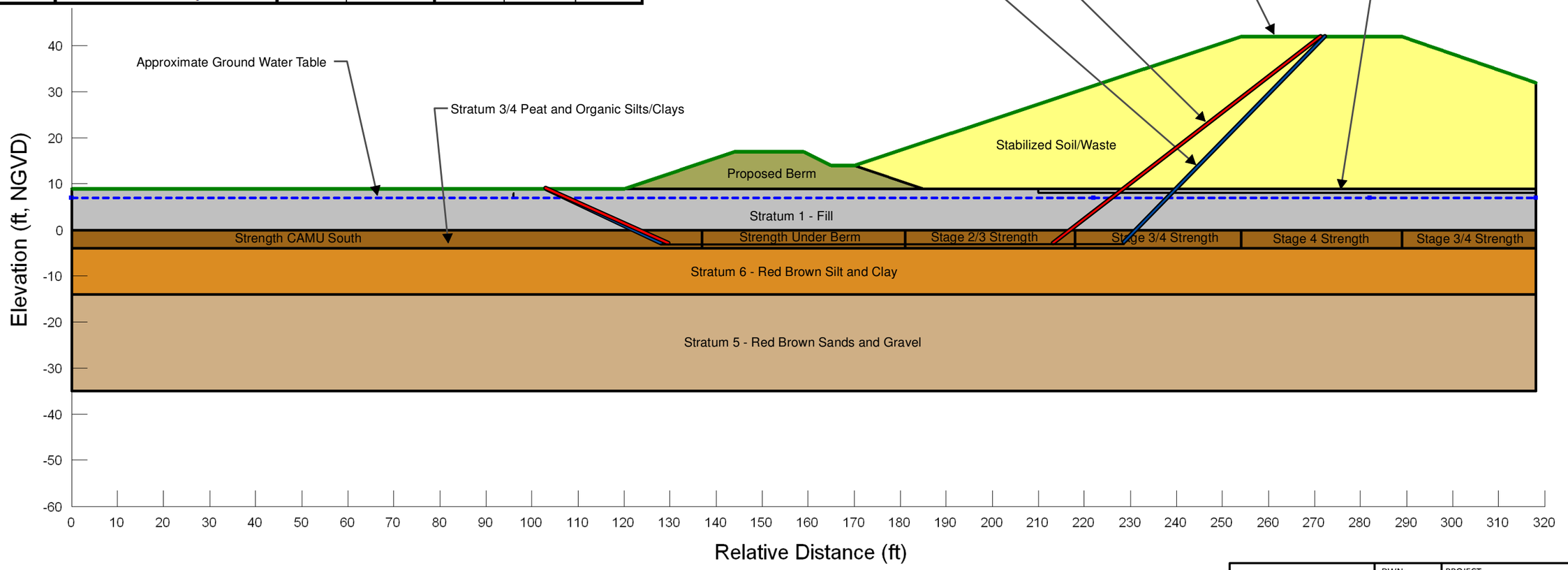
Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils.Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU south		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22



SECTION 4 STAGE 3 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-9a	FILE NAME: CAMU FDR Sec 4 Stg 3 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays					
	Stage 4 strength	85	900	85	0	18
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU south		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

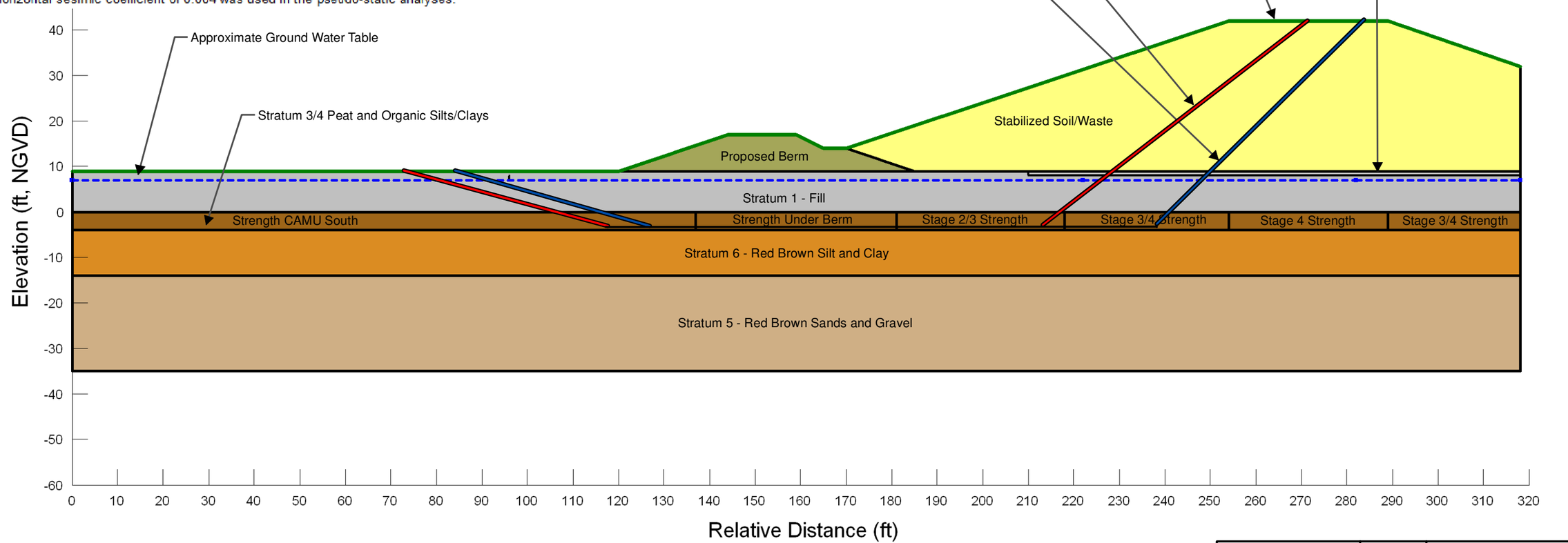


SECTION 4 STAGE 4 STATIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-9b	FILE NAME: CAMU FDR Sec 4 Stg 4 Static

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays					
	Stage 4 strength	85	900	85	0	18
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Proposed)		450			
	Strength CAMU south		300			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.

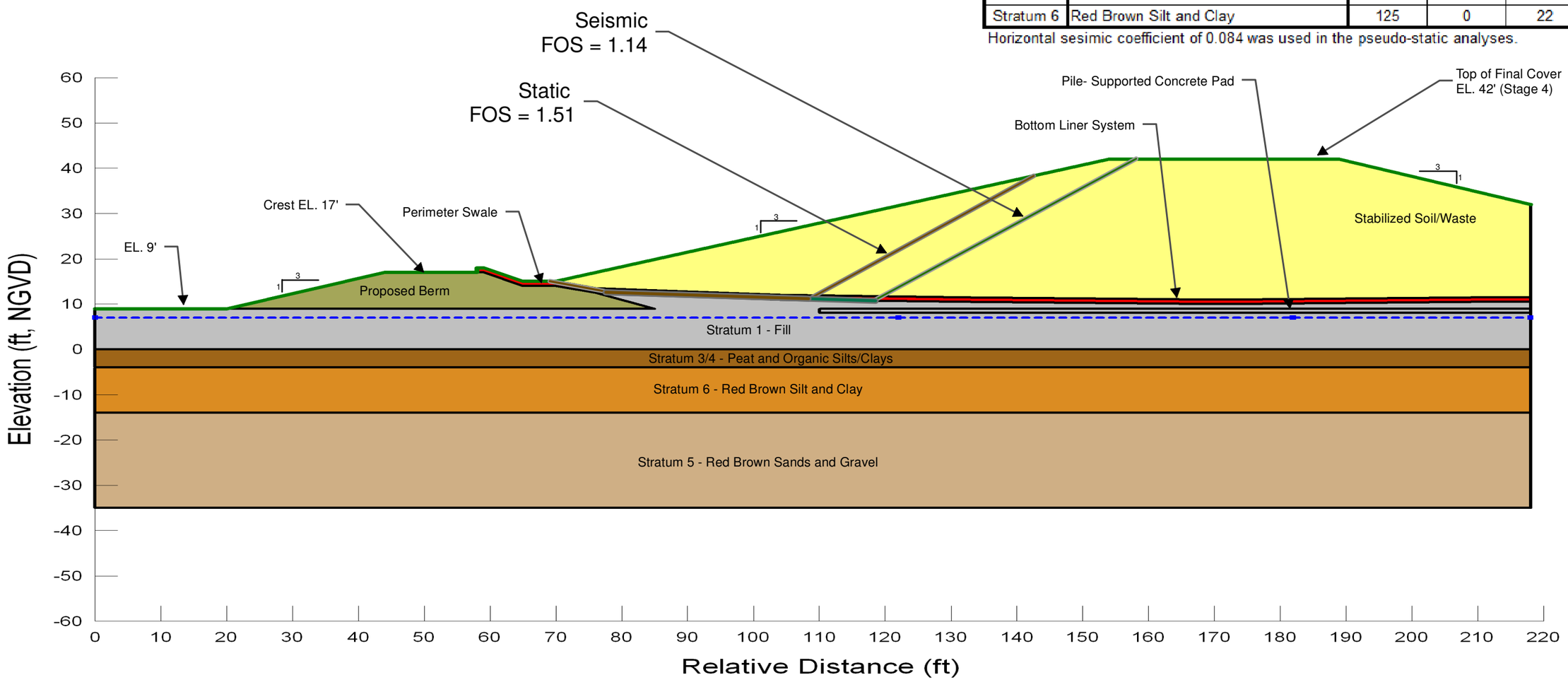


SECTION 4 STAGE 4 SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-9c	FILE NAME: CAMU FDR Sec 4 Stg 4 Seismic

Stratum #	Description	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Cohesion (c') (psf)	Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	120	0	30
	Proposed Berm Soils	120	0	30
	Bottom Liner Material	60	0	14.5
Stratum 1	Fill	125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85	0	18
Stratum 5	Red Brown Sand and Gravel	120	0	30
Stratum 6	Red Brown Silt and Clay	125	0	22

Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.

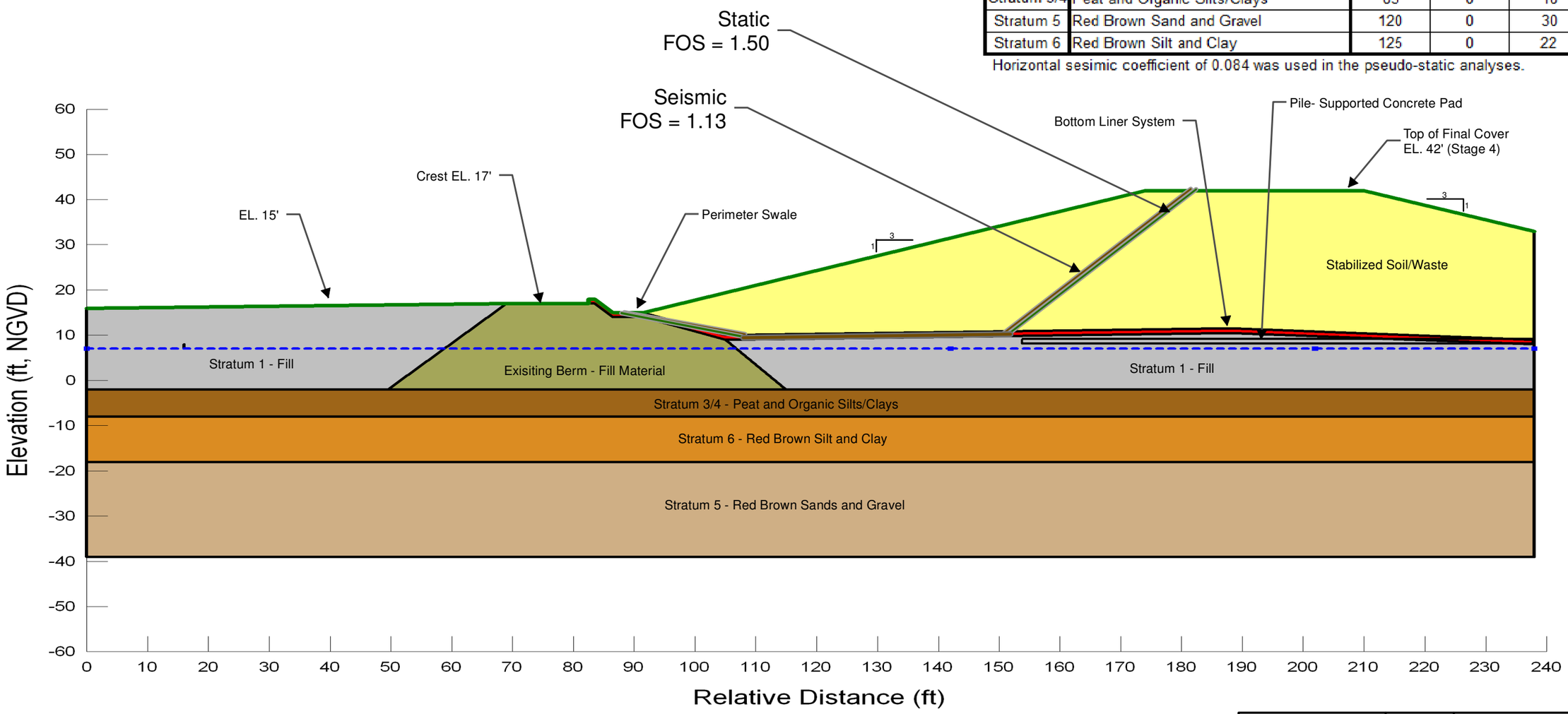


FAILURE ALONG BOTTOM LINER SYSTEM FOR NORTH-SOUTH SECTION
STATIC AND SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-10	FILE NAME: Bottom Liner NS Results

Stratum #	Description	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Cohesion (c') (psf)	Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	120	0	30
	Existing Perimeter Berm Soils	125	0	22
	Bottom Liner Material	60	0	13
Stratum 1	Fill	125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85	0	18
Stratum 5	Red Brown Sand and Gravel	120	0	30
Stratum 6	Red Brown Silt and Clay	125	0	22

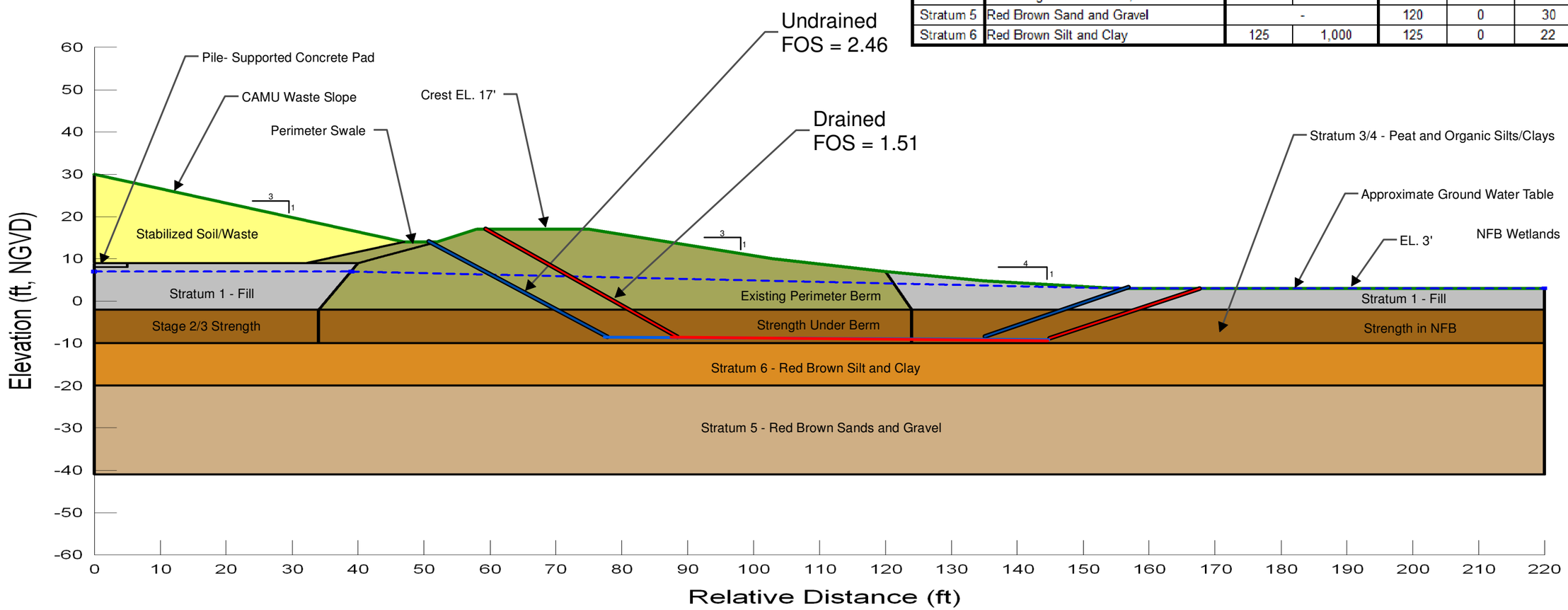
Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.



FAILURE ALONG BOTTOM LINER SYSTEM FOR EAST-WEST SECTION
STATIC AND SEISMIC STABILITY ANALYSIS RESULTS

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-11	FILE NAME: Bottom Liner EW Results

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Existing Permimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

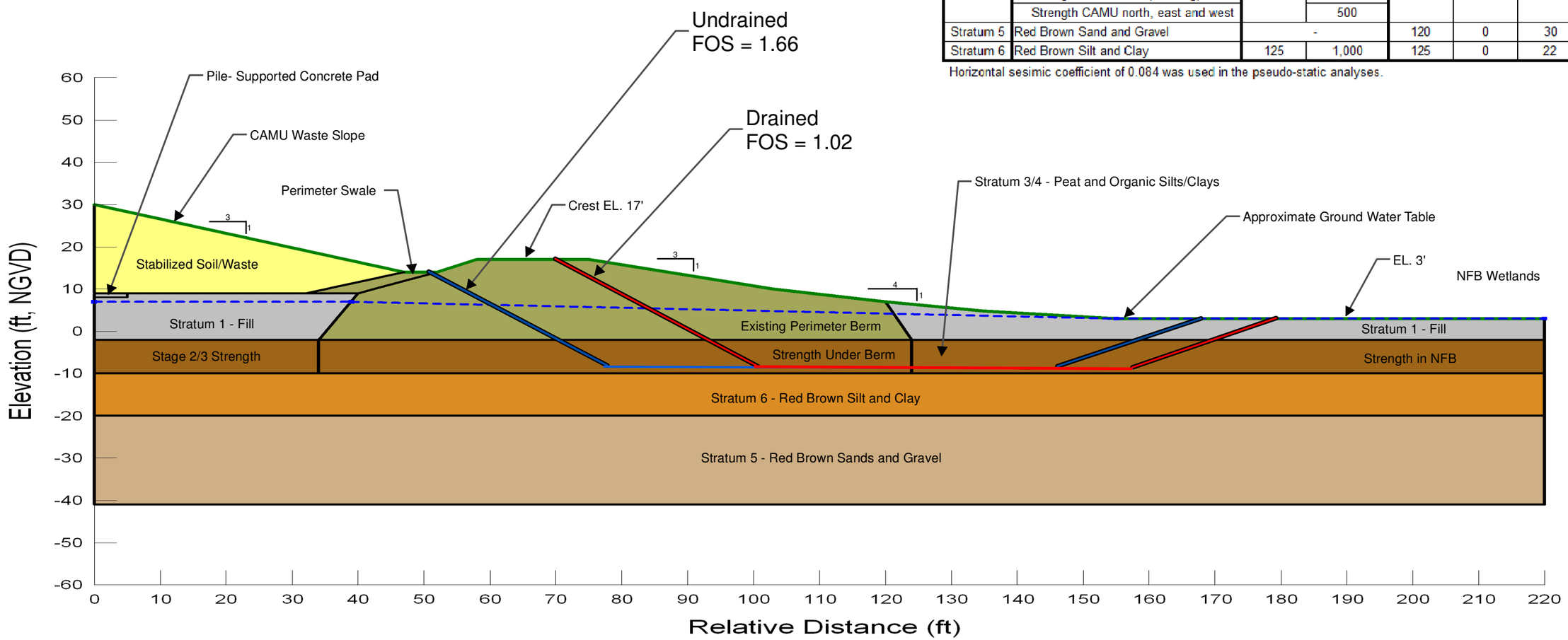


STATIC STABILITY ANALYSIS RESULTS FOR EXISTING PERIMETER BERM (SECTION 1)

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-12	FILE NAME: Sec 1 Static Exisiting Per Berm

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Existing Permimeter Berm Soils	125	1,000	125	0	22
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

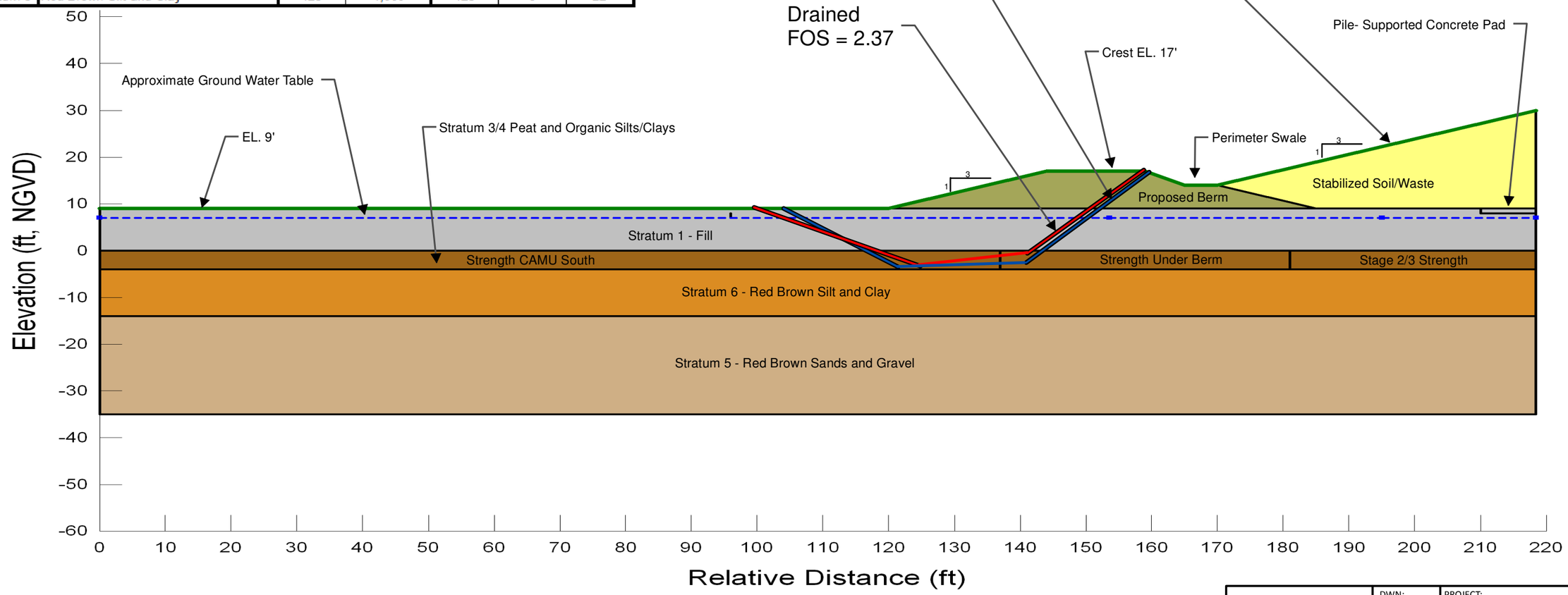
Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.



SEISMIC STABILITY ANALYSIS RESULTS FOR EXISTING PERIMETER BERM (SECTION 1)

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-13	FILE NAME: Sec 1 Seismic Exisiting Per Berm

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays	85		85	0	18
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength		700			
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

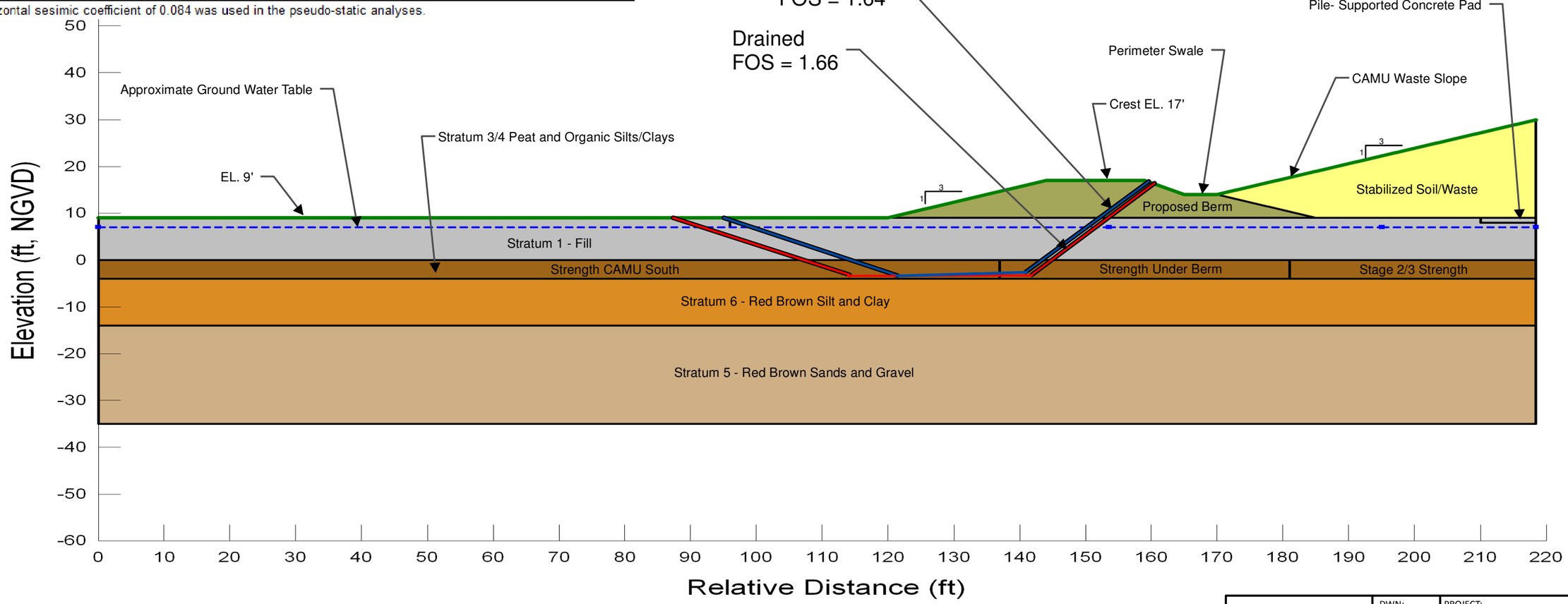


STATIC STABILITY ANALYSIS RESULTS FOR PROPOSED PERIMETER BERM (SECTION 4)

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-14	FILE NAME: Section 4 Static Proposed berm

Stratum #	Description	Undrained (Total) Total Unit Wt. (γ_t) (pcf)	Undrained (Total) Shear Strength (S_u) (psf)	Drained (Effective) Total Unit Wt. (γ_t) (pcf)	Drained (Effective) Cohesion (c') (psf)	Drained (Effective) Friction Angle (ϕ') (degrees)
	Stabilized Soils/Waste	-		120	0	30
	Proposed Berm Soils	-		120	0	30
Stratum 1	Fill	-		125	0	30
Stratum 3/4	Peat and Organic Silts/Clays					
	Stage 4 strength		900			
	Stage 3/4 strength		800			
	Stage 3 strength	85	700	85	0	18
	Stage 2/3 strength		575			
	Strength under berm (Existing)		500			
	Strength CAMU north, east and west		500			
Stratum 5	Red Brown Sand and Gravel	-		120	0	30
Stratum 6	Red Brown Silt and Clay	125	1,000	125	0	22

Horizontal sesimic coefficient of 0.084 was used in the pseudo-static analyses.



SEISMIC STABILITY ANALYSIS RESULTS FOR PROPOSED PERIMETER BERM (SECTION 4)

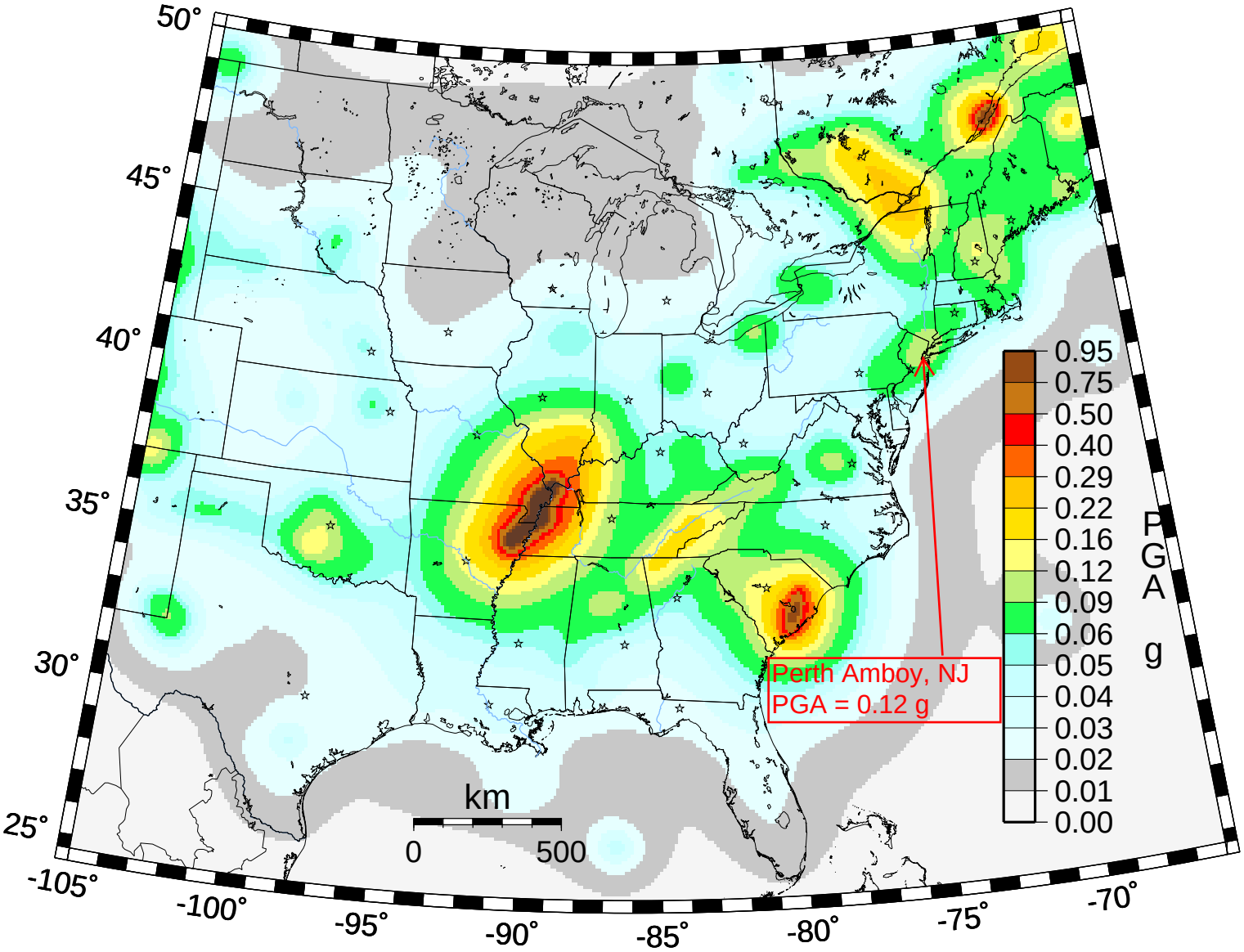
Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: B-15	FILE NAME: Sec 4 Seismic Proposed berm

ATTACHMENT B-1

MUESER RUTLEDGE CONSULTING ENGINEERS (MRCE) REPORT (RELAVANT SECTIONS ONLY)

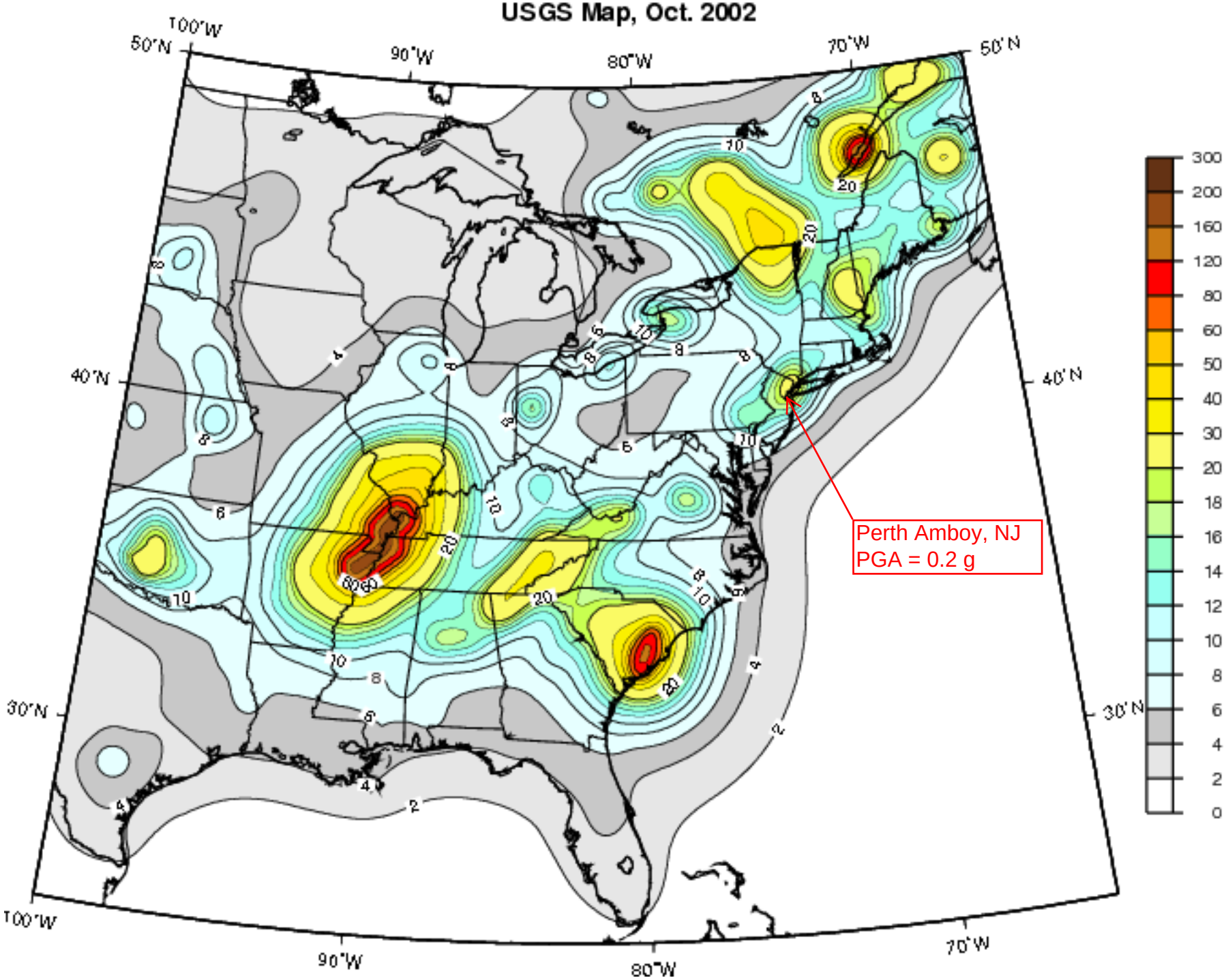
Hard Rock PGA 2%/50 year PE

2008 Update (Rev. III, Jan 2010)



GMT 2009 Apr 15 14:03:39 **Horiz.-comp PGA for NEHRP A-class rock site condition and NSHMP 2008 Seismic Hazard model**

Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002



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October 17, 2003

Parsons
200 Cottontail Lane
Somerset, NJ 08873

Attention: Mr. Robert Strahle

Re: Site-Specific Ground Motion Analysis and Seismic Coefficient k_s
North Field Basin and Surge Pond
Chevron Texaco, Perth Amboy, New Jersey
MRCE File 9971

Dear Mr. Strahle:

This letter presents a summary of a site-specific ground motion study performed to determine the seismic coefficient, k_s, to be used in stability analysis of the landfill slope.

The study was considered necessary in order to derive the pseudostatic seismic force in the finite element modeling for the slope stability and sheet pile wall analyses that are presented on a separate letter also dated October 17, 2003. The force is equal to a fraction of the acceleration at the ground surface. The surface ground acceleration is determined from the rock acceleration times a site factor that depends on the geologic conditions at the site. Due to the thickness of the soft clay at the site (more than 10 feet), current codes prescribe a high site factor. Numerous site-specific analyses we have performed in the New York Metropolitan area (Nikolaou et al, 2001) have indicated that the code-prescribed factor could be conservative for our site condition. Our analysis showed a lower site factor than the one given in codes.

The project design criteria are based on the New Jersey Administrative Code (NJAC) for Sanitary Landfills. As New Jersey has recently adopted parts of the International Building Code (IBC) and is in the process of fully adopting the seismic portion of it, this letter also evaluates the seismic event which IBC would determine for this site. This letter presents analyses of alternative seismic coefficients for slope stability evaluations.

List of Exhibits

The following exhibits and appendices are provided to illustrate the analysis and findings

Exhibit	Description
Plate 1	Site-specific seismic analysis. Soil stratigraphy and profiles studied.
Plate 2	Site-specific seismic analysis. Shear wave velocity V_s profiles.
Plate 3	Seismic hazard terms definitions
Plate 4	2002 USGS earthquake hazard map. $T_r = 2{,}500$ years, Rock "B" conditions
Plate 5	Site-specific seismic analysis. Site Factor F results.
Plate 6	Classification of structures according to IBC Table 1604.5

Appendix	Description
Appendix 1	ASCE Paper on Site Factors by Nikolaou et al (2001)
Appendix 2	IBC 2000 Tables
Appendix 3	SHAKE2000 Input Files
Appendix 4	SHAKE2000 O1 Output Files
Appendix 5	SHAKE2000 GRF Output Files

Site-Specific Seismic Ground Motion Analyses

Soil Profiles

A site-specific analysis was performed for the two soil profiles illustrated on Plate No. 1. Profile 1 is within the landfill, with 20 feet of cement stabilized fill at the ground surface. Profile 2 is through the work platform at the toe of the slope. Geotechnical field and laboratory data were taken from the August 2003 Parsons Report. The soil profile is based on results from subsurface investigations conducted from 1993 to 2003 by several consultants. The bedrock surface was assumed at Elev. -80 for the analysis based on information from our files. We understand a boring on the site encountered bedrock at Elev. -86. The higher elevation used in the analysis would not create significant difference in ground motion estimation.

Low-strain shear wave velocity V_s profiles were derived using the Sykora (1987) correlations for Standard Penetration Test (SPT) data and the Egan and Ebeling (1985) correlation for undrained shear strength. Available site SPT data and previous MRCE studies in the area were used (Appendix 1). The shear wave velocity profiles are shown in Plate No. 2. The average shear wave velocity is on the order of 670 ft/sec and the profiles studied fit a Soil Class "E" category as defined in the 2000 International Building Code (IBC), i.e., a soft profile with more than 10 ft of soft clay within the top 100 ft. The V_s values were varied by ±20% to account for uncertainty and to capture the upper and lower bound of the expected properties.

New Jersey Administrative Code Ground Motions

The acceleration level for the project is defined in the New Jersey Administrative Code (NJAC). This Code references EPA RCRA Subtitle D (258).

> *"The foundation shall be designed to resist the maximum horizontal acceleration in lithified material for the sanitary landfill. The maximum expected horizontal acceleration, as defined by 40 CFR Parts 257 and 258, shall mean the maximum expected acceleration depicted on a seismic hazard map, with a 90% or greater probability that the acceleration will not be exceeded in 250 years."*

This hazard level has a return period T_r of 2,380 years. This event is practically equivalent to an earthquake whose acceleration has 2% probability to be exceeded in 50 years, or an approximate return period, T_r of 2,500 years, as defined on Plate No. 3. The design bedrock acceleration for the 2,500 year return event is defined in USGS seismic hazard maps which were last published in 2002 (Plate No. 4). The USGS maps provide Peak Ground Acceleration (PGA) at the bedrock surface of:

$PGA_{r,B} = 0.2$ g (40.5208 Lat., -74.2788 Long.) PGAr,B = 0.12g based on 2008 update

This $PGA_{r,B}$ value corresponds to Soil Class "B" conditions, i.e., rock with shear wave velocity between 2,500 and 5,000 ft/sec. The accelerations for other soil or rock conditions are given by the $PGA_{r,B}$ value multiplied by a site factor "F." At this site bedrock is expected to be stiffer than Class B, and therefore F = 0.8.

A site-specific analysis using Profiles 1 and 2 was performed to define a more likely site factor, F. This analysis was performed using one-dimensional wave propagation with the equivalent-linear program SHAKE2000 at the soil profiles illustrated on Plates Nos. 1 and 2. Three rock input motions were used, each having a rock outcrop response spectrum with scaled ground acceleration equal to the expected rock acceleration $PGA_{r,A} = PGA_{r,B} \times 0.8 = 0.16$ g. The ground motions were taken from the recommended Rock "A" time histories of the 1998 NYCDOT Seismic Criteria Guidelines for New York City, which has a similar hazard as the Perth Amboy site.

Nine cases were examined for each profile, (three time histories with three variations of shear wave velocities). The peak acceleration at the ground surface, PGA, was calculated for each case. The site factor was calculated as $F = PGA_s / PGA_{r,B} = 0.8 \times PGA_s / PGA_{r,A}$ to be comparable with site factors in current codes. The results of this site-specific analysis are provided in Plate No. 5. For Profile 1 the mean site factor is F = 1.5; for Profile 2, F = 1.25. We recommend using an average in the slope analysis of F = 1.4.

NJAC Seismic Coefficient k_s

Coefficient, k_s determines the effective acceleration, in g, that is used to evaluate the stability of the slopes. It represents the coefficient that will accelerate the failure plane below the ground surface. According to EPA RCRA Subtitle D (258), the coefficient, k_s can be taken as one half of the Peak Ground Acceleration (PGA) at the ground surface, i.e.:

$$k_s = ½\ PGA_s / g = ½\ F\ PGA_{r,B} = ½\ F \times 0.2 = 0.1\ F$$

Slope-W slope stability analysis software incorporates earthquake loads as a uniform, pseudostatic acceleration value. Based on the shape of the static failure slip surfaces calculated for this project, we have recommended using a site factor F = 1.4. Therefore the effective coefficient is:

$$k_s = ½\ PGA_s / g = ½\ F\ PGA_{r,B} = ½ \times 1.4 \times 0.2 = 0.14$$ Ks = 0.084 for PGAr,B = 0.12g

International Building Code Ground Motions

The seismic coefficient developed from guidelines of the New Jersey Administrative Code for landfills is relatively extreme (Kavazanjian & Matasovic, 1995) and high compared to other codes criteria. The 2000 International Building Code (IBC) recently being applied in the State of New Jersey, and the current NYCDOT Seismic Criteria Guidelines, recommend for "essential structures" reducing the seismic design parameters taken from the 2,500-year return period event maps by 2/3 for "essential" or (Category I) structures. All related tables of the IBC Code are given in Appendix 2.

IBC Seismic Coefficient k_s

If IBC criteria are used to determine the seismic coefficient k_s, then: the Maximum Credible Earthquake (MCE), Rock Class B Spectral Accelerations for short period $S_s = 0.406$ g (Period T = 0.2 s), and for long period $S_1 = 0.091$ g (Period T = 1 s). The Design Peak Ground Acceleration for Rock Class B is:

$$PGA_{r,B} = 2/3 \times 0.4 \times S_s = 2/3 \times 0.4 \times 0.406 = 0.108\ g.$$

The resulting site-specific surface acceleration PGAs , based on the average site factor F = 1.4, is given by:

$$PGA_s = F \times PGA_{r,B} = 1.4 \times 0.108 = 0.151\ g.$$

However, the IBC requires that the site-specific ground motion shall be greater than or equal to 80% of the ground acceleration determined by the generic site factors $F_{IBC,E}$ in the code, $PGA_{s,min}$. The soil profile according to IBC is classified as Soil Class E, because it contains more than 10 ft of soft clay. Based on Table 1615.1.2 of IBC, $F_{IBC,E} = 2.0$, and:

$$PGA_{s,min} = 80\% \times (F_{IBC,E} \times PGA_{r,B}) = 0.8 \times 2.0 \times 0.108 = 0.173 \text{ g} > PGA_s = 0.151 \text{ g}$$

Therefore, the surface acceleration should be equal to:

$$PGA_s = 0.173 \text{ g} = PGA_{s,min}$$

The corresponding seismic coefficient, k_s, based on IBC is given by:

$$k_s = \tfrac{1}{2} PGA_s = \tfrac{1}{2} \times 0.173 = 0.086$$

Therefore the IBC Code yields a lower seismic coefficient ($k_s = 0.086$) than the New Jersey Administrative Code for Landfills ($k_s = 0.14$).

Please do not hesitate to call us if you have any questions regarding this letter.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

By: _____
Sissy Nikolaou

[digital signature]

By: _____
Peter Deming

SN: PWD:PHE/9971/Ltr-Seismic_101703

References

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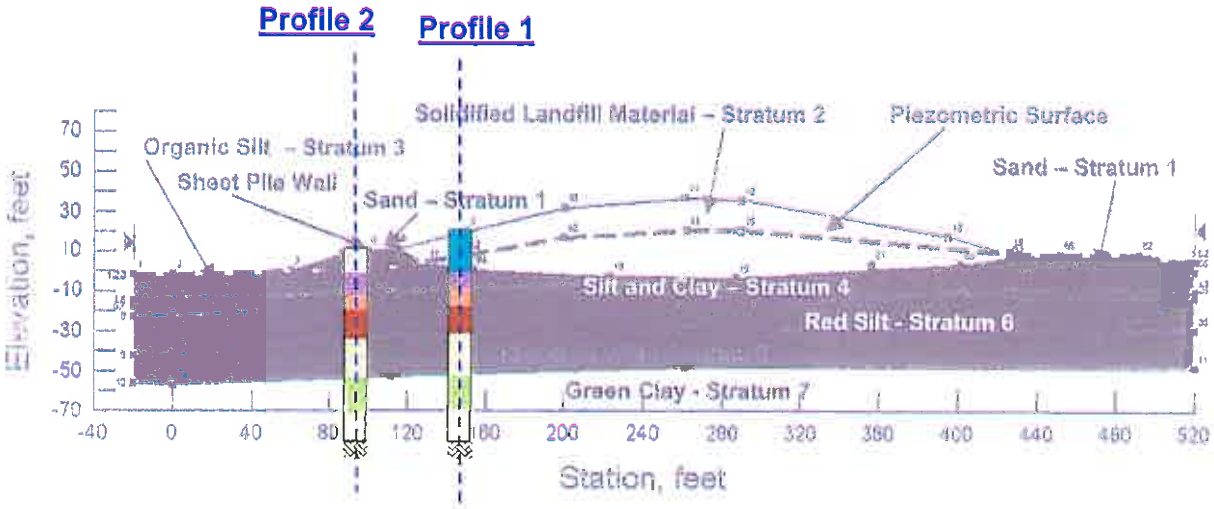
EXHIBITS

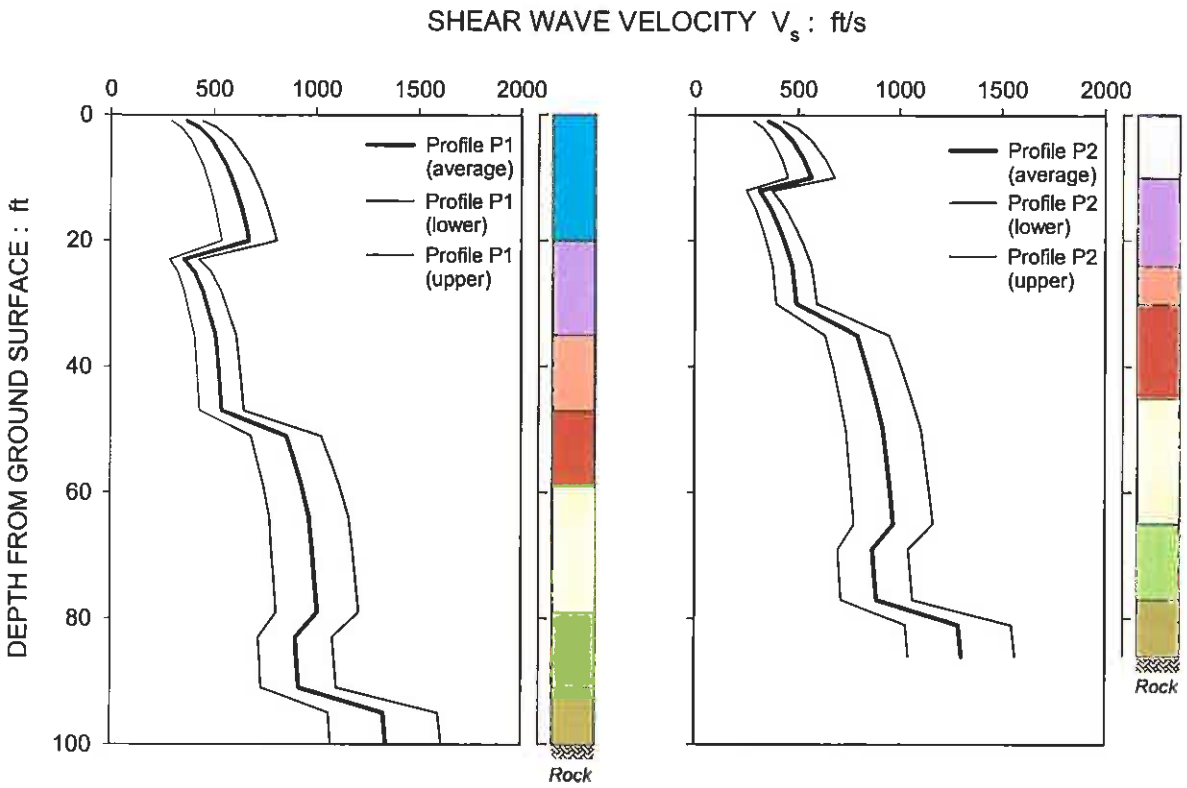


Note: Stratigraphy profile modified from Fig. 1 of Parsons Feasibility Study Report (Draft 2, Aug. 2003).

LEGEND

- Stratum 1 - Sand
- Stratum 2 – Solidified Landfill
- Stratum 3 – Organic Silt
- Stratum 4 – Silt & Clay
- Stratum 5 –Sand & Gravel
- Stratum 6 – Red Silt
- Stratum 7 – Green Clay
- Decomposed Rock
- Rock

TEXACO CHEVRON			
Perth Amboy			NJ
MUESER RUTLEDGE CONSULTING ENGINEERS			
225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE N/A	MADE BY: SN	DATE: 9-11-03	FILE No.
	CH'KD BY: PWD	DATE: 9-11-03	9971
SITE-SPECIFIC SEISMIC ANALYSIS SOIL STRATIGRAPHY & PROFILES STUDIED			PLATE 1



LEGEND

- Stratum 1 - Sand
- Stratum 2 – Solidified Landfill
- Stratum 3 – Organic Silt
- Stratum 4 – Silt & Clay
- Stratum 5 –Sand & Gravel
- Stratum 6 – Red Silt
- Stratum 7 – Green Clay
- Decomposed Rock
- Rock

TEXACO CHEVRON			
Perth Amboy			NJ
MUESER RUTLEDGE CONSULTING ENGINEERS			
225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE N/A	MADE BY: JW	DATE: 10-11-03	FILE No.
	CH'KD BY: SN	DATE: 10-11-03	9971
SITE-SPECIFIC SEISMIC ANALYSIS SHEAR WAVE VELOCITY Vs PROFILES			PLATE 2

SEISMIC HAZARD TERM DEFINITIONS

A seismic hazard at a site is commonly described by:

- a return period T_r (or recurrence rate $\lambda = 1 / T_r = 1$ earthquake every T_r years), or
- a probability P of the hazard to be exceeded during a design time period t_d

These parameters are equivalent, i.e., if you know T_r you can calculate P for a design time t_d, and vise versa. The model that generates them in statistics is the Poisson distribution, a probability distribution that characterizes discrete events occurring independently of one another in time. This model says that:

$$P \approx \lambda t_d = t_d / T_r \rightarrow T_r = t_d / P \qquad (1)$$

The New Jersey Administrative Code defines a Seismic Design Earthquake with 90% or greater probability that the acceleration will not be exceeded in 250 years. This is equivalent to

$$P = 10\% \text{ in } t_d = 250 \text{ years} \qquad (2)$$

From Eqn (1):

$$T_r \approx 250 / 0.1 = 2{,}500 \text{ years} \qquad (3)$$

IBC 2000 defines a Maximum Credible Earthquake (MCE) with a return period of 2,500 years. The Seismic Design Earthquake for Occupancy Category I (see Table 1) is equal to:

$$2/3 \times \text{the 2,500-year earthquake} \qquad (4)$$

Note that in the West Coast, such an event is comparable with the 500-year loads, which is not the case in the East, where the 2/3 loads are significantly higher than the 500-year ones, and closer to a 1,000 to 1,500-year earthquake. Figure 1 compares design spectra for a soil profile with $600 < V_s < 1{,}200$ ft/sec within the top 100 ft (Soil Class D) estimated using IBC 2000, for Los Angeles and New York City (after Nikolaou, Deming, & Edinger, 2003).

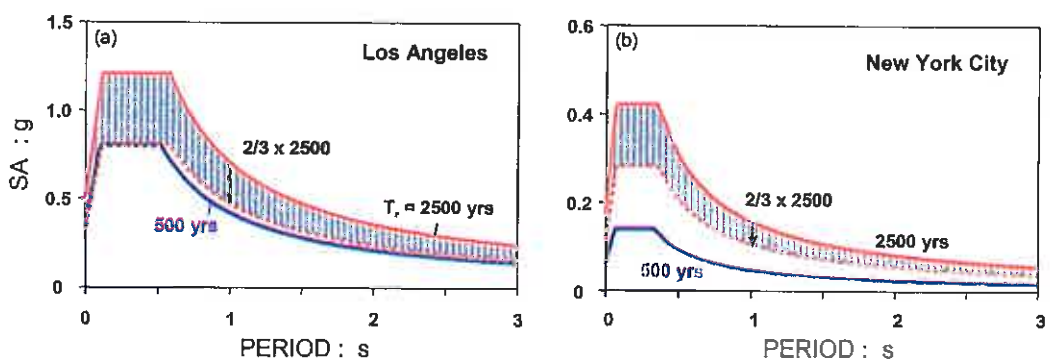


Figure 1. Effect of the "2/3" factor in IBC-2000 for Site Class D, in (a) West and (b) East Coast.

TEXACO CHEVRON			
Perth Amboy			NJ
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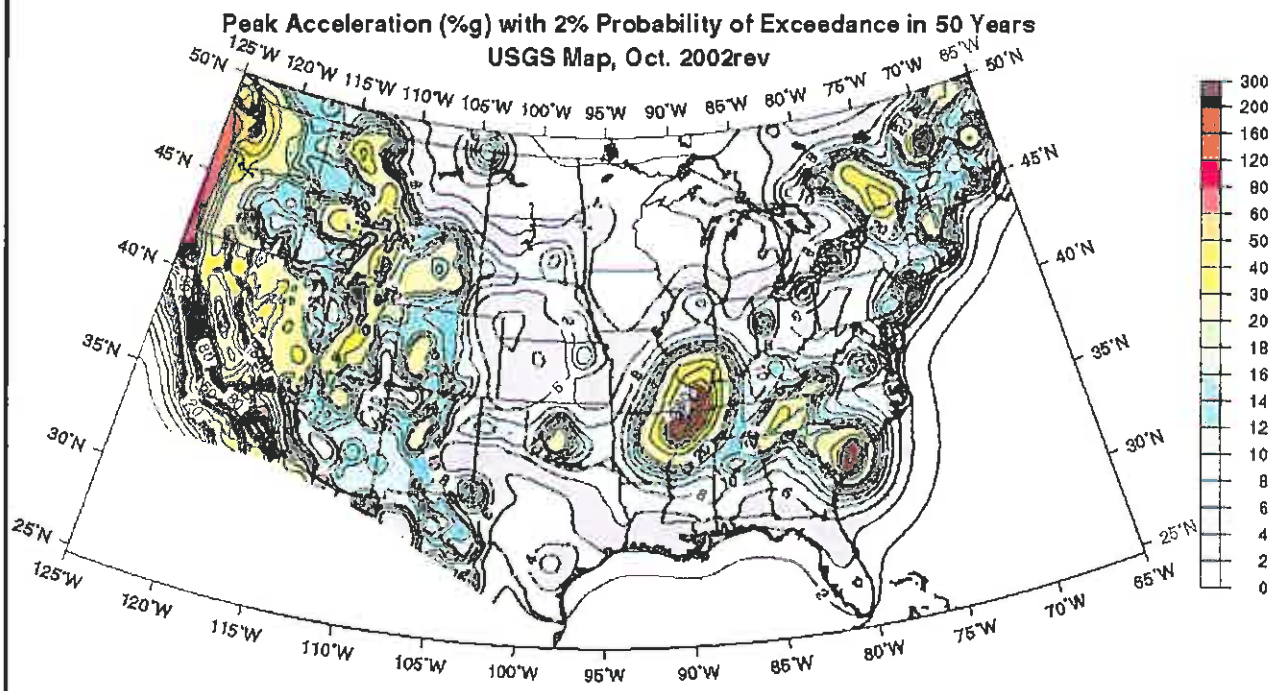
225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE	MADE BY: SN	DATE: 9-24-03	FILE No.
N/A	CH'KD BY: PWD	DATE: 9-26-03	9971
SEISMIC HAZARD TERMS DEFINITIONS			PLATE 3



Chevron Texaco, Perth Amboy, NJ site is located at 40.5208 Lat. -74.2788 Long.

USGS
Earthquake Hazards Program

ZIP CODE 8861, LOCATION 40.5208 Lat. -74.2788 Long.
DISTANCE TO NEAREST GRID POINT 2.9206 kms

Gridded Data Values, 2002, Revised April 2003

PGA	2% PE in 50 yr	
-74.2500	40.5500	20.3368
-74.3000	40.5500	20.1859
-74.2500	40.5000	19.8496
-74.3000	40.5000	19.7338

Note: Rock acceleration selected at the site is $PGA_{r,B}$ = 0.2 g

TEXACO CHEVRON			
Perth Amboy			NJ
MUESER RUTLEDGE CONSULTING ENGINEERS 225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE N/A	MADE BY: SN CH'KD BY: PWD	DATE: 9-11-03 DATE: 9-11-03	FILE No. 9971
2002 USGS EARTHQUAKE HAZARD MAP Tr = 2,500 YEARS, ROCK "B" CONDITIONS			PLATE 4

SEISMIC SITE FACTOR F RESULTS

V_s Variation	Seismic Motion	Profile 1	Profile 2
		Site Factor F	
Average	1	1.10	1.76
	2	1.13	1.48
	3	1.22	1.66
Upper	1	1.49	1.58
	2	1.60	1.51
	3	1.34	1.68
Lower	1	0.98	1.28
	2	1.03	1.30
	3	1.33	1.37
Mean Site Factor		1.25	1.51

TEXACO CHEVRON			
Perth Amboy			NJ
MUESER RUTLEDGE CONSULTING ENGINEERS			
225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE	MADE BY: SN	DATE: 9-13-03	FILE No.
N/A	CH'KD BY: PWD	DATE: 9-13-03	9971
SITE-SPECIFIC SEISMIC ANALYSIS SITE FACTOR F RESULTS			PLATE 5

Category	*Nature of Occupancy*
I	Buildings and other structures except those listed in Categories II, III, IV
II	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: ▪ Buildings and other structures where > 300 people congregate in one area ▪ Buildings and other structures with elementary school, secondary school or ▪ Day-care facilities with capacity > 250 ▪ Buildings and other structures with a capacity > 500 for colleges or adult education facilities ▪ Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities ▪ Jails and detention facilities ▪ Any other occupancy with an occupant load greater that 5,000 ▪ Power-generating stations, water treatment for potable water, wastewater ▪ Treatment facilities and other public utility facilities not included in Category III ▪ Buildings and other structures not included in Category III containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released
III	Buildings and other structures designated as essential facilities including, but not limited to: ▪ Hospitals and other health care facilities having surgery or emergency treatment facilities ▪ Fire, rescue and police stations and emergency vehicle garages ▪ Designated earthquake, hurricane or other emergency shelters ▪ Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response ▪ Power-generating stations and other public utility facilities required as emergency back-up facilities for Category III structures ▪ Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the exempt amounts of Table 307.7(2) ▪ Aviation control towers, air traffic control centers and emergency aircraft hangars ▪ Buildings and other structures having critical national defense functions ▪ Water treatment facilities required to maintain water pressure for fire suppression
IV	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: ▪ Agricultural facilities ▪ Certain temporary facilities ▪ Minor storage facilities

TEXACO CHEVRON			
Perth Amboy			NJ
MUESER RUTLEDGE CONSULTING ENGINEERS 225 WEST 34TH STREET, NEW YORK NY 10122			
SCALE	MADE BY: SN	DATE: 9-25-03	FILE No.
N/A	CH'KD BY: PWD	DATE: 9-26-03	9971
CLASSIFICATION OF STRUCTURES ACCORDING TO IBC TABLE 1604.5			PLATE 6

ATTACHMENT B-2

STRATUM 3/4 UNDRAINED SHEAR STRENGTH (S_U) CALCULATION METHODOLOGY

UNDRAINED SHEAR STRENGTH FOR STRATUM 3/4

CAMU Stability Analyses

Chevron Perth Amboy Facility, NJ

Assumptions

- All elevations (EL.) noted are in feet, NGVD
- Existing ground surface in tank basins/cells = EL. 9'
- Groundwater table is 2 ft (bgs)
- Stratum 1 layer thickness = 10 ft
- Stratum 3/4 layer thickness = 8 ft
- Stratum 1 unit weight = 120 pcf
- Stratum 3/4 unit weight = 85 pcf
- Stress at mid-depth of Stratum 3/4 represents average stress in the stratum.

Stage 1 – Existing / End of Construction

σ_{v1} = (10 x 120) + (4 x 85) – (12 * 62.4) = 791 psf

Using S_{u1} = 300 psf (see Table A-13 and Figure A-5 in Appendix A)

(*Note:* Table A-13 and Figure A-5 are included in this attachment for ready reference)

Stage 2 – Waste Raised to Top of Perimeter Berm (EL. 17')

Waste loading = EL. 17 – EL. 9 = 8'

$\Delta\sigma_{1-2}$ = 8 x 120 = 960 psf

$\sigma_{v2} = \sigma_{v1} + \Delta\sigma_{1-2}$ = 791 + 960 = 1,751 psf

S_{u2} = 1,751* 0.25 = 438 psf

Using S_{u2} = 450 psf

Stage 3 – Waste Raised to EL. 30'

Surcharge = EL. 30 – EL. 9 = 21'

$\Delta\sigma_{1-3}$ = 21 x 120 = 2,520 psf

$\sigma_{v3} = \sigma_{v1} + \Delta\sigma_{1-3}$ = 791 + 2,520 = 3,311 psf

S_{u3} = 3,311 * 0.25 = 828 psf

Using 80 % of peak strength to restrict strain to less than 5 % for strain compatibility,

S_{u3} = 828 * 0.8 = 662 psf

Using S_{u3} = 700 psf

Stage 4 – Waste Raised to Full Height (~EL. 40')

Surcharge = EL. 40 – EL. 9 = 31'

$\Delta\sigma_{1-4}$ = 31 x 120 = 3,720 psf

$\sigma_{v4} = \sigma_{v1} + \Delta\sigma_{1-4} =$ 791 + 3,720 = 4,511 psf

S_{u4} = 4,511 * 0.25 = 1,128 psf

Using 80 % of peak strength to restrict strain to less than 5 % for strain compatibility,

S_{u4} = 1,128 * 0.8 = 902 psf

Using S_{u4} = 900 psf

Proposed Berms (Crest EL. 17')

The proposed berms include the intercell berms (modeled in Section 2) and the perimeter berm on south side of the CAMU cells (modeled in Section 4). The loading due to these proposed berms is same as that discussed for Stage 2 above. As a result, S_u of 450 psf was used under the proposed berms as well.

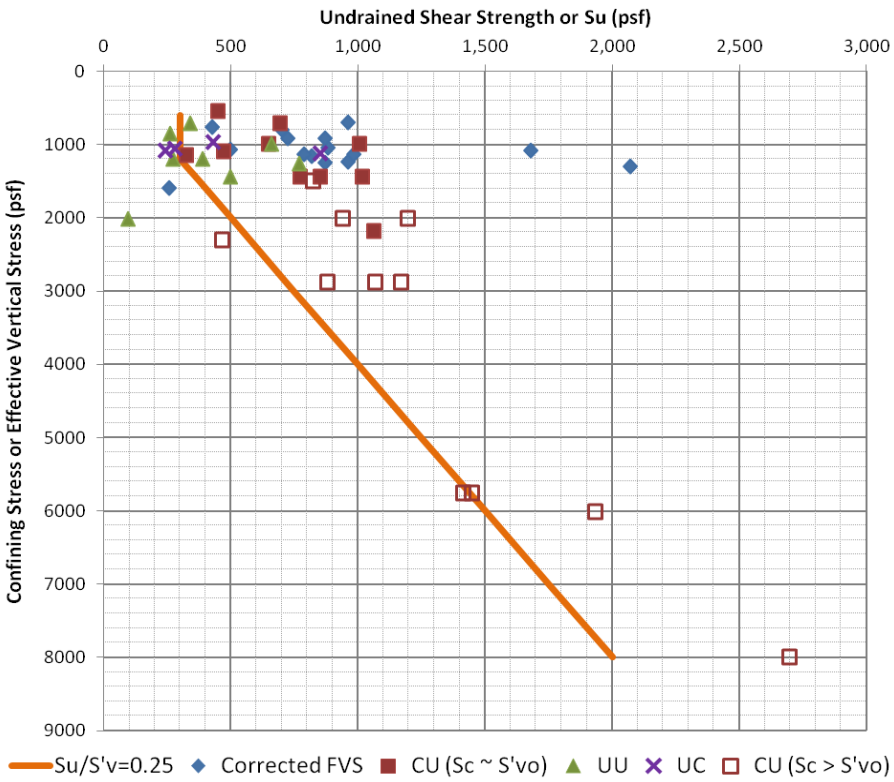
Table A-13

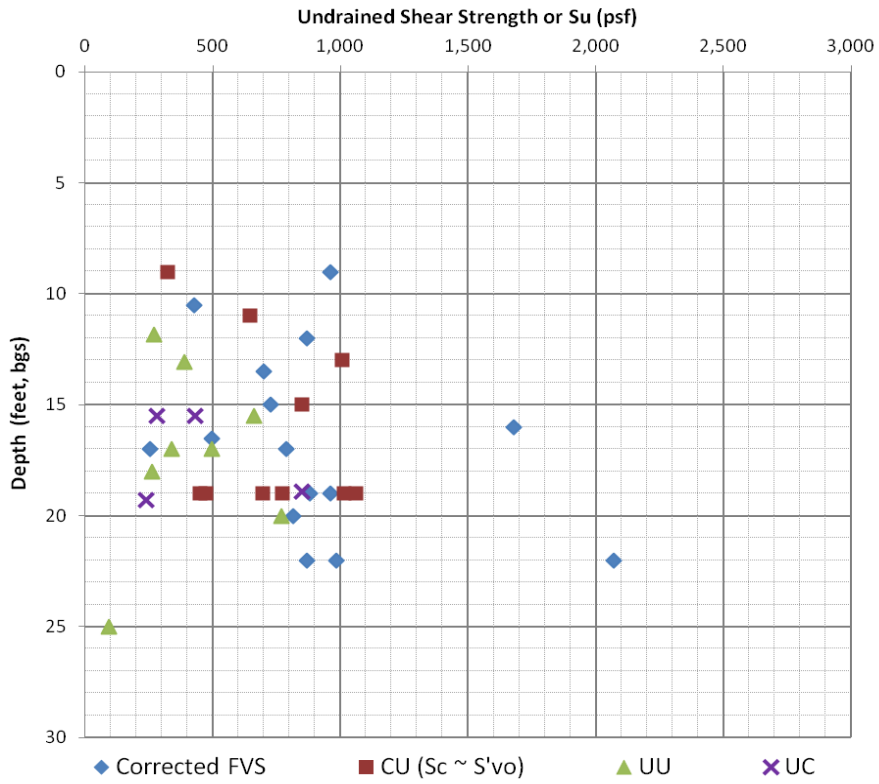
GEOTECHNICAL PROPERTIES SELECTED FOR USE IN CAMU DESIGN AND ANALYSES
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Stratum (Ground surface to Bedrock)	Thickness	Total Unit Weight	Modified Compression Index	Modified Re-Compression Index	Ratio for Secondary Compression	Coefficient of Consolidation	Undrained Shear Strength	Effective Cohesion	Effective Friction Angle
	(feet)	γ_t (pcf)	$C_{c\epsilon}$	$C_{r\epsilon}$	$C_{\alpha\epsilon}/C_{c\epsilon}$	Cv (ft^2/yr)	Su (psf)	c' (psf)	ϕ' (degrees)
Stratum 1 - Fill	9-11	120						0	30
Stratum 3 - Peat	4-8	70	0.490	NA[1]	0.050	15	300 [3]	550	11
Stratum 4 - Organic Silts/Clays		95	0.245	NA[1]	0.035	25	(Su/σ_v' = 0.25) [4]	0	18
Stratum 6 - Red-Brown Silt and Clay	10	125	0.081	0.010 [2]	0.016	85	1,000	0	22
Stratum 5 - Red Brown Sands and Gravel	20	120						0	30
Stratum 8 - Tan/Gray Sands	20	120						0	30
Stratum 7 - Gray Green Clays	Not needed as part of CAMU design and analyses								
Stratum 9 - Weathered Saprolites									

Notes:

1. NA - Stratum soils were considered to be normally consolidated.
2. A maximum past pressure of 2,400 psf was used in analyses.
3. Represents existing undrained shear strength in CAMU basin areas.
4. Su/σ_v' of 0.25 was used to evaluate gain in Su with increase in effective stresses due to loading by CAMU.
5. σ_v' = Effective vertical stress; $C_{\alpha\epsilon}$ = Modified secondary compression index.





Legend

FVS	Corrected Field Vane Shear Strength (psf)
Sc	Confining stress (psf)
S'vo	Existing vertical stress (psf)
S'v	Effective vertical stress (psf)
	Undrained shear strength envelop as a function of effective vertical stress selected for use in engineering design and analysis of CAMU

UNDRAINED SHEAR STRENGTH RESULTS FOR STRATUM 3/4

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON PERTH AMBOY	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: A-5	FILE NAME: A-5 Undrained Shear Strength Results	

ATTACHMENT B-3

SLOPE/W OUTPUT FILES FOR REPRESENTATIVE CASES

CAMU Slope

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File Information

SECTION 1, STAGE 3, STATIC UNDRAINED STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 275
Last Edited By: Ali, Syed
Date: 9/17/2012
Time: 3:33:12 PM
File Name: Case 1a.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Section 1\
Last Solved Date: 9/18/2012
Last Solved Time: 9:39:56 AM

Project Settings

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Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

CAMU - Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Dike - Fill Material

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Strength In NFB

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 300 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf

Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Strength Under Berm

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 500 psf
Pore Water Pressure
Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stage 3 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 700 psf
Pore Water Pressure
Piezometric Line: 1

Stage 2/3 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 575 psf
Pore Water Pressure
Piezometric Line: 1

.

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 21) ft

Right Coordinate: (360, 3) ft

Slip Surface Block

Left Grid

Upper Left: (118, -2.5) ft
Lower Left: (118, -9.5) ft
Lower Right: (163, -9.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 2

Right Grid

Upper Left: (243.977, -3) ft
Lower Left: (244, -9.5) ft
Lower Right: (287, -9.5) ft
X Increments: 4
Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	180	7
	295	3
	360	3

Seismic Loads

Horz Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	Dike - Fill Material	2,27,26,7,8,9,14,19,35,17	1253.5
Region 2	Stratum 6 - Red Brown Clay and Silt	4,34,38,18,20,11,12,16,23,5	3600
Region 3	Stratum 5 - Red Brown Sands and Gravel	5,23,16,12,13,6	7560
Region 4	Strength In NFB	19,25,11,20	752
Region 5	Stratum 1 - Fill	1,22,21,32,2,17,37,33,3	1947

Region 6	Stratum 1 - Fill	14,36,15,10,25,19	544.49995
Region 7	CAMU - Stabilized Waste	28,29,30,31,1,22,21,32	3361.5
Region 8	.	26,27,2,32,28	32.5
Region 9	Strength Under Berm	35,19,20,18	704
Region 10	Stage 2/3 Strength	35,18,38,37,17	312
Region 11	Stage 3 Strength	38,34,33,37	856
Region 12	Stage 2/3 Strength	34,4,3,33	256

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	180	9
Point 3	0	-2
Point 4	0	-10
Point 5	0	-20
Point 6	0	-41
Point 7	198	17
Point 8	215	17
Point 9	243	10
Point 10	360	3
Point 11	360	-10
Point 12	360	-20
Point 13	360	-41
Point 14	260	7
Point 15	295	3
Point 16	173	-20
Point 17	174	-2
Point 18	178	-10
Point 19	264	-2
Point 20	268	-10
Point 21	137	9
Point 22	123	9
Point 23	123	-20
Point 24	173	3
Point 25	360	-2
Point 26	192	14
Point 27	183	10.25
Point 28	187	14
Point 29	139	30
Point 30	32	30
Point 31	0	21
Point 32	172	9
Point 33	32	-2
Point 34	32	-10
Point 35	178	-2
Point 36	275	4.85714
Point 37	139	-2

Point 38	139	-10

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	670	1.72	(208.02, 36.75)	79.49	(112.25, 30)	(297.901, 3)

Slices of Slip Surface: 670

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	670	115.75	26.5	-1216.8297	297.3081	171.65091	0
2	670	122.75	19.5	-779.99938	891.91418	514.94689	0
3	670	129.75	12.5	-343.19932	1486.5405	858.25454	0
4	670	134.25	8	-62.398641	1868.7772	1078.939	0
5	670	136.125	6.125	54.600759	2039.4574	1145.9575	0
6	670	138	4.25	171.60068	2223.1792	1184.4794	0
7	670	141.625	0.625	397.79808	2504.1009	1216.0745	0
8	670	148	-5.75	795.59897	3136.3491	0	575
9	670	155.125	-9.5	1029.6	3871.7037	0	575
10	670	161.875	-9.5	1029.6	3601.7778	0	575
11	670	168.625	-9.5	1029.6	3331.7037	0	575
12	670	173	-9.5	1029.6	3156.75	0	575
13	670	176	-9.5	1029.6	3055	0	575
14	670	178.45455	-9.5	1029.6	2974.29	0	500
15	670	179.45455	-9.5	1029.6001	2943.5086	0	500
16	670	181.5	-9.5	1026.3333	2869.7667	0	500
17	670	185	-9.5	1018.75	2737	0	500
18	670	189.5	-9.5	1008.98	2666.4	0	500
19	670	195	-9.5	997.05	2859.1667	0	500
20	670	200.83335	-9.5	984.38818	3046.5881	0	500
21	670	206.5	-9.5	972.08818	3046.5881	0	500
22	670	212.16665	-9.5	959.78818	3046.5881	0	500
23	670	217.8	-9.5	947.55357	2959.1071	0	500
24	670	223.4	-9.5	935.41071	2784.1071	0	500
25	670	229	-9.5	923.25	2609.1071	0	500
26	670	234.6	-9.5	911.08929	2434.1071	0	500
27	670	240.2	-9.5	898.94643	2259.1071	0	500
28	670	245.83335	-9.5	886.71171	2109.1763	0	500
29	670	251.5	-9.5	874.41171	1984.2352	0	500
30	670	257.16665	-9.5	862.11171	1859.1175	0	500
31	670	260.62805	-9.5	854.60696	1778.7925	0	500
32	670	262.62805	-9.5	850.25987	1722.0222	0	500
33	670	265.875	-9.5	843.22667	1650.9333	0	500
34	670	271.375	-9.5	831.28276	1543.0345	0	300
35	670	275.625	-9.5	822.08	1473.92	0	300

36	670	279.4976	-7.625	696.65333	1471.4667	0	300
37	670	285.9928	-3.875	448.54667	1051.9333	0	300
38	670	292.1202	-0.337341	214.50583	547.0004	191.96583	0
39	670	296.4503	2.162659	52.24871	126.25677	42.728572	0

CAMU Slope

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File Information

SECTION 2, STAGE 4, STATIC, UNDRAINED STABILITY ANALYSES

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Revision Number: 229
Last Edited By: Ali, Syed
Date: 9/18/2012
Time: 10:03:40 AM
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Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Section 2\
Last Solved Date: 9/18/2012
Last Solved Time: 10:03:52 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Dike - Fill Material

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Strength Under Berm

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 450 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stage 4 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 900 psf
Pore Water Pressure
Piezometric Line: 1

Strength CAMU Existing Conditions

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 300 psf
Pore Water Pressure
Piezometric Line: 1

Stage 2/3 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 575 psf
Pore Water Pressure
Piezometric Line: 1

Stage 3/4 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 800 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 9) ft

Right Coordinate: (318, 32) ft

Slip Surface Block

Left Grid

Upper Left: (88.9617, -2.5) ft
Lower Left: (88.9617, -7.5) ft
Lower Right: (149.0057, -7.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 145 °
Ending Angle: 165 °
Angle Increments: 2

Right Grid

Upper Left: (188.969, -3) ft
Lower Left: (189.003, -7.5) ft
Lower Right: (252.052, -7.5) ft
X Increments: 4
Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	222	7
	282	7
	318	7

Seismic Loads

Horz Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	Dike - Fill Material	2,7,8,22,23,14	277.5
Region 2	Stratum 6 - Red Brown Clay and Silt	4,16,32,27,30,10,11,17,20,5	3180
Region 3	Stratum 5 - Red Brown Sands and Gravel	5,20,17,11,12,6	6678
Region 4	Stratum 1 - Fill	1,19,2,14,13,15,21,9,29,26,31,18,3	3498.252
Region 5	Stage 4 Strength	9,29,30,10	384

Region 6	Stabilized Waste	21,28,25,24,23,14,13,15	3525.248
Region 7	Strength CAMU Existing Conditions	18,16,4,3	822
Region 8	Strength Under Berm	18,31,32,16	252
Region 9	Stage 3/4 Strength	29,30,27,26	216
Region 10	Stage 2/3 Strength	31,26,27,32	234

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	125	9
Point 3	0	-2
Point 4	0	-8
Point 5	0	-18
Point 6	0	-39
Point 7	149	17
Point 8	159	17
Point 9	318	-2
Point 10	318	-8
Point 11	318	-18
Point 12	318	-39
Point 13	219	9
Point 14	185	9
Point 15	243	9
Point 16	137	-8
Point 17	128	-18
Point 18	137	-2
Point 19	61	9
Point 20	61	-18
Point 21	318	9.00672
Point 22	165	14
Point 23	170	14
Point 24	254	42
Point 25	289	42
Point 26	218	-2
Point 27	218	-8
Point 28	318	32
Point 29	254	-2
Point 30	254	-8
Point 31	179	-2
Point 32	179	-8

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	612	1.48	(187.837, 50.25)	85.597	(285.79, 42)	(98.6103, 9)

Slices of Slip Surface: 612

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	612	100.75482	8	-62.399589	171.94013	99.269682	0
2	612	106.1161	5.5	93.600081	570.11201	275.11429	0
3	612	112.54965	2.5	280.80165	1022.5953	428.27475	0
4	612	118.98315	-0.5	467.99336	1475.0786	581.44091	0
5	612	123.59995	-2.6528515	602.35212	1604.0174	0	300
6	612	129.49735	-5.4028515	773.93914	2046.8428	0	300
7	612	135.49735	-7.5	904.80152	2235.9831	0	300
8	612	140	-7.5	904.8	2430.3333	0	450
9	612	146	-7.5	904.8	2670.3333	0	450
10	612	151.5	-7.5	904.8	2790.4	0	450
11	612	156.5	-7.5	904.8	2790.4	0	450
12	612	162	-7.5	904.8	2610.3333	0	450
13	612	167.5	-7.5	904.8	2430.4	0	450
14	612	174.5	-7.5	904.8	2610.4444	0	450
15	612	182	-7.5	904.8	2922.3333	0	575
16	612	188.3	-7.5	904.80303	3174.2424	0	575
17	612	194.9	-7.5	904.80303	3438.3333	0	575
18	612	201.5	-7.5	904.80303	3702.2727	0	575
19	612	208.1	-7.5	904.80303	3966.3636	0	575
20	612	214.7	-7.5	904.80303	4230.303	0	575
21	612	218.5	-7.5	904.8	4403.8	0	800
22	612	220.5	-7.5	904.8	4483.6667	0	800
23	612	225.57245	-7.5	904.80239	4686.716	0	800
24	612	232.71735	-7.5	904.80239	4972.5153	0	800
25	612	239.0398	-4.75	733.20541	3900.7865	0	800
26	612	242.3949	-1.394875	523.84035	3334.1085	1622.509	0
27	612	246.8949	3.105125	243.03831	3026.5868	1607.0825	0
28	612	251.7902	8.0004385	-62.427818	2706.1125	1562.3748	0
29	612	253.3953	9.6055635	-162.58447	2619.0558	1512.1126	0
30	612	257.5	13.71025	-418.71833	2301.5315	1328.7899	0
31	612	264.5	20.71025	-855.51839	1732.0075	999.97502	0
32	612	271.5	27.71025	-1292.2881	1162.5846	671.21851	0
33	612	278.5	34.71025	-1729.0781	593.06056	342.40367	0
34	612	283.8949	40.105125	-2065.6716	154.15758	89.002919	0

CAMU Slope

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File Information

SECTION 3, STAGE 4, DRAINED, STATIC STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 274
Last Edited By: Ali, Syed
Date: 9/18/2012
Time: 12:47:03 PM
File Name: Case 1e.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Section 3\
Last Solved Date: 9/18/2012
Last Solved Time: 12:47:22 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

CAMU - Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Dike - Fill Material

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 3/4 - Peat and Organic Silts/Clays

Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 18 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brwon Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

.

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 20) ft
Right Coordinate: (247.20696, 15.752532) ft

Slip Surface Block

Left Grid
Upper Left: (112.019, -2.5) ft
Lower Left: (112.019, -9.5) ft
Lower Right: (166.961, -9.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 2
Right Grid
Upper Left: (193.932, -3) ft
Lower Left: (193.962, -9.5) ft
Lower Right: (250.071, -9.5) ft
X Increments: 4

Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	181	7
	360	7

Seismic Loads

Horz Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	Dike - Fill Material	2,29,7,8,17,34,18	730.375
Region 2	Stratum 6 - Red Brown Clay and Silt	4,25,19,15,21,11,12,16,26,5	3600
Region 3	Stratum 5 - Red Brwon Sands and Gravel	5,26,16,12,13,6	7560
Region 4	Stratum 1 - Fill	1,23,22,35,36,2,18,24,3	1970.5001
Region 5	Stratum 1 - Fill	8,9,14,10,28,20,17	2400.5
Region 6	CAMU - Stabilized Waste	30,31,32,33,1,23,22,35,36	4201.4166
Region 7	Stratum 3/4 - Peat and Organic Silts/Clays	24,18,34,17,20,28,11,21,15,19,25,4,3	2880
Region 8	.	30,36,2,29	23.70834

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	183	10.25
Point 3	0	-2
Point 4	0	-10
Point 5	0	-20
Point 6	0	-41
Point 7	198	17
Point 8	213	17
Point 9	243	16
Point 10	360	15
Point 11	360	-10
Point 12	360	-20

Point 13	360	-41
Point 14	260	15
Point 15	229	-10
Point 16	173	-20
Point 17	229	-2
Point 18	173	-2
Point 19	190	-10
Point 20	264	-2
Point 21	264	-10
Point 22	137	9
Point 23	123	9
Point 24	152	-2
Point 25	152	-10
Point 26	123	-20
Point 27	173	3
Point 28	360	-2
Point 29	192	14
Point 30	187	14
Point 31	103	42
Point 32	68	42
Point 33	0	20
Point 34	190	-2
Point 35	153	9
Point 36	175	9.91667

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	301	2.32	(159.377, 48.462)	76.759	(74.2545, 42)	(238.395, 16.1535)

Slices of Slip Surface: 301

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	301	77.12905	39.12545	-2004.6849	257.61166	148.73216	0
2	301	82.87815	33.37635	-1645.9103	772.83498	446.19648	0
3	301	88.62725	27.62725	-1287.1358	1287.9968	743.6253	0
4	301	94.37635	21.87815	-928.39823	1803.2201	1041.0896	0
5	301	100.12545	16.12905	-569.64832	2318.4434	1338.5539	0
6	301	105.12725	11.12725	-257.54674	2703.2768	1560.7376	0
7	301	108.2545	8	-62.398641	2890.0516	1668.5721	0
8	301	111.5045	4.75	140.39998	3107.1843	1712.8738	0
9	301	116.0045	0.25	421.19994	3422.0826	1732.5604	0

10	301	120.62725	-4.37275	709.65483	3913.1892	1040.8914	0
11	301	124.37725	-8.12275	943.6648	4072.1857	1016.5181	0
12	301	128.5659	-9.5	1029.603	4960.7399	1277.3038	0
13	301	134.18865	-9.5	1029.603	4732.0261	1202.9902	0
14	301	139.5	-9.5	1029.6	4516	1132.8	0
15	301	144.5	-9.5	1029.6	4312.6	1066.7114	0
16	301	149.5	-9.5	1029.6	4109.2	1000.6227	0
17	301	152.5	-9.5	1029.6	3987.1	960.95	0
18	301	155.5	-9.5	1029.6	3865	921.27731	0
19	301	160.5	-9.5	1029.6	3661.6	855.18864	0
20	301	165.5	-9.5	1029.6	3458.2	789.09997	0
21	301	170.5	-9.5	1029.6	3254.8	723.01131	0
22	301	174	-9.5	1029.6	3118.65	678.77349	0
23	301	177.67345	-9.5	1029.5984	2992.1793	637.68117	0
24	301	180.67345	-9.5	1029.5972	2888.7032	604.06016	0
25	301	182	-9.5	1029.6	2843.05	589.22562	0
26	301	185	-9.5	1029.6	2731.5	552.98083	0
27	301	188.5	-9.5	1029.6	2657.5	528.93677	0
28	301	191	-9.5	1029.6	2662.8	530.65885	0
29	301	192.981	-9.5	1029.6126	2727.2681	551.60169	0
30	301	195.981	-8.33433	956.85294	3232.4751	739.39445	0
31	301	200.2381	-5.876495	803.49646	3151.1069	762.78486	0
32	301	204.7143	-3.292165	642.23609	2906.5561	735.72215	0
33	301	209.9762	-0.254203	452.65852	2639.4818	0	1000
34	301	215.10525	2.7070685	267.87898	2219.504	0	1000
35	301	219.3158	5.138017	116.18716	1848.1675	0	1000
36	301	221.60425	6.45924	33.742676	1646.3532	0	1000
37	301	222.1641	6.7824945	13.572077	1567.2025	896.98893	0
38	301	225.1832	8.52558	-95.196425	1278.2331	737.98821	0
39	301	230.468	11.576745	-285.59583	766.93656	442.79103	0
40	301	235.7528	14.62791	-475.98212	255.64006	147.59386	0

CAMU Slope

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File Information

SECTION 4, STAGE 4, DRAINED, PSEUDO-STATIC STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 211
Last Edited By: Ali, Syed
Date: 9/18/2012
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File Name: Case 1f.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Section 4\
Last Solved Date: 9/18/2012
Last Solved Time: 1:12:14 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Proposed Berm

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

St. 3/4 - Peat and Organic Silts/Clays

Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 18 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 9) ft
Right Coordinate: (318, 33) ft

Slip Surface Block

Left Grid
Upper Left: (96, -0.5) ft
Lower Left: (96, -3.5) ft
Lower Right: (141, -3.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 145 °
Ending Angle: 165 °
Angle Increments: 2
Right Grid
Upper Left: (201.977, -0.5) ft
Lower Left: (202, -3.5) ft
Lower Right: (245, -3.5) ft
X Increments: 4
Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	222	7
	282	7
	318	7

Seismic Loads

Horz Seismic Load: 0.085
Ignore seismic load in strength: No

Regions

	Material	Points	Area (ft²)
Region 1	Proposed Berm	2,7,8,22,23,14	317.5
Region 2	Stratum 6 - Red Brown Clay and Silt	4,16,27,10,11,17,20,5	3180
Region 3	Stratum 5 - Red Brown Sands and Gravel	5,20,17,11,12,6	6678
Region 4	Stratum 1 - Fill	1,19,2,14,13,15,21,9,26,18,3	2862.252
Region 5	Stabilized Waste	21,25,28,24,23,14,13,15	3539.748
Region 6	St. 3/4 - Peat and Organic Silts/Clays	18,26,9,10,27,16,4,3	1272

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	120	9
Point 3	0	0
Point 4	0	-4
Point 5	0	-14
Point 6	0	-35
Point 7	144	17
Point 8	159	17
Point 9	318	0
Point 10	318	-4
Point 11	318	-14
Point 12	318	-35
Point 13	219	9
Point 14	185	9
Point 15	243	9
Point 16	137	-4
Point 17	128	-14
Point 18	137	0
Point 19	61	9
Point 20	61	-14

Point 21	318	9.00672
Point 22	165	14
Point 23	170	14
Point 24	254	42
Point 25	318	33
Point 26	210	0
Point 27	210	-4
Point 28	289	42

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	485	1.27	(167.868, 50.25)	88.474	(272.047, 42)	(71.8494, 9)

Slices of Slip Surface: 485

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	485	75.581415	8	-62.399975	165.76065	95.701955	0
2	485	82.579015	6.125	54.600464	459.05623	233.51265	0
3	485	89.1101	4.375	163.79548	714.1187	317.72926	0
4	485	95.641185	2.625	273.00232	969.16637	401.9305	0
5	485	102.17227	0.875	382.19437	1224.214	486.14028	0
6	485	108.70335	-0.875	491.40122	1320.8645	269.50895	0
7	485	115.23445	-2.625	600.59327	1483.8465	286.98637	0
8	485	119.25	-3.5	655.2	1394.3333	240.15898	0
9	485	122.83335	-3.5	655.19996	1512.4587	278.54026	0
10	485	128.5	-3.5	655.19996	1748.7705	355.3226	0
11	485	134.16665	-3.5	655.19996	1985.1175	432.11641	0
12	485	140.5	-3.5	655.2	2249.2857	517.94985	0
13	485	147.75	-3.5	655.2	2395.2	565.36027	0
14	485	155.25	-3.5	655.2	2395.2	565.36027	0
15	485	162	-3.5	655.2	2207.5	504.37284	0
16	485	167.5	-3.5	655.2	2019.8	443.38542	0
17	485	173.75	-3.5	655.2	2176.2667	494.22452	0
18	485	181.25	-3.5	655.2	2489.0667	595.8594	0
19	485	188.125	-3.5	655.2	2775.68	688.98572	0
20	485	194.375	-3.5	655.2	3036.32	773.67279	0
21	485	200.625	-3.5	655.2	3296.96	858.35986	0
22	485	206.875	-3.5	655.2	3557.6	943.04693	0
23	485	211.375	-3.5	655.2	3745.4545	1004.0846	0
24	485	215.03065	-1.75	546.00679	2759.4285	719.18429	0
25	485	218.15565	0.647897	396.37335	2501.0171	1215.1166	0
26	485	220.5	2.4467845	284.12629	2397.8577	1220.3634	0
27	485	224.21695	5.2988875	106.14866	2234.3036	1228.6908	0
28	485	227.7371	8	-62.401095	2089.8782	1206.5917	0
29	485	232.16025	11.39403	-274.19352	1931.0262	1114.8785	0

30	485	238.4002	16.18209	-572.9635	1706.7485	985.39169	0
31	485	244.64015	20.97015	-871.73348	1482.5979	855.97828	0
32	485	250.88005	25.75821	-1170.5162	1258.4346	726.55754	0
33	485	257.0078	30.4602	-1463.9012	955.28125	551.53189	0
34	485	263.0234	35.07612	-1751.9336	573.17666	330.9237	0
35	485	269.039	39.69204	-2039.9661	191.05889	110.3079	0

CAMU Slope

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File Information

BOTTOM LINER EAST WEST ALIGNMENT PSEUDO-STATIC STABILITY ANALYSES

Created By: Gupta, Ayushma
Revision Number: 249
Last Edited By: Ali, Syed
Date: 10/11/2012
Time: 12:33:22 PM
File Name: Section 5 East to West Seismic.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\bottom liner EW cell3\
Last Solved Date: 10/11/2012
Last Solved Time: 12:53:20 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Existing Berm - Fill Material

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 22 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Silt and Clay

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 3/4 - Peat and Organic Silts/Clays

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 900 psf
Pore Water Pressure
Piezometric Line: 1

Liner

Model: Mohr-Coulomb
Unit Weight: 60 pcf
Cohesion: 0 psf
Phi: 13 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (87, 15) ft
Right Coordinate: (236.72977, 33.408288) ft

Slip Surface Block

Left Grid
Upper Left: (108.522, 10) ft
Lower Left: (108.522, 9.2009) ft
Lower Right: (126.003, 9.5009) ft
X Increments: 4
Y Increments: 4
Starting Angle: 145 °
Ending Angle: 165 °
Angle Increments: 2
Right Grid
Upper Left: (134.004, 10.5) ft
Lower Left: (134.029, 9.6) ft
Lower Right: (179, 10.5) ft
X Increments: 5
Y Increments: 3
Starting Angle: 30 °

Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	142	7
	202	7
	238	7

Seismic Loads

Horz Seismic Load: 0.085
Ignore seismic load in strength: No

Regions

	Material	Points	Area (ft²)
Region 1	Stratum 6 - Red Brown Silt and Clay	2,8,9,12,3	2380
Region 2	Stratum 5 - Red Brown Sands and Gravel	3,12,9,10,4	4998
Region 3	Stabilized Waste	14,18,16,15,26,11,20	3339.582
Region 4	Liner	21,14,20,11,26,24,33,25,34,32,6,31,23,22	155.668
Region 5	Stratum 1 - Fill	7,21,22,23,28,17,19,30	1482.75
Region 6	Existing Berm - Fill Material	28,23,31,6,32,34,5,27,13	830.5
Region 7	Stratum 1 - Fill	5,27,1,29	1091.25
Region 8	Stratum 3/4 - Peat and Organic Silts/Clays	1,27,13,28,17,19,30,7,8,2	1428

Points

	X (ft)	Y (ft)
Point 1	0	-2
Point 2	0	-8
Point 3	0	-18
Point 4	0	-39
Point 5	69	17
Point 6	86.5	14
Point 7	238	-2
Point 8	238	-8
Point 9	238	-18
Point 10	238	-39
Point 11	105	10
Point 12	48	-18

Point 13	57	-2
Point 14	238	9.00672
Point 15	174	42
Point 16	210	42
Point 17	136	-2
Point 18	238	33
Point 19	174	-2
Point 20	188	11.5
Point 21	238	8
Point 22	188	10.5
Point 23	105	9
Point 24	86.5	15
Point 25	82.5	18
Point 26	91.5	15
Point 27	49.5	-2
Point 28	115	-2
Point 29	0	16
Point 30	210	-2
Point 31	91.5	14
Point 32	83.5	17
Point 33	83.5	18
Point 34	82.5	17

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	1269	1.13	(129.827, 48.75)	49.206	(183.441, 42)	(87.625, 15)

Slices of Slip Surface: 1269

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1269	89.562515	14.480855	-466.81435	39.215696	9.0536568	0
2	1269	91.686945	13.911615	-431.28559	112.61633	45.499951	0
3	1269	93.501155	13.425495	-400.9387	273.86051	63.225681	0
4	1269	96.75569	12.553445	-346.5364	591.68805	136.60195	0
5	1269	100.01023	11.681395	-292.11926	909.5245	209.98028	0
6	1269	103.9208	10.633565	-226.72864	1710.4803	987.54625	0
7	1269	107.36305	9.7112175	-169.18019	1558.2846	359.75835	0
8	1269	110.1959	9.445308	-152.5863	1403.7964	324.09193	0
9	1269	113.5437	9.5345745	-158.15813	1530.0732	353.24524	0
10	1269	116.8915	9.623841	-163.72697	1656.3203	382.39166	0
11	1269	120.2393	9.713107	-169.2988	1782.5971	411.54498	0

12	1269	123.5871	9.8023735	-174.86765	1908.8442	440.6914	0
13	1269	126.9349	9.89164	-180.43948	2035.121	469.84471	0
14	1269	130.2827	9.9809065	-186.00832	2161.3681	498.99113	0
15	1269	133.6305	10.070175	-191.58015	2287.6449	528.14445	0
16	1269	136.9783	10.15944	-197.14899	2413.8919	557.29087	0
17	1269	140.3261	10.248705	-202.71783	2540.1688	586.44418	0
18	1269	143.6668	10.337785	-208.27867	2666.1565	615.53073	0
19	1269	147.0004	10.42667	-213.82329	2791.8626	644.55226	0
20	1269	150.33395	10.515555	-219.37091	2917.5986	673.58072	0
21	1269	152.1481	10.70737	-231.33872	1862.8829	430.0804	0
22	1269	153.8458	12.40506	-337.26517	1578.526	911.36238	0
23	1269	156.94645	15.505705	-530.76675	1435.3553	828.70277	0
24	1269	160.0471	18.606355	-724.24553	1292.1847	746.04316	0
25	1269	163.14775	21.707005	-917.72431	1149.0368	663.39671	0
26	1269	166.2484	24.80765	-1111.2031	1005.8662	580.7371	0
27	1269	169.34905	27.908295	-1304.6819	862.69552	498.07749	0
28	1269	172.4497	31.008945	-1498.1607	719.54767	415.43104	0
29	1269	175.57345	34.132725	-1693.0822	539.97345	311.75382	0
30	1269	178.72035	37.279635	-1889.4464	323.97059	187.04451	0
31	1269	181.86725	40.426545	-2085.8106	107.99244	62.349466	0

CAMU Slope

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File Information

BOTTOM LINER NORTH SOUTH ALIGNMENT STATIC STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 245
Last Edited By: Ali, Syed
Date: 10/11/2012
Time: 12:35:02 PM
File Name: Section 6 Liner NS Static.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\bottom Liner NS cell 3\
Last Solved Date: 10/11/2012
Last Solved Time: 12:35:20 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Proposed Berm

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 3/4 - Peat and Organic Silts/Clays

Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 18 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Bottom Liner

Model: Mohr-Coulomb
Unit Weight: 60 pcf
Cohesion: 0 psf
Phi: 14.5 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (65, 15) ft
Right Coordinate: (218, 32) ft

Slip Surface Block

Left Grid
Upper Left: (78.0011, 13.25) ft
Lower Left: (78.0011, 12.5) ft
Lower Right: (101.501, 11.25) ft
X Increments: 4
Y Increments: 4
Starting Angle: 145 °
Ending Angle: 165 °
Angle Increments: 2
Right Grid
Upper Left: (108.008, 11.75) ft
Lower Left: (108.003, 11) ft
Lower Right: (148.991, 10.5) ft
X Increments: 4

Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	122	7
	182	7
	218	7

Seismic Loads

Horz Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	Proposed Berm	2,7,47,8,20,21,33,14	321.25
Region 2	Stratum 6 - Red Brown Clay and Silt	4,15,32,30,26,28,10,11,16,5	2180
Region 3	Stratum 5 - Red Brown Sands and Gravel	5,16,11,12,6	4578
Region 4	Stratum 1 - Fill	1,18,2,14,33,34,13,35,36,19,9,27,25,29,31,17,3	2182.5
Region 5	Stabilized Waste	37,23,24,22,45,42,41,40,39,38	3195.25
Region 6	Bottom Liner	19,37,38,39,40,41,42,45,43,46,44,47,8,20,21,33,34,13,35,36	160
Region 7	Stratum 3/4 - Peat and Organic Silts/Clays	9,27,25,29,31,17,3,4,15,32,30,26,28,10	872

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	20	9
Point 3	0	0
Point 4	0	-4
Point 5	0	-14

Point 6	0	-35
Point 7	44	17
Point 8	59	17
Point 9	218	0
Point 10	218	-4
Point 11	218	-14
Point 12	218	-35
Point 13	133	10.5
Point 14	85	9
Point 15	37	-4
Point 16	28	-14
Point 17	37	0
Point 18	4	9
Point 19	218	10.5
Point 20	65	14
Point 21	70	14
Point 22	154	42
Point 23	218	32
Point 24	189	42
Point 25	154	0
Point 26	154	-4
Point 27	189	0
Point 28	189	-4
Point 29	118	0
Point 30	118	-4
Point 31	81	0
Point 32	81	-4
Point 33	76	12.5
Point 34	104	11
Point 35	171	10
Point 36	209	10.5
Point 37	218	11.5
Point 38	209	11.5
Point 39	171	11
Point 40	133	11.5
Point 41	104	12
Point 42	76	13.5
Point 43	65	15
Point 44	58	18
Point 45	70	15
Point 46	59	18
Point 47	58	17

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	167	1.51	(100.151, 44.208)	39.76	(142.695, 38.3662)	(68.671, 15)

Slices of Slip Surface: 167

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	167	69.335485	14.821945	-488.09152	13.097514	3.3872473	0
2	167	71.5	14.241965	-451.89223	154.27121	39.897248	0
3	167	74.5	13.438115	-401.72849	410.42182	106.1423	0
4	167	77.00055	12.768095	-359.92819	609.50209	157.62796	0
5	167	79.18287	12.470465	-341.35623	649.12077	167.87404	0
6	167	81.546405	12.41139	-337.67223	758.66809	196.20491	0
7	167	83.90994	12.352315	-333.98399	868.25771	224.54671	0
8	167	86.27348	12.29324	-330.29999	977.80504	252.87758	0
9	167	88.637015	12.234165	-326.61175	1087.3524	281.20844	0
10	167	91.00055	12.17509	-322.92352	1196.8997	309.5393	0
11	167	93.364085	12.116015	-319.23951	1306.447	337.87017	0
12	167	95.72762	12.05694	-315.55128	1415.9943	366.20103	0
13	167	98.09116	11.997865	-311.86727	1525.5417	394.5319	0
14	167	100.45471	11.93879	-308.17904	1635.089	422.86276	0
15	167	102.81825	11.879715	-304.49504	1744.6363	451.19363	0
16	167	105.002	11.825135	-301.08858	1843.5359	476.7708	0
17	167	107.006	11.775045	-297.96082	1931.7319	499.57984	0
18	167	108.1233	11.83846	-301.91838	1397.1962	361.3395	0
19	167	109.38535	12.80688	-362.33338	1259.5365	727.19376	0
20	167	111.6789	14.5668	-472.15758	1172.7841	677.1072	0
21	167	113.9725	16.32672	-581.98178	1086.0662	627.04061	0
22	167	116.2661	18.08664	-691.80597	999.34832	576.97402	0
23	167	118.55965	19.84656	-801.63017	912.63044	526.90743	0
24	167	120.8532	21.60648	-911.45437	825.87797	476.82087	0
				-			

25	167	123.29345	23.478925	1028.2834	733.62066	423.55608	0
26	167	125.8803	25.4639	-1152.1534	635.81888	367.0902	0
27	167	128.46715	27.448875	-1276.0234	537.98644	310.60661	0
28	167	131.05405	29.43385	-1399.8627	440.18466	254.14073	0
29	167	133.6409	31.418825	-1523.7326	342.35222	197.65714	0
30	167	136.22775	33.4038	-1647.6026	244.54124	141.18595	0
31	167	138.81465	35.388775	-1771.4726	146.72413	84.711217	0
32	167	141.40155	37.373745	-1895.3119	48.907021	28.236482	0

CAMU Slope

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File Information

EXISTING PERIMETER BERM (SECTION 1) STATIC UNDRAINED STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 323
Last Edited By: Ali, Syed
Date: 10/11/2012
Time: 1:04:44 PM
File Name: Per Berm cell2 NFB udrained Static test.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Existing perimeterBerm cell 2 NFB\
Last Solved Date: 10/11/2012
Last Solved Time: 1:05:00 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

CAMU - Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
- Piezometric Line: 1

Dike - Fill Material

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Strength in NFB

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 300 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure
- Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf

Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Strength Under Berm

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 500 psf
Pore Water Pressure
Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

.

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stage 2/3 Strength

Model: Undrained (Phi=0)
Unit Weight: 85 pcf
Cohesion: 575 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 30) ft
Right Coordinate: (220, 3) ft

Slip Surface Block

Left Grid
Upper Left: (56, -3.5) ft
Lower Left: (56, -10.5) ft

Lower Right: (101, -10.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 120 °
Ending Angle: 140 °
Angle Increments: 2

Right Grid
Upper Left: (113.977, -3) ft
Lower Left: (114, -9.5) ft
Lower Right: (157, -9.5) ft
X Increments: 4
Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	7
	39	7
	155	3
	220	3

Seismic Loads

Horz Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	Dike - Fill Material	1,22,21,3,4,5,10,15,13	1253.5
Region 2	Stratum 6 - Red Brown Clay and Silt	28,14,16,7,8,12,18	2200
Region 3	Stratum 5 - Red Brown Sands and Gravel	18,12,8,9,2	4620
Region 4	Strength in NFB	15,20,7,16	768
Region 5	Stratum 1 - Fill	17,25,1,13,27	407
Region 6	Stratum 1 - Fill	10,26,11,6,20,15	544.49995
Region 7	CAMU - Stabilized Waste	23,24,17,25	573.5
Region 8	.	25,1,22,21,23	32.5
Region 9	Stage 2/3 Strength	27,13,14,28	272
Region 10	Strength Under Berm	13,15,16,14	720

Points

	X (ft)	Y (ft)
Point 1	40	9
Point 2	0	-41
Point 3	58	17
Point 4	75	17
Point 5	103	10
Point 6	220	3
Point 7	220	-10
Point 8	220	-20
Point 9	220	-41
Point 10	120	7
Point 11	155	3
Point 12	33	-20
Point 13	34	-2
Point 14	34	-10
Point 15	124	-2
Point 16	124	-10
Point 17	0	9
Point 18	0	-20
Point 19	33	3
Point 20	220	-2
Point 21	52	14
Point 22	43	10.25
Point 23	47	14
Point 24	0	30
Point 25	32	9
Point 26	135	4.85714
Point 27	0	-2
Point 28	0	-10

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	1387	2.46	(105.127, 16.75)	44.506	(51.3876, 14)	(157.151, 3)

Slices of Slip Surface: 1387

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1387	51.489205	13.91475	-458.35831	8.301948	4.7931319	0
2	1387	51.7954	13.65782	-442.98391	-263.17322	0	1000
3	1387	53.5	12.22749	-357.38526	-2.8254272	0	1000
4	1387	56.5	9.710191	-206.77071	476.12214	0	1000
5	1387	59.30914	7.353042	-	846.56602	0	1000

				65.729919			
6	1387	62.257845	4.878785	82.320312	1141.5466	0	1000
7	1387	65.536975	2.127271	246.95159	1469.5851	0	1000
8	1387	68.8161	-0.624243	411.60156	1797.6235	0	1000
9	1387	72.72783	-3.9065755	608.00275	2267.9575	0	500
10	1387	76.75	-7.2815755	809.94965	2489.4253	0	500
11	1387	80.25	-8.7730265	895.46534	2793.5582	0	500
12	1387	83.75	-8.819079	890.8086	2688.1673	0	500
13	1387	87.25	-8.8651315	886.15186	2582.7764	0	500
14	1387	90.75	-8.9111845	881.49512	2477.4141	0	500
15	1387	94.25	-8.957237	876.83838	2372.0232	0	500
16	1387	97.75	-9.0032895	872.18164	2266.6323	0	500
17	1387	101.25	-9.049342	867.5249	2161.27	0	500
18	1387	104.7	-9.0947365	862.95479	2072.9972	0	500
19	1387	108.1	-9.1394735	858.42577	2001.8563	0	500
20	1387	111.5	-9.1842105	853.89675	1930.7154	0	500
21	1387	114.9	-9.2289475	849.36773	1859.5745	0	500
22	1387	118.3	-9.2736845	844.83871	1788.4336	0	500
23	1387	120.63035	-9.304347	841.76046	1735.7096	0	500
24	1387	122.63035	-9.3306625	839.08339	1681.16	0	500
25	1387	125.83335	-9.372807	834.82775	1610.8879	0	300
26	1387	129.5	-9.4210525	829.94635	1552.1748	0	300
27	1387	133.16665	-9.469298	825.06496	1493.4617	0	300
28	1387	135.25	-9.4967105	822.28879	1461.5934	0	300
29	1387	137.1238	-8.5625	759.97333	1484.0533	0	300
30	1387	140.3714	-6.6875	635.97333	1281.7333	0	300
31	1387	143.619	-4.8125	512	1079.44	0	300
32	1387	146.8666	-2.9375	388	877.12	0	300
33	1387	150.1178	-1.0604175	263.87518	614.47505	202.41893	0
34	1387	153.3726	0.81874755	139.61254	316.92268	102.37005	0
35	1387	156.0753	2.379165	38.740164	84.068231	26.170171	0

CAMU Slope

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File Information

PROPOSED PERIMETER BERM (SECTION 4) PSEUDO-STATIC DRAINED STABILITY ANALYSES

Created By: Gupta, Ayushman
Revision Number: 246
Last Edited By: Ali, Syed
Date: 10/11/2012
Time: 5:28:57 PM
File Name: per berm cell 2 camu south drained seismic.gsz
Directory: Z:\Chevron\447218-CMI CAMU\Stability\Try 10\Final Global Stability\Proposed perimeterberm cell2 camu south\
Last Solved Date: 10/11/2012
Last Solved Time: 5:29:16 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

CAMU Slope

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: No
Advanced
Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Stabilized Waste

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Proposed Berm

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 3/4 - Peat and Organic Silts/Clays

Model: Mohr-Coulomb
Unit Weight: 85 pcf
Cohesion: 0 psf
Phi: 18 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 6 - Red Brown Clay and Silt

Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion: 1000 psf
Pore Water Pressure

Piezometric Line: 1

Stratum 5 - Red Brown Sands and Gravel

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Stratum 1 - Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 9) ft
Right Coordinate: (185.61037, 19.149813) ft

Slip Surface Block

Left Grid
Upper Left: (80.5, -0.5) ft
Lower Left: (80.5, -3.5) ft
Lower Right: (125.5, -3.5) ft
X Increments: 4
Y Increments: 4
Starting Angle: 145 °
Ending Angle: 165 °
Angle Increments: 2
Right Grid
Upper Left: (130.977, -0.5) ft
Lower Left: (131, -3.5) ft
Lower Right: (174, -3.5) ft
X Increments: 4
Y Increments: 3
Starting Angle: 30 °
Ending Angle: 45 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-0.0086	7
	153.56901	7
	195.07647	7
	218.5	7

Seismic Loads

Horz Seismic Load: 0.085
Ignore seismic load in strength: No

Regions

	Material	Points	Area (ft²)
Region 1	Proposed Berm	2,7,8,20,21,14	317.5
Region 2	Stratum 6 - Red Brown Clay and Silt	4,15,24,10,11,16,19,5	2185
Region 3	Stratum 5 - Red Brown Sands and Gravel	5,19,16,11,12,6	4588.5
Region 4	Stratum 1 - Fill	1,18,2,14,13,9,23,17,3	1966.5
Region 5	Stabilized Waste	13,22,21,14	593
Region 6	Stratum 3/4 - Peat and Organic Silts/Clays	3,17,23,9,10,24,15,4	874

Points

	X (ft)	Y (ft)
Point 1	0	9
Point 2	120	9
Point 3	0	0
Point 4	0	-4
Point 5	0	-14
Point 6	0	-35
Point 7	144	17
Point 8	159	17
Point 9	218.5	0
Point 10	218.5	-4
Point 11	218.5	-14
Point 12	218.5	-35
Point 13	218.5	9
Point 14	185	9
Point 15	137	-4
Point 16	128	-14
Point 17	137	0
Point 18	61	9
Point 19	61	-14

Point 20	165	14
Point 21	170	14
Point 22	218.5	30
Point 23	181	0
Point 24	181	-4

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	606	1.66	(123.818, 17.646)	32.243	(161.167, 15.9167)	(87.4437, 9)

Slices of Slip Surface: 606

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	606	88.515915	8.5	-93.601476	81.053942	46.796515	0
2	606	90.660425	7.5	-31.199788	243.16183	140.38955	0
3	606	92.98364	6.4166665	36.398293	408.50274	214.8346	0
4	606	95.485565	5.25	109.1985	577.01872	270.09613	0
5	606	97.98749	4.0833335	181.99871	745.57093	325.37857	0
6	606	100.48943	2.9166665	254.79892	914.08691	380.6401	0
7	606	102.99135	1.75	327.59913	1082.6391	435.92254	0
8	606	105.49325	0.5833335	400.38847	1251.1913	491.21126	0
9	606	107.9952	-0.5833335	473.19955	1291.002	265.72011	0
10	606	110.49715	-1.75	546.01062	1399.9288	277.45483	0
11	606	112.99905	-2.9166665	618.78548	1508.8556	289.20132	0
12	606	115.6875	-3.5	655.2	1380.6957	235.72783	0
13	606	118.5625	-3.5	655.2	1380.6957	235.72783	0
14	606	121.2143	-3.5	655.20012	1429.9767	251.74018	0
15	606	123.64285	-3.5	655.20012	1528.5532	283.76962	0
16	606	126.0714	-3.5	655.20012	1627.1297	315.79906	0
17	606	128.5	-3.5	655.20012	1725.7062	347.82851	0
18	606	130.9286	-3.5	655.20012	1824.2827	379.85795	0
19	606	133.35715	-3.5	655.20012	1922.8592	411.88739	0
20	606	135.7857	-3.5	655.20012	2021.4357	443.91684	0
21	606	138.1875	-3.5	655.2	2118.9053	475.58667	0
22	606	140.5625	-3.5	655.2	2215.3263	506.91577	0
23	606	142.875	-2.375	585.01292	1746.8992	377.51973	0
24	606	144.625	-0.625	475.798	1653.7247	382.73159	0
25	606	146.41665	1.1666665	363.98823	1388.4343	591.46423	0
26	606	148.75	3.5	218.399	1164.4532	546.20466	0
27	606	151.08335	5.8333335	72.800676	940.50243	500.96784	0
28	606	152.9095	7.659505	-41.15287	773.84443	446.77929	0
29	606	153.9095	8.659505	-103.55269	691.01233	398.95616	0
				-			

30	606	155.4375	10.1875	198.90096	564.40522	325.85951	0
31	606	157.8125	12.5625	-347.09269	367.636	212.25475	0
32	606	160.08335	14.833335	-488.7849	134.63206	77.729856	0

APPENDIX C

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SETTLEMENT ANALYSES

1.0 INTRODUCTION

This appendix presents the settlement analyses for the Corrective Action Management Unit (CAMU) proposed at the Chevron Perth Amboy Facility (Facility) in New Jersey. The settlement analyses were performed to evaluate the settlement of the proposed base grade for each cell under the loading expected by the stabilized soils/waste that will be disposed in the CAMU cells. The results of the settlement analyses were used to ensure that the post-settlement slope of the leachate collection system is adequate and the maximum strain in the bottom liner system is within acceptable limit.

This calculation package includes the analysis parameters, the analysis method, the estimated total settlements, and the surcharge plan developed to reduce the settlements after construction of the cells. It also presents the minimum post-settlement slope of the leachate collection system and the maximum strain in the bottom liner system.

2.0 ANALYSES PARAMETERS

2.1 Subsurface Stratigraphy

The subsurface stratigraphy in the CAMU area was discussed in Appendix A. As noted in Appendix A, the stratigraphy in CAMU area consists of (from top to bottom) fill layer (Stratum 1), peat / organic silt and clay (Stratum 3/4), red brown silt and clay (Stratum 6), red brown sands and gravel (Stratum 5), tan/gray sands (Stratum 8), gray green clays (Stratum 7), and weathered bedrock. Stratum 3/4 is characteristically a highly compressible layer and was the primary layer of concern in the settlement analyses. The settlement analyses evaluated the consolidation of Strata 3/4 and 6 under the expected loading. The settlement due to the remaining strata was estimated to be less than two inches and was ignored in the analyses.

A thickness of 9 to 11 feet was used for Stratum 1 in the analyses. Based on the discussion in Section 4.1 of Appendix A, Strata 3 and 4 were encountered intermixed in the field and were modeled as a single layer. The thickness of Stratum 3/4 was considered to be 8 feet on the north side, 6 feet in the middle and 4 feet on the south side of the CAMU footprint in the settlement analyses. A thickness of 10 feet was used for Stratum 6 in the analyses.

A reinforced concrete tank pad exists in the center of each of the three CAMU cells. These concrete pads served as the foundation for the tanks that existed previously in these basins (the tanks were demolished but the footings were left in place). Each concrete tank pad is approximately 125-foot in diameter and 1.5-foot in thickness. Each tank pad is supported by more than 600 timber piles that are located on a 4.5-foot by 4.5-foot grid pattern. The design capacity of these plies was 30 tons and the post-installation computed capacity typically ranged from 40 to 60 tons.

The existing pile-supported concrete tank pad in each cell will remain in place and will not be removed during cell construction. Based on the available information for the reinforced concrete tank pads and the underlying piles, negligible settlement of the slab is expected under the loads that will be imposed by the CAMU. As a result, it was assumed in the settlement analyses that these tank pads will not settle under the proposed loading.

Based on the groundwater monitoring performed in the CAMU area over the years, the groundwater has been observed to be within few feet of the existing ground surface in the tank basins. The groundwater was modeled to be 2 feet below the existing ground surface (at EL. 7 feet, NGVD) in the settlement analyses.

2.2 Soil Properties

The soil properties of the strata encountered in the CAMU area were discussed in Section 4.2 of Appendix A. The soil properties selected for use in the engineering design and analyses of the CAMU were summarized in Table A-13 in Appendix A. The properties used in settlement analyses are reiterated in Table C-1.

Strata 3 and 4 were encountered intermixed with each other in the field and hence were combined into a single layer (Stratum 3/4). However, these two materials exhibited considerably different consolidation characteristics. As a result, the settlements were estimated using both Stratum 3 (Peat) and Stratum 4 (Organic silt and clay) properties.

2.3 Stabilized Soils/Waste Loading

The existing topography in the CAMU area based on a 2012 survey is presented in Figure C-1. The grades indicated in Figure C-1 were used as the existing grades in the settlement analyses. A ground surface elevation of 9 feet (NGVD) was used in the analyses for the tank basins. The proposed grades for the CAMU with the stabilized soils/waste raised to full height are presented in Figure C-2. The difference between the proposed grades (top of stabilized soils/waste grades indicated in Figure C-2) and the existing grades (Figure C-1) was used to evaluate the loading in the settlement analyses.

2.4 Grid Used in Analysis

The settlement within the CAMU footprint due to the proposed stabilized soils/waste loading was evaluated on a 15-foot by 15-foot grid. The grid used in the settlement analyses is indicated in Figures C-1 and C-2. The settlements were evaluated at each grid node, which were then used to develop settlement contours for the CAMU.

As noted in Section 2.1 above, the thickness of Stratum 3/4 varied from 8 feet on the north side to 4 feet on the south side of the CAMU footprint. As a result, a thickness of 8 feet was used for Stratum 3/4 along the grid rows 1 through 5. The thickness was reduced to 6 feet along the grid rows 6 through 10 and to 4

feet along the grid rows 11 through 14 in the analyses. A thickness of 10 feet was used for Stratum 6 in the analyses for the entire CAMU footprint.

3.0 ANALYSIS METHOD

3.1 Consolidation Theory

The settlement of Strata 3/4 and 6 soils was computed using one-dimensional consolidation theory. The theory was used to compute the magnitude and rate of expected settlements. The magnitude of settlement was evaluated taking into consideration the primary as well as the secondary consolidation of the strata. The primary consolidation represents settlement due to change in stress from the stabilized soils/waste loading whereas the secondary consolidation represents settlement with time at constant stress.

The following equations were used to estimate settlement due to primary consolidation of Strata 3/4 and 6:

$$s_p = C_{r\varepsilon} H_o \log\left(\frac{\sigma_p}{\sigma_{vo}}\right) + C_{c\varepsilon} H_o \log\left(\frac{\sigma_{vo} + \Delta\sigma_v}{\sigma_p}\right)$$

$$C_{r\varepsilon} = \frac{C_r}{1+e_o} = \frac{\Delta\varepsilon_r}{\Delta \log \overline{\sigma}_v}$$

$$C_{c\varepsilon} = \frac{C_c}{1+e_o} = \frac{\Delta\varepsilon_c}{\Delta \log \overline{\sigma}_v}$$

where: s_p is settlement due to primary consolidation,
$C_{r\varepsilon}$ is the modified recompression index or recompression ratio,
C_r is the recompression index,
$C_{c\varepsilon}$ is the modified compression index or compression ratio,
C_c is the compression index,
σ_{vo} is the initial effective stress at the middle of the layer,
σ_p is the maximum past pressure ($\sigma_p = \sigma_{vo}$ for normally consolidated soils),
$\Delta\sigma_v$ is the change in vertical effective stress due to stabilized soils/waste loading,
e_o is the initial void ratio,
H_o is the initial thickness of layer, and
$\Delta\varepsilon$ is the vertical strain in the layer (= s/H_o).

The following equations were used to estimate settlement due to secondary consolidation of Strata 3/4 and 6:

$$s_s = C_{\alpha\varepsilon}\, H_o \log \frac{t_{design}}{t_{90}}$$

$$C_{\alpha\varepsilon} = \frac{C_\alpha}{1+e_o} = \frac{\Delta\varepsilon_\alpha}{\Delta \log t}$$

where: s_s is settlement due to secondary consolidation,
$C_{\alpha\varepsilon}$ is the modified secondary compression index or secondary compression ratio,
C_α is the secondary compression index,
H_o is the initial thickness of layer,
$\Delta\varepsilon$ is the vertical strain in the layer (= s/H_o),
t_{design} is the design life (assumed to be 30 years), and
t_{90} is the time corresponding to 90 percent average consolidation.

Terzaghi's one-dimensional consolidation equation was used to estimate the approximate time to complete the primary consolidation, which was assumed to correspond to time required to complete 90 percent average consolidation of the entire layer. Based on the theory,

$$\mathrm{T} = \frac{c_v\, t}{H_{dr}^2}$$

where: T is the time factor (= 0.848 for 90 percent average consolidation),
c_v is the coefficient of consolidation,
t is the consolidation time (t_{90} is time corresponding to 90% average consolidation), and
H_{dr} is the length of the longest drainage path (Strata 3/4 and 6 were considered singly drained in the analyses, i.e., $H_{dr} = H_o$).

3.2 Primary Assumptions

The primary assumptions used in the settlement analyses were as follows:

- Thickness of Stratum 3/4 reduces from 8 feet on north side of the CAMU footprint to 4 feet on the south side.
- Stratum 3/4 is normally consolidated ($\sigma_p = \sigma_{vo}$).
- Stratum 6 is over-consolidated ($\sigma_p > \sigma_{vo}$). A σ_p of 2,400 pounds per square foot (psf) was used for Stratum 6 is in the analyses.

- Time to complete the primary consolidation was assumed to correspond to time required to complete 90 percent average consolidation of the entire layer.
- Stratum 3/4 and Stratum 6 were assumed to be singly-drained because they are both adjacent low permeability layers between higher permeability layers above and below. Stratum 3/4 is assumed to drain upward into the Stratum 1 (Fill) and Stratum 6 is assumed to drain downward into Stratum 5 (Red brown sands and gravel). To compute t_{90} for these strata, H_{dr} was assumed to be equal to H_o for each of the layers.
- To compute secondary consolidation of Strata 3/4 and 6, a time period of 30 years was used in the analyses, which corresponds to the post-closure monitoring period.
- Two surcharge periods of 9 months and 18 months were evaluated in the stability analyses. A surcharge period of 9 months was assumed for Cell 1 and a surcharge period of 18 months was assumed for the remaining two cells. Surcharging of each cell is discussed below.
- Strata 3 and 4 exhibited different consolidation characteristics. Settlements were computed using Stratum 3 (Peat) as well as Stratum 4 (Organic silt and clay) characteristics. Since Strata 3 and 4 were encountered intermixed in the field as a single layer, it was assumed that the expected settlement due to consolidation of Stratum 3/4 will be within the range of settlements computed using Stratum 3 and Stratum 4 properties individually.

4.0 TOTAL SETTLEMENTS

Based on the analysis method and parameters discussed above, the settlements were computed by first assigning Stratum 3/4 the consolidation characteristics of Stratum 3 and then by assigning Stratum 3/4 the consolidation characteristics of the Stratum 4. Strata 3/4 and 6 were each divided into sub-layers. The consolidation of each sub layer (primary and secondary consolidation) was computed and added to obtain the total settlement at each grid node.

A sample settlement computations at grid node N7 (Column N and Row 7) is included in Attachment C-1. The sample calculations present the total estimated settlements at grid node N7. Row 7 of the grid corresponds to a Stratum 3/4 thickness of 6 feet and will be subjected to a stabilized soils/waste height of 31 feet (waste raised to full height). The consolidation characteristics of Stratum 3 (Peat) were assigned to Stratum 3/4 in the sample calculations. Attachment C-1 also includes a summary of the estimated total primary and secondary settlements at each grid node for both the strata evaluated in the analyses.

Figure C-3 presents the total expected settlements computed by assigning Stratum 3/4 the consolidation characteristics of Stratum 3 (Peat). It also presents the settlement contours developed using the total settlements computed at the grid nodes. As noted, the expected settlements at the edge of the cells (near the perimeter berms where the loading due to stabilized soils/waste will be minimal) range from 0.5 to 1 foot approximately. The settlement in areas of the cells that will experience the full height of the stabilized soils/waste is up to 3 feet.

Figure C-4 presents the total expected settlements and the settlement contours evaluated by assigning Stratum 3/4 the consolidation characteristics of Stratum 4 (Organic silt and clay). As noted, the expected settlements are approximately 50 percent of the settlements indicated in Figure C-3.

Since the total settlements are expected to be relatively large with significant differential settlements that could potentially have a negative impact on the liner and leachate collection system, a surcharge plan was developed to pre-load each cell prior to construction. The objective was to reduce the settlement of the base grade and the bottom liner system after the liner is placed during the construction of the cell. The surcharge plan was developed and implemented for Cell 1, the first cell that will be developed as part of the phased development of the CAMU.

5.0 SURCHARGE PLAN

5.1 Plan Development Criteria

One of the criteria used in the development of the surcharge plan was to pre-load areas of potential concern in each cell. Based on the computed total settlements, three areas of potential concern were identified as follows:

(i) Areas of the cell where the total settlement was expected to be 2 feet or more (2 feet of approximate average expected settlement based on the two sets of consolidation parameters used in the settlement analyses);

(ii) Areas where the sumps will be constructed, especially the sumps along the intercell berms where some of the highest settlements were computed; and

(iii) Areas along the edge of the existing concrete pad where the expected settlement represent differential settlement that can potentially result in unacceptable strains in the bottom liner system.

Another criteria used in the development of the surcharge plan was to limit the volume of soil used in surcharging a cell to the estimated volume of soil needed to construct the cell (base grading and perimeter berms). This would allow soils used to surcharge in construction of the cell.

5.2 Surcharge Plan

Each cell will be surcharged prior to construction, one cell at a time, starting with Cell 1. Surcharge was placed in Cell 1 in August 2012 and in Cell 3 in May 2013. During construction of Cell 1, the surcharge fill from Cell 1 will be moved to Cell 2. The surcharge fill will remain in Cell 2 during the period Cell 1 is constructed and raised to full height. As noted, the surcharge plan developed was such that the soil volume needed for surcharging was roughly equal to the soil volume needed for constructing a cell. This will allow the surcharge fill in Cells 2 and 3 to be eventually used in the construction of the respective cells.

The surcharge plan developed and implemented for Cell 1 is presented in Figure C-5**.** As noted, it surcharged areas with average settlement of 2 feet or more by placing 10 feet of fill with top of fill at approximate EL. 19 feet (NGVD). The 10-foot fill thickness was extended up to the edge of the existing concrete pad in Cell 1. In the area around the proposed east side sump in Cell 1 (where one of the highest settlements were estimated), 20 feet of fill was placed corresponding to approximate top EL. 29 feet (NGVD) to minimize the settlements after construction of the cell. A similar surcharge plan was developed and implemented for Cell 3.

Certified clean fill predominantly consisting of silty sands with gravel (10 to 20 percent gravel, typically less than 1 inch in size, and a fines content of less than 15 percent) was used to surcharge Cells 1 and 3. Soils were placed and tracked with a dozer. After placing surcharge to the grades indicated in Figure C-5, the fill was covered with an erosion control mattress.

Cell 1 surcharge plan included a monitoring program to measure the settlements under the surcharge loads. Seven settlement plates (consisting of steel plates and steel rods) were installed at the locations indicated in Figure C-5 prior to initiating the placement of the surcharge fill. The settlement plates were surveyed soon after installation and continue to be surveyed on a weekly basis thereafter using professional-grade survey equipment. The results available to-date are discussed in Section 5.3 below.

A surcharge and monitoring plan similar to that implemented in Cell 1 was implemented in Cell 3 as well. A similar surcharge and monitoring plan will be implemented in Cell 2 when Cell 2 is surcharged. It is noted that the maximum height of stabilized soils/waste that will be placed in the CAMU cells is approximately 30 feet. Based on the proposed surcharge plan for the cells, most of the cell footprint will be pre-loaded with one-third of the maximum loads that will be eventually imposed by the stabilized soils/waste in the cells. The sump areas along the intercell berms (where some of the highest settlements are expected) will be pre-loaded with two-thirds of the maximum loads expected from disposal of the stabilized soils/waste in the cells.

5.3 Settlements Under Surcharge Loads

The settlements under the surcharge loads were computed using the analysis procedure discussed above. The surcharge fill grading plan indicated in Figure C-5 was used to evaluate loading due to surcharge fill at the grid nodes. Settlements were computed assuming a surcharge loading period of 9 months (assumed for Cell 1) and a loading period of 18 months (assumed for Cells 2 and 3). Due to the relatively short loading periods, only settlements due to primary consolidation were considered in the analyses and the settlements due to secondary consolidation were ignored.

Figure C-6 presents the settlements under surcharge loads computed by assigning Stratum 3/4 the consolidation characteristics of Stratum 3 (Peat). Figures C-6a and C-6b present the settlements and the settlement contours for surcharge period of 9 months and 18 months, respectively. For 9 months of surcharge loading, 10 feet of surcharge fill resulted in 30 to 35 percent of the total settlements (presented

in Section 4.0 above) and 20 feet of surcharge fill resulted in nearly 50 percent of the total settlement. For 18 months of surcharge loading, 10 feet of surcharge fill resulted in 40 to 50 percent of the total settlements and 20 feet of surcharge fill resulted in more than 60 percent of the total settlement.

Figure C-7 presents the settlements under surcharge loads computed by assigning Stratum 3/4 the consolidation characteristics of Stratum 4 (Organic silt and clay). Figures C-7a and C-7b present the settlements and the settlement contours for surcharge period of 9 months and 18 months, respectively. For 9 months of surcharge loading, 10 feet of surcharge fill resulted in 40 to 45 percent of the total settlements and 20 feet of surcharge fill resulted in nearly 60 percent of the total settlement. For 18 months of surcharge loading, 10 feet of surcharge fill resulted in 45 to 60 percent of the total settlements and 20 feet of surcharge fill resulted in nearly 65 percent of the total settlement.

For the surcharge fill placed in Cells 1 and 3, settlements are being measured at the location of each settlement plate on a weekly basis. The settlements measured in the field were compared to the computed settlements and are presented in Attachment C-2. Figures C2a through C2c in Attachment C-2 present the measured and calculated settlements for plates installed in Cell 1. Figure C2a presents the settlements for plates SP-1, SP-2 and SP-3 in Cell 1, which are located in grid rows 1 through 5 (corresponding to 8 feet of Stratum 3/4). Figure C2b presents the measured and calculated settlements for plates SP-4, SP-5 and SP-6 in Cell 1, which are located in grid rows 6 through 10 (corresponding to 6 feet of Stratum 3/4). Figure C2c presents the measured and calculated settlements for plate SP-7 in Cell 1, which is located in grid rows 11 through 14 (corresponding to 4 feet of Stratum 3/4).

As noted, the measured settlements for all plates to-date is less than the calculated settlements with the exception of plate SP-4, where the measured settlement is slightly greater than the calculated settlement. Further, all settlement plates appear to have reached the end of primary consolidation within 30 days of completion of the surcharge activities. Based on the measured settlements to-date, the consolidation parameters used in the settlement analyses seem to be conservative.

Similar to Cell 1, settlement plates were installed in Cell 3 to measure settlements due to the surcharge loading in the cell. Figure C2d in Attachment C-2 presents the measured settlements for plates installed in Cell 3. As noted, the magnitude and rate of settlements measured in Cell 3 are similar to that observed in Cell 1.

6.0 POST-CONSTRUCTION SETTLEMENTS

6.1 Resulting Settlements

The resulting settlements correspond to the difference between the total settlements (presented in Section 4) and settlements induced by the surcharge loads (presented in Section 5). It represents the settlement of the base grade and the bottom liner system after construction of the cells.

Figure C-8 presents the resulting settlements computed by assigning Stratum 3/4 the consolidation characteristics of Stratum 3 (Peat). Figures C-8a and C-8b present the resulting settlements and corresponding contours for surcharge period of 9 months and 18 months, respectively. The resulting settlements are 50 to 70 percent of the total settlements in the areas loaded with 10 feet of surcharge fill. The resulting settlements are 40 to 50 percent of the total settlements in the areas loaded with 20 feet of surcharge fill.

Figure C-9 presents the resulting settlements computed by assigning Stratum 3/4 the consolidation characteristics of Stratum 4 (Organic silt and clay). Figures C-8a and C-8b present the resulting settlements and corresponding contours for surcharge period of 9 months and 18 months, respectively. The resulting settlements are 40 to 60 percent of the total settlements in the areas loaded with 10 feet of surcharge fill. The resulting settlements are 35 to 40 percent of the total settlements in the areas loaded with 20 feet of surcharge fill.

It is noted that the total settlements estimated for Cells 2 and 3 are similar to that estimated for Cell 1. Since a similar surcharging plan has been or will be implemented for Cells 2 and 3, the resulting settlements presents for Cell 1 also represent the resulting settlements expected in Cells 2 and 3.

6.2 Post-Settlement Slopes

The resulting settlements were used to estimate the post-settlement slope of the bottom grades and the post-settlement slope of the leachate collection pipe in the cell. The post-settlement slopes were calculated by using the maximum difference in the resulting settlements between two adjacent grid nodes (15 feet apart). The as-built slope of the bottom grades in the cells is 2 percent. Post-settlement, the minimum slope of the bottom grades was evaluated to be approximately 1 percent. The as-built slope of the central leachate collection pipe is 2.5 percent. Post-settlement, the minimum slope of the leachate collection pipe was evaluated to be 1.5 percent.

6.3 Bottom Liner Strain

The resulting settlements corresponding to Stratum 3 consolidation characteristics and a surcharge loading period of 9 months were conservatively used to estimate the strain in the bottom liner system. Within the cell, the maximum differential settlement at adjacent grid nodes was approximately 1 foot, which corresponds to less than 1 percent tensile strain in the bottom geomembrane. Along the perimeter berm, the maximum differential settlement was just over 1 foot, which resulted in approximately 2 percent tensile strain in the bottom geomembrane. The maximum strain expected in the bottom geomembrane is well within the recommended range of less than 5 percent strain.

6.4 Additional Measures

Even though the computed strains in the bottom liner system were within acceptable range, two additional measures will be implemented during cell construction to prevent unacceptable strains in the bottom

geomembrane. First, a high strength, biaxial geogrid will be included as part of the bottom liner system to smoothen the localized differential settlements due to uneven settlement of the underlying Stratum 3/4. This geogrid will also prevent excessive strain in the bottom geomembrane at the edge of the existing concrete pads. The geogrid will be placed directly on the prepared base grade as the lowermost layer of the geosynthetics in the bottom liner system.

Second, the base grades will be stepped up 1 foot along the circumference of the existing concrete pads in each cell (see Permit Drawings). The settlement at the edge of the existing concrete pads represents differential settlement that can potentially result in unacceptable strains in the bottom liner system. The 1-foot step-up at the edge of the concrete pads along with the geogrid in the bottom liner system will minimize the potential for unacceptable strains in the bottom liner system.

APPENDIX C

TABLES

Table C-1

CONSOLIDATION CHARACTERISTICS USED IN SETTLEMENT ANALYSES

CAMU Final Design Report

Chevron Perth Amboy Facility, NJ

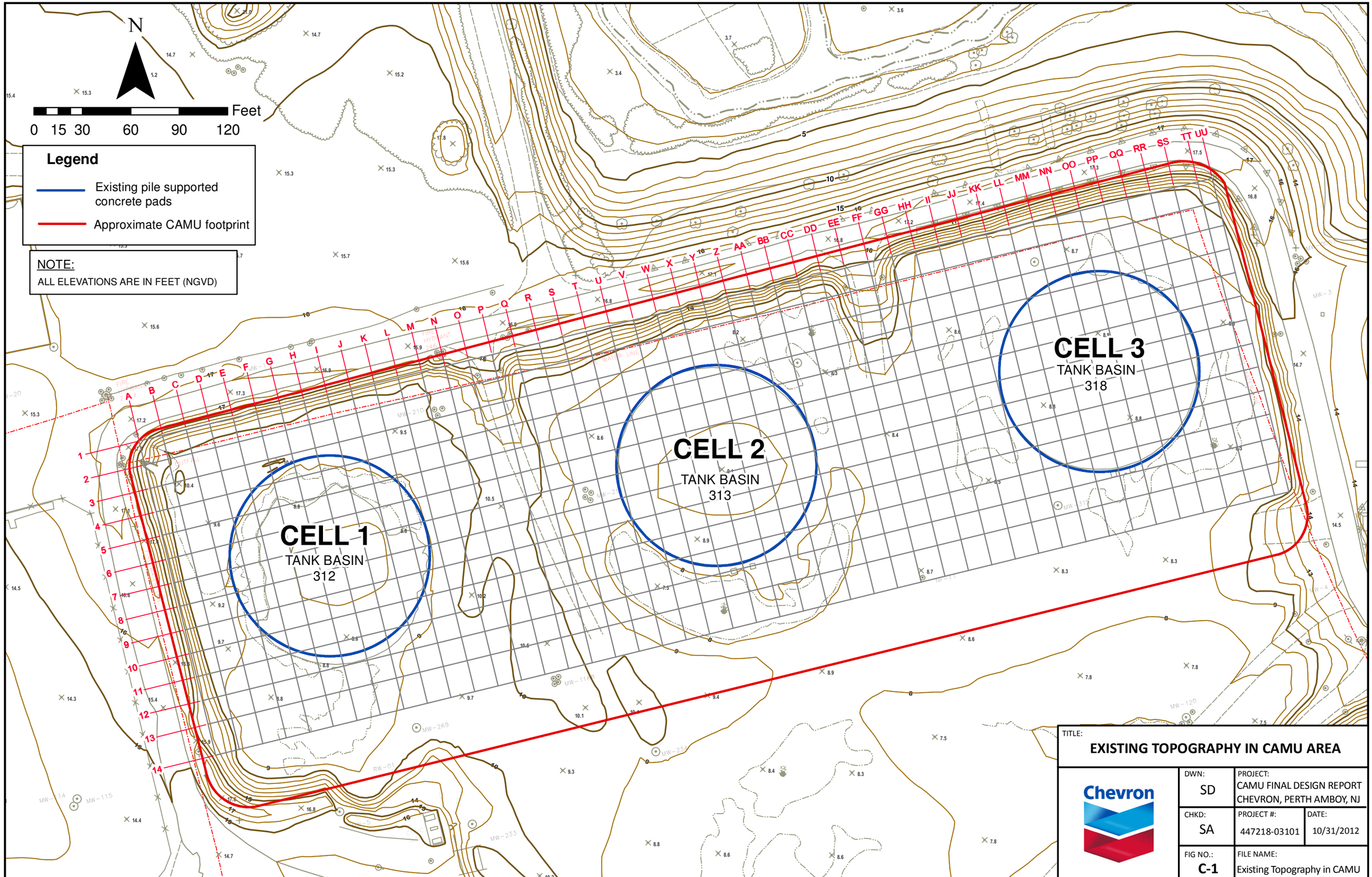
Stratum	Total Unit Weight	Modified Compression Index	Modified Re-Compression Index	Ratio for Secondary Compression	Coefficient of Consolidation
	γ_t (pcf)	$C_{c\epsilon}$	$C_{r\epsilon}$	$C_{\alpha\epsilon}/C_{c\epsilon}$	Cv (ft^2/yr)
Stratum 3 - Peat	70	0.490	NA[1]	0.050	15
Stratum 4 - Organic Silts/Clays	95	0.245	NA[1]	0.035	25
Stratum 6 - Red-Brown Silt and Clay	125	0.081	0.010 [2]	0.016	85

Notes:

1. NA - Stratum soils were considered to be normally consolidated.
2. A maximum past pressure of 2,400 psf was used in analyses.
3. Settlement due to remaining strata was relatively insignificant and was ignored in the analyses.
4. $C_{\alpha\epsilon}$ = Modified secondary compression index or secondary compression ratio.

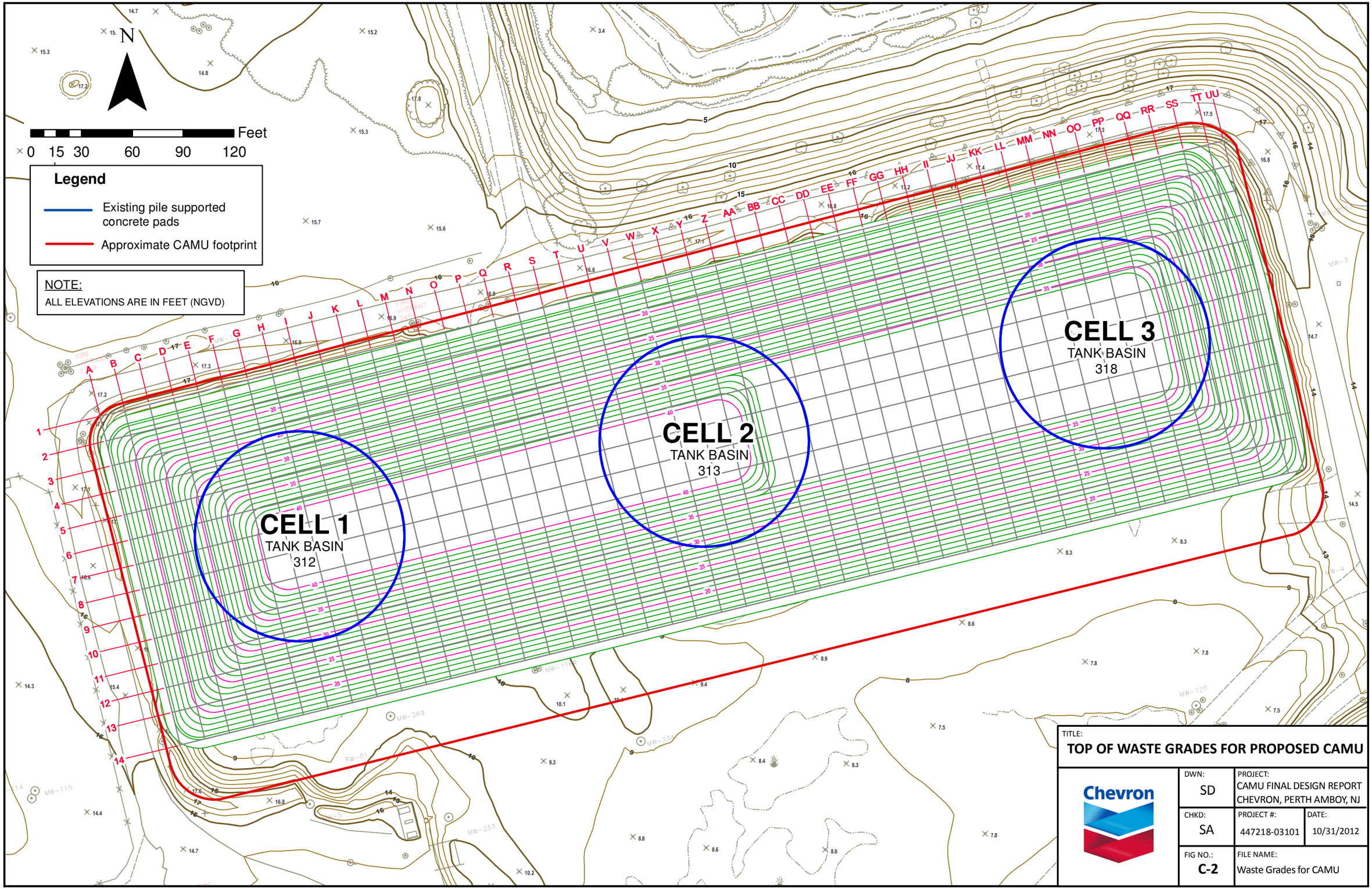
APPENDIX C

FIGURES



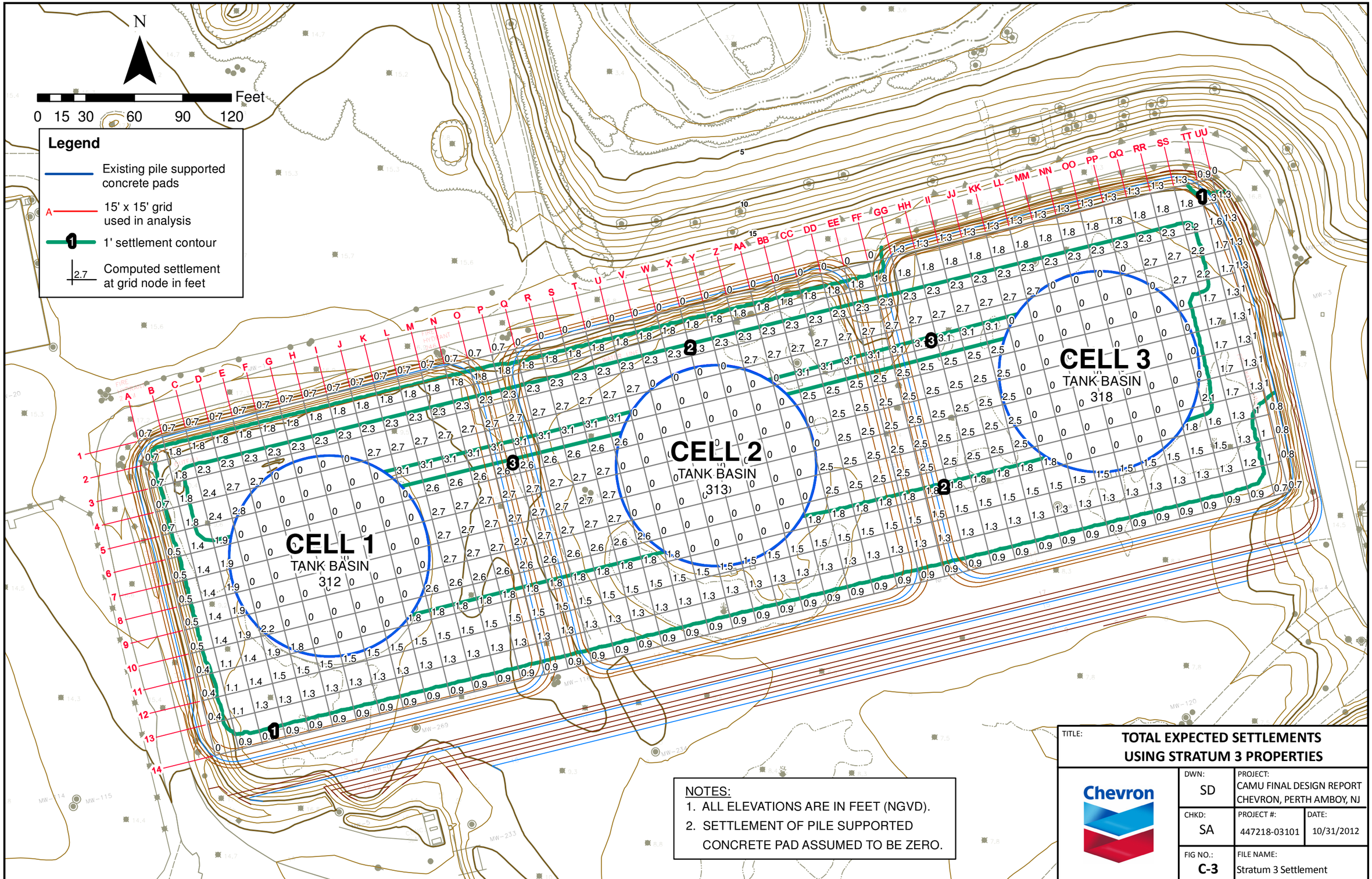
TITLE:
EXISTING TOPOGRAPHY IN CAMU AREA

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: C-1	FILE NAME: Existing Topography in CAMU



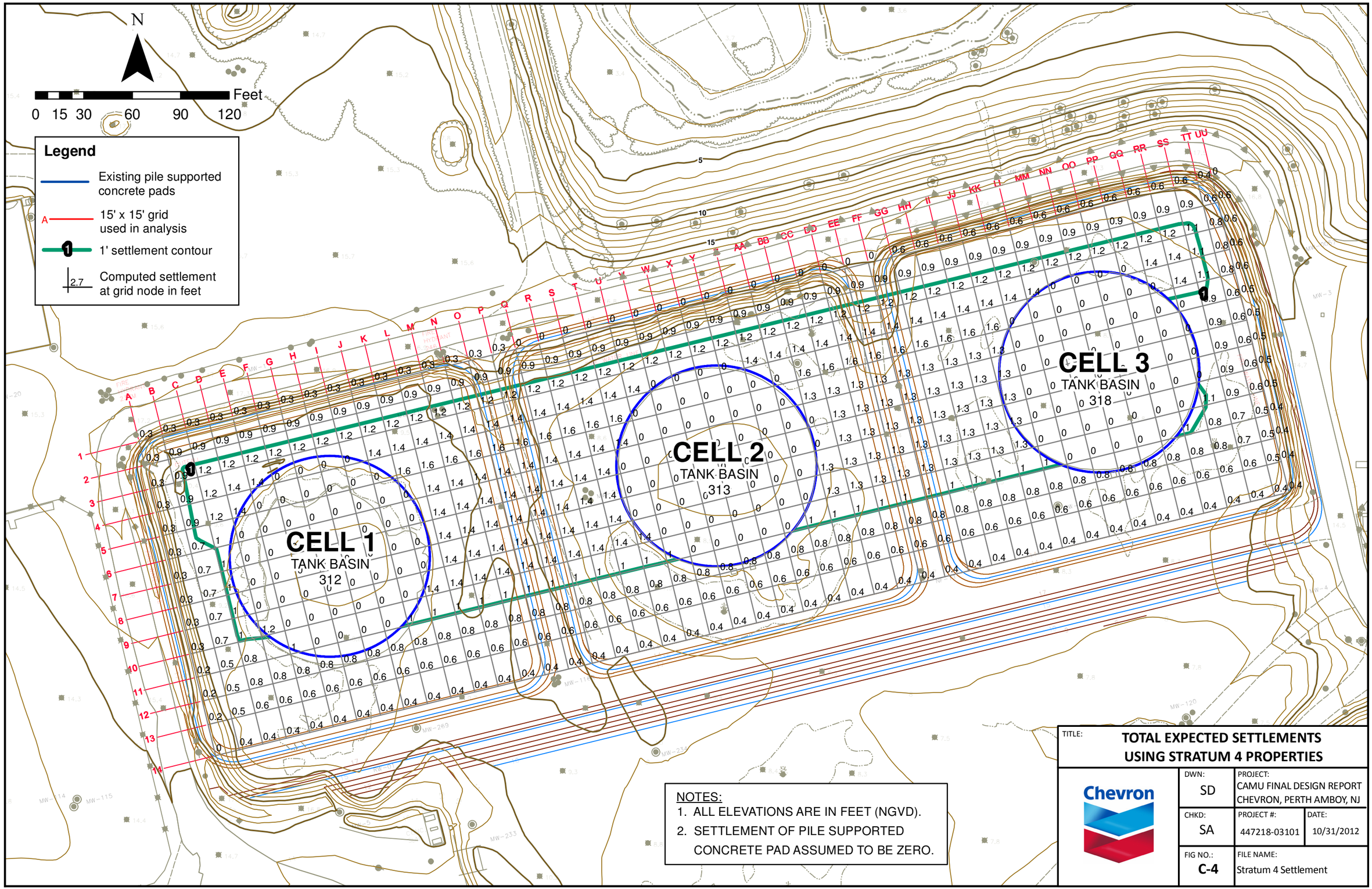
TITLE:
TOP OF WASTE GRADES FOR PROPOSED CAMU

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: C-2	FILE NAME: Waste Grades for CAMU



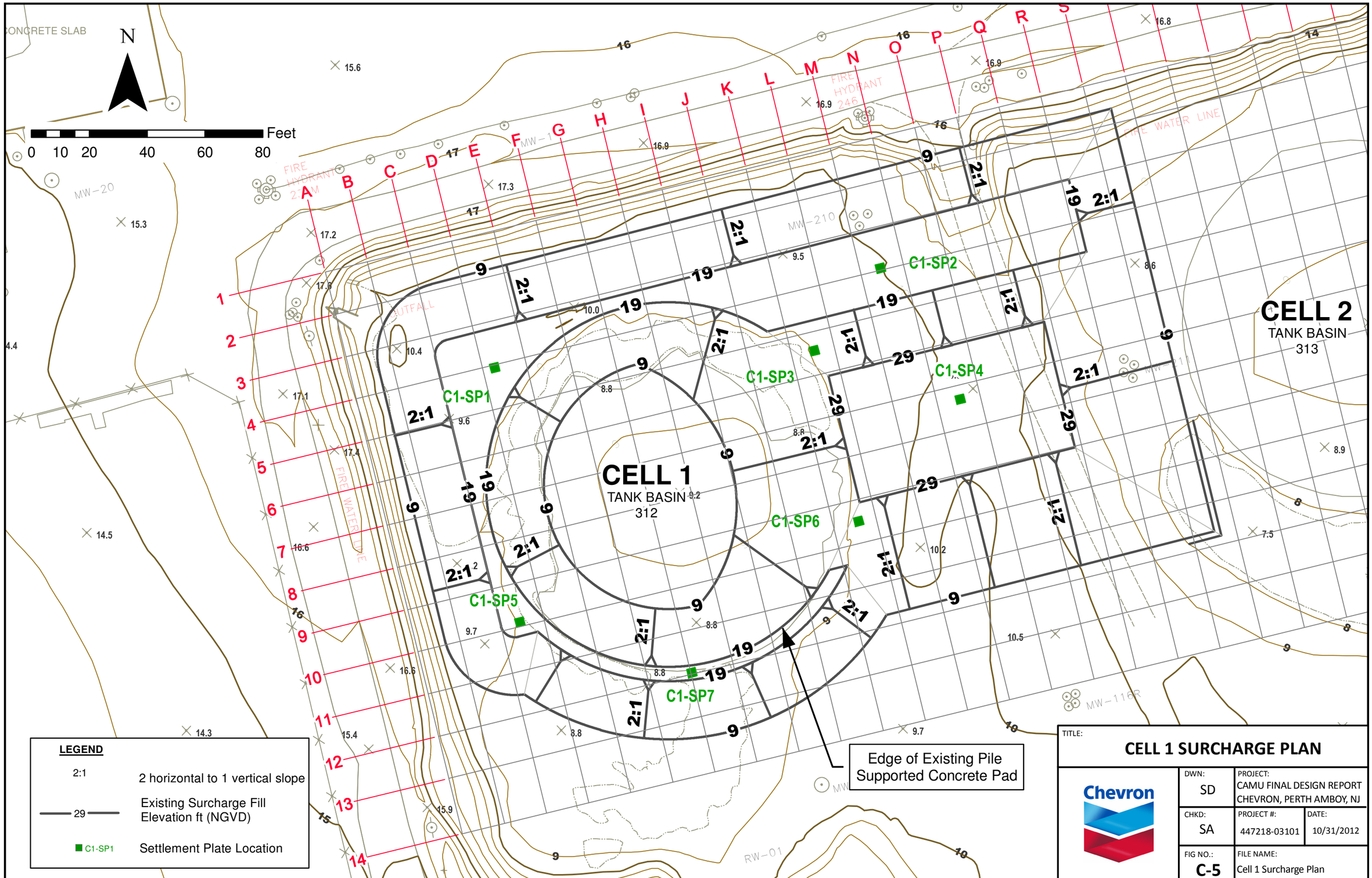
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.

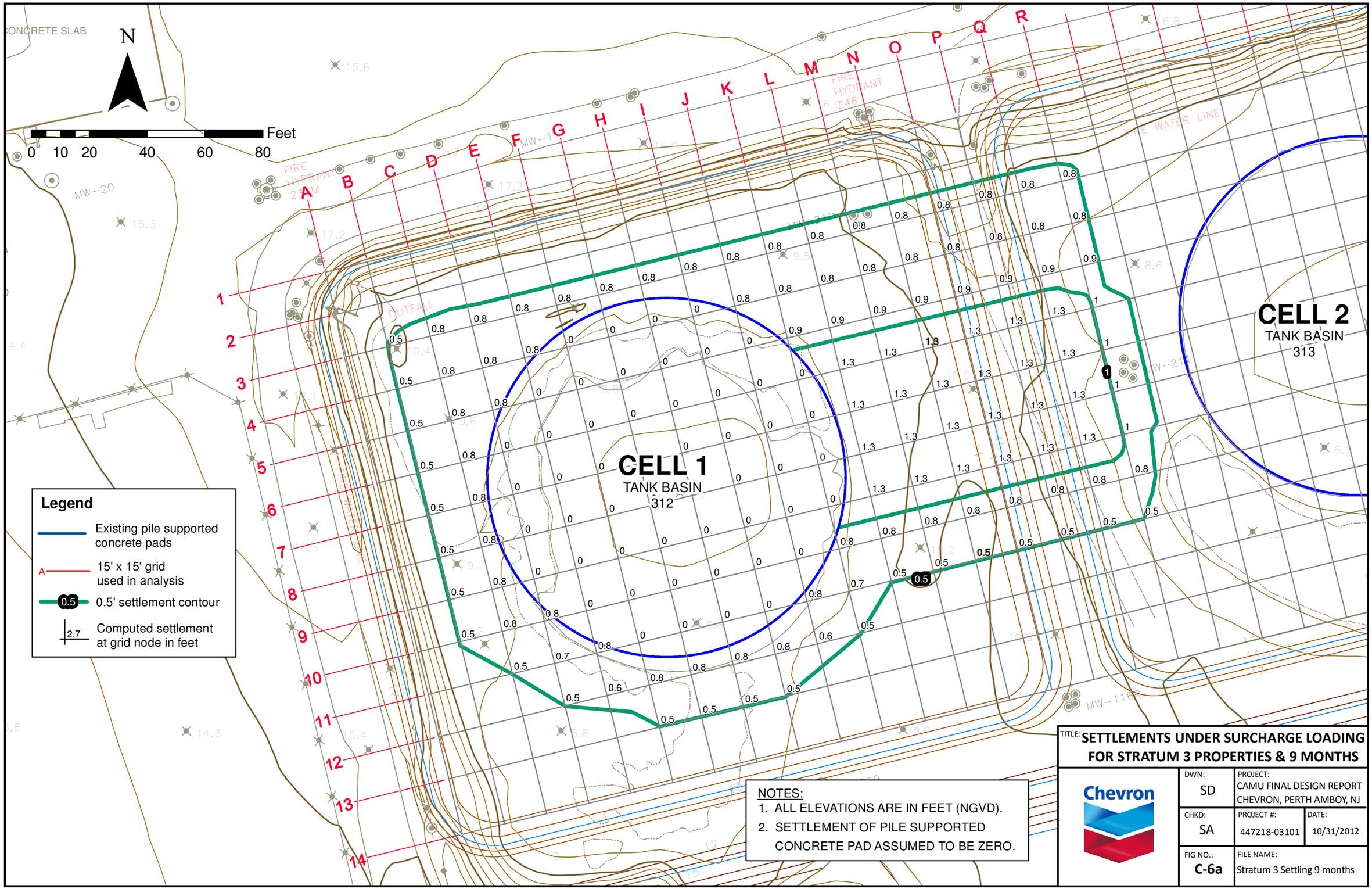
TITLE: TOTAL EXPECTED SETTLEMENTS USING STRATUM 3 PROPERTIES			
Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
	CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
	FIG NO.: C-3	FILE NAME: Stratum 3 Settlement	



NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.

TITLE: TOTAL EXPECTED SETTLEMENTS USING STRATUM 4 PROPERTIES			
Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
	CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
	FIG NO.: C-4	FILE NAME: Stratum 4 Settlement	


N
Feet
0 10 20 40 60 80
CONCRETE SLAB
MW-20
FIRE HYDRANT 246
FIRE WATER LINE
OUTFALL
MW-210
MW-116R
RW-01
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
C1-SP1
C1-SP2
C1-SP3
C1-SP4
C1-SP5
C1-SP6
C1-SP7
2:1
Edge of Existing Pile Supported Concrete Pad
LEGEND
2:1 2 horizontal to 1 vertical slope
29 Existing Surcharge Fill Elevation ft (NGVD)
C1-SP1 Settlement Plate Location
TITLE:
CELL 1 SURCHARGE PLAN
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-5
FILE NAME: Cell 1 Surcharge Plan

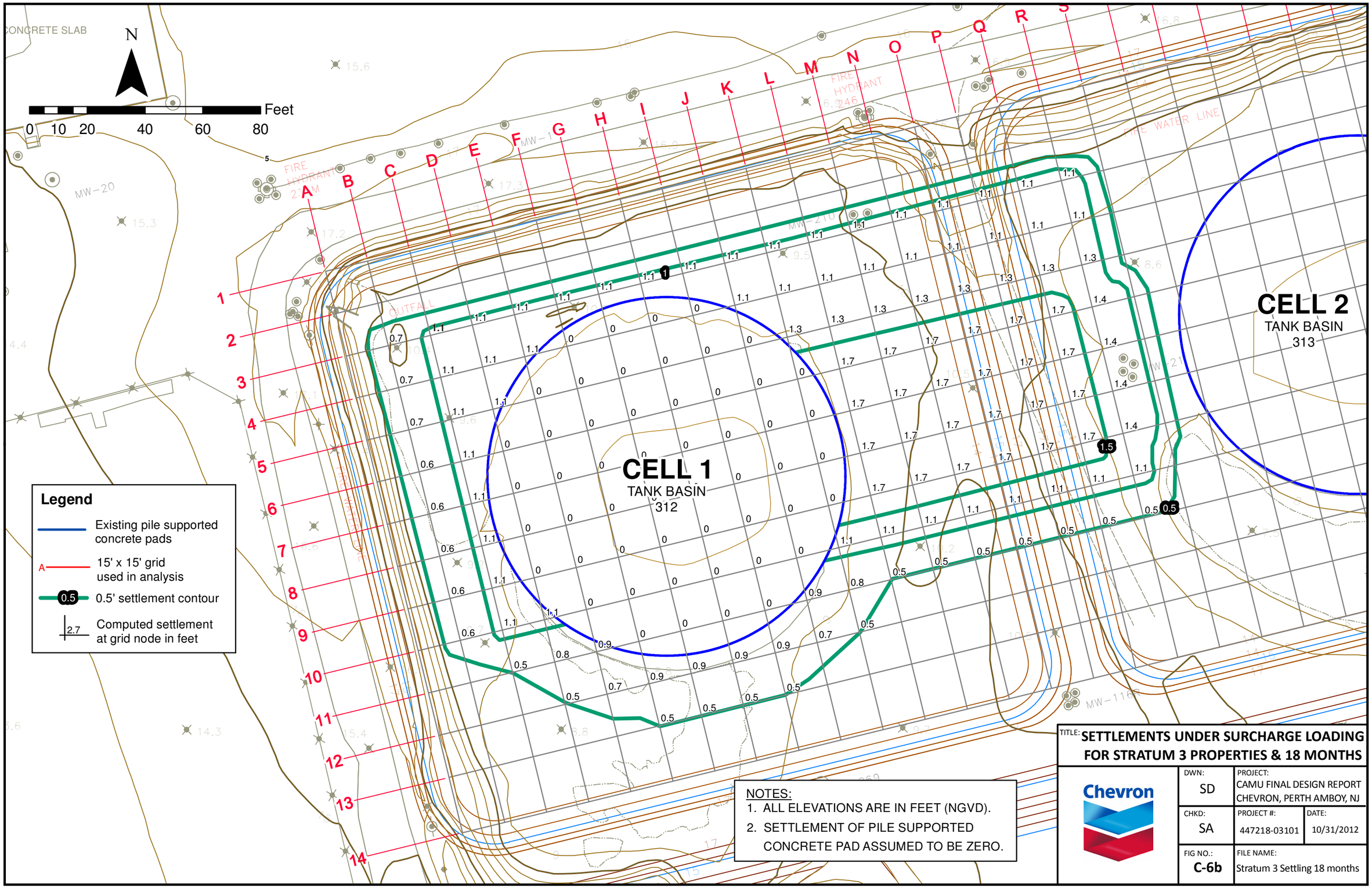


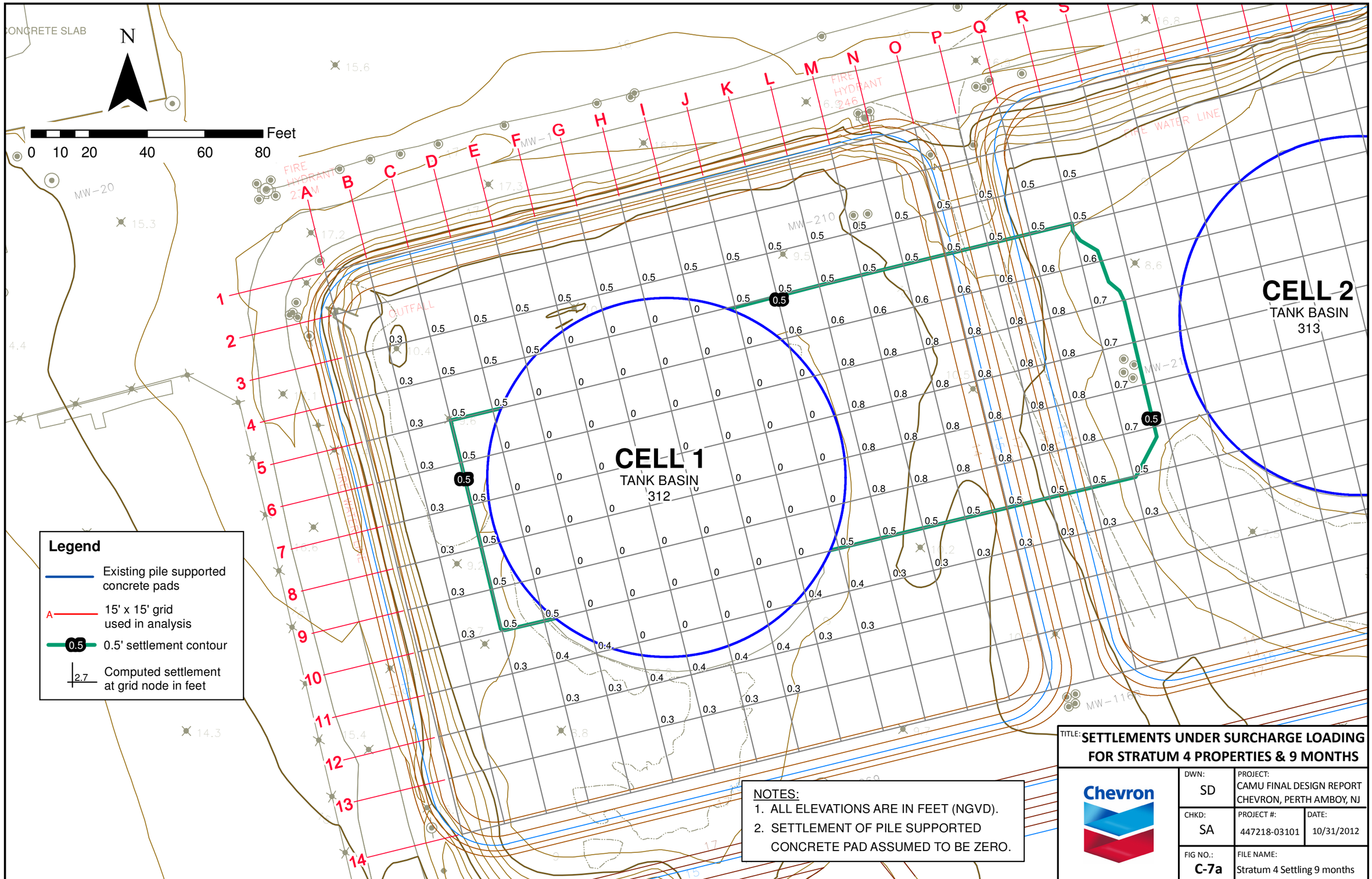
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.

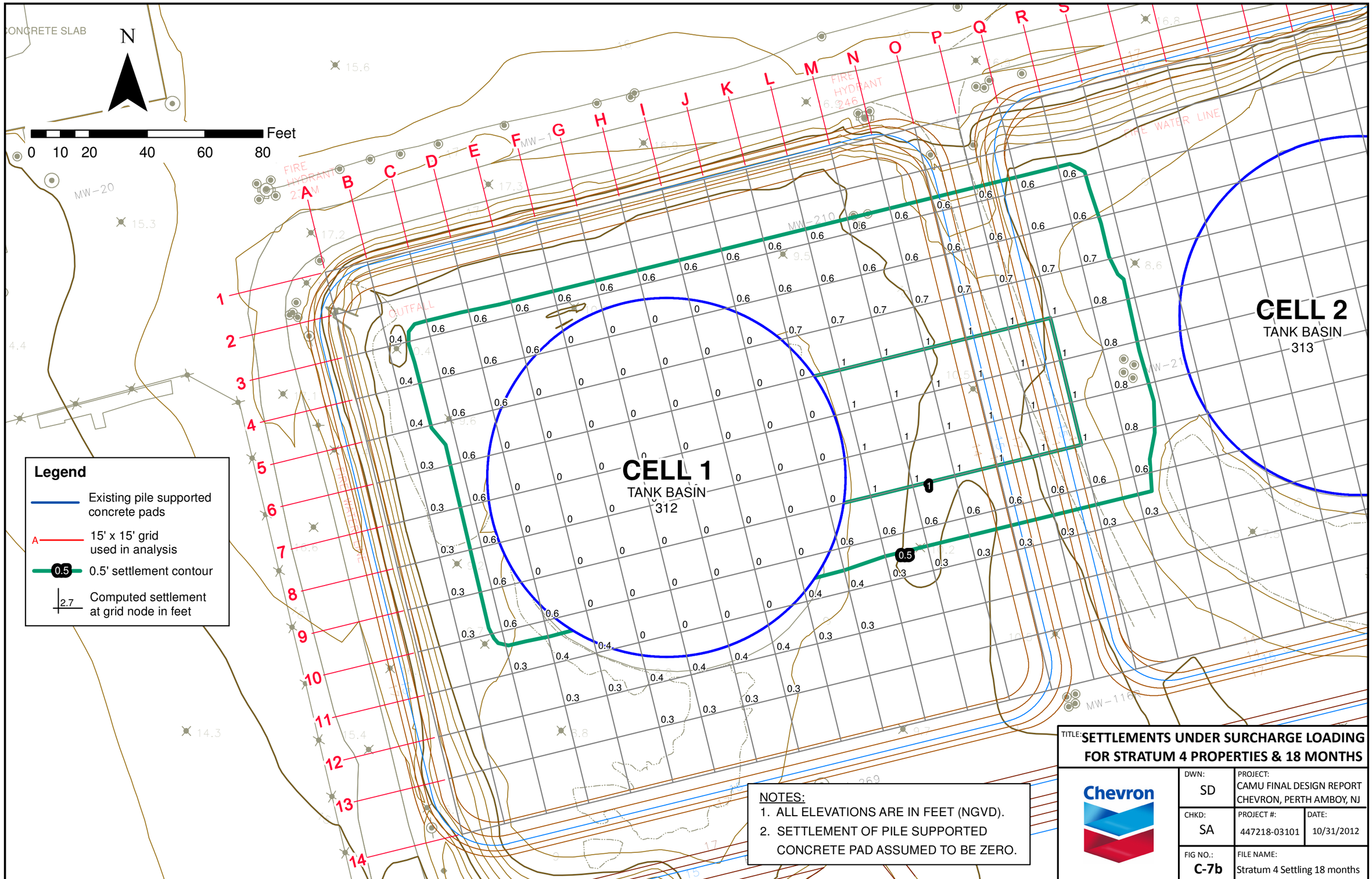
TITLE: SETTLEMENTS UNDER SURCHARGE LOADING FOR STRATUM 3 PROPERTIES & 9 MONTHS

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: C-6a	FILE NAME: Stratum 3 Settling 9 months	


N
Feet
0 10 20 40 60 80
CONCRETE SLAB
FIRE HYDRANT
OUTFALL
FIRE WATER LINE
MW-20
MW-21
MW-116
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
0.5' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: SETTLEMENTS UNDER SURCHARGE LOADING FOR STRATUM 3 PROPERTIES & 18 MONTHS
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-6b
FILE NAME: Stratum 3 Settling 18 months


N
Feet
0 10 20 40 60 80
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
0.5' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: SETTLEMENTS UNDER SURCHARGE LOADING FOR STRATUM 4 PROPERTIES & 9 MONTHS
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-7a
FILE NAME: Stratum 4 Settling 9 months

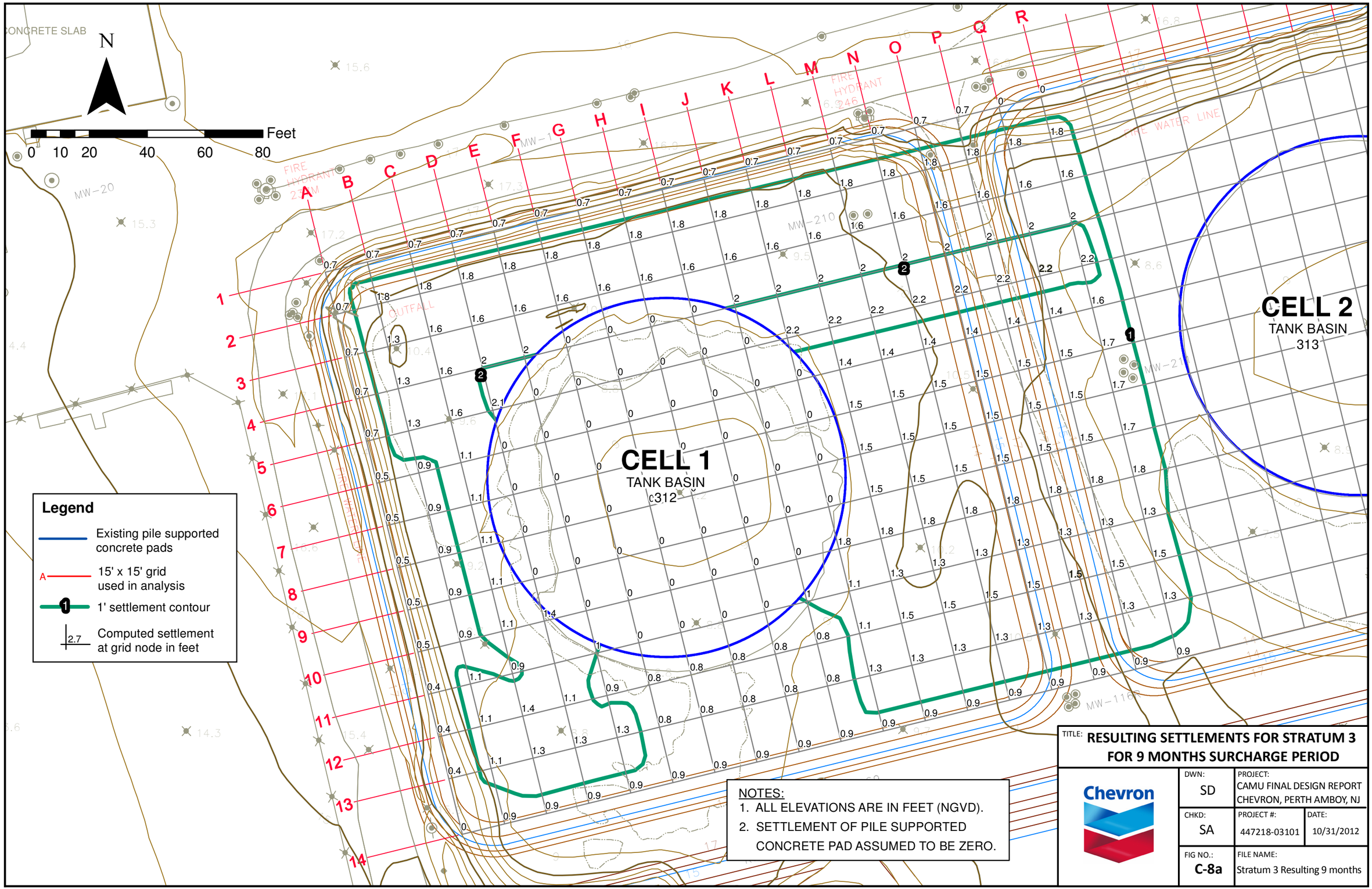


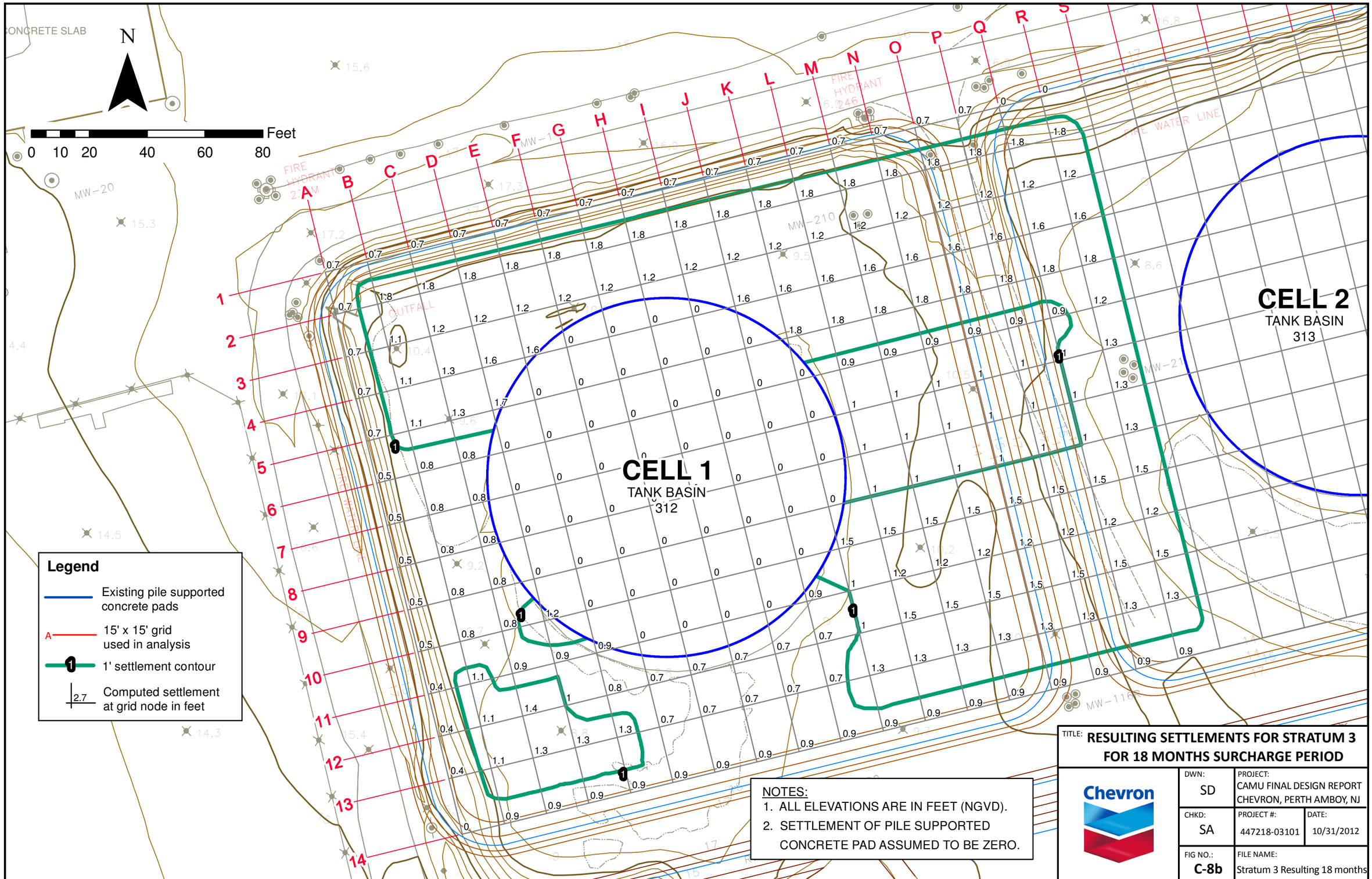
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.

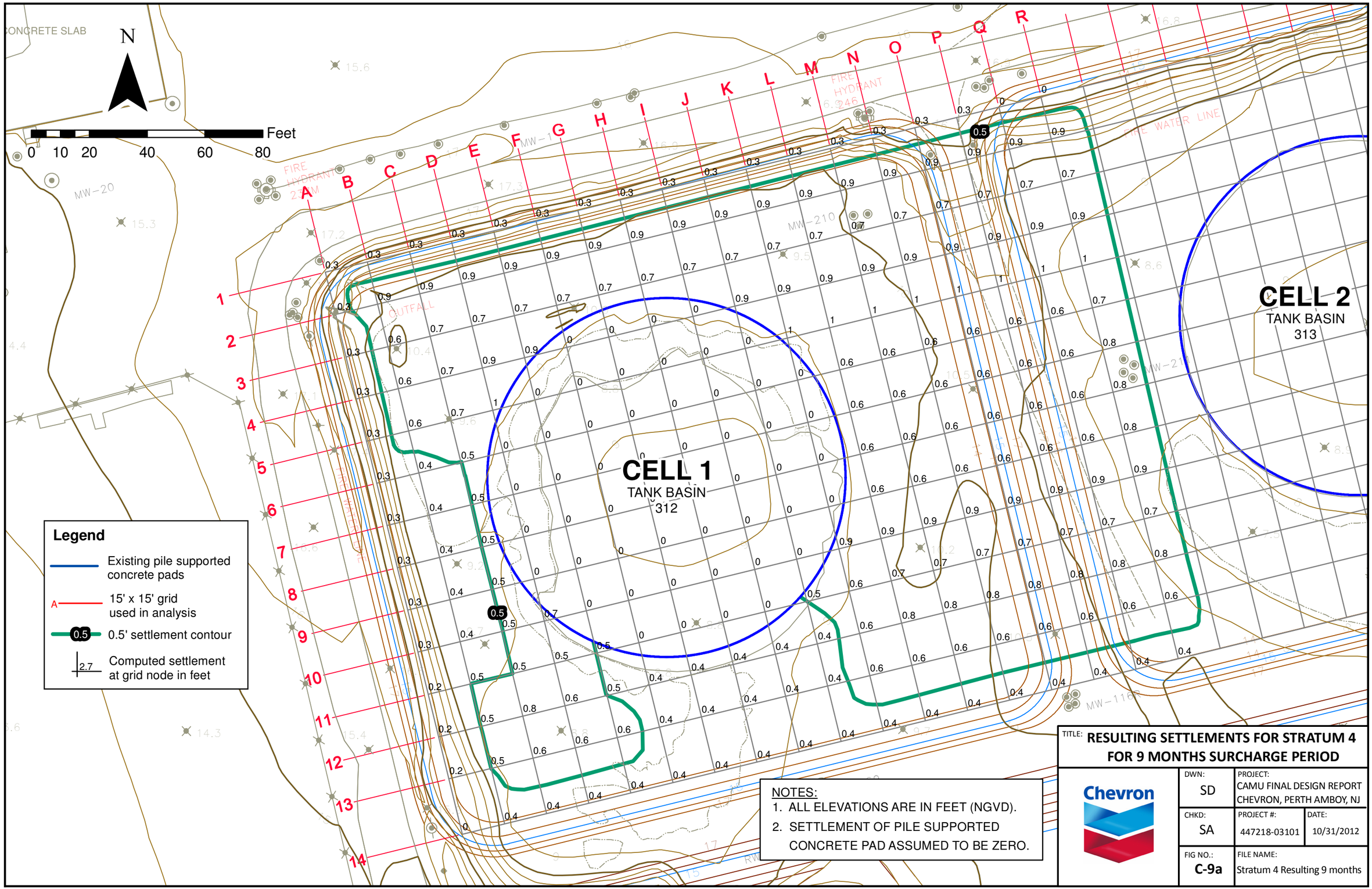
TITLE: SETTLEMENTS UNDER SURCHARGE LOADING FOR STRATUM 4 PROPERTIES & 18 MONTHS

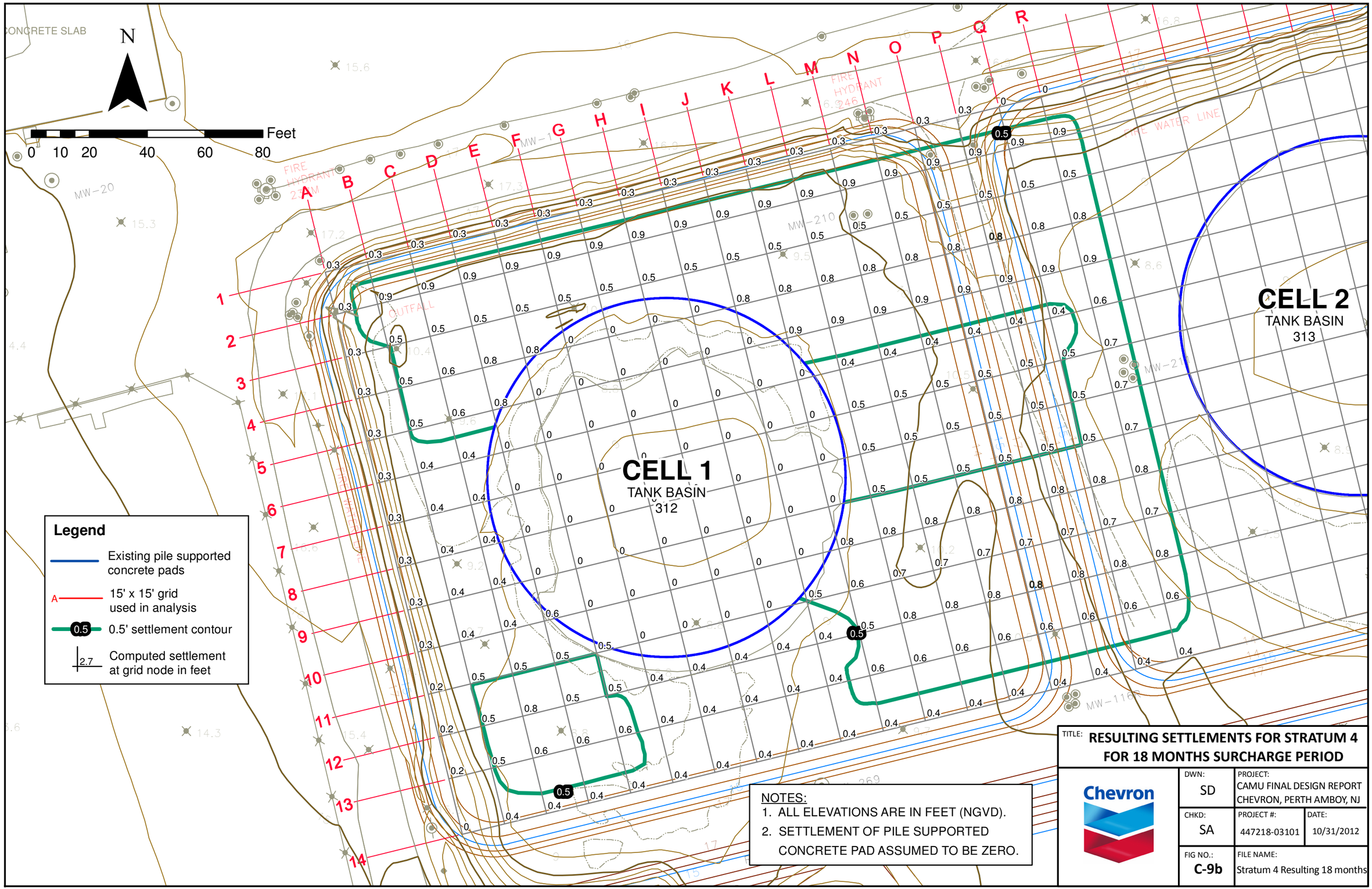
Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: C-7b	FILE NAME: Stratum 4 Settling 18 months	


N
Feet
0 10 20 40 60 80
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
1' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: RESULTING SETTLEMENTS FOR STRATUM 3 FOR 9 MONTHS SURCHARGE PERIOD
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-8a
FILE NAME: Stratum 3 Resulting 9 months


N
Feet
0 10 20 40 60 80
CONCRETE SLAB
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
1' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: RESULTING SETTLEMENTS FOR STRATUM 3 FOR 18 MONTHS SURCHARGE PERIOD
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-8b
FILE NAME: Stratum 3 Resulting 18 months


N
Feet
0 10 20 40 60 80
CONCRETE SLAB
FIRE HYDRANT
OUTFALL
FIRE WATER LINE
MW-20
MW-210
MW-116
A B C D E F G H I J K L M N O P Q R
1 2 3 4 5 6 7 8 9 10 11 12 13 14
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
0.5' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: RESULTING SETTLEMENTS FOR STRATUM 4 FOR 9 MONTHS SURCHARGE PERIOD
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-9a
FILE NAME: Stratum 4 Resulting 9 months


N
Feet
0 10 20 40 60 80
CONCRETE SLAB
CELL 1
TANK BASIN
312
CELL 2
TANK BASIN
313
Legend
Existing pile supported concrete pads
15' x 15' grid used in analysis
0.5' settlement contour
Computed settlement at grid node in feet
NOTES:
1. ALL ELEVATIONS ARE IN FEET (NGVD).
2. SETTLEMENT OF PILE SUPPORTED CONCRETE PAD ASSUMED TO BE ZERO.
TITLE: RESULTING SETTLEMENTS FOR STRATUM 4 FOR 18 MONTHS SURCHARGE PERIOD
Chevron
DWN: SD
PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: SA
PROJECT #: 447218-03101
DATE: 10/31/2012
FIG NO.: C-9b
FILE NAME: Stratum 4 Resulting 18 months

ATTACHMENT C-1

SAMPLE SETTLEMENT CALCULATION

EXAMPLE SETTLEMENT CALCULATION

CAMU Settlement Analyses
Chevron Perth Amboy Facility, NJ

Example Calculation Presented for the Following Case

1) Total expected settlement under waste loading at grid node N7 (Waste height of 31 feet)
2) Stratum 3/4 thickness of 6 feet
3) Stratum 3 consolidation properties assigned to Stratum 3/4

Stratum Properties Used in the Analyses

Soil	Moist Unit Weight (pcf)	Stratum Thickness (feet)	Ccε	Crε	Cαε	Cv (ft^2/yr)
Stabilized Waste/Soils	120	31				
Stratum 1 - Fill	120	11				
Stratum 3 - Peat	70	6	0.490	NA[1]	0.025	15
Stratum 6: Red-Brown Clays	125	10	0.081	0.010	0.002	85
Stratum 3/4	85					
Water	62.4					

Notes:
1. NA - Stratum soils were considered to be normally consolidated
2. Ccε = Compression Ratio, Crε = Re-compression Ratio
3. Cαε = Secondary Compression Ratio, Cv = Coefficient of Consolidation

Assumptions
1. Depth to water table (bgs) = 2 feet
2. Stratum 6 pre-consolidation Stress (σ p) = 2400 psf

Primary Consolidation Settlement of Stratum 3/4

Number of sub-layers in Stratum 3/4 = 4
Each sub-layer thickness = 1.5 feet

Equation used to estimate settlement due to primary consolidation

$$S_p = C_{c\in} H_o \log\left(\frac{\sigma'_{vo} + \Delta\sigma}{\sigma'_{vo}}\right)$$

Primary Settlement at middle of first sub-layer:

Initial effective overburden pressure (σ'vo) = 764.1 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.6 feet
Final layer thickness = 0.9 feet

Sub-Layer	Depth (bgs) to Layer	
	Top	Center
Sub-layer 1	11.0	11.75
Sub-layer 2	12.5	13.25
Sub-layer 3	14.0	14.75
Sub-layer 4	15.5	16.25

Primary Settlement at middle of second sub-layer:

Initial effective overburden pressure (σ'vo) = 775.5 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.6 feet
Final layer thickness = 0.9 feet

Primary Settlement at middle of third sub-layer:

Initial effective overburden pressure (σ'vo) = 786.9 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.6 feet
Final layer thickness = 0.9 feet

Primary Settlement at middle of fourth layer:

Initial effective overburden pressure (σ'vo) = 798.3 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.6 feet
Final layer thickness = 0.9 feet

Total Primary Settlement in Stratum 3 = 2.2 feet
Final Stratum 3 Thickness = 3.8 feet

Primary Consolidation Settlement of Stratum 6:

Number of sub-layers in Stratum 6 = 4.0
Each sub-Layer thickness = 2.5 feet

Equation used to estimate settlement due to primary consolidation

$$s_p = C_{r\varepsilon} H_o \log\left(\frac{\sigma_p}{\sigma_{vo}}\right) + C_{c\varepsilon} H_o \log\left(\frac{\sigma_{vo} + \Delta\sigma}{\sigma_p}\right)$$

Primary Settlement at middle of first sub-layer:

Initial effective overburden pressure (σ'vo) = 882.3 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.1 feet
Final layer thickness = 2.4 feet

Sub-Layer	Depth (bgs) to Layer	
	Top	Center
Sub-layer 1	17.0	18.25
Sub-layer 2	19.5	20.75
Sub-layer 3	22.0	23.25
Sub-layer 4	24.5	25.75

Primary Settlement at middle of second sub-layer:

Initial effective overburden pressure (σ'vo) = 1038.8 psf
Change in effective stress (Δσ) = 3720.0 psf

Settlement = 0.1 feet
Final layer thickness = 2.4 feet

Primary Settlement at middle of third sub-layer:

Initial effective overburden pressure (σ'vo) = 1195.3 psf
Change in effective stress ($\Delta\sigma$) = 3720.0 psf

Settlement = 0.1 feet
Final layer thickness = 2.4 feet

Primary Settlement at middle of fourth sub-layer:

Initial effective overburden pressure (σ'vo) = 1351.8 psf
Change in effective stress ($\Delta\sigma$) = 3720.0 psf

Settlement = 0.1 feet
Final layer thickness = 2.4 feet

Total Primary Settlement in Stratum 6 = **0.3 feet**
Final Stratum 6 Thickness = **9.7 feet**

Total Primary Settlement (Stratum 3/4 + Stratum 6) = **2.5 feet**

Time Required to Estimate Primary Consolidation:

Equation used to estimate the time required to complete primary consolidation

$$t = \left[\frac{T\ H_{dr}^2}{c_v} \right]$$

where,
T = time factor (0.848 for 90% average consolidation)
t = consolidation time (t90 is time required to 90% consolidation)
H_{dr} = length of the longest drainage path

Stratum 3/4

Assuming single drainage, H_{dr} = 6 feet
Total Primary Settlement of Stratum 3 = 2.2 feet

Uavg	T	Sc (ft)	t (year)	t (days)
0.1	0.008	0.00	0.02	7
0.2	0.031	0.00	0.07	27
0.3	0.071	0.00	0.17	62
0.4	0.126	0.00	0.30	110
0.5	0.197	0.00	0.47	173
0.6	0.287	0.00	0.69	251
0.7	0.403	0.00	0.97	353
0.8	0.567	0.00	1.36	497
0.9	0.848	0.00	2.04	743
0.95	1.163	0.00	2.79	1019

Stratum 6

Assuming single drainage, H_{dr} = 10 feet

Total Primary Settlement of Stratum 6 = 0.3 feet

Uavg	T	Sc (ft)	t (year)	t (days)
0.1	0.008	0.00	0.01	3
0.2	0.031	0.00	0.04	13
0.3	0.071	0.00	0.08	30
0.4	0.126	0.00	0.15	54
0.5	0.197	0.00	0.23	85
0.6	0.287	0.00	0.34	123
0.7	0.403	0.00	0.47	173
0.8	0.567	0.00	0.67	243
0.9	0.848	0.00	1.00	364
0.95	1.163	0.00	1.37	499

Secondary Settlement

Equation used to estimate secondary settlement

$$s_s = C_{\alpha\varepsilon}\ H_o \log \frac{t_{design}}{t_{90}}$$

where,

t_{design} = design life (assumed to be 30 years)

t_{90} = time corresponding to 90% average consolidation

H_0 = initial thickness of layer

	Stratum 3	Stratum 6
Time required for 90% average consolidation, t (yr)=	2.04	1.00

Stratum 3 Secondary Settlement in 30 years = **0.17 feet**

Stratum 6 Secondary Settlement in 30 years = **0.02 feet**

Total secondary settlement in 30 years = **0.19 feet**

Settlement Calculation Summary

Total Primary Settlement in Stratum 3 and 6 = **2.52 feet**

Total secondary settlement in 30 years = **0.19 feet**

Total Settlement in 30 years = **2.7 feet**

Table C-1a

TOTAL EXPECTED SETTLEMENTS IN CAMU
(Stratum 3 Consolidation Properties used for Stratum 3/4)

Row			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ	KK	LL	MM	NN	OO	PP	QQ	RR	SS	TT	UU
1		Waste Height	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	3.0	0.0
	Total Primary	Stratum 3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.9	0.0
2		Waste Height	2.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.5	5.5
	Total Primary	Stratum 3	0.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.3	1.3
3		Waste Height	2.0	10.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.0	8.0	6.0
	Total Primary	Stratum 3	0.5	1.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.4	1.1
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.7	1.8	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	1.6	1.3
4		Waste Height	2.0	10.0	16.0	20.0	20.0	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Pad	Pad	Pad	Pad	20.0	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.5	1.6	2.1	2.4	2.4					2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4					2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4					2.4	2.3	1.9	1.5	1.1
		Stratum 6	0.0	0.0	0.1	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0
		Total	0.7	1.8	2.4	2.7	2.7	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0	0.0	0.0	0.0	2.7	2.7	2.2	1.7	1.3
5		Waste Height	2.0	10.0	16.0	21.0	Pad	Pad	Pad	Pad	Pad	Pad	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.5	1.6	2.1	2.4							2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7								2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7								2.3	1.9	1.5	1.1
		Stratum 6	0.0	0.0	0.1	0.2							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0
		Total	0.7	1.8	2.4	2.8	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.2	1.7	1.3
6		Waste Height	2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	1.2	1.6									2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2								2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1									1.5	1.1	0.8
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.5	1.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.0
7		Waste Height	2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	1.2	1.6									2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2										2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1									1.5	1.1	0.8
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.5	1.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.0
8		Waste Height	2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	1.2	2.2									2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2										2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1									1.5	1.1	0.8
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.5	1.4	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.0
9		Waste Height	2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	1.2	1.6									2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2										2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1									1.5	1.1	0.8
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.5	1.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.0
10		Waste Height	2.0	10.0	16.0	21.0	Pad	Pad	Pad	Pad	Pad	Pad	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	1.2	1.6	1.8							2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1								2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1								1.7	1.5	1.1	0.8
		Stratum 6	0.0	0.0	0.1	0.2							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.2	0.2	0.2	0.2							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.2	0.2	0.2
		Stratum 6	0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0
		Total	0.5	1.4	1.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.7	1.3	1.0
11		Waste Height	2.0	10.0	16.0	21.0	23.0	Pad	Pad	Pad	Pad	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	Pad	Pad	Pad	Pad	Pad	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	Pad	Pad	Pad	Pad	Pad	23.0	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	0.9	1.2	1.3	1.4					1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4						1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4						1.4	1.3	1.1	0.8	0.6
		Stratum 6	0.0	0.0	0.1	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2						0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2						0.2	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1						0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0
		Total	0.4	1.1	1.4	1.7	1.8	0.0	0.0	0.0	0.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	0.0	0.0	0.0	0.0	0.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	0.0	0.0	0.0	0.0	0.0	1.8	1.6	1.3	1.0	0.8
12		Waste Height	2.0	10.0	16.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	17.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.3	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	0.8	0.6
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.4	1.1	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.0	0.8
13		Waste Height	2.0	10.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.0	9.0	6.0
	Total Primary	Stratum 3	0.3	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.6
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.4	1.1	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.0	0.8
14		Waste Height	0.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5.0	5.0
	Total Primary	Stratum 3	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7

Table C-1b

TOTAL EXPECTED SETTLEMENTS IN CAMU
(Stratum 4 Consolidation Properties used for Stratum 3/4)

			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	Waste Height		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary	Stratum 3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Waste Height		2.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	Total Primary	Stratum 3	0.2	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
3	Waste Height		2.0	10.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
	Total Primary	Stratum 3	0.2	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.3	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
4	Waste Height		2.0	10.0	16.0	20.0	20.0	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.7	1.0	1.1	1.1					1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1			
		Stratum 6	0.0	0.0	0.1	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			
		Stratum 6	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		Total	0.3	0.9	1.2	1.4	1.4	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0
5	Waste Height		2.0	10.0	16.0	21.0	Pad	Pad	Pad	Pad	Pad	Pad	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.7	1.0	1.1							1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
		Stratum 6	0.0	0.0	0.1	0.2							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2				
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
		Stratum 6	0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
		Total	0.3	0.9	1.2	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.0	0.0	0.0	0.0
6	Waste Height		2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.6	0.8									1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3				
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
		Total	0.3	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0
7	Waste Height		2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.6	0.8									1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1					
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3					
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1					
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		Total	0.3	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0	0.0
8	Waste Height		2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.6	0.8									1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1					
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3					
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1					
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		Total	0.3	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0	0.0
9	Waste Height		2.0	10.0	16.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	Pad	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.6	0.8									1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1					
		Stratum 6	0.0	0.0	0.1									0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3					
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1					
		Stratum 6	0.0	0.0	0.0									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
		Total	0.3	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0	0.0
10	Waste Height		2.0	10.0	16.0	21.0	Pad	Pad	Pad	Pad	Pad	Pad	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	Pad	Pad	Pad	Pad
	Total Primary	Stratum 3	0.2	0.6	0.8	0.9							1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
		Stratum 6	0.0	0.0	0.1	0.2							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3				
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
		Stratum 6	0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
		Total	0.3	0.7	1.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0
11	Waste Height		2.0	10.0	16.0	21.0	23.0	Pad	Pad	Pad	Pad	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	Pad	Pad	Pad
	Total Primary	Stratum 3	0.1	0.4	0.6	0.6	0.7					0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7			
		Stratum 6	0.0	0.0	0.1	0.2	0.2					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			
		Stratum 6	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
		Total	0.2	0.5	0.8	0.9	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
12	Waste Height		2.0	10.0	16.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	Total Primary	Stratum 3	0.1	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.2	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
13	Waste Height		2.0	10.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
	Total Primary	Stratum 3	0.1	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		Stratum 6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.2	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
14	Waste Height		0.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	Total Primary	Stratum 3	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

			Y	Z	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ	KK	LL	MM	NN	OO	PP	QQ	RR	SS	TT	UU
1	Waste Height		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	3.0	0.0
	Total Primary	Stratum 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.4	0.0
2	Waste Height		10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.5	5.5
	Total Primary	Stratum 3	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.6
3	Waste Height		15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.0	8.0	6.0
	Total Primary	Stratum 3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.5
		Stratum 6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	0.8	0.6
4	Waste Height		Pad	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Pad	Pad	Pad	Pad	20.0	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1					1.1	1.1	0.9	0.7	0.5
		Stratum 6		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0.2	0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1					0.1	0.1	0.1	0.1	0.1
		Stratum 6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0
		Total	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0	1.4	1.4	1.1	0.8	0.6
5	Waste Height		Pad	Pad	Pad	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3				1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3								1.1	0.9	0.7	0.5
		Stratum 6				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1								0.1	0.1	0.1	0.1
		Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0
		Total	0.0	0.0	0.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.1	0.8	0.6
6	Waste Height		Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0									0.7	0.5	0.4
		Stratum 6				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									0.1	0.1	0.1
		Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.5
7	Waste Height		Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3					1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0									0.7	0.5	0.4
		Stratum 6					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									0.1	0.1	0.1
		Stratum 6					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.5
8	Waste Height		Pad	Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3					1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0									0.7	0.5	0.4
		Stratum 6					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									0.1	0.1	0.1
		Stratum 6					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.5
9	Waste Height		Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	14.0	9.0	6.0
	Total Primary	Stratum 3				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0									0.7	0.5	0.4
		Stratum 6				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2									0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									0.1	0.1	0.1
		Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.0	0.0	0.0
		Total	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.5
10	Waste Height		Pad	Pad	Pad	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0								0.8	0.7	0.5	0.4
		Stratum 6				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2								0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1								0.1	0.1	0.1	0.1
		Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.0	0.0	0.0	0.0
		Total	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.9	0.6	0.5
11	Waste Height		Pad	Pad	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	Pad	Pad	Pad	Pad	Pad	23.0	19.0	14.0	9.0	6.0
	Total Primary	Stratum 3			0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7						0.7	0.6	0.5	0.4	0.3
		Stratum 6			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2						0.2	0.2	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1						0.1	0.1	0.1	0.1	0.1
		Stratum 6			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0
		Total	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.7	0.5	0.4
12	Waste Height		18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	17.0	14.0	9.0	6.0
	Total Primary	Stratum 3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.4	0.3
		Stratum 6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5	0.4
13	Waste Height		13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.0	9.0	6.0
	Total Primary	Stratum 3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.3
		Stratum 6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.4
14	Waste Height		6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5.0	5.0
	Total Primary	Stratum 3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years)	Stratum 3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Stratum 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Total	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table C-1c

SETTLMENTS EXPECTED UNDER SURCHARGE LOADS
(Stratum 3 Consolidation Properties used for Stratum 3/4)

Expected Settlements for a Surcharge Period of 9 months

			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	1	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	2	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	5.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5
	3	Stratum 6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5
		Waste Height	0.0	5.0	10.0	10.0	10.0	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.5	0.7	0.7	0.7					0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5
	4	Stratum 6		0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.8	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5
		Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	5.0
Total Primary		Stratum 3		0.5	0.7	0.7						0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5
	5	Stratum 6		0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.5
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.5	0.7									1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.7
	6	Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.0	0.8
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.5	0.7									1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.7
	7	Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.0	0.8
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.5	0.7									1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.7
	8	Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.0	0.8
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.5	0.7									1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.7
	9	Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.0	0.8
		Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.5	0.7	0.7						0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5
	10	Stratum 6		0.0	0.0	0.0						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.5	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5
		Waste Height	0.0	0.0	5.0	8.0	10.0	Pad	Pad	Pad	Pad	10.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total Primary		Stratum 3			0.5	0.7	0.8					0.8	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	11	Stratum 6			0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.5	0.7	0.8	0.0	0.0	0.0	0.0	0.8	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		Waste Height	0.0	0.0	0.0	5.0	7.0	10.0	10.0	10.0	10.0	7.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3				0.5	0.6	0.8	0.8	0.8	0.8	0.6	0.5								
	12	Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.5	0.6	0.8	0.8	0.8	0.8	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3						0.5	0.5	0.5	0.5										
	13	Stratum 6						0.0	0.0	0.0	0.0										
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	14	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Expected Settlements for a Surcharge Period of 18 months

			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	1	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	2	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	5.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.7
	3	Stratum 6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.7
		Waste Height	0.0	5.0	10.0	10.0	10.0	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.7	1.1	1.1	1.1					1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.7
	4	Stratum 6		0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.7	1.1	1.1	1.1	0.0	0.0	0.0	0.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.7
		Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	5.0
Total Primary		Stratum 3		0.7	1.1	1.1							1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.7
	5	Stratum 6		0.0	0.0	0.0							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.7	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.7
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.6	1.0									1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.0
	6	Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.4	1.1
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.6	1.0									1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.0
	7	Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.4	1.1
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.6	1.0									1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.0
	8	Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.4	1.1
		Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
Total Primary		Stratum 3		0.6	1.0									1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.0
	9	Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.4	1.1
		Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Total Primary		Stratum 3		0.6	1.0	1.0							1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6
	10	Stratum 6		0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.6	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.6
		Waste Height	0.0	0.0	5.0	8.0	10.0	Pad	Pad	Pad	Pad	10.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total Primary		Stratum 3			0.5	0.7	0.8					0.8	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	11	Stratum 6			0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.5	0.8	0.9	0.0	0.0	0.0	0.0	0.9	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		Waste Height	0.0	0.0	0.0	5.0	7.0	10.0	10.0	10.0	10.0	7.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3				0.5	0.7	0.8	0.8	0.8	0.8	0.7	0.5								
	12	Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.5	0.7	0.9	0.9	0.9	0.9	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3						0.5	0.5	0.5	0.5										
	13	Stratum 6						0.0	0.0	0.0	0.0										
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Primary		Stratum 3																			
	14	Stratum 6																			
Total Secondary (30 years)		Stratum 3																			
		Stratum 6																			
		Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C-1d

SETTLMENTS EXPECTED UNDER SURCHARGE LOADS
(Stratum 4 Consolidation Properties used for Stratum 3/4)

Expected Settlements for a Surcharge Period of 9 months

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Waste Height	0.0	5.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
	Total Primary: Stratum 6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
4	Waste Height	0.0	5.0	10.0	10.0	10.0	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.3	0.4	0.4	0.4					0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
	Total Primary: Stratum 6		0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
5	Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	5.0
	Total Primary: Stratum 3		0.3	0.4	0.4							0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
	Total Primary: Stratum 6		0.0	0.0	0.0							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.3
6	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.4									0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
7	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.4									0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
8	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.4									0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
9	Waste Height		5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.4									0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
10	Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.3	0.4	0.4							0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
	Total Primary: Stratum 6		0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
11	Waste Height	0.0	0.0	5.0	8.0	10.0	Pad	Pad	Pad	Pad	10.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Total Primary: Stratum 3			0.2	0.3	0.4					0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Total Primary: Stratum 6			0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.3	0.4	0.4	0.0	0.0	0.0	0.0	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
12	Waste Height	0.0	0.0	0.0	5.0	7.0	10.0	10.0	10.0	10.0	7.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3				0.2	0.3	0.4	0.4	0.4	0.4	0.3	0.2								
	Total Primary: Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Waste Height	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3						0.2	0.2	0.2	0.2										
	Total Primary: Stratum 6						0.0	0.0	0.0	0.0										
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Expected Settlements for a Surcharge Period of 18 months

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Waste Height	0.0	5.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.4
4	Waste Height	0.0	5.0	10.0	10.0	10.0	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.4	0.6	0.6	0.6					0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.4
	Total Primary: Stratum 6		0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.4	0.6	0.6	0.6	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.4
5	Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	5.0
	Total Primary: Stratum 3		0.4	0.6	0.6							0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.4
	Total Primary: Stratum 6		0.0	0.0	0.0							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.4	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.4
6	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.5									0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
	Total Primary: Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.6
7	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.5									0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
	Total Primary: Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.6
8	Waste Height	0.0	5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.5									0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
	Total Primary: Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.6
9	Waste Height		5.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	Pad	Pad	20.0	20.0	20.0	20.0	20.0	20.0	15.0	10.0
	Total Primary: Stratum 3		0.3	0.5									0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.5
	Total Primary: Stratum 6		0.0	0.0									0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.6
10	Waste Height	0.0	5.0	10.0	10.0	Pad	Pad	Pad	Pad	Pad	Pad	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.0
	Total Primary: Stratum 3		0.3	0.5	0.5							0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3
	Total Primary: Stratum 6		0.0	0.0	0.0							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.3	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.3
11	Waste Height	0.0	0.0	5.0	8.0	10.0	Pad	Pad	Pad	Pad	10.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Total Primary: Stratum 3			0.2	0.3	0.4					0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Total Primary: Stratum 6			0.0	0.0	0.0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.3	0.4	0.4	0.0	0.0	0.0	0.0	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
12	Waste Height	0.0	0.0	0.0	5.0	7.0	10.0	10.0	10.0	10.0	7.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3				0.2	0.3	0.4	0.4	0.4	0.4	0.3	0.2								
	Total Primary: Stratum 6				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Waste Height	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3						0.2	0.2	0.2	0.2										
	Total Primary: Stratum 6						0.0	0.0	0.0	0.0										
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Waste Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Primary: Stratum 3																			
	Total Primary: Stratum 6																			
	Total Secondary (30 years): Stratum 3																			
	Total Secondary (30 years): Stratum 6																			
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ATTACHMENT C-2

MEASURED VERSUS COMPUTED SETTLEMENTS

- **Figure C2a – SP 1, 2 and 3 located in Grid Rows 1 through 5**
- **Figure C2b – SP 4, 5 and 6 located in Grid Rows 6 through 10**
- **Figure C2c – SP 7 located in Grid Rows 11 through 14**

Figure C2a

MEASURED VERSUS CALCULATED SETTLEMENTS FOR GRID ROWS 1 TO 5

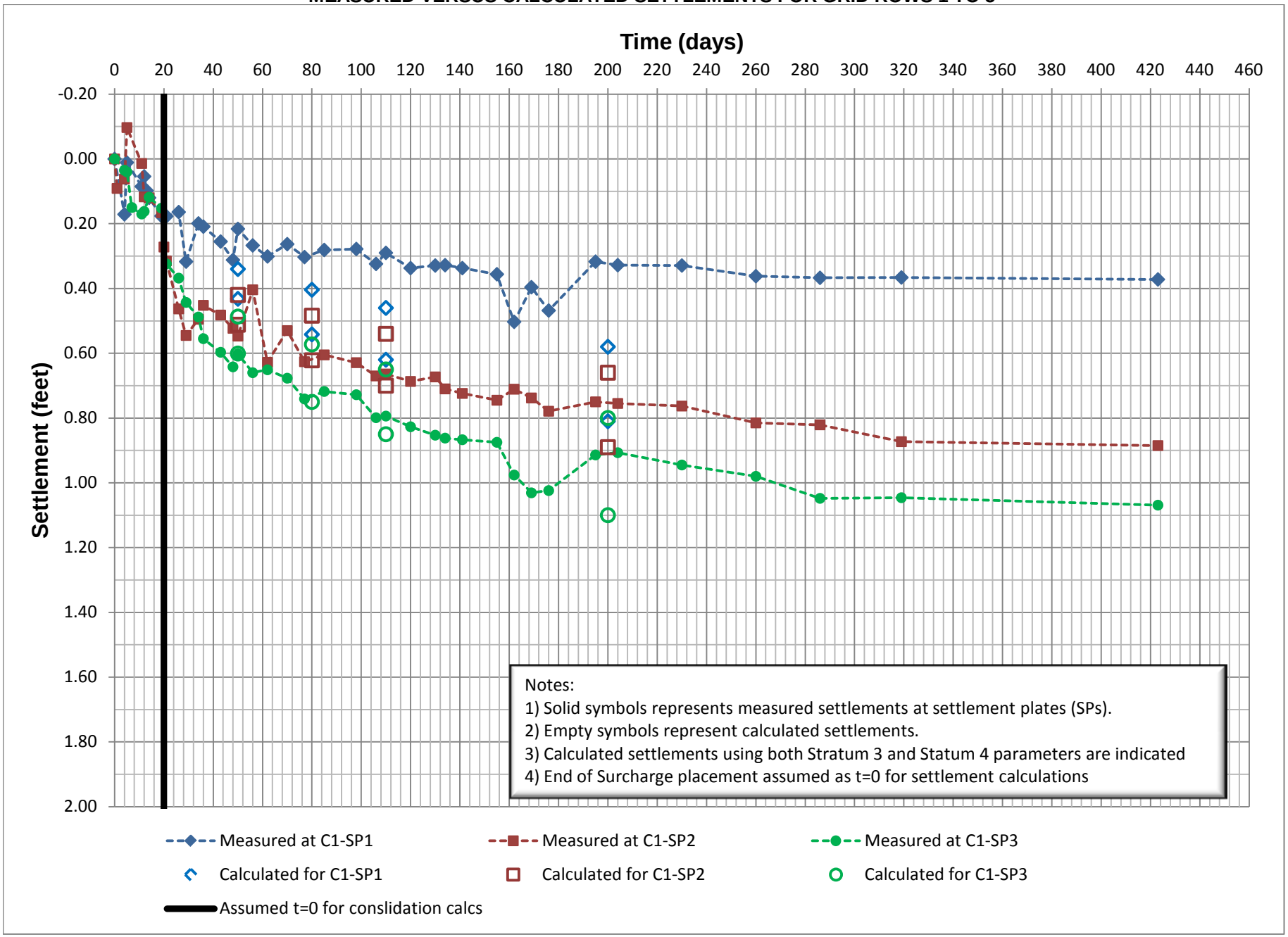


Figure C2b

MEASURED VERSUS CALCULATED SETTLEMENTS FOR GRID ROWS 6 TO 10

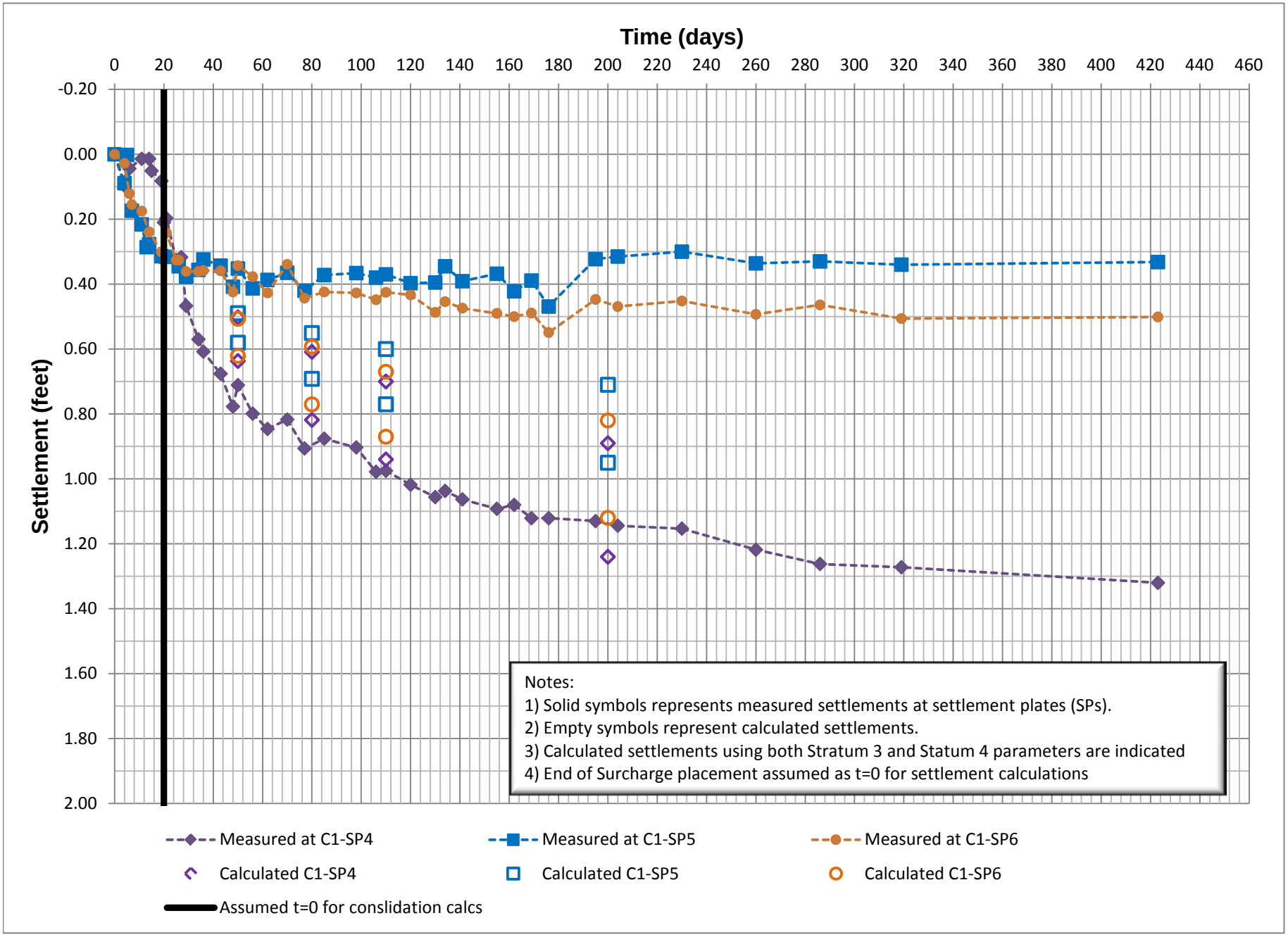


Figure C2c

MEASURED VERSUS CALCULATED SETTLEMENTS FOR GRID ROWS 11 TO 14

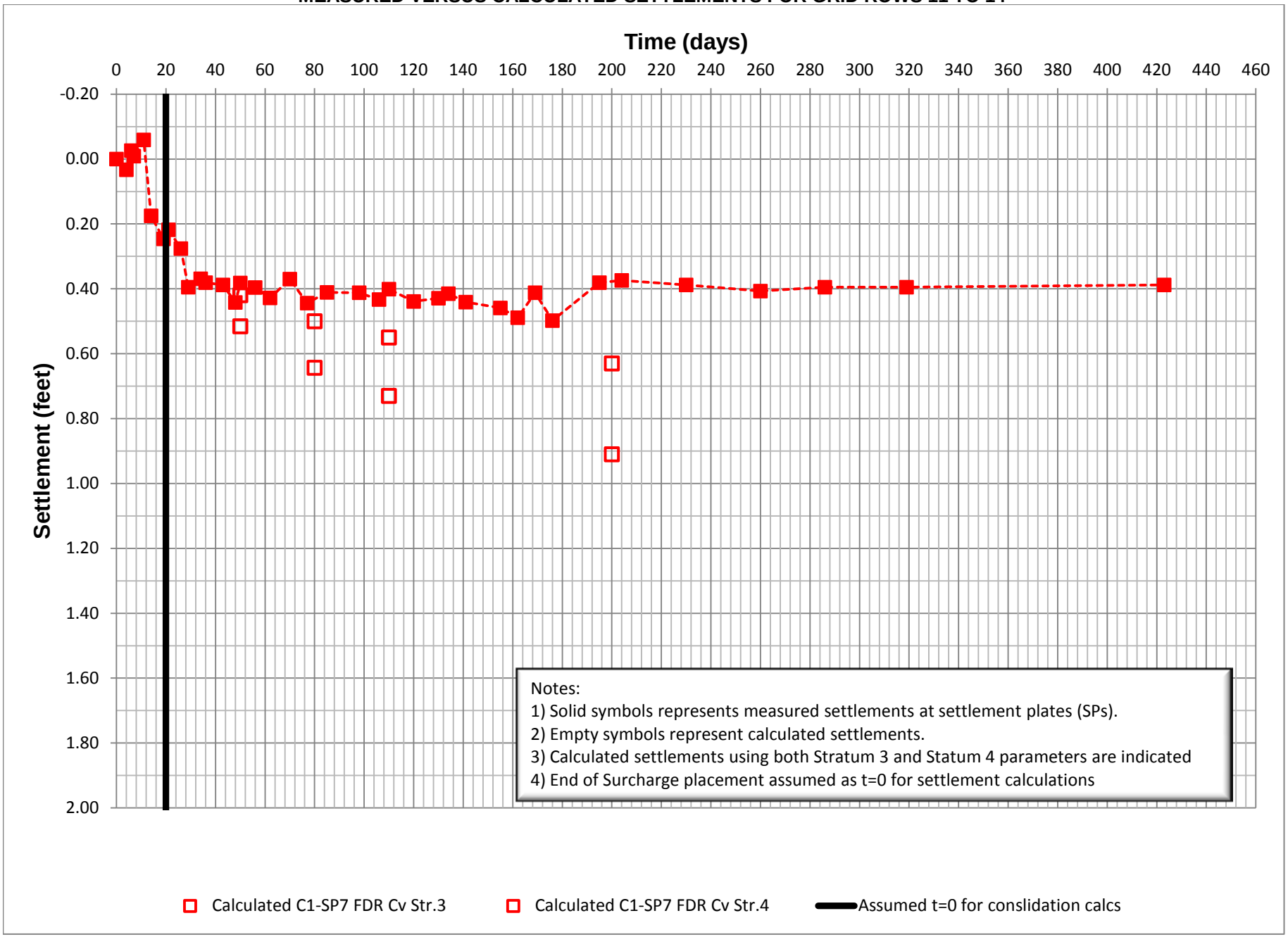
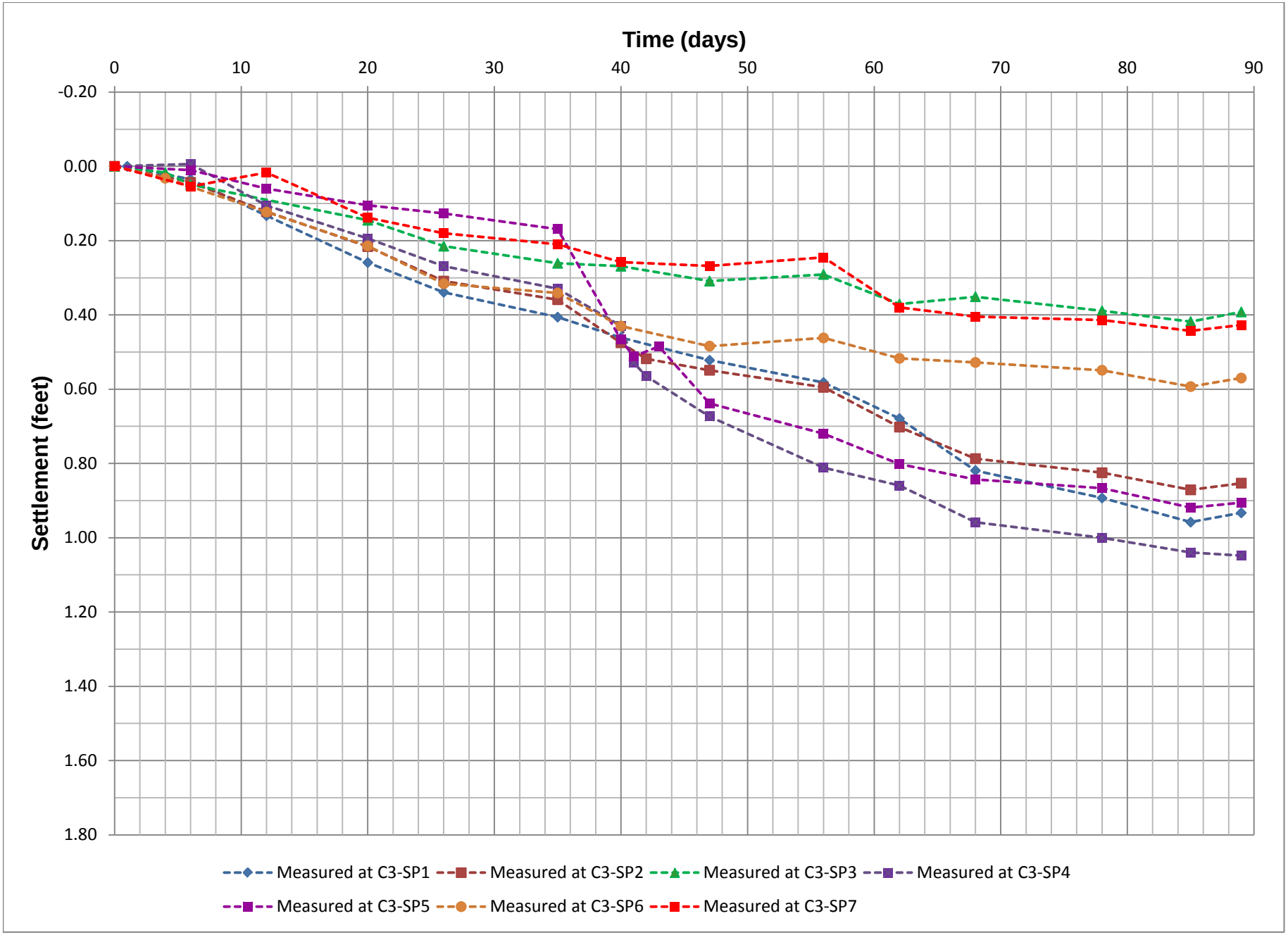


Figure C2d

MEASURED SETTLEMENTS IN CELL 3



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LEACHATE MANAGEMENT SYSTEM

1.0 INTRODUCTION

This calculation package presents the engineering design for the leachate collection system and provides a description of the leachate transmission system that will be constructed as part of the proposed Corrective Action Management Unit (CAMU) at the Chevron Perth Amboy facility (Facility) in New Jersey. The leachate collection system includes a leachate collection layer, leachate collection corridors, and leachate sumps that will be constructed in each of the three cells to collect and remove the leachate from the cells (see Permit Drawings). The leachate transmission system includes sump pumps, a transmission pipeline and a pump-out system that will be constructed to pump the leachate out of the cells and convey it to an on-site or an offsite facility for treatment and disposal. The leachate collection and the leachate transmission system are collectively referred to as the leachate management system.

2.0 RELEVANT SYSTEMS

2.1 Leachate Management System

The leachate collection system is designed to collect the leachate that percolates vertically through the stabilized soils/waste and convey it to the sumps for removal from the cell. The system is designed to limit the maximum head on the bottom geomembrane to no more than 30 centimeters (1 foot) in accordance with the requirements of 40 CFR 264.552(e)(3)(i).

Each of the three cells proposed for the CAMU include a conventional “herringbone” pattern bottom grading. The dual slope of the herringbone pattern is designed to convey the leachate towards the center and towards the east and west sides of the cell. The leachate collection layer will consist of an 18-inch thick layer that will be installed directly on top of the geomembrane in the bottom liner system. The leachate collection layer will be constructed using coarse sand and/or gravel and will have an as-built slope of 2 percent to convey the leachate to the leachate collection corridors.

Three leachate collection corridors will be provided to efficiently collect and convey the leachate from the cell to the sumps. A central leachate collection corridor will be provided in the valley of the herringbone-shaped cell (in the center of each cell) and will be aligned along the east-west direction (see Permit Drawings). Toe leachate collection corridors will be provided at the toe of the perimeter berm and will run in the north-south direction. The toe leachate collection corridors will be provided along the toe of the berms on the east and west sides of each cell. Cell leachate collection corridors will be constructed in the middle of the cell footprint as indicated on the Permit Drawings. The leachate collection corridors will convey the leachate to two sumps that will be constructed in each cell, one on the east side and the other on the west side of the cells.

The leachate transmission system includes sump pumps, a transmission pipeline and a pump-out system. Each cell will be equipped with two pumps to remove leachate, one pump in each of the two leachate

sumps on the east and west sides of the cell. A transmission pipeline will be constructed to pump the leachate from each cell directly to an on-site effluent treatment plant (ETP) that is located in close proximity to the proposed CAMU. To facilitate offsite disposal of leachate, a pump-out system will also be constructed between the CAMU and the ETP. The pump-out system will be designed to pump leachate into trucks for offsite disposal, if needed.

2.2 Bottom Liner System

The bottom liner system proposed for the CAMU will include a single composite liner system that will consist of the following components from top to bottom:

- 18-inch thick liner protective/leachate collection layer;
- 60-mil HDPE textured geomembrane liner;
- Geosynthetic clay liner (GCL);
- High strength, biaxial geogrid and
- 6-inch thick prepared subbase.

Since the sumps are expected to have standing leachate for extended periods of time, an additional compacted clay liner (CCL) layer will be provided under the footprint of the sumps as part of the bottom liner system. The CCL layer will be 12-inch thick and will be provided directly under the geogrid layer.

2.3 Final Cover System

The final cover system proposed for the CAMU will consist of the following components from top to bottom:

- 6-inch thick gravel layer;
- 18-inch thick cover protective layer;
- Geocomposite drainage layer consisting of a geonet with non-woven geotextile heat-bonded on both sides (on side-slopes only);
- 60-mil HDPE textured geomembrane liner; and
- 6-inch thick gas venting/leveling layer.

3.0 DESIGN REQUIREMENTS

In accordance with the requirements of 40 CFR 264.552(e)(3)(i), the leachate collection system shall be designed and constructed to maintain less than 30-centimeters (1-foot) depth of leachate over the bottom geomembrane liner.

4.0 HELP MODEL ANALYSES

4.1 Purpose

The Hydrogeologic Evaluation of Landfill Performance (HELP) model, Version 3.07 [Schroeder, et. al., EPA/600/R-94/168a and EPA/600/R-94/168b, 1994] was used to estimate leachate generation rates and maximum head on the bottom geomembrane liner for the proposed leachate collection system in the CAMU cells (Cells 1 through 3). The HELP model is a quasi-two dimensional water balance computer program used to evaluate the vertical movement of water through the stabilized soils/waste and components of the liner system. The computer program, along with site-specific weather data and design information, was utilized to estimate runoff, evapotranspiration, drainage, and leachate collection for the different development conditions.

The maximum head on the bottom geomembrane liner obtained from the HELP model for the different scenarios analyzed were used to design and optimize the performance of the proposed leachate collection system. The leachate generation rates obtained from the HELP model were used to design the leachate collection system pipes and the sumps.

4.2 Development Stages Analyzed

The leachate generation rates were estimated for four different stages during the life of the proposed CAMU cells. The leachate generation rates and the maximum heads on the bottom geomembrane liner were estimated for the development stages described below. Based on the layout of the cells presented in the Permit Drawings, an area of 1.2 acres was used in the analyses.

4.2.1 Case 1

This development stage corresponded to a stabilized soils/waste height of 10 feet and represented the initial conditions during the active life of the proposed cells. Case 1 assumed minimal runoff (since 10-foot height of stabilized soils/waste will be just above the top of the perimeter berms) and no surface vegetation. This case represented the critical conditions for leachate collection system design because the limited stabilized soils/waste thickness resulted in very little storage of precipitation, the lack of vegetation resulted in limited evapotranspiration and the small height of stabilized soils/waste resulted in minimal runoff.

4.2.2 Case 2

This development stage corresponded to a stabilized soils/waste height of 20 feet and represented the intermediate conditions during the active life of the proposed cells. For this case, runoff from the stabilized soils/waste surface was allowed and bare ground surface without vegetation was assumed.

4.2.3 Case 3

This development stage corresponded to a stabilized soils/waste height of 30 feet and represented the final conditions during the active life of the proposed cells prior to installation of the final cover system. For this case, runoff from the stabilized soils/waste surface was allowed and bare ground surface without vegetation was assumed.

4.2.4 Case 4

This case also analyzed a stabilized soils/waste height of 30 feet representing the full height of the stabilized soils/waste in CAMU but analyzed the post-closure conditions (i.e., after installation of the final cover system). For this case, runoff from the final cover surface (6-inch thick gravel layer) was allowed and bare ground conditions were assumed because of the gravel layer.

4.3 Reduction Factors

The reduction factors used to predict the long-term performance of the leachate collection layer (proposed as part of the bottom liner system) are discussed below. The following discussion provides details of the reduction factors applied to permeability of the leachate collection layer as suggested by Robert M. Koerner, 1998.

The required permeability ($K_{req'd}$) is the minimum permeability required for the leachate collection layer to maintain the maximum head on the geomembrane liner below the regulatory requirement of 30 centimeters (1 foot). It represents the minimum permeability that will be specified for the leachate collection layer during construction. The analysis permeability (K_{anal}) is the permeability used in the HELP model analysis to maintain the maximum head below the regulatory requirement. It represents the anticipated long-term permeability (a reduced permeability) of the leachate collection layer during operations and post-closure. The analysis permeability (K_{anal}) was obtained by applying the cumulative reduction factors (Π RF) and a factor of safety (FS) to the required permeability ($K_{req'd}$).

$$K_{anal} = \frac{K_{req'd}}{FS * \Pi(RF)} = \frac{K_{req'd}}{FS * (RF_{pc} * RF_{cc} * RF_{bc})}$$

K_{anal} = Permeability used in the HELP model analysis and represents the anticipated long-term permeability of the leachate collection layer;
$K_{req'd}$ = Minimum permeability required for the leachate collection layer during construction;
FS = Overall factor of safety (FS = 2 was used in the analyses);
RF_{pc} = Reduction factor for particulate clogging;
RF_{cc} = Reduction factor for chemical clogging;

RF_{bc} = Reduction factor for biological clogging; and
$\Pi(RF)$ = Cumulative reduction factors.

The reduction factors used for the leachate collection layer are summarized in the table below. A FS of 2 was used in the analyses.

Case #	RF_{pc}	RF_{cc}	RF_{bc}	$\Pi(RF)$	RF x FS
1 (10-ft waste)	1.1	1.5	1.5	2.5	5.0
2 (20-ft waste)	1.2	1.75	1.75	3.7	7.4
3 (30-ft waste)	1.3	2.0	2.0	5.2	10.4
4 (30 ft with final cover)	1.5	2.0	2.0	6.0	12.0

5.0 HELP MODEL INPUT DATA

The HELP model requires weather, soil, and basic design data as input and uses solution techniques that account for more than 10 above-surface and subsurface hydraulic processes including precipitation, runoff, and evapotranspiration. The simulation period used in the HELP model analyses was over 30 years.

5.1 Weather Data Description

The weather data required in HELP model are classified into four groups: evapotranspiration, precipitation, temperature, and solar radiation. The description for these options is described as follows:

5.1.1 Evapotranspiration

The evapotranspiration screen data requires the parameters: evaporative zone depth, maximum leaf area index, starting and ending dates of the growing season, normal average wind speed, and normal average quarterly relative humidity. The values used in the analyses are described below.

5.1.1.1 *Evaporative Zone Depth*

This indicates the maximum depth from which water can be removed by evapotranspiration. The surface of the stabilized soils/waste that will be disposed in the CAMU was assumed to be bare ground without any vegetation in the analyses. An evaporative zone depth of 8 inches corresponding to depth of capillary draw of sandy soils was used for all cases in the HELP model analyses

5.1.1.2 *Maximum Leaf Area Index*

The leaf area index (LAI) is a ratio of the area of actively transpiring vegetation to the surface area of the land. The amount of water removed due to evapotranspiration increases with increasing LAI. An LAI of 0 corresponding to bare ground was used for all cases in the HELP model analyses.

5.1.1.3 *Growing Season*

Growing season start and end dates were based on the default values provided by the HELP model for Newark, New Jersey. For Newark, New Jersey, the growing season start date is the 108th day of the year and the growing season end date is the 301th day.

5.1.1.4 *Normal Average Annual Wind Speed*

Based on the default values provided by the HELP model for Newark, New Jersey, an average wind speed of 10.2 miles per hour (mph) was used in the analyses.

5.1.1.5 *Normal Average Quarterly Relative Humidity*

The default normal average quarterly relative humidity values provided by the HELP model for Newark, New Jersey were used in the analyses, which are as follows:

Quarter	Humidity (%)
1st	64
2nd	61
3rd	66
4th	68

5.1.2 Precipitation

The HELP model provides default and synthetically generated precipitation data for specific cities in the United States. The default precipitation data for Newark was available only for a period of 5 years. Daily precipitation data for a 31-year period from 1980 to 2010 was obtained from the National Climatic Data Center (NCDC) website and was used to simulate the rainfall at the Facility. A summary of the annual rainfall for the 31-year period (1980 thru 2010) used in the analyses is presented in Table D-1. As shown in the table, the average annual precipitation for the 31-year period was 46.3 inches and the annual precipitation ranged from 31.2 to 59.9 inches.

It is noted that the precipitation data used in the analyses included a maximum precipitation of 6.65 inches over a 24-hour period (on August 10, 1982). This precipitation event exceeds the 25-year 24-hour event for the Perth Amboy area.

5.1.3 Temperature

The HELP model provides default normal mean monthly temperature data for Newark, New Jersey. However, the default data available was only for a period of 5 years from 1975 through 1979. As a result, daily temperature data for a 31-year period from 1980 to 2010 was also obtained from the National Climatic Data Center (NCDC) website and used in the analyses.

5.1.4 Solar Radiation Data

The solar radiation data for the Facility was synthetically generated using the HELP model. The default station latitude for Newark was 40.7 degrees.

5.2 Soil and Design Data

The soil and design data required in the HELP model are model plan area, runoff area, initial moisture content, and layer data. The soil and design data used in the analyses are discussed below.

5.2.1 Model Plan Area

Based on the layout of the cells indicated in the Permit Drawings, the area of each cell is approximately 1.2 acres. As a result, an area of were of 1.2 acre (52,272 square feet) was used in the HELP analyses.

5.2.2 Runoff Area

This input parameter specified the percentage of the area that allows drainage from the surface. Based on the waste grading plans indicated in the Permit Drawings, the runoff area percentage used in the analyses was as follows:

Case	Runoff (%)
1	36
2	55
3	75
4	75

5.2.3 Initial Moisture Content

Default values for initial moisture content calculated by the HELP model for steady-state conditions were used for all the soil layers.

5.2.4 Layer Data

The HELP model recognizes four general types of layers: (i) vertical percolation layer; (ii) lateral drainage layer designed to convey drainage laterally to a collection and removal system; (iii) a soil barrier layer designed to restrict vertical leakage or percolation through which a saturated vertical flow is allowed; and (iv) geomembrane liners.

The HELP model provides default parameter values based on the soil classification according to the Unified Soil Classification System (USCS) or the United States Department of Agriculture (USDA) textural classification system. Layer data was selected based on Parson's experience and knowledge with local soils and site conditions with additional guidance provided by the HELP model.

Attachment D-1 presents the input properties of the layer type used for the different cases analyzed. The tables in Attachment D-1 also summarize the other information used in the HELP model analyses for each of the four cases analyzed.

5.3 Miscellaneous Input

5.3.1 Geomembrane Liner

Pinhole density is the number of assumed defects per unit area with a hole diameter equal to or smaller than the geomembrane thickness. A hole diameter of 1 millimeter (mm) was conservatively used in the HELP model analyses. Two pinholes per acre were assumed in the analyses, which correspond to a manufacturer with a good quality control (QC) program at the manufacturing facility prior to shipment of the geomembrane.

Installation defects represent the number of defects per unit area with a hole diameter larger than the geomembrane thickness. A hole size of 1 square centimeter (cm^2) was used in the HELP model analyses. Installation defects are the result of seaming faults and punctures during installation. Two installation defects per acre were assumed in the analyses, which correspond to a good construction quality assurance (CQA) program during geomembrane installation.

5.3.2 Drainage Path Lengths

Based on the layout of the cells indicated in the Permit Drawings, the longest drainage path for the proposed base grading for each cell is approximately 100 feet. As a result, a maximum drainage length of 100 feet was used in the HELP model analyses.

6.0 RESULTS OF HELP MODEL ANALYSES

HELP model analyses were performed for the four development stages discussed above to evaluate the minimum analysis permeability (K anal) for the leachate collection layer such that the maximum head on the geomembrane liner is below the regulatory requirement of 30 centimeters (1 foot). The minimum required permeability (K req'd) was then computed using the cumulative reduction factors (Π(RF)) and the assumed factor of safety (FS) of 2. The minimum required permeability (K req'd) was iteratively evaluated such that the same required permeability (K req'd) resulted in an acceptable maximum head on the geomembrane for each case analyzed.

Table D-2 presents a summary of the HELP model analyses results for each of the four cases along with the major parameters used in the analyses. As noted, the minimum required permeability ($K_{req'd}$) for the leachate collection was evaluated to be 0.25 centimeters per sec (cm/sec). The average peak daily head (average maximum head on the geomembrane for the peak day in 31 years analyzed) was evaluated to be less than 6 inches during the active life of the cell and almost zero post-closure. The average head on the geomembrane on an annual basis was evaluated to be less than 2.5 inches during the active life of the cell and was almost zero post-closure.

A summary of the input data used in the HELP model analyses is presented in Attachment D-1 of this calculation package. The output files from the HELP model for each case analyzed are included in Attachment D-2.

7.0 LEACHATE TRANSMISSION SYSTEM

The leachate transmission system includes sump pumps, a transmission pipeline and a pump-out system that will be constructed to pump the leachate out of the cells and convey it to an on-site or an offsite facility for treatment and disposal. Each cell will be equipped with two leachate removal pumps, one pump in each of the two leachate sumps on east and west sides of the cell. The selected pumps will be submersible sump pumps commonly used for leachate handling. Each sump pump will be sized to remove the peak daily leachate generated (based on the results of the HELP model analyses) from the cell. The sump pumps will be controlled by level transducers. Pump operations will be monitored by a main control system located in the CAMU area. This system will monitor the system for proper operations and limit the number of pumps operating at one time to manage maximum flow rate in the leachate transmission pipeline.

The leachate transmission pipeline will convey the leachate generated from the leachate sumps to the on-site effluent treatment plant (ETP) or a pump-out system. The on-site ETP is in close proximity to the CAMU area. The leachate generated in the CAMU is expected to be primarily conveyed to the ETP for treatment and disposal. To facilitate offsite disposal of leachate, a pump-out system will also be constructed between the CAMU and the ETP. The pump-out system will be designed to pump leachate into trucks for offsite disposal, if needed.

The leachate transmission pipeline will be constructed using HDPE pipe because of its resistance to the chemicals and compounds contained in leachate. HDPE pipe also provides the additional benefits of ease of construction and maintenance, low coefficient of friction, and resistance to ultraviolet radiation. The leachate transmission pipeline will be installed within the perimeter berm proposed on the south side of the CAMU.

8.0 LEACHATE COLLECTION SYSTEM PIPE DESIGN

8.1 Peak Leachate Flow

An analysis was performed to evaluate the performance of the proposed leachate collection system pipes that will be installed in Cells 1 through 3. A 6-inch diameter perforated HDPE pipe having a standard dimension ratio (SDR) of 11 will be used in the leachate collection system in Cells 1through 3.

For design of the leachate collection pipe, the peak daily lateral drainage in the leachate collection layer obtained from the HELP model analyses was used to compute the flow rate. As noted in Table D-2, Case 1 with 0.28 inches/day represents the critical case for the peak daily lateral drainage. A peak flow rate of approximately 3.2 gallons per minute (gpm) or 610 cubic feet per day (ft^3/day) was used in the analyses. This corresponds to half of the cell area or 0.6 acres since two collection pipes are proposed as part of the central leachate collection system (see Permit Drawings).

8.2 Pipe Flow Capacity

The pipe flow capacity was calculated using the Manning's equation as follows:

$$Q_p = \frac{1.486 R_h^{0.66} i_p^{0.5} A_p}{n}$$

where:

Q_p = Pipe flow capacity in cubic feet per second (cfs);
R_h = Hydraulic radius (B_i/4 for pipe flowing full) in feet (ft);
B_i = Pipe inner diameter in feet (ft);
i_p = Hydraulic gradient (based on the slope and length of the pipe);
A_p = Cross-sectional area of the pipe in square feet (ft^2); and
n = Manning's roughness coefficient.

The flow capacity of the proposed leachate collection pipe was evaluated for 1 percent (slope of pipe after estimated settlement) and using the following input data corresponding to a 6-inch diameter SDR 11 HDPE pipe:

Parameter	6-inch Dia. Pipe
B_i	5.3
R_h	1.3
i_p	1.0%
A_p	22.4
n	0.009

Using Manning's equation, the pipe flow capacity was computed to be 272 gpm, which is considerably larger than the required capacity. A larger diameter pipe than required will be provided to account for pipe clogging over time and to facilitate cleaning and maintenance.

8.3 Pipe Perforation Sizing

The maximum allowable perforation diameter in the 6-in diameter leachate collection pipe that will prevent gravel (gravel around the perforated pipes in the leachate collection corridors) from passing through may be determined as follows (USEPA, 1983):

$$d_{h\max} = \frac{d_{85}}{F}$$

where:

d_{hmax} = Maximum perforation diameter to provide particle retention (inches);

d_{85} = Gravel particle size for which 85 percent (by weight) of the particles are finer (inches); and
F = Factor varying from 1.2 to 2.0.

The pipe perforation size proposed for the leachate collection pipe is 1/2 inch. Using a factor, F, of 1.5, the required d_{85} for the gravel around the pipe was calculated to be 3/4 inches. A d_{85} of 3/4 inches will be specified for the gravel around the perforated pipes in the leachate collection corridors.

8.4 Pipe Structural Stability

Calculations were performed to evaluate the ability of the 6-inch diameter leachate collection pipe to withstand the applied load. Cross-sectional details of the leachate pipe are shown on the Permit Drawings.

The potential failure mechanisms that were checked in the analyses included: (i) wall crushing; (ii) wall buckling; (iii) excessive ring deflection; and (iv) excessive bending strain. Stresses on the 6 inch pipe were evaluated for two loading conditions – an initial condition corresponding to loading due to construction equipment and a final condition corresponding to maximum loading due to stabilized soils/waste.

8.4.1 Calculation of Applied Stresses

8.4.1.1 *Initial Condition*

The initial condition considers the 6-inch pipe with 1 ft of cover material and the stresses due to traffic applied by a 35 ton truck with a wheel load of 20,000 lb. Therefore, the total stress on the pipe can be calculated as described by ASCE (1979) as follows:

$$\sigma_{ic} = \gamma_p D_p + C_s \frac{PF_{ic}}{L_{ic} D_{od}}$$

where:

γ_p = Average unit weight of the overburden materials, pcf;
D_p = Thickness of the overburden materials (assumed 1 ft for critical conditions);
D_{od} = Pipe outer diameter, ft;
C_s = Load coefficient (see Attachment D-3);
P = Concentrated load, lb;
F_{ic} = Impact factor accounting for dynamic loads (1.0-2.5), assume 2 for construction loads;
L_{ic}= Effective length of pipe equal to 3 if the pipe is longer than 3 ft or equal to the actual pipe length if the pipe is shorter than 3 ft (ASCE, 1979); and

σ_{ic}= Stress on the pipe, psf.

The table below shows a summary of the parameters used and the applied stresses calculated for the initial condition for both 6-inch pipe:

Data	6-in Pipe
γ_p	120 pcf
D_p	1 ft
D_{od}	0.552 ft
Cs	0.292
P	20,000 lb
F_{ic}	2
L_{ic}	3 ft
σ_{ic}	7172 psf (50 psi)

8.4.1.1 *Final Condition*

During the post-closure condition, the stresses on the 6-inch pipe are due to the overburden materials (stabilized soils/waste) above the pipe. The stress is calculated as follows:

$$\sigma_p = \gamma_p D_p$$

For the 6-inch pipe, overburden depth was assumed to be approximately 31 feet of stabilized soils/waste with a density of 120 pcf and 2 feet of soil cover with a density of 120 pcf.

The following table summarizes the parameters used and the applied stresses calculated for the post-closure condition:

Data	6-in Pipe
γ_p	120 pcf (waste and cover)
D_p	33 ft of waste and cover
σ_p	3,960 psf (27.5 psi)

Additional calculation was performed to account for loads on the perforated pipe. There is no standard procedure for estimating the effect of loads on perforated pipes. A conservative method is suggested by the Washington State Department of Ecology (1987) as described in Sharma and Lewis (1994). This method increases the load in proportion to the reduction in the effective length of the pipe using the following equation:

$$DesignLoad = AcualLoad \times \frac{L}{(L - L_P)}$$

Data	6-in Pipe
L	12 in (1 ft)
L_p	4.0 in
$L/(L - L_p)$	1.5
σ_p (initial)	75 psi
σ_p (final)	41 psi

where L is the unit length of the pipe and Lp is the cumulative length of perforations per unit length of pipe. The parameters used and the results for initial and final conditions are as follows:

Based on the above calculations, the 6-inch pipe structural stability was checked using a stress of 75 psi.

8.4.2 Wall Crushing

Wall crushing occurs when the stress in the pipe wall due to external pressures exceeds the compressive strength of the pipe material. The maximum applied stress which may be withstood by the pipe can be calculated as follows:

$$\sigma_{crush} = \frac{2\sigma_y}{(SDR - 1)}$$

Where σ_y is the compressive strength of an HDPE pipe based on typical physical properties of HDPE pipes (See Attachment D-3). σ_{crush} is the maximum applied stress that can be withstood by the pipe. The parameters used and the results are as follows:

Data	6-in Pipe
σ_y	1,600 psi
SDR	11
σ_{crush}	320 psi > 75 psi

Based on these calculations, the compressive strength for the pipe is greater than the estimated applied stress.

8.4.3 Wall Buckling

Wall buckling occurs when the external vertical pressure exceeds the critical buckling pressure of the pipe/gravel aggregate system. The maximum applied stress that may be withstood by the pipe can be calculated as follows:

$$\sigma_{buckle} = 1.2\left[\frac{E'E}{SDR^3}\right]^{1/2}$$

where E is the long-term modulus of elasticity of the pipe material, E' is the modulus of soil reaction for the pipe bedding material, SDR is the standard dimension ratio of the pipe, and σ_{buckle} is the maximum applied stress that can be withstood by the pipe.

The modulus of soil reaction (E') is calculated using Young's modulus (E_s), Poisson's ratio (ν) and an empirical factor (k) which may vary from 0.7 to 2.3. The Young's modulus and Poisson ratio were taken from data presented by Selig (1990) for soils at various overburden stress levels, (see Attachment D-3) The following equations were used to obtain the modulus of soil reaction:

$$M_s = \frac{E_s(1-\nu)}{(1+\nu)(1-2\nu)}$$

$$E' = k * M_s$$

where:

M_s= Constrained modulus, psi;
E_s= Young's modulus, psi;
ν = Poisson's ratio;
E'= Modulus of soil reaction, psi; and
k= Empirical factor

The following table presents the parameters used and the results calculated using the above equations:

Data	6-in Pipe
SDR	11
σ_{vo}	27.5 psi
E	16,000 psi
Es	4,000 psi
ν	0.23
Ms	4637 psi
k	1.5
E'	6955 psi
σ_{buckle}	346 psi > 75 psi

Modulus of soil reaction (E') tables have also been established by ASCE in their journal of geotechnical engineering division, January 1977 (See Attachment D-3). An E' of 3,000 psi is presented by ASCE for crushed rock/gravel with slight compaction (<85% proctor). This value of E' was used in the above equation and the resulting maximum applied stress that can be withstood by the pipe was calculated to be (σ_{buckle}) = 227 psi (>75 psi)

8.4.4 Ring Deflection

Excessive ring deflection is a horizontal over-deflection of the pipe causing a reversal of curvature in the pipe wall. This can occur if large external vertical pressures are applied to the pipe/bedding system. Excessive ring deflection can also lead to a substantial loss in flow capacity. Ring deflection is calculated using the Modified Iowa equation:

$$\Delta X = \frac{D_L K W_c}{\frac{EI}{r^3} + (0.061E')}$$

where:

D_L= Deflection lag factor which varies from 1 to 1.5 (Koerner, 1998);
K= Bedding constant with values from 0.083 to 0.11 (Wilson-Fahmy and Koerner, 1994)
W_c= Martson prism load per unit length (overburden stress times the pipe outside diameter);
E= Modulus of elasticity of the pipe material;
E'= Modulus of soil reaction for the bedding material; (refer to Attachment D-3)
I= Moment of inertia of the pipe wall;
r= Mean radius of the pipe ((D_{od}-t)/2); and
ΔX= Horizontal deflection.
The ring deflection is the horizontal deflection divided by the outside diameter of pipe.

The allowable ring deflection for HDPE pipe is 3.0 percent (Koerner, 1998). A conservative value of E' = 3000 psi was used in this calculation (see discussion above). The table below shows the parameters used and the results obtained.

Data	6-in Pipe
D_L	1.0
K	0.1
W_c	82.5 lb/in
E	16,000 psi
I	0.018 in^3
r	2.67 in
E'	3000 psi
ΔX	0.042
Ring Deflection	0.63% < 3.0%

Based on these calculations, the calculated ring deflection for the pipe (under maximum stresses) is below the 3 percent allowable limit.

8.4.5 Bending Strain

When a pipe deflects under load, bending strains are induced in the pipe wall. Bending strain occurs in the pipe wall as external pressures are applied to the pipe/bedding aggregate system. Bending strain is calculated using the following equation (Mosher, 1990):

$$\varepsilon_b = f_d \frac{t\Delta_y}{D^2}$$

where:

ε_b= Bending strain, percent;
f_d= deformation shape factor (Chevron, 1994); For an elliptically deformed pipe, the deformation shape factor (fD) is 4.28. However irregular deformation can occur, resulting in a less than perfectly elliptical shape. To account for this, the deformation shape factor used is equal to 6
t= minimum wall thickness, in;
Δ_y= vertical deflection, in; and
D= inside pipe diameter, in.

The recommendations for allowable bending strain from the literature and manufacturers are as follows:

- An allowable bending strain of 5 percent is recommended in Wilson-Fahmy and Koerner (1994) based on ASHTO guidelines for long-term use of smooth polyethylene pipes.
- An allowable bending strain of 4.2 percent is recommended as conservative in Chevron (1994). It is noted that strains up to 8 percent are reported in literature as acceptable for a design period of 50 years.

The following table presents the parameters used and the results of the bending strain calculations:

Data	6-in Pipe
f_d	6
t	0.440 in
Δ_y	0.078
D	3.027 in
ε_b	0.53 % < 4.2 %

Based on these parameters, the calculated strain for the pipe is less than published allowable values.

9.0 REFERENCES

- ASCE, "Design and Construction of Sanitary and Storm Sewers", Manual and Report on Engineering Practice No. 37, American Society of Civil Engineers, New York, NY, Printed 1969, Reprinted 1979.

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APPENDIX D

TABLES

Table D-1

PRECIPITATION DATA USED IN HELP MODEL ANALYSES

CAMU Final Design Report

Chevron Perth Amboy Facility, NJ

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Monthly Average (in.)	Monthly Maximum (in.)	Monthly Minimum (in.)
January	1.8	0.3	7.0	2.4	2.8	1.2	4.8	4.7	3.5	2.2	5.6	3.7	1.4	3.3	6.8	3.4	5.4	3.5	4.0	6.6	4.1	2.6	2.0	3.0	1.8	4.0	4.8	3.6	3.0	4.3	2.0	3.5	7.0	0.3
February	1.0	4.2	2.5	2.9	3.7	3.5	4.0	0.9	3.8	2.3	1.6	1.9	1.4	3.7	6.2	2.7	2.4	2.3	4.7	2.6	1.6	1.9	0.6	3.5	2.4	2.8	3.8	1.6	5.8	0.6	5.4	2.8	6.2	0.6
March	4.8	1.2	2.6	11.9	7.7	1.3	1.9	3.8	2.2	3.7	2.8	5.8	3.4	8.7	8.1	1.9	4.3	3.4	4.2	4.4	3.5	7.0	3.4	4.2	3.3	5.0	0.8	4.1	3.8	1.6	10.1	4.3	11.9	0.8
April	7.1	2.9	6.7	11.8	6.2	1.6	5.9	5.6	1.8	3.6	4.0	4.0	1.5	4.0	5.1	1.8	5.1	4.9	6.2	1.9	3.7	1.8	3.9	2.4	5.0	3.5	4.1	12.0	3.6	4.6	2.9	4.5	12.0	1.5
May	2.7	4.2	1.9	3.3	7.2	3.8	1.4	2.5	5.9	8.9	6.9	4.6	2.4	1.1	4.1	2.8	3.0	2.9	6.2	4.2	5.9	3.0	3.5	2.9	4.7	1.6	4.6	2.1	3.4	4.8	3.5	3.9	8.9	1.1
June	3.3	2.8	5.5	2.8	3.3	3.3	1.0	4.1	1.0	5.4	3.7	3.0	6.4	3.4	3.7	1.7	5.5	2.5	6.1	0.4	3.5	3.4	6.8	11.0	3.0	3.2	6.0	5.3	6.4	7.2	2.8	4.1	11.0	0.4
July	2.8	2.4	2.1	1.7	9.9	4.4	6.1	4.7	10.1	2.6	4.9	5.5	4.9	3.0	5.6	6.1	5.1	7.0	1.6	1.1	6.2	2.6	1.2	2.5	9.0	4.1	7.0	6.7	3.2	7.0	1.9	4.6	10.1	1.1
August	1.7	0.9	9.5	3.3	0.9	2.6	3.4	5.1	1.9	4.6	7.9	6.1	4.6	2.9	7.1	0.3	4.9	2.8	3.6	5.5	4.8	2.4	4.5	8.2	3.7	0.5	3.0	7.3	2.8	4.5	2.4	4.0	9.5	0.3
September	2.1	3.7	1.9	1.8	2.3	3.5	1.2	2.9	1.7	4.1	2.1	3.2	3.8	7.9	2.4	3.9	6.1	2.1	2.7	8.7	4.6	4.3	4.2	5.8	8.0	0.5	3.4	1.8	7.1	1.7	3.6	3.6	8.7	0.5
October	1.8	3.6	2.2	6.0	3.9	1.0	1.3	3.3	2.5	5.0	5.8	1.4	1.0	4.9	2.0	4.8	6.9	0.0	1.9	2.9	0.6	0.6	5.7	3.7	1.0	13.2	7.0	3.9	2.9	5.4	4.1	3.6	13.2	0.0
November	3.8	1.2	1.4	5.8	2.9	8.0	7.1	2.9	5.6	3.5	2.8	2.1	5.5	3.0	5.1	5.9	2.3	0.0	0.9	2.9	2.7	0.9	4.7	4.3	4.4	3.8	7.1	2.5	2.4	1.6	1.9	3.5	8.0	0.0
December	0.8	3.9	1.0	6.0	3.8	1.5	5.2	2.5	0.7	0.3	5.5	3.7	5.8	5.6	3.8	2.1	7.1	4.2	1.0	2.9	3.5	2.1	3.6	6.0	3.4	5.2	2.2	5.5	7.1	7.8	4.4	3.8	7.8	0.3
Annual Total (in)	**33.6**	**31.2**	**44.2**	**59.7**	**54.5**	**35.7**	**43.3**	**42.8**	**40.7**	**46.1**	**53.5**	**44.8**	**42.0**	**51.4**	**59.9**	**37.3**	**58.2**	**35.7**	**43.1**	**44.2**	**44.7**	**32.5**	**44.1**	**57.5**	**49.9**	**47.3**	**53.5**	**56.5**	**51.3**	**51.0**	**45.0**	**46.3** [3]	**59.9** [3]	**31.2** [3]

Notes:

1. 25-year 24-hour rainfall event for the area is approximately 6.2 inches based on maps provided by National Resources Conseration Service (NRCS).
2. Data used in analyses includes exceedance of the 25-year 24-hour storm event (6.65 inches of rain on August 10, 1982).
3. Average, maximum, or minimum annual precipitation.

Table D-2

RESULTS OF HELP MODEL ANALYSES
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Case No.	Height of Soils or Waste	Maximum Drainage Length	Bottom Liner Slope	Leachate Collection or Drainage Layer				Peak Daily Results			Average Annual Results	
				$K_{req'd}$ [1]	RF*FS	K_{anal} [2]	Thickness	Laterial Drainage	Average Head on Geomembrane	Maximum Head on Geomembrane	Laterial Drainage	Average Head on Geomembrane
	(feet)	(feet)	(%)	(cm/sec)		(cm/sec)	(in)	(in/1.2 ac/day)	(inches)	(inches)	(in/1.2 ac/year)	(inches)
Case 1	10	100	1.7	2.5E-01	5.0	5.0E-02	18	0.28	5.8	7.3	15.6	0.9
Case 2	20	100	1.4	2.5E-01	7.4	3.4E-02	18	0.15	5.5	6.8	13.9	1.4
Case 3	30	100	1.0	2.5E-01	10.4	2.4E-02	18	0.09	5.8	6.9	12.0	2.4
Case 4	30	100	1.0	2.5E-01	12.0	2.1E-02	18	0.00	0.00	0.01	0.01	0.00

Notes:
1. Minimum hydraulic conductivity (K) that will be required for the leachate collection layer
2. Hydraulic conductivity used in the HELP model analysis after applying the reduction factors (RF) and a factor of safety (FS)

ATTACHMENT D-1

HELP MODEL ANALYSES INPUT DATA SUMMARY

ATTACHMENT D-1
CASE 1- INPUT DATA SUMMARY
10 FT OF WASTE AND BOTTOM LINER SYSTEM

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

WEATHER DATA AND SOIL LAYERS PROPERITIES

A. Evapotranspiration Data

Data	Value	Units
Nearby City	Newark	
State	New Jersey	
Latitude	27.8	
Evaporative zone depth	10	in
Sands	4-8	
Silts	8-18	
Clays	12-60	
Maximum leaf area index	0	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	108	
Growing season end day	301	
Average wind speed	10.2	mph
First quarter relative humidity	64	%
Second quarter relative humidity	61	%
Third quarter relative humidity	66	%
Fourth quarter relative humidity	68	%

B. Precipitation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

C. Temperature

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

D. Normal Mean Monthly Temperature (°F)

January	32.4	July	77.6
Febuary	35	August	76.1
March	42.2	September	68.9
April	52.9	October	57.3
May	63	November	47.5
June	72.6	December	37.1

E. Solar Radiation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

F. Other conditions

Areas assumed in analysis	1.2	ac
Area where runoff is possible	36.4	%
Slope Length	10	ft
Slope	33.3	%
Surface Slope Vegetation	1	
bare ground	1	
grass (poor)	2	
grass (fair)	3	
grass (good)	4	
grass (excelle	5	
Runoff curve number (CN)	91	

G. Geomembrane

Placement of geomembrane	3
Pinhole (# of defects/area)	2
Defect density per acre	2

H. Material Properties

Layers	Type	Description	Thickness (in.)	Texture Number	Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	k (cm/sec)	Length Drain (ft)	Liner Slope (%)
1	1	Vertical percolation	120	7	0.473	0.222	0.104	5.2E-04		
2	2	Lateral drainage	18		0.417	0.045	0.018	5.0E-02	100	1.7
3	4	Geomembrane liner	0.06	35				2.0E-13		
4	3	GCL	0.25	17	0.75	0.747	0.4	3.0E-09		
5	1	Vertical percolation	120	7	0.473	0.222	0.104	5.2E-04		

ATTACHMENT D-1
CASE 2- INPUT DATA SUMMARY
20 FT OF WASTE AND BOTTOM LINER SYSTEM

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

WEATHER DATA AND SOIL LAYERS PROPERITIES

A. Evapotranspiration Data

Data	Value	Units
Nearby City	Newark	
State	New Jersey	
Latitude	27.8	
Evaporative zone depth	10	in
Sands	4-8	
Silts	8-18	
Clays	12-60	
Maximum leaf area index	0	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	108	
Growing season end day	301	
Average wind speed	10.2	mph
First quarter relative humidity	64	%
Second quarter relative humidity	61	%
Third quarter relative humidity	66	%
Fourth quarter relative humidity	68	%

B. Precipitation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

C. Temperature

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

D. Normal Mean Monthly Temperature (°F)

January	32.4	July	77.6
Febuary	35	August	76.1
March	42.2	September	68.9
April	52.9	October	57.3
May	63	November	47.5
June	72.6	December	37.1

E. Solar Radiation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

F. Other conditions

Areas assumed in analysis	1.2	ac
Area where runoff is possible	55.2	%
Slope Length	40	ft
Slope	33.3	%
Surface Slope Vegetation	1	
bare ground	1	
grass (poor)	2	
grass (fair)	3	
grass (good)	4	
grass (excelle	5	
Runoff curve number (CN)	91	

G. Geomembrane

Placement of geomembrane	3
Pinhole (# of defects/area)	2
Defect density per acre	2

H. Material Properties

Layers	Type	Description	Thickness (in.)	Texture Number	Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	k (cm/sec)	Length Drain (ft)	Liner Slope (%)
1	1	Vertical percolation	240	7	0.473	0.222	0.104	5.2E-04		
2	2	Lateral drainage	18		0.417	0.045	0.018	3.4E-02	100	1.4
3	4	Geomembrane liner	0.06	35				2.0E-13		
4	3	GCL	0.25	17	0.75	0.747	0.4	3.0E-09		
5	1	Vertical percolation	120	7	0.473	0.222	0.104	5.2E-04		

ATTACHMENT D-1
CASE 3 - INPUT DATA SUMMARY
30 FT OF WASTE AND BOTTOM LINER SYSTEM

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

WEATHER DATA AND SOIL LAYERS PROPERITIES

A. Evapotranspiration Data

Data	Value	Units
Nearby City	Newark	
State	New Jersey	
Latitude	27.8	
Evaporative zone depth	10	in
Sands	4-8	
Silts	8-18	
Clays	12-60	
Maximum leaf area index	0	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	108	
Growing season end day	301	
Average wind speed	10.2	mph
First quarter relative humidity	64	%
Second quarter relative humidity	61	%
Third quarter relative humidity	66	%
Fourth quarter relative humidity	68	%

B. Precipitation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

C. Temperature

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

D. Normal Mean Monthly Temperature (°F)

January	32.4	July	77.6
Febuary	35	August	76.1
March	42.2	September	68.9
April	52.9	October	57.3
May	63	November	47.5
June	72.6	December	37.1

E. Solar Radiation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

F. Other conditions

Areas assumed in analysis	1.2	ac
Area where runoff is possible	75	%
Slope Length	70	ft
Slope	33.3	%
Surface Slope Vegetation	1	
bare ground	1	
grass (poor)	2	
grass (fair)	3	
grass (good)	4	
grass (excelle	5	
Runoff curve number (CN)	91	

G. Geomembrane

Placement of geomembrane	3
Pinhole (# of defects/area)	2
Defect density per acre	2

H. Material Properties

Layers	Type	Description	Thickness (in.)	Texture Number	Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	k (cm/sec)	Length Drain (ft)	Liner Slope (%)
1	1	Vertical percolation	360	7	0.473	0.222	0.104	5.2E-04		
2	2	Lateral drainage	18		0.417	0.045	0.018	2.4E-02	100	1
3	4	Geomembrane liner	0.06	35				2.0E-13		
4	3	GCL	0.25	17	0.75	0.747	0.4	3.0E-09		
5	1	Vertical percolation	120	7	0.473	0.222	0.104	5.2E-04		

ATTACHMENT D-1
CASE 4 - INPUT DATA SUMMARY
Final cover, 30 FT OF WASTE AND BOTTOM LINER SYSTEM

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

WEATHER DATA AND SOIL LAYERS PROPERITIES

A. Evapotranspiration Data

Data	Value	Units
Nearby City	Newark	
State	New Jersey	
Latitude	27.8	
Evaporative zone depth	10	in
Sands	4-8	
Silts	8-18	
Clays	12-60	
Maximum leaf area index	0	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	108	
Growing season end day	301	
Average wind speed	10.2	mph
First quarter relative humidity	64	%
Second quarter relative humidity	61	%
Third quarter relative humidity	66	%
Fourth quarter relative humidity	68	%

B. Precipitation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

C. Temperature

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

D. Normal Mean Monthly Temperature (°F)

January	32.4	July	77.6
Febuary	35	August	76.1
March	42.2	September	68.9
April	52.9	October	57.3
May	63	November	47.5
June	72.6	December	37.1

E. Solar Radiation

Data	Value
Nearby city	Newark
State	New Jersey
Years for data generation	1980-2010

F. Other conditions

Areas assumed in analysis	1.2	ac
Area where runoff is possible	75	%
Slope Length	80	ft
Slope	33.3	%
Surface Slope Vegetation	1	
bare ground	1	
grass (poor)	2	
grass (fair)	3	
grass (good)	4	
grass (excelle	5	
Runoff curve number (CN)	91	

G. Geomembrane

Placement of geomembrane	3
Pinhole (# of defects/area)	2
Defect density per acre	2

H. Material Properties

Layers	Type	Description	Thickness (in.)	Texture Number	Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	k (cm/sec)	Length Drain (ft)	Liner Slope (%)
1	1	Vertical percolation	6	21	0.397	0.032	0.013	3.0E-11		
2	1	Vertical percolation	18	5	0.457	0.131	0.056	1.0E-03		
3	2	Lateral Drainage	0.25		0.85	0.01	0.005	1.57	80	33
4	4	Geomembrane liner	0.06	35				2.0E-13		
5	1	Vertical percolation	6	1	0.417	0.045	0.018	1.0E-02		
6	1	Vertical percolation	360	7	0.473	0.222	0.104	5.2E-04		
7	2	Lateral Drainage	18		0.417	0.045	0.018	2.1E-02	100	1
8	4	Geomembrane liner	0.06	35				2.0E-13		
9	3	GCL	0.25	17	0.75	0.747	0.4	3.0E-09		
10	1	Vertical percolation	120	7	0.473	0.222	0.104	5.2E-04		

ATTACHMENT D-2

HELP MODEL ANALYSES OUTPUT FILES

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\camu\try 4\case1\input\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\camu\try 4\case1\input\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\camu\try 4\case1\input\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\camu\try 4\case1\input\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\camu\try 4\case1\input\T4C1.D10
OUTPUT DATA FILE:           c:\HELP3\camu\try 4\case1\Case 1.OUT


TIME:   9:44     DATE:  11/19/2012


******************************************************************************

     TITLE:  Perth Amboy - CAMU - CASE 1e

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   7
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.4730 VOL/VOL
          FIELD CAPACITY               =      0.2220 VOL/VOL
          WILTING POINT                =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2517 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.520000001000E-03 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
```

CASE 1

MATERIAL TEXTURE NUMBER 52

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0468	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.500000007000E-01	CM/SEC
SLOPE	=	1.70	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 7

THICKNESS	=	120.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

CASE 1

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	91.00	
FRACTION OF AREA ALLOWING RUNOFF	=	36.4	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.200	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.619	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.784	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.832	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	57.872	INCHES
TOTAL INITIAL WATER	=	57.872	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NEWARK NEW JERSEY

STATION LATITUDE	=	40.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	108	
END OF GROWING SEASON (JULIAN DATE)	=	301	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	64.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	61.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	68.00	%

NOTE: PRECIPITATION DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR NEWARK NEW JERSEY
AND STATION LATITUDE = 40.70 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 5

CASE 1

TOTALS	1.6742	1.3851	1.6051	2.0662	1.6653	1.0922
	1.0474	0.9697	1.0206	0.9124	1.0234	1.1615
STD. DEVIATIONS	1.1138	0.7122	0.8734	1.4173	1.0724	0.4364
	0.4729	0.5872	0.6011	0.4602	0.7523	0.7117

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	1.1210	1.0185	1.0747	1.4289	1.1149	0.7557
	0.7014	0.6493	0.7062	0.6110	0.7081	0.7778
STD. DEVIATIONS	0.7458	0.5258	0.5847	0.9783	0.7175	0.3020
	0.3166	0.3932	0.4159	0.3081	0.5206	0.4766

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2010

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.30	(8.112)	201664.5	100.00
RUNOFF	3.480	(1.4225)	15159.60	7.517
EVAPOTRANSPIRATION	27.140	(4.3447)	118221.81	58.623
LATERAL DRAINAGE COLLECTED FROM LAYER 2	15.62313	(4.83657)	68054.344	33.74631
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00010	(0.00003)	0.442	0.00022
AVERAGE HEAD ON TOP OF LAYER 3	0.889	(0.275)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00008	(0.00030)	0.337	0.00017

CASE 1

CHANGE IN WATER STORAGE	0.052	(2.9657)	228.46	0.113

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2010

	(INCHES)	(CU. FT.)
PRECIPITATION	6.65	28967.402
RUNOFF	1.607	7001.1113
DRAINAGE COLLECTED FROM LAYER 2	0.28193	1228.10193
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.01102
AVERAGE HEAD ON TOP OF LAYER 3	5.757	
MAXIMUM HEAD ON TOP OF LAYER 3	7.323	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	37.4 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.001200	5.22635
SNOW WATER	4.50	19603.9492

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4730
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2010

LAYER	(INCHES)	(VOL/VOL)
1	30.1970	0.2516
2	0.9389	0.0522

3	0.0000	0.0000
4	0.1875	0.7500
5	26.6396	0.2220
SNOW WATER	1.535	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\HELP3\camu\try 4\case2\input\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\camu\try 4\case2\input\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\camu\try 4\case2\input\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\camu\try 4\case2\input\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\camu\try 4\case2\input\T4C2.D10
OUTPUT DATA FILE:           c:\HELP3\camu\try 4\case2\Case 2.OUT


TIME:   9:47     DATE:  11/19/2012


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     TITLE:  Perth Amboy - CAMU - CASE 2

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   7
          THICKNESS                    =    240.00   INCHES
          POROSITY                     =      0.4730 VOL/VOL
          FIELD CAPACITY               =      0.2220 VOL/VOL
          WILTING POINT                =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2467 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.520000001000E-03 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
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CASE 2

MATERIAL TEXTURE NUMBER 53

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0489	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.337000005000E-01	CM/SEC
SLOPE	=	1.40	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 7

THICKNESS	=	120.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

CASE 2

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	91.00	
FRACTION OF AREA ALLOWING RUNOFF	=	55.2	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.200	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.626	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.784	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.832	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	86.918	INCHES
TOTAL INITIAL WATER	=	86.918	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NEWARK NEW JERSEY

STATION LATITUDE	=	40.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	108	
END OF GROWING SEASON (JULIAN DATE)	=	301	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	64.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	61.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	68.00	%

NOTE: PRECIPITATION DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR NEWARK NEW JERSEY
AND STATION LATITUDE = 40.70 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 5

EVAPOTRANSPIRATION	26.534	115582.172	58.94
DRAINAGE COLLECTED FROM LAYER 2	19.7782	86153.687	43.93
PERC./LEAKAGE THROUGH LAYER 4	0.000256	1.117	0.00
AVG. HEAD ON TOP OF LAYER 3	2.0264		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-5.482	-23877.533	-12.18
SOIL WATER AT START OF YEAR	96.604	420808.719	
SOIL WATER AT END OF YEAR	89.588	390246.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.535	6684.659	3.41
ANNUAL WATER BUDGET BALANCE	0.0000	0.140	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2010

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.53	2.85	4.35	4.49	3.86	4.11
	4.61	3.99	3.65	3.56	3.51	3.81
STD. DEVIATIONS	1.65	1.47	2.65	2.53	1.81	2.18
	2.51	2.33	2.11	2.66	2.01	2.06
RUNOFF						
TOTALS	0.594	0.791	0.775	0.422	0.246	0.265
	0.472	0.400	0.318	0.367	0.264	0.284
STD. DEVIATIONS	0.789	0.735	0.979	0.628	0.263	0.322
	0.525	0.538	0.469	0.634	0.335	0.324
EVAPOTRANSPIRATION						
TOTALS	1.164	1.006	2.267	3.107	3.082	3.073
	3.227	2.721	2.339	2.115	1.661	1.338
STD. DEVIATIONS	0.542	0.617	0.731	0.873	1.103	1.336
	1.349	1.212	0.874	0.766	0.572	0.313

LATERAL DRAINAGE COLLECTED FROM LAYER 2

CASE 2

TOTALS	1.0168	1.1764	1.2793	1.3740	1.6305	1.3464
	1.2360	1.0539	1.0148	0.9710	0.8787	0.8861
STD. DEVIATIONS	0.5848	0.6362	0.6033	0.7306	0.9160	0.6855
	0.4291	0.3972	0.4451	0.3992	0.3127	0.3938

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0002	0.0000	0.0000	0.0002	0.0000	0.0002
	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	1.2265	1.5573	1.5430	1.7108	1.9616	1.6774
	1.4909	1.2713	1.2649	1.1713	1.0953	1.0689
STD. DEVIATIONS	0.7054	0.8422	0.7274	0.9060	1.0914	0.8520
	0.5176	0.4791	0.5548	0.4816	0.3898	0.4750

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2010

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.30	(8.112)	201664.5	100.00
RUNOFF	5.199	(2.1417)	22644.74	11.229
EVAPOTRANSPIRATION	27.098	(4.2987)	118037.61	58.532
LATERAL DRAINAGE COLLECTED FROM LAYER 2	13.86379	(4.44547)	60390.660	29.94610
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00017	(0.00006)	0.735	0.00036
AVERAGE HEAD ON TOP OF LAYER 3	1.420	(0.456)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00015	(0.00041)	0.674	0.00033

CASE 2

CHANGE IN WATER STORAGE	0.136	(3.5415)	590.87	0.293

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2010

	(INCHES)	(CU. FT.)
PRECIPITATION	6.65	28967.402
RUNOFF	2.468	10751.1465
DRAINAGE COLLECTED FROM LAYER 2	0.15164	660.54102
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000002	0.01031
AVERAGE HEAD ON TOP OF LAYER 3	5.482	
MAXIMUM HEAD ON TOP OF LAYER 3	6.835	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	39.7 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.001200	5.22655
SNOW WATER	4.50	19603.9492

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4730
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2010

LAYER	(INCHES)	(VOL/VOL)
1	61.6275	0.2568
2	1.1340	0.0630

CASE 2

3	0.0000	0.0000
4	0.1875	0.7500
5	26.6393	0.2220
SNOW WATER	1.535	

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CASE 3

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\camu\try 4\case3\input\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\camu\try 4\case3\input\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\camu\try 4\case3\input\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\camu\try 4\case3\input\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\camu\try 4\case3\input\T4C3.D10
OUTPUT DATA FILE:           c:\HELP3\camu\try 4\case3\Case 3.OUT


TIME:   9:56     DATE:  11/19/2012


******************************************************************************

     TITLE:  Perth Amboy - CAMU - CASE 3

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   7
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.4730 VOL/VOL
          FIELD CAPACITY               =      0.2220 VOL/VOL
          WILTING POINT                =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2379 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.520000001000E-03 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
```

CASE 3

MATERIAL TEXTURE NUMBER 54

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0552	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.238000005000E-01	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 7

THICKNESS	=	120.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

CASE 3

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	91.00	
FRACTION OF AREA ALLOWING RUNOFF	=	75.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.200	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.630	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.784	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.832	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	113.475	INCHES
TOTAL INITIAL WATER	=	113.475	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NEWARK NEW JERSEY

STATION LATITUDE	=	40.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	108	
END OF GROWING SEASON (JULIAN DATE)	=	301	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	64.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	61.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	68.00	%

NOTE: PRECIPITATION DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR NEWARK NEW JERSEY
AND STATION LATITUDE = 40.70 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 5

EVAPOTRANSPIRATION	26.429	115123.531	58.70
DRAINAGE COLLECTED FROM LAYER 2	18.3838	80079.820	40.83
PERC./LEAKAGE THROUGH LAYER 4	0.000506	2.203	0.00
AVG. HEAD ON TOP OF LAYER 3	3.5625		
PERC./LEAKAGE THROUGH LAYER 5	0.001200	5.226	0.00
CHANGE IN WATER STORAGE	-5.301	-23089.629	-11.77
SOIL WATER AT START OF YEAR	129.156	562604.625	
SOIL WATER AT END OF YEAR	122.321	532830.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.535	6684.659	3.41
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2010

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.53	2.85	4.35	4.49	3.86	4.11
	4.61	3.99	3.65	3.56	3.51	3.81
STD. DEVIATIONS	1.65	1.47	2.65	2.53	1.81	2.18
	2.51	2.33	2.11	2.66	2.01	2.06
RUNOFF						
TOTALS	0.791	1.038	1.025	0.565	0.331	0.357
	0.637	0.540	0.431	0.485	0.358	0.383
STD. DEVIATIONS	1.050	0.978	1.302	0.834	0.354	0.433
	0.699	0.732	0.639	0.822	0.455	0.434
EVAPOTRANSPIRATION						
TOTALS	1.164	1.006	2.262	3.107	3.086	3.060
	3.200	2.715	2.323	2.102	1.658	1.338
STD. DEVIATIONS	0.541	0.617	0.731	0.875	1.104	1.332
	1.326	1.207	0.877	0.756	0.572	0.313

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.7616	0.8592	1.0415	1.0207	1.2192	1.2146
	1.1835	1.0761	0.9656	0.9737	0.8510	0.8302
STD. DEVIATIONS	0.3409	0.4283	0.4643	0.5170	0.5725	0.6003
	0.5018	0.3800	0.3393	0.3511	0.2799	0.2762

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001
STD. DEVIATIONS	0.0002	0.0000	0.0000	0.0000	0.0003	0.0000
	0.0000	0.0000	0.0004	0.0000	0.0000	0.0003

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	1.8132	2.2223	2.4518	2.4704	2.8311	2.9055
	2.7684	2.5424	2.3652	2.3108	2.0968	1.9817
STD. DEVIATIONS	0.8013	1.0614	1.0436	1.1854	1.2494	1.3551
	1.1170	0.8583	0.8019	0.8119	0.6844	0.6565

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2010

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.30	(8.112)	201664.5	100.00
RUNOFF	6.942	(2.8852)	30240.73	14.996
EVAPOTRANSPIRATION	27.022	(4.2892)	117706.01	58.367
LATERAL DRAINAGE COLLECTED FROM LAYER 2	11.99676	(3.92402)	52257.875	25.91327
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00031	(0.00012)	1.357	0.00067
AVERAGE HEAD ON TOP OF LAYER 3	2.397	(0.758)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00031	(0.00053)	1.349	0.00067

CASE 3

CHANGE IN WATER STORAGE	0.335	(3.7518)	1458.57	0.723

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2010

	(INCHES)	(CU. FT.)
PRECIPITATION	6.65	28967.402
RUNOFF	3.439	14979.3301
DRAINAGE COLLECTED FROM LAYER 2	0.08655	377.00308
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.01101
AVERAGE HEAD ON TOP OF LAYER 3	5.753	
MAXIMUM HEAD ON TOP OF LAYER 3	6.886	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	46.3 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.001200	5.22655
SNOW WATER	4.50	19603.9492

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4730
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2010

LAYER	(INCHES)	(VOL/VOL)
1	93.8579	0.2607
2	1.6367	0.0909

CASE 3

3	0.0000	0.0000
4	0.1875	0.7500
5	26.6389	0.2220
SNOW WATER	1.535	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\camu\try 4\case4\input\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\camu\try 4\case4\input\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\camu\try 4\case4\input\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\camu\try 4\case4\input\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\camu\try 4\case4\input\T4C4.D10
OUTPUT DATA FILE:           c:\HELP3\camu\try 4\case4\Case 4.OUT


TIME:  10:43     DATE:  11/19/2012


******************************************************************************

     TITLE:  Perth Amboy - CAMU - CASE 4

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  21
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.3970 VOL/VOL
           FIELD CAPACITY              =      0.0320 VOL/VOL
           WILTING POINT               =      0.0130 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0313 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.300000012000     CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
```

CASE 4

MATERIAL TEXTURE NUMBER 5

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1805	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 65

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0111	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	1.57000005000	CM/SEC
SLOPE	=	33.00	PERCENT
DRAINAGE LENGTH	=	80.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0455	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

LAYER 6

CASE 4

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   7
THICKNESS                    =    360.00   INCHES
POROSITY                     =      0.4730 VOL/VOL
FIELD CAPACITY               =      0.2220 VOL/VOL
WILTING POINT                =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2220 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.520000001000E-03 CM/SEC
```

LAYER 7

```
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  55
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4170 VOL/VOL
FIELD CAPACITY               =      0.0450 VOL/VOL
WILTING POINT                =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.209999997000E-01 CM/SEC
SLOPE                        =      1.00   PERCENT
DRAINAGE LENGTH              =    100.0    FEET
```

LAYER 8

```
            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      2.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 9

```
              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

CASE 4
LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	120.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	91.00	
FRACTION OF AREA ALLOWING RUNOFF	=	75.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.200	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.347	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.296	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.194	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	111.270	INCHES
TOTAL INITIAL WATER	=	111.270	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NEWARK NEW JERSEY

STATION LATITUDE	=	40.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	108	
END OF GROWING SEASON (JULIAN DATE)	=	301	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	64.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	61.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	68.00	%

NOTE: PRECIPITATION DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

NOTE: TEMPERATURE DATA FOR NEWARK NEW JERSEY
WAS ENTERED FROM AN ASCII DATA FILE.

CASE 4

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR NEWARK NEW JERSEY
AND STATION LATITUDE = 40.70 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 4
DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4
HEAD #2: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #2: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 9
LEAK #3: PERCOLATION OR LEAKAGE THROUGH LAYER 10

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DAILY OUTPUT FOR YEAR 1980

DAY	A I R	S O I L IN.	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.	HEAD #2 IN.	DRAIN #2 IN.	LEAK #2 IN.	HEAD #3 IN.	DRAIN #3 IN.	LEAK #3 IN.
1		*	0.00	0.000	0.000	0.0434	0.0003	.1109E-01	.6492E-05	0.0005	.6422E-05	.6961E-08	0.0000	.0000E+00	.0000E+00
2		*	0.00	0.000	0.000	0.0434	0.0003	.1068E-01	.6309E-05	0.0006	.6550E-05	.6964E-08	0.0000	.0000E+00	.0000E+00
3		*	0.00	0.000	0.000	0.0434	0.0003	.1029E-01	.6136E-05	0.0006	.6680E-05	.6967E-08	0.0000	.0000E+00	.0000E+00
4	*	*	0.00	0.000	0.000	0.0434	0.0003	.9935E-02	.5974E-05	0.0006	.6811E-05	.6970E-08	0.0000	.0000E+00	.0000E+00
5	*	*	0.26	0.000	0.038	0.0434	0.0003	.9600E-02	.5820E-05	0.0006	.6942E-05	.6972E-08	0.0000	.0000E+00	.0000E+00
6	*	*	0.00	0.000	0.035	0.0434	0.0003	.9285E-02	.5675E-05	0.0006	.7074E-05	.6975E-08	0.0000	.0000E+00	.0000E+00
7	*	*	0.00	0.000	0.044	0.0434	0.0003	.8990E-02	.5537E-05	0.0006	.7206E-05	.6978E-08	0.0000	.0000E+00	.0000E+00
8		*	0.00	0.003	0.033	0.0568	0.0003	.8711E-02	.5407E-05	0.0006	.7339E-05	.6981E-08	0.0000	.0000E+00	.0000E+00
9	*	*	0.00	0.000	0.000	0.0568	0.0003	.8449E-02	.5282E-05	0.0006	.7471E-05	.6984E-08	0.0000	.0000E+00	.0000E+00
10	*	*	0.00	0.000	0.000	0.0568	0.0002	.8201E-02	.5164E-05	0.0006	.7602E-05	.6987E-08	0.0000	.0000E+00	.0000E+00
11		*	0.00	0.000	0.000	0.0568	0.0002	.7967E-02	.5052E-05	0.0006	.7733E-05	.6990E-08	0.0000	.0000E+00	.0000E+00
12		*	0.67	0.251	0.001	0.1090	0.0002	.7745E-02	.4945E-05	0.0007	.7863E-05	.6993E-08	0.0000	.0000E+00	.0000E+00
13	*	*	0.00	0.000	0.000	0.1090	0.0002	.7534E-02	.4842E-05	0.0007					

CASE 4

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2010

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.53	2.85	4.35	4.49	3.86	4.11
	4.61	3.99	3.65	3.56	3.51	3.81
STD. DEVIATIONS	1.65	1.47	2.65	2.53	1.81	2.18
	2.51	2.33	2.11	2.66	2.01	2.06
RUNOFF						
TOTALS	0.690	0.941	0.919	0.475	0.288	0.310
	0.548	0.472	0.389	0.393	0.306	0.279
STD. DEVIATIONS	0.974	0.949	1.224	0.704	0.320	0.365
	0.601	0.678	0.622	0.627	0.399	0.331
EVAPOTRANSPIRATION						
TOTALS	1.059	0.828	1.592	2.189	2.190	2.237
	2.276	1.831	1.687	1.473	1.297	1.253
STD. DEVIATIONS	0.483	0.497	0.626	0.600	0.755	0.961
	0.911	0.814	0.687	0.618	0.523	0.311
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	1.5018	1.0487	2.2089	1.9900	1.5671	1.4190
	1.7504	1.7855	1.3938	1.8097	1.5630	2.2679
STD. DEVIATIONS	0.9440	0.8258	1.5089	1.4297	0.8430	0.9986
	1.1376	1.1210	0.8384	1.4620	1.0136	1.4413
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0005	0.0004	0.0007	0.0007	0.0006	0.0005
	0.0006	0.0006	0.0005	0.0006	0.0006	0.0007
STD. DEVIATIONS	0.0003	0.0002	0.0004	0.0003	0.0002	0.0003
	0.0003	0.0003	0.0002	0.0003	0.0003	0.0004
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005
	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
STD. DEVIATIONS	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0015	0.0011	0.0022	0.0020	0.0015	0.0014
	0.0017	0.0017	0.0014	0.0018	0.0016	0.0022
STD. DEVIATIONS	0.0009	0.0009	0.0015	0.0014	0.0008	0.0010
	0.0011	0.0011	0.0008	0.0014	0.0010	0.0014

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0013	0.0015	0.0015	0.0014	0.0014	0.0014
	0.0015	0.0014	0.0015	0.0015	0.0015	0.0014
STD. DEVIATIONS	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
	0.0005	0.0004	0.0004	0.0004	0.0005	0.0005

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2010

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.30	(8.112)	201664.5	100.00
RUNOFF	6.011	(2.6746)	26183.38	12.984
EVAPOTRANSPIRATION	19.911	(3.0860)	86734.39	43.009
LATERAL DRAINAGE COLLECTED FROM LAYER 3	20.30585	(4.37207)	88452.297	43.86111
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00703	(0.00114)	30.602	0.01517
AVERAGE HEAD ON TOP OF LAYER 4	0.002	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00622	(0.00152)	27.087	0.01343

PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (	0.00000)	0.011	0.00001
AVERAGE HEAD ON TOP OF LAYER 8	0.001 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000 (	0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	0.061 (	1.0056)	267.39	0.133

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2010

	(INCHES)	(CU. FT.)
PRECIPITATION	6.65	28967.402
RUNOFF	3.364	14651.7549
DRAINAGE COLLECTED FROM LAYER 3	1.75208	7632.07080
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000283	1.23149
AVERAGE HEAD ON TOP OF LAYER 4	0.053	
MAXIMUM HEAD ON TOP OF LAYER 4	0.112	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00003	0.13230
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 8	0.003	
MAXIMUM HEAD ON TOP OF LAYER 8	0.005	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.5 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00000
SNOW WATER	4.50	19603.9492

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4120

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0242

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering

CASE 4
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2010

LAYER	(INCHES)	(VOL/VOL)
1	0.3241	0.0540
2	3.4563	0.1920
3	0.0030	0.0121
4	0.0000	0.0000
5	0.2977	0.0496
6	79.9200	0.2220
7	0.8107	0.0450
8	0.0000	0.0000
9	0.1875	0.7500
10	26.6389	0.2220
SNOW WATER	1.535	

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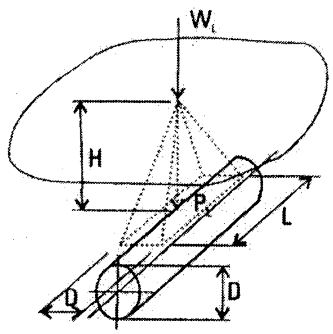
****

ATTACHMENT D-3

LEACHATE PIPE STRUCTURAL STABILITY CALCULATION REFERENCES

Table 7-4 Load Coefficient, C_H, for Holl's Integration of Boussinesq's Equation



D/2H	L/2H													
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5	2.0	20.0
0.1	0.019	0.037	0.053	0.067	0.079	0.089	0.097	0.103	0.108	0.112	0.117	0.121	0.124	0.127
0.2	0.037	0.072	0.103	0.131	0.155	0.174	0.189	0.202	0.211	0.219	0.229	0.238	0.244	0.248
0.3	0.053	0.103	0.149	0.190	0.224	0.252	0.274	0.292	0.306	0.318	0.333	0.346	0.355	0.361
0.4	0.067	0.131	0.190	0.241	0.284	0.320	0.349	0.373	0.391	0.405	0.425	0.442	0.454	0.462
0.5	0.079	0.155	0.224	0.284	0.336	0.379	0.414	0.441	0.463	0.481	0.505	0.525	0.540	0.550
0.6	0.089	0.174	0.252	0.320	0.379	0.428	0.467	0.499	0.524	0.544	0.572	0.596	0.613	0.625
0.7	0.097	0.189	0.274	0.349	0.414	0.467	0.511	0.546	0.574	0.597	0.628	0.655	0.674	0.688
0.8	0.103	0.202	0.292	0.373	0.441	0.499	0.546	0.584	0.615	0.639	0.674	0.703	0.725	0.740
0.9	0.108	0.211	0.306	0.391	0.463	0.524	0.574	0.615	0.647	0.673	0.711	0.743	0.766	0.783
1.0	0.112	0.219	0.318	0.405	0.481	0.544	0.597	0.639	0.673	0.701	0.740	0.775	0.800	0.818
1.2	0.117	0.229	0.333	0.425	0.505	0.572	0.628	0.674	0.711	0.740	0.783	0.821	0.849	0.871
1.5	0.121	0.238	0.346	0.422	0.525	0.596	0.655	0.703	0.743	0.775	0.821	0.863	0.895	0.920
2.0	0.124	0.244	0.355	0.454	0.540	0.613	0.674	0.725	0.766	0.800	0.849	0.895	0.930	0.960
20.0	0.127	0.248	0.361	0.462	0.550	0.625	0.688	0.740	0.783	0.818	0.871	0.920	0.960	1.000

0.292

Boussinesq's Equation

$$P_L = \frac{3 I_l W_L H^3}{2 \pi r^5} \qquad \textbf{(7-13)}$$

Where terms are previously defined and:

H = vertical depth to point on pipe crown, ft
r = distance from the point of load application to the pipe crown, ft

$$r = \sqrt{X^2 + H^2} \qquad \textbf{(7-14)}$$

Where:

X = horizontal distance from the point of load application to the pipe crown, ft

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HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	**Specification**	**Unit**	**Nominal Value**
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	**ASTM D3350-99**		**345464C**
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190¡C)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73¡ F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore “D”	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2”/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/¡F	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

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E_{long} = long term modulus of elasticity, lb/in^2 (see table below)

The long term modulus of elasticity is recommended if the pipe is subject to the pressure in the normal operations. If the pipe is subject to the pressure for short time periods and infrequently, the use of the short-term modulus of elasticity is acceptable.

E' = modulus of soil reaction, lb/in^2 (table 52–2)

I_{pw} = pipe wall moment of inertia

$$= \frac{t^3}{12}, \text{in}^4/\text{in} \quad \text{(for solid wall pipe)}$$

where:

t = pipe wall thickness, in

D_o = outside pipe diameter, in

Material	Modulus of elasticity* (lb/in^2)
PVC	140,000 (long term)
ABS	65,000 (long term)
Polyethylene	22,000 (long term)

* Long-term modulus of elasticity varies with the cell class of each plastic. Specific values may be obtained from the manufacturer.

Pipes that are out-of-round or deflected increase in bending moment and have less allowable buckling pressure. The allowable buckling pressure should be reduced by the following factor:

$$C = \left[\frac{\left(1 - \frac{\%\Delta X}{D}\frac{1}{100}\right)}{\left(1 + \frac{\%\Delta X}{D}\frac{1}{100}\right)^2} \right]^3 \qquad (52\text{–}34)$$

where:

C = reduction factor for buckling pressure

$\frac{\%\Delta X}{D}$ = percent deflection

Used 16,000 psi in the calculations.
(Factor of Safety of approximately 1.4)

Table 52–2 Average values of the modulus of soil reaction for the Modified Iowa Equation

Soil type – pipe bedding material (Unified Soil Classification – ASTM D2487)	E' for degree of compaction of bedding, lb/in^2 1/ Dumped	Slight, < 85% proctor, < 40% relative density	Moderate, 85-95% proctor, 40-70% relative density	High, > 95% proctor, > 70% relative density
Fine-grained soil (LL>50) 2/ Soil with medium to high plasticity CH, MH, CH-MH	No data available, use E' = 0 or consult with a geotechnical engineer			
Fine-grained soil (LL<50) soil with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Fine-grained soil (LL<50) soil with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles. Coarse-grained soil with fines GM, GC, SM, SC contains more than 12% fines	100	400	1,000	2,000
Coarse-grained soil with little or no fines GW, GP, SW, SP contains less than 12% fines	200	1,000	2,000	3,000
Crushed rock	1,000	3,000	3,000	3,000

1/ Source ASCE Journal of Geotechnical Engineering Division, January 1977
2/ LL = liquid limit

back-calculated from actual projects by Howard (1977), and thus concluded that the properties are likely achievable but not suitable for routine design where backfill sources may be undependable and soil gradations variable.

Table 1—Elastic soil properties for Backfill (Selig, 1990)

Gravelly Sand (SW)						
Maximum Principal Stress Level (psi)	95% Standard Compaction			85% Standard Compaction		
	E (psi)	B (psi)	v	E (psi)	B (psi)	v
0 to 1	1,600	2,800	0.40	1,300	900	0.26
1 to 5	4,100	3,300	0.29	2,100	1,200	0.21
5 to 10	6,000	3,900	0.24	2,600	1,400	0.19
10 to 20	8,600	5,300	0.23	3,300	1,800	0.19
20 to 40	13,000	8,700	0.25	4,100	2,500	0.23
40 to 60	16,000	13,000	0.29	4,700	3,500	0.28
Sandy Silt (ML)						
Maximum Principal Stress Level (psi)	95% Standard Compaction			85% Standard Compaction		
	E (psi)	B (psi)	v	E (psi)	B (psi)	v
0 to 1	1,800	1,900	0.34	600	400	0.25
1 to 5	2,500	2,000	0.29	700	450	0.24
5 to 10	2,900	2,100	0.27	800	500	0.23
10 to 20	3,200	2,500	0.29	850	700	0.30
20 to 40	3,700	3,400	0.32	900	1,200	0.38
40 to 60	4,100	4,500	0.35	1,000	1,800	0.41
Silty Clay (CL)						
Maximum Principal Stress Level (psi)	95% Standard Compaction			85% Standard Compaction		
	E (psi)	B (psi)	v	E (psi)	B (psi)	v
0 to 1	400	800	0.42	100	100	0.33
1 to 5	800	900	0.35	250	200	0.29
5 to 10	1,100	1,000	0.32	400	300	0.28
10 to 20	1,300	1,100	0.30	600	400	0.25
20 to 40	1,400	1,600	0.35	700	800	0.35
60	1,500	2,100	0.38	800	1,300	0.40

2.2 Elasto-Plastic

The Mohr-Coulomb failure criterion is used in many geotechnical engineering applications to describe the shear strength of soil. The principal feature of the Mohr-Coulomb criterion is that strength is dependent on confining stress. In common applications soil strength is described by a friction angle and cohesion intercept. In this study, we report on the 3-D Mohr-Coulomb model as implemented in Plaxis. This model uses an elastic perfectly-plastic constitutive model (Brinkgreve and Broere, 2004). For stress states within the yield surface, the soil behavior is

APPENDIX E

FINAL COVER SYSTEM EVALUATION

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FINAL COVER SYSTEM EVALUATION

1.0 INTRODUCTION

This appendix evaluates the performance of the final cover system proposed for the Corrective Action Management Unit (CAMU) that will be constructed at the Chevron Perth Amboy Facility (Facility) in New Jersey. The evaluation of the final cover system performance included unit gradient analysis and veneer stability analysis. The unit gradient analysis was performed to determine the transmissivity required for the geocomposite drainage layer in the final cover system. The veneer stability analysis was performed to determine the minimum interface friction angle between required different materials in the final cover system.

The remainder of this calculation package includes a description of the final cover system, the unit gradient analysis and the veneer slope stability analysis.

2.0 DESCRIPTION OF FINAL COVER SYSTEM

The details of the final cover system proposed for the CAMU are indicated in the Permit Drawings. As noted, the final cover system consists of the following components (from top to bottom):

- 6-inch thick gravel layer;
- 18-inch thick cover protective layer;
- Geocomposite drainage layer consisting of a geonet with non-woven geotextile heat-bonded on both sides;
- 60-mil HDPE textured geomembrane; and
- 6-inch thick gas venting/leveling layer.

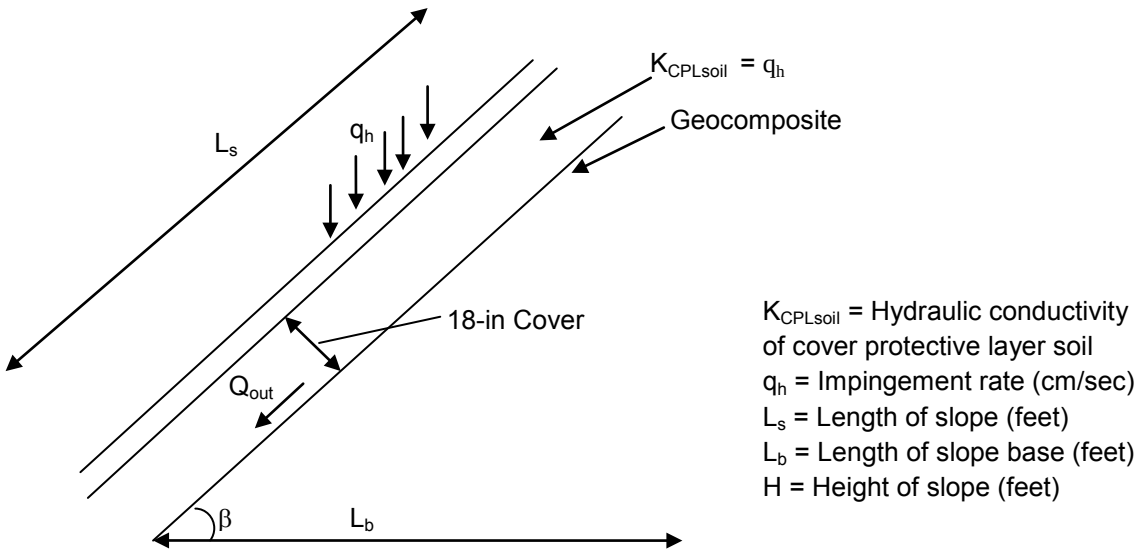
The geocomposite drainage layer will be provided on the 3 horizontal to 1 vertical (3H:1V) side slopes only and will convey the storm water from the closed side slopes to the post-closure perimeter swale that will be constructed at the toe of the closed slopes.

3.0 UNIT GRADIENT ANALYSIS

The unit gradient analysis was performed to determine the required transmissivity of the geocomposite drainage layer to maintain continuous flow within the thickness of the geocomposite. Darcy's law was used to estimate the rate of water flowing into and out of the geocomposite. The required transmissivity of the geocomposite layer was determined by equating the inflow and outflow. Recommended reduction factors and a factor of safety (FS) of 2.5 were used to evaluate the transmissivity of the geocomposite drainage layer.

3.1 Slope Geometry

A typical cover section used in the unit gradient analysis is shown in below.



The cover protective layer will consist of sandy soils, silty sands to clayey sands. These soils generally have a hydraulic conductivity in the range of $1x10^{-4}$ to $1x10^{-3}$ centimeters per second (cm/sec). The unit gradient analysis was performed using two hydraulic conductivities for the cover protective layer. Hydraulic conductivities of $1x10^{-4}$ and $1x10^{-3}$ cm/sec were used in the unit gradient analysis. The longest slope length (77 feet) will be in Cell 2 from top of final cover (EL. 42 feet, NGVD) to the low point in the perimeter swale (EL. 17.5 feet, NGVD) at the toe of the slope. A slope length of 80 feet was used in the unit gradient analysis. The side slope of the final cover system corresponds to 3H:1V (33%). The table below presents the values of the different parameters used in unit gradient analysis.

Case	L_s	H	Slope	$K_{CPLsoil}$
	(ft)	(ft)	(%)	(cm/sec)
Case 1	80	24.5	33.3	$1x10^{-4}$
Case 2	80	24.5	33.3	$1x10^{-3}$

3.2 Unit Gradient Analysis Calculations

The formulae used to calculate the required and the ultimate transmissivity are presented below.

$$\theta_{anal} = \frac{q_h \times L_s}{\sin \beta}$$

$$\theta_{req'd} = \theta_{anal} \times FS \times RF_{in} \times RF_{cr} \times RF_{cc} \times RF_{bc}$$

$$(RF)_{total} = RF_{in} \times RF_{cr} \times RF_{cc} \times RF_{bc}$$

where,

q_h = Impingement rate = Permeability of the cover protective layer soils ($K_{CPLsoil}$)
L_s = Length of slope
β = Slope angle
θ_{anal} = Transmissivity used in the analysis
$\theta_{req'd}$ = Minimum transmissivity that will be specified during construction
FS = Overall design factor of safety
RF_{in} = Reduction factor for intrusion
RF_{cr} = Reduction factor for creep
RF_{cc} = Reduction factor for chemical clogging
RF_{bc} = Reduction factor for biological clogging
RF_{total} = Cumulative reduction factors

The required transmissivity ($\theta_{req'd}$) is the minimum transmissivity required for the geocomposite drainage layer to limit the head on the geomembrane within the thickness of the geocomposite. It represents the minimum transmissivity that will be specified for the geocomposite drainage layer during construction of the final cover system. The analysis transmissivity (θ_{anal}) is the transmissivity used in the analysis to limit the head on the geomembrane within the thickness of the geocomposite. It represents an anticipated long-term transmissivity (a reduced transmissivity) of the geocomposite drainage layer post-closure. The analysis transmissivity (θ_{anal}) was obtained by applying the cumulative reduction factors (RF_{total}) and a factor of safety (FS) to the required transmissivity ($\theta_{req'd}$).

3.3 Reduction Factors

Reductions factors (RF) used for the geocomposite drainage layer are summarized below. Reduction factors for infiltration, creep, chemical clogging, and biological clogging were used in the unit gradient analysis. An overall design factor of safety (FS) of 2.5 was used in the analysis.

RF_{in}	RF_{cr}	RF_{cc}	RF_{bc}	$(RF)_{total}$
1.1	1.3	1.1	1.3	2.04

3.4 Analysis Results

The analysis transmissivity (θ_{anal}) and the required transmissivity ($\theta_{req'd}$) of the geocomposite drainage layer using the two hydraulic conductivities for the cover protective layer soils are summarized in the table below. As noted, the analysis transmissivity (θ_{anal}) ranged from 7.7×10^{-5} m^2/sec to 7.7×10^{-4} m^2/sec and the required transmissivity ($\theta_{req'd}$) ranged from 3.9×10^{-4} m^2/sec to 3.9×10^{-3} m^2/sec.

Case	$K_{CPLsoil}$	L_s	Slope Gradient	θ_{anal}	$\theta_{req'd}$
	(cm/sec)	(ft)	(%)	(m^2/sec)	(m^2/sec)
Case 1	1×10^{-4}	80	33.3	7.7×10^{-5}	3.9×10^{-4}
Case 2	1×10^{-3}	80	33.3	7.7×10^{-4}	3.9×10^{-3}

Based on the results presented above, the computed transmissivities correspond to the readily available transmissivities of a geocomposite drainage layer. A maximum permeability of 1×10^{-3} cm/sec will be specified for the cover protective layer soils.

4.0 VENEER SLOPE STABILITY ANALYSIS

The veneer stability analysis was performed to evaluate the stability of the final cover system that will be installed on the side slopes of the CAMU. The veneer slope stability analysis was performed using the method proposed by Giroud et al. (1995).

4.1 Method of Analysis

The veneer slope stability of the final cover system was evaluated for geosynthetic-soil layered systems on a 3H:1V slope using the method proposed by Giroud et al. (1995). The factor of safety (FS) for a layered system of uniform thickness assuming no water flow along the slope length is given by the following equation. The assumption (no water flowing along the slope length) is valid when the head on the geomembrane is less than the thickness of the geocomposite overlying the geomembrane.

$$FS = \frac{\tan\delta}{\tan\beta} + \frac{a}{\gamma\, t \sin\beta} + \frac{t}{h}\frac{\tan\phi\,/\,(2\sin\beta\cos^2\beta)}{1-\tan\beta\,\tan\phi} + \frac{c}{\gamma\, h}\frac{1/(\sin\beta\cos\beta)}{1-\tan\beta\,\tan\phi} + \frac{T}{\gamma\, h\, t}$$

where:

a = Interface adhesion along the slip surface;
c = Cohesion of the soil component of the layered system;
h = Vertical height of the slope;
T = tension in the geosynthetics above the slip surface;
t = soil layer thickness above the geomembrane;
β = slope angle;
δ = interface friction angle along the slip surface;
ϕ = internal friction angle of the soil component of the layered system; and
γ_t = total unit weight of soil.

4.2 Input Parameters and Assumptions

The following geometric parameters, material properties, and assumptions were used to evaluate the veneer slope stability of the final cover system on the side slope of the CAMU.

- Final cover system side slope is 3H:1V (33%);
- Total unit weight of final cover system soil/gravel is 110 pcf;
- Assumed an internal friction angle (ϕ) of 30° and a cohesion (c) of zero for the cover protective layer soil;
- Final cover system thickness is 2 ft;
- Maximum vertical height of the 3H:1V side slope is 24.5 ft;
- Assumed negligible water flow thickness (i.e., no seepage forces) along the length of the 3H:1V side slopes for the cover system;
- Assume zero interface adhesion (a) along a defined slip surface; and
- Assume zero tension (T) in the geosynthetics above the slip surface.

Using the above equation, the factor of safety against veneer slope failure was calculated for different values of the interface friction angle along the slip surface to establish the minimum interface friction angle (δ) such that the calculated veneer stability FOS is equal to or greater than 1.5, the typical requirement for long-term slope stability.

4.3 Results of Veneer Slope Stability Analysis

Table E-1 presents the results for the veneer slope stability analysis. Based on the analysis results, a minimum interface friction angle (δ) of 25° with no adhesion is required to meet a FOS of 1.5. A minimum strength envelop corresponding to δ of 25° with no adhesion will be specified for the soil-geosynthetics and geosynthetic-geosynthetic interfaces in the final cover system. This value is within the range of the interface friction angles reported in the literature as noted in Table E-2.

5.0 REFERENCES

- Giroud, J.P., Williams, N.D., Pelte, T., and Beech, J.F., "*Stability of Geosynthetic-Soil Layered Systems on Slopes, Geosynthetics International*", Vol. 2, No. 6, pp. 1115-1148, 1995

- Robert M. Koerner, "*Designing With Geosynthetics, Sixth Edition*", 2012

APPENDIX E

TABLES

Table E-1

VENEER STABILITY ANALYSIS RESULTS
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Cover System Parameters	Run 1	Run 2	Run 3	Run 4	Run 5
Total unit Weight of soil γ_t, pcf	110	110	110	110	110
Thickness of soil layer t, ft	2	2	2	2	2
Thickness of water flow along slope t_w, ft	0	0	0	0	0
Slope angle β, degrees	18.4	18.4	18.4	18.4	18.4
Interface friction angle δ, degrees	**21**	**23**	**25**	**27**	**29**
Interface adhesion a, psf	0	0	0	0	0
Sol internal friction angle ϕ, degrees	30	30	30	30	30
Height of slope h, ft	24.5	24.5	24.5	24.5	24.5
Tension in geosynthetics T, lbs/ft	0	0	0	0	0
Soil cohesion c, psf	0	0	0	0	0
Computed Factor of Safety	**1.3**	**1.4**	**1.5**	**1.6**	**1.8**

Table E-2

SUMMARY OF DOCUMENTED INTERFACE FRICTION VALUES

CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

GEOSYNTHETIC / GEOSYNTHETIC	δ (degrees)
Smooth HDPE / Nonwoven Geotextile	6 to 12
Textured HDPE / Nonwoven Geotextile	25 to 35
Smooth HDPE / Geonet	8 to 15
Textured HDPE / Geonet	8 to 15
Textured HDPE / Geocomposite Drainage Layer	17 to 29
Geonet / Nonwoven Geotextile	14 to 22
Smooth HDPE / GCL (hydrated)	5 to 12
Textured HDPE / GCL (hydrated)	18 to 37
GEOSYNTHETIC / SOIL	**tan δ / tan ϕ'**
Smooth HDPE / Clay	0.4 to 0.7
Textured HDPE / Clay	0.8 to 0.9
Smooth HDPE / Sand	0.5 to 0.6
Textured HDPE / Sand	0.7 to 0.8
Needlepunched Geotextile / Sand	0.8 to 1.0
Needlepunched Geotextile / Angular Gravel	0.7 to 0.9
Needlepunched Geotextile / Rounded Gravel	0.6 to 0.8
Needlepunched Geotextile / Silty Sands	0.96
Geogrid / Soil	1
GCL / Sand	δ = 17 to 35 degrees

Notes:

1. δ = Interface friction angle; ϕ' = Soil internal friction angle.
2. Adapted from tests by Martin et al. (1984), Williams and Houlihan (1986), Koerner et al. (1986), manufacturers literature, and other unpublished results.

APPENDIX F

STORM WATER SYSTEM ANALYSES

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STORM WATER SYSTEM ANALYSES

1.0 INTRODUCTION

This calculation package presents the storm water analyses for the Corrective Action Management Unit (CAMU) proposed at Chevron Perth Amboy facility (Facility) in New Jersey. Two storm water management systems were designed for the CAMU, one to manage the storm water during cell operations (i.e., during the active life of the cell) and the other to manage the storm water post-closure (i.e., after installation of the final cover system). The storm water during operation of the CAMU cells will be collected and managed (treated and disposed) as leachate. The storm water post-closure will be collected and discharged beyond the CAMU footprint. Since non-contact storm water does not require treatment, it will be discharged to the North Field Basin (NFB) wetlands on the north side and to the existing basin areas on the south side of the CAMU.

This appendix presents the analyses performed for the two storm water management systems, storm water system during operations and post-closure. It includes the design of the perimeter swales, rip-rap needed to line the swales, outlet structures, outlet pipes, and the erosion control mattresses.

2.0 ANALYSES METHOD

The storm water flow analysis was performed using the HEC-HMS software program (TR-55 based), version 3.1.0 published by the United States Army Corps of Engineers Hydrologic Engineering Center. This program is the successor to the HEC-1 program. The HEC-HMS program is designed to simulate the precipitation-runoff processes of dendritic watershed systems.

The storm water calculations for the proposed system were performed in accordance with the following:

- New Jersey Department of Environmental Protection, Division of Watershed Management "Storm Water Best Management Practices Manual", April 2004;
- New Jersey Department of Transportation "Soil Erosion and Sediment Control Standards", 2008 Edition; and
- U.S. Department of Transportation FHWA "Hydraulic Engineering Circular No. 15, Third Edition", September 2005.

3.0 STORM WATER SYSTEM DURING OPERATIONS

The storm water during cell operations will be managed using a perimeter swale at the toe of the waste slopes as indicated on the Permit Drawings. The perimeter swale during operations will have a constant invert elevation of 15.5 feet (NGVD), an invert width of 5 feet, and a depth of 3 feet. The perimeter swale during operations will collect the storm water runoff from the waste side slopes and convey it to two storm water sumps that will be constructed on the east and west sides of the operating cell(s) as

indicated on the Permit Drawings. A storm water pump will be installed in each sump to pump the storm water from the sumps directly into the leachate transmission line. During operations, the storm water will be mixed with leachate and handled (treated and disposed) as leachate.

This section presents the analysis performed to check the adequacy of the perimeter swale proposed during operation of the CAMU cells. It also includes the evaluation of the pump capacity needed to manage up to a 25-year storm event during operations.

3.1 Input Data

3.1.1 Design Storm

The rainfall data for a 25-year 24-hour, Type III design storm for Middlesex County, New Jersey was taken from the NRCS 24 hour Design Storm Rainfall Depths (revised in September 2004) and used in the analysis. The 25-year 24-hour storm corresponded to 6.2-inches of rainfall.

3.1.2 Catchment Area

It is anticipated that the CAMU cells will be closed as they are raised to the full design height. However, the timing for closure of the cell(s) is not certain. Since the timing of cell closure is uncertain, a conservative approach was used to evaluate the storm water system during operation of the CAMU cells. The storm water system was evaluated for a worst case scenario, which assumed that all three cells were raised to full design height and none of the cells was closed.

The storm water calculations for this scenario assume that the entire CAMU footprint (raised to full height) will contribute flow to the perimeter swale. The catchment area for the perimeter swale during operations for all three CAMU cells is 3.5 acres approximately. Since the perimeter swale will convey the storm water runoff to two storm water sumps that will be located on the east and west sides of the operating cell(s), the catchment area was divided into two halves. It was assumed that the east half of the catchment area will convey the storm water runoff to the east side storm water sump and the west half of the catchment area will convey the storm water runoff to the west side storm water sump.

3.1.3 Weighted Curve Number (CN)

A CN value of 91 was selected in the analysis for the bare waste side slopes in accordance with the *Urban Hydrology for* Small *Watersheds*, Technical Release 55 (Table 2-2a) as indicated in Attachment F-1.

3.1.4 Times of Concentration

The time of concentration (Tc) for sheet flow was calculated using the following relationship (Equation 3.3 from the TR-55 Manual):

$$Tc = 0.007\ (nL)^{0.8}/P_2^{\ 0.5}\ S^{0.4}$$

where: n = Manning's coefficient
L = Length of travel (feet)
P_2 = NRCS 2-year storm event (inches) = 3.3 inches for Middlesex County
S = Slope

The time of concentration for shallow channel flow (T_L) was calculated using the following relationship (Equation 3.1 in the TR-55 Manual):

$$T_L = L / 3600V$$

where: L = Flow length (feet)
V = Flow velocity (feet/sec)

When the time of concentration was evaluated to be less than 9 minutes, a time of concentration of 9 minutes was used in the analysis.

3.2 Primary Assumptions

The following primary assumptions were made in the design of the storm water system during operations:

- Two storm water sump pumps (on the east and the west sides of the operating cells) will be used during operations of the CAMU cell(s) to pump the storm water from perimeter swale into the leachate transmission line.
- Waste side slopes are bare and comprise of soils with relatively low permeability. A Soil Type D was assumed for the waste side slopes.
- Perimeter swale and the storm water sump pumps should be designed to handle a 25-year 24-hour storm event.
- Perimeter swale is trapezoidal in shape with a 5-foot invert width, 3-foot depth, and side slopes of 2 horizontal to 1 vertical (2H:1V) and 3H:1V.
- A maximum depth of storm water allowed in the perimeter swale is 2.5 feet, i.e, the minimum permissible freeboard is 0.5 feet.
- For times of concentrations (Tc) less than 9 minutes, a minimum Tc of 9 minutes was used in the analysis.

3.3 Analysis Results

A total runoff of 5.15 inches was calculated for the 25-year 24-hour storm event using the Urban Hydrology for Small Watersheds (TR-55) method (see Attachment F-1). For a catchment area of 3.5 acres, the total runoff volume (over the 24-hour storm event) is 490,000 gallons approximately. For a

maximum water depth of 2.5 feet, the storage in the perimeter swale is 366,000 gallons approximately. Hence, the volume of storm water runoff that needs to be pumped out of the swale over the 24-hour period to maintain at least 0.5 feet of freeboard is 124,000 gallons approximately.

Sump pumps capable of pumping up to 50 gallons per minute (gpm) are proposed in each of the two storm water sumps. As a result, the total volume of water that the proposed pumps can pump out of the perimeter swale over a period of 24 hours is 144,000 gallons. The proposed pumps are capable of pumping more water than is required to be pumped out of the swale to maintain a minimum freeboard of 0.5 feet.

Two 50-gpm pumps will be installed in the two storm water sumps (one pump in each sump) during operation of the CAMU cell(s).

4.0 STORM WATER SYSTEM POST-CLOSURE

After installation of the final cover system, storm water will flow over the cover geomembrane and not come in contact with the stabilized soils/waste. The non-contact storm water will be managed using a post-closure perimeter swale that will be constructed at the toe of the closed slope as indicated on the Permit Drawings. The post-closure perimeter swale will be sloped at 1 percent from high points (on the east and west sides of the CAMU footprint) to low points (on the north and south sides of Cell 2). The post-closure perimeter swale will have an invert elevation of 21.5 feet (NGVD) at the high points on the west side of Cell 1 and on the east side of Cell 3. The post-closure perimeter swale will have an invert elevation of 17.5 feet (NGVD) at the low points on the north and south sides of Cell 2 (see Permit Drawings). The post-closure perimeter swale will have an invert width of 3 feet and a minimum depth of 2 feet.

The post-closure perimeter swale will collect the storm water runoff from the closed side slopes and convey it to the low points on the north and south sides of Cell 2. Storm water structures (weir box, drop box, outlet pipe, swale, and/or erosion control mattress) will be provided at the low points to discharge the storm water beyond the CAMU footprint as indicated on the Permit Drawings. Since non-contact storm water does not require treatment, it will be discharged to the NFB wetlands on the north side and to the existing basin areas on the south side of the CAMU.

This section presents the analysis performed to design of the post-closure perimeter swale, rip-rap needed to line the swales, outlet structures, outlet pipes, and the erosion control mattresses.

4.1 Input Data

The design storm, weighted curve number, and the times of concentration used in the post-closure analysis were same as that discussed in Section 3.1 above. The catchment area used in the post-closure analysis is discussed below.

4.1.1 Catchment Area

Post-closure storm water computations were conservatively performed assuming that the entire CAMU (i.e., all 3 cells) will be developed and will contribute flow to the post-closure perimeter swale. The catchment area for this scenario is approximately 3 acres (see final cover grading plan in the Permit Drawings). Since the perimeter swale will convey the storm water runoff to two storm water outlet structures that will be located on the north and south sides of Cell 2, the catchment area was divided into two halves. The north half of the catchment area will convey the storm water runoff to the north side outlet structure, which will discharge the non-contact storm water to the NFB wetlands. The south half of the catchment area will convey the storm water runoff to the south side outlet structure, which will discharge the non-contact storm water to the existing basin areas south of the CAMU footprint.

4.2 Primary Assumptions

The following primary assumptions were made in the design of the post-closure storm water system:

- Two storm water outlet structures (on the north and the south sides of Cell 2) will be used after closure of the CAMU to discharge the non-contact storm water beyond the footprint of the CAMU.
- Cover system includes 6 inch gravel cover (bare ground) underlain by 18 inch cover protective layer consisting of silty to clayey sands. The cover system was conservatively assumed to consist of low-permeability soils corresponding to Soil Type D in the storm water analysis.
- A 25-year design storm was used for calculating the post-closure perimeter swale capacity and the storm flow discharge structures and a 2-year design storm was used for calculating the cleanout velocities.
- Post-closure perimeter swale is trapezoidal in shape with a minimum invert width of 2 feet, depth of 2 feet, and has side slopes no steeper than 2H:1V.
- For times of concentrations (Tc) less than 9 minutes, a minimum Tc of 9 minutes was used in the analysis.
- Discharge pipe or swale outlets are not submerged.

4.3 Outlet Pipe Design

The HEC-HMS analysis results indicate a peak inflow of 6 cubic feet per second (cfs) to each storm water outlet structure (weir box) as indicated in Attachment F-2. The peak flow in the post-closure perimeter swale is 3 cfs. The storm water approaches each storm water outlet structure from two directions, the east and west directions. As a result, the peak inflow to each storm water structure is 6 cfs. The flow from the perimeter swale will be routed into the weir box through a 2-foot wide sharp crested weir at the inlet. The

discharge from the weir box will occur through an outlet pipe on the downstream end of each structure. The invert of the outlet pipe will be located at least 6 inches below the invert of the inlet weir.

The analysis indicates that the peak flow through the weir inlet control to the outlet pipe is 3.4 cfs. The depth of storm water within the post-closure perimeter swale during peak flow is just over 1 foot. Based on the storm water routing analysis, a 12-inch diameter outlet pipe provides sufficient capacity to discharge the peak flow of 3.4 cfs without overtopping the post-closure perimeter swale.

The outlet pipe was sized using the Manning's formula as follows:

$$Q = 1.49 \times R^{2/3} \times S^{1/2} \times A/n$$

where:

R = Hydraulic Radius = A/P ($A=\pi r^2$ and $P = 2\pi r$)

S = Pipe slope (Outlet pipe will have a minimum slope of 1 percent)

n = Manning's coefficient = 0.013 (for HDPE pipe with smooth interior)

For a 12-inch diameter smooth HDPE outlet pipe sloped at 1 percent, the flow capacity

$$Q = 1.49 \times ((\pi*0.5^2)/(2*\pi*0.5))^{2/3} \times (0.01)^{1/2} \times (\pi*0.5^2)/0.013$$

$$= 3.57 \text{ cfs}$$

The flow capacity of the outlet pipe exceeds the peak inflow into the weir box. A 12-inch diameter pipe will be provided as the outlet pipe at both the outlet structures (weir boxes) as indicated on the Permit Drawings.

4.4 Perimeter Swale Rip-Rap Analysis

As discussed above, the peak flow rate in the post-closure perimeter swale is 3 cfs based on the HEC-HMS analysis results. This section presents the analysis performed to evaluate the minimum size of rip-rap needed along the post-closure perimeter swale to prevent erosion. The rip-rap sizing was performed for a peak flow of 3 cfs.

The minimum rip-rap size was calculated using the Blodgett equation (Section 6 of the FHWA Hydraulic Engineering Circular No. 15 (HEC-15 manual). An iterative trial and error method was used to compute the minimum rip-rap size and the Manning's n-value. First, a value was estimated for the average rip-rap diameter (D_{50}) and the mid-channel depth (d). Using these parameters, the swale area, hydraulic radius, and average depth (da) were computed (see Attachment F-3). This information was then used to calculate the Manning's n-value using the Blodgett equation noted below.

$$n = \frac{\alpha\, d_a^{1/6}}{2.25 + 5.23 \log\left(\frac{d_a}{D_{50}}\right)}$$

where,

n = Manning's roughness coefficient, dimensionless

d_a = average flow depth in the channel, m (ft)

D_{50} = median riprap/gravel size, m (ft)

α = unit conversion constant, 0.319 (SI) and 0.262 (CU)

Source: Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition, "Design of Roadside Channels with Flexible Linings".

The calculated Manning's n-value (obtained using the above equation) was then used in the Manning's equation to obtain a predicted flow for the estimated depth. The estimated parameters were adjusted (as needed) and the process repeated until the predicted flow was approximately equal to the flow obtained from the HEC-HMS analysis.

The rip-rap size based on the above evaluation was checked using the following equation for rip-rap sizing in FHWA HEC-15 manual, which is based on permissible shear:

$$D_{50} \geq \frac{SF\, d\, S_o}{F_*(SG - 1)}$$

where,

d = maximum channel depth, m (ft)

SG = specific gravity of rock (γ_s/γ), dimensionless

Source: Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition, "Design of Roadside Channels with Flexible Linings".

The safety factor (SF) and shields number (F*) were obtained from Table 6.1 of the FHWA HEC-15 manual based on the Reynolds number for each swale. A slope (S_o) of 1 percent was used for the post-closure perimeter swale in the analysis.

The computations for sizing the rip-rap for the post-closure perimeter swale are included in Attachment F-3. As noted, average rip-rap size of less than 1 inch is sufficient for the perimeter swale. The average size of the gravel in top 6 inches of the final cover will be at least 2 inches. The same gravel will be used to line the post-closure perimeter swale as indicated on the Permit Drawings.

4.5 North Discharge Swale Rip-Rap Analysis

At the north side outlet structure, the outlet pipe discharges storm water into a swale that conveys the storm water to the NFB wetlands. This swale is referred to as the North discharge swale. This swale will have a minimum bottom width of 2 feet and 3H:1V side slopes as indicated on the Permit Drawings. The North discharge swale will be constructed on the existing perimeter berm side slope of 4H:1V.

As discussed above, the peak flow for the outlet pipe is 3.5 cfs. This section presents the analysis performed to evaluate the minimum size of rip-rap needed along the North discharge swale to prevent erosion. The rip-rap sizing was performed for a peak flow of 3.5 cfs.

The rip-rap sizing for the North discharge swale was also evaluated using the methodology in FHWA HEC-15 manual. As the depth of flow in the discharge swale is expected to be small compared to the rip-rap size, Manning's n-value was calculated using the Bathurst equation, as required by FHWA HEC-15 manual. As discussed earlier, an iterative trial and error method was used to compute the minimum rip-rap size and the Manning's n-value. First, a value was estimated for the average rip-rap diameter (D_{50}) and the mid-channel depth (d). Using these parameters, the swale area, hydraulic radius, and average depth (d_a) were computed (see Attachment F-4). This information was then used to calculate the Manning's n-value using the Bathurst equation noted below.

$$n = \frac{\alpha\, d_a^{1/6}}{\sqrt{g}\; f(Fr)\; f(REG)\; f(CG)}$$

where,

d_a = average flow depth in the channel, m (ft)
g = acceleration due to gravity, 9.81 m/s^2 (32.2 ft/s^2)
Fr = Froude number
REG = roughness element geometry
CG = channel geometry
α = unit conversion constant, 1.0 (SI) and 1.49 (CU)

where,

$$f(Fr) = \left(\frac{0.28Fr}{b}\right)^{\log(0.755/b)}$$

$$f(REG) = 13.434\left(\frac{T}{D_{50}}\right)^{0.492} b^{1.025(T/D_{50})^{0.118}}$$

$$f(CG) = \left(\frac{T}{d_a}\right)^{-b}$$

where,

T = channel top width, m (ft)

b = parameter describing the effective roughness concentration.

and

$$b = 1.14\left(\frac{D_{50}}{T}\right)^{0.453}\left(\frac{d_a}{D_{50}}\right)^{0.814}$$

Source: Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition, "Design of Roadside Channels with Flexible Linings".

The calculated Manning's n-value (obtained using the above equation) was then used in the Manning's equation to obtain a predicted flow for the estimated depth. The estimated parameters were adjusted (as needed) and the process repeated until the predicted flow was approximately equal to the flow obtained from the HEC-HMS analysis.

The rip-rap size based on the above evaluation was checked using the Simons and Senturk equation in FHWA HEC-15 manual, which is used for sizing rip-rap for swales with a bed slope of ten percent or more. The equation is as follows:

$$D_{50} \geq \frac{SF\, d\, S\, \Delta}{F_s(SG-1)}$$

where,

Δ = function of channel geometry and riprap size

where,

$$\Delta = \frac{K_1(1+\sin(\alpha+\beta))\tan\phi}{2(\cos\theta\tan\phi - SF\sin\theta\cos\beta)} \quad (6.12)$$

where,

α = angle of the channel bottom slope

β = angle between the weight vector and the weight/drag resultant vector in the plane of the side slope

θ = angle of the channel side slope

ϕ = angle of repose for the riprap

Finally, β is defined by:

$$\beta = \tan^{-1}\left(\frac{\cos\alpha}{\frac{2\sin\theta}{\eta\tan\phi}+\sin\alpha}\right) \quad (6.13)$$

where,

η = stability number

The stability number is calculated using:

$$\eta = \frac{\tau_s}{F_s(\gamma_s-\gamma)D_{50}} \quad (6.14)$$

Source: Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition, "Design of Roadside Channels with Flexible Linings".

The computations for sizing the rip-rap for the North discharge swale are included in Attachment F-4. As noted, average rip-rap size of about 9 inches is needed for the North discharge swale. An average rip-rap size of 9 inches will be specified for the North discharge swale (see Permit Drawings).

4.6 Erosion Control Protection Analysis

The objective of this analysis was to design the erosion control mattresses required at the storm water outlet structures. At the south-side storm water outlet structure, an erosion control mattress is needed to prevent erosion due to discharge from the 12-inch diameter South outlet pipe. At the north-side storm water outlet structure, an erosion control mattress is needed in the NFB wetlands area to prevent erosion due to discharge from the North discharge swale. The analysis was performed in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey, Section 12, Standard for Conduit Outlet Protection.

4.6.1 South Outlet Pipe

The South outlet pipe at the south-side storm water outlet structure will consist of a 12-inch diameter pipe. As discussed earlier, the maximum design flow for the South outlet pipe is 3.5 cfs.

For a 12-inch diameter pipe, the depth of flow (D_o) and width of flow (W_o) is 1 foot. The flow per unit width (q) is:

$$q = Q/W_o = 3.5 \text{ cfs} / 1 \text{ ft} = 3.5 \text{ ft}^2/\text{sec}$$

For tail water depth (TW) < 1/2 D_o, the length of the apron or erosion control mattress (L_a), the upstream width of apron (W_{a-u}) and the downstream width of apron (W_{a-d}) is calculated as follows:

$$L_a = 1.8\ (q/D_o^{1.5}) + 7D_o = 1.8\ (3.5/1)+7 = 13.3 \text{ ft}$$

$$W_{a-u} = 3W_o = 3*1 = 3 \text{ ft}$$

$$W_{a-d} = 3W_o + L_a = 3*1+13.3 = 16.3 \text{ ft}$$

Finally, the median stone diameter (D_{50}) was calculated as follows:

$$D_{50} = 0.016/TW*q^{1.33} = 0.42 \text{ ft or 5 inches}$$

where $TW = 0.2*D_o = 0.2$ ft

Based on the computations, a trapezoidal erosion control mattress will be provided at the south-side storm water outlet structure. As indicated on the Permit Drawings, the trapezoidal mattress will have an upstream width of 3 feet, a downstream width of 17 feet, and length of 14 feet. A rip-rap with median size (D_{50}) of at least 5 inches will be specified for the erosion control mattress.

4.6.2 <u>North Discharge Swale</u>

The North discharge swale at the north-side storm water outlet structure will consist of a trapezoidal channel with 2- foot bottom width, 2-foot depth and 3H:1V side slopes. As discussed earlier, the maximum design flow for the North discharge swale is 3.5 cfs. The calculations for the North discharge swale indicate that the maximum depth of flow in the swale is 0.23 feet and the peak flow velocity in the swale is 5.7 feet per second or fps (see Attachment F-4). The North discharge swale will discharge in the North Basin where no tail water is expected.

The outlet protection is sized by computing the equivalent discharge for a pipe with the diameter equal to the depth of flow in the open channel (d = 0.23 feet) and a flow velocity equal to that in the channel (V = 5.7 fps). Therefore,

$$Q = \frac{\pi\, d^2}{4} V$$

where,

Q = Flow rate (cfs)
d = Pipe diameter = 0.23 ft

V = Velocity = 5.7 fps

Using the noted parameters, the flow rate (Q) was calculated to be 0.24 cfs. The flow per unit width (q) is:

$$q = Q/W_o = 0.24/2 = 0.12 \text{ ft}^2/\text{sec}$$

where W_o = Bottom width of the swale = 2 ft

For tail water depth (TW) < 1/2 D_o, the length of the apron or erosion control mattress (L_a), the upstream width of apron (W_{a-u}) and the downstream width of apron (W_{a-d}) is calculated as follows:

$$L_a = 1.8\ (q/D_o^{1.5}) + 7D_o = 1.8\ (0.12 / 0.23^{1.5}) + 7(0.23) = 3.6 \text{ ft}$$

$$W_{a-u} = 3W_o = 3*2 = 6 \text{ ft}$$

$$W_{a-d} = 3W_o + L_a = 3*2+3.6 = 9.6 \text{ ft}$$

Finally, the median stone diameter (D_{50}) was calculated as follows:

$$D_{50} = 0.016/TW*q^{1.33} = 0.05 \text{ ft or} < 1 \text{ inch}$$

where $TW = 0.2*D_o = 0.2*0.23 = 0.046$ ft

Based on the computations, a trapezoidal erosion control mattress will be provided at the north-side storm water outlet structure (in the NFB wetlands area). As indicated on the Permit Drawings, the trapezoidal mattress will have an upstream width of 6 feet, a downstream width of 10 feet, and length of 4 feet. A rip-rap with median size (D_{50}) of at least 1 inch will be specified for the erosion control mattress.

5.0 REFERENCES

- New Jersey Department of Environmental Protection, *"Stormwater Best Management Practices Manual"*, Division of Watershed Management, April 2004.
- New Jersey Department of Transportation, *"Soil Erosion and Sediment Control Standards"*, 2008
- U.S. Department of Transporation, Federal Highway Administration, *"Design of Roadside Channels with Flexible Linings"*, Hydraulic Engineering Circular No. 15, Third Edition September 2005
- United States Department of Agriculture, *"Urban hydrology for Small Watersheds, Technical Release 55"*, Natural Resources Conservation Service, June 1986
- The New Jersey Association of Conservation Districts, *"Soil Erosion and Sediment Control in New Jersey"*, Sixth Edition

ATTACHMENT F–1

RAINFALL AND RUNOFF BASED ON TR-55

(DURING OPERATIONS CONDITIONS)

Worksheet 1: Runoff curve number and runoff

Project	Chevron CAMU	By	NG	Date	8/15/12
Location	Flow to single swale	Checked	SMA	Date	8/15/12

Check one: ☐ Present ☑ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
D	Subarea 1 Capped (gravel cover)	91			1.75	159.2
	Totals ➡				1.75	159.2

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{159.2}{1.75} = 91$; Use CN ➡ 91

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	100	25	10
Rainfall, P (24-hour)	in	8.3	6.2	5.0
Runoff, Q	in	7.22	5.15	3.98

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

(POST-CLOSURE CONDITIONS)

Worksheet 1: Runoff curve number and runoff

Project	By	Date
Chevron CAMU	NG	8/15/12
Location	**Checked**	**Date**
Flow to single swale	SMA	8/15/12

Check one: ☐ Present ☑ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
D	Subarea 1 Capped (gravel cover)	91			1.475	134.2
	Totals ➡				1.475	134.2

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{134.2}{1.475} = 91$; Use CN ➡ 91

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	100	25	10
Rainfall, P (24-hour)	in	8.3	6.2	5.0
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	7.22	5.15	3.98

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

ATTACHMENT F–2

HEC-HMS RESULTS

Project: Chevron Single Swale

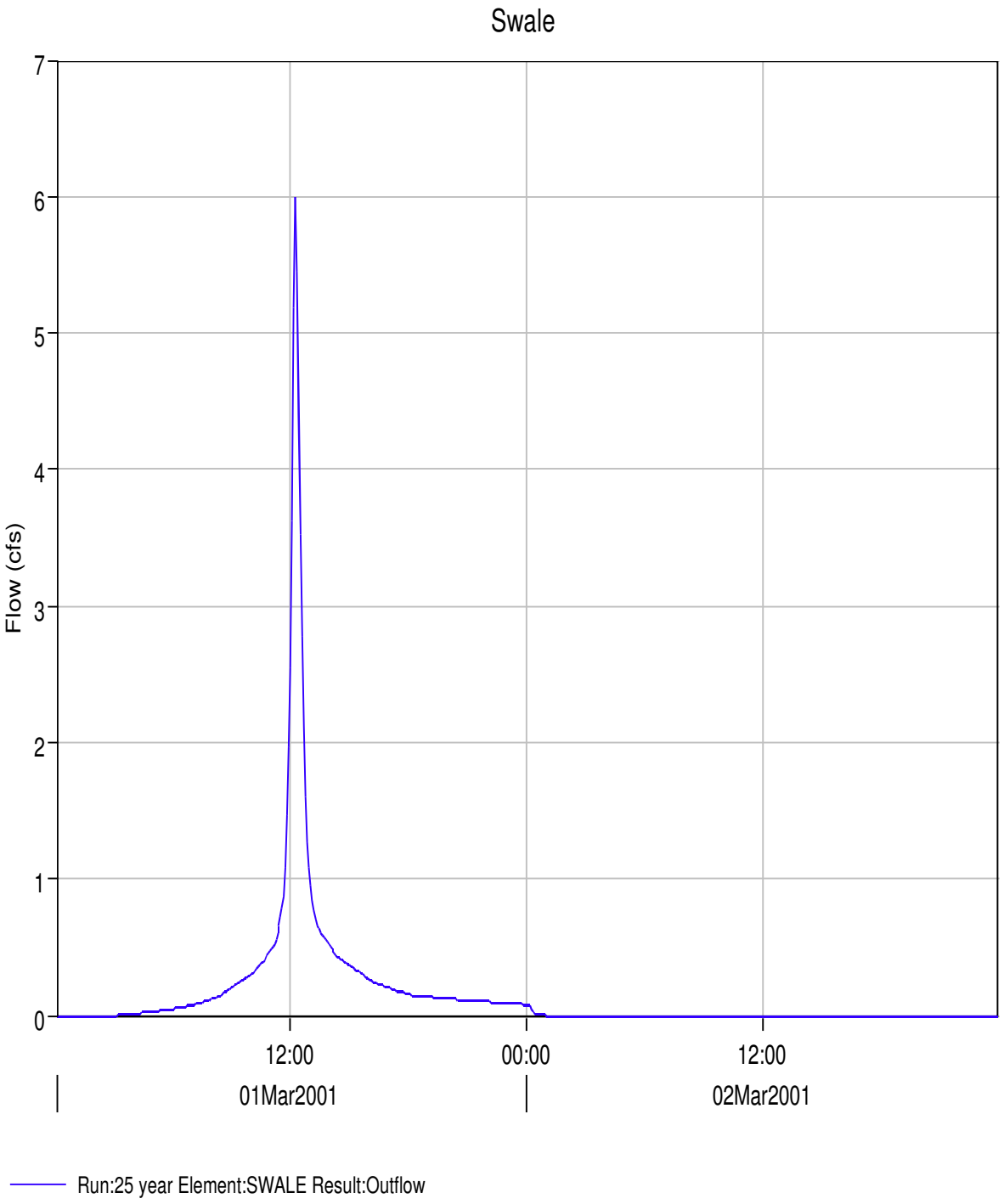
Simulation Run: 25 year Reservoir: Reservoir-1

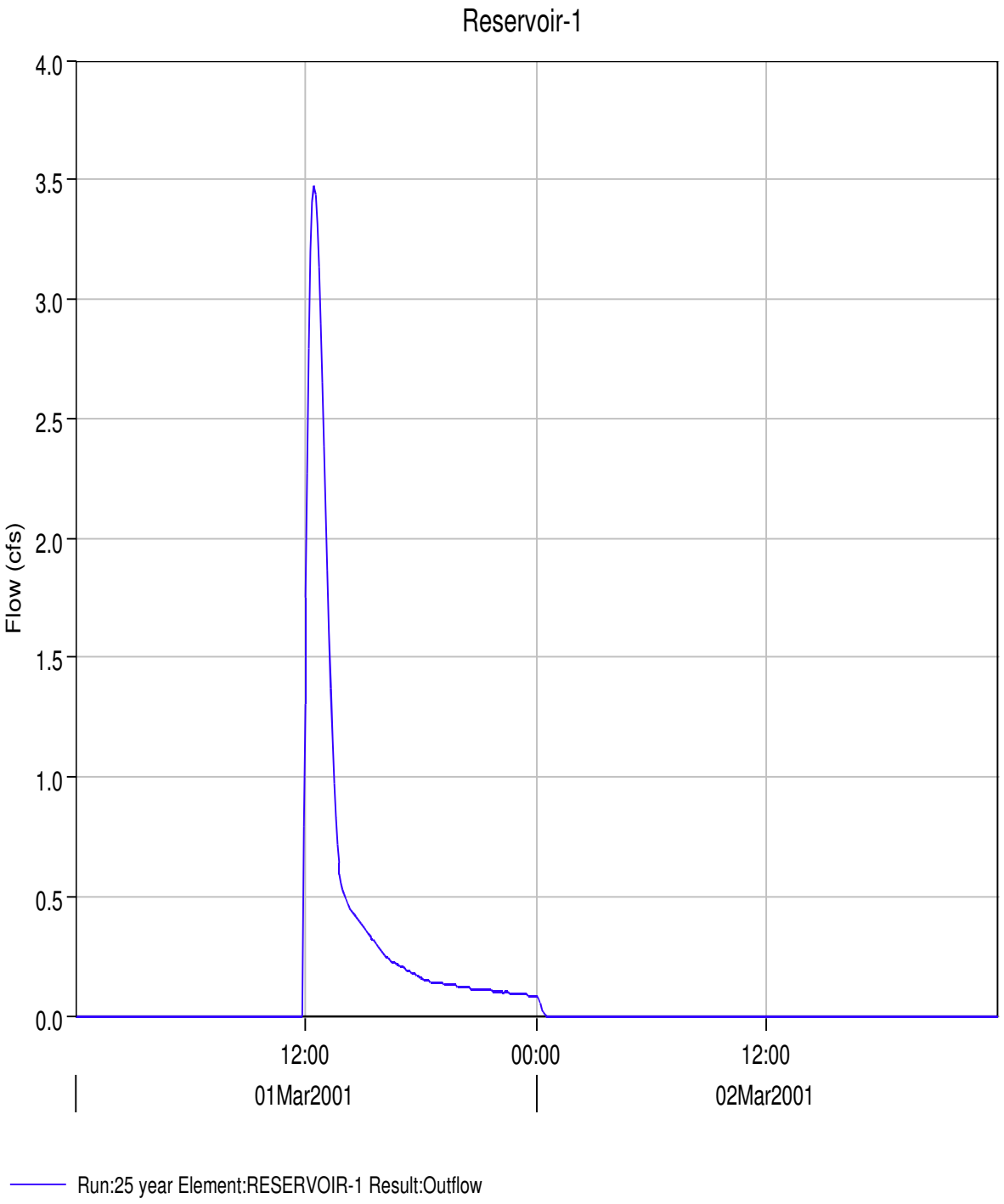
Start of Run:	01Mar2001, 00:05	Basin Model:	Swale Catchment
End of Run:	02Mar2001, 23:55	Meteorologic Model:	25 year
Compute Time:	09Oct2012, 16:07:05	Control Specifications:	Control 1

Volume Units: IN

Computed Results

Peak Inflow :	6.0 (CFS)	Date/Time of Peak Inflow :	01Mar2001, 12:15
Peak Outflow :	3.5 (CFS)	Date/Time of Peak Outflow :	01Mar2001, 12:30
Total Inflow :	5.15 (IN)	Peak Storage :	0.4 (AC-FT)
Total Outflow :	4.03 (IN)	Peak Elevation :	215.2 (FT)


Swale
Flow (cfs)
7
6
5
4
3
2
1
0
12:00
00:00
12:00
01Mar2001
02Mar2001
Run:25 year Element:SWALE Result:Outflow


Reservoir-1
Flow (cfs)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
12:00
00:00
12:00
01Mar2001
02Mar2001
Run:25 year Element:RESERVOIR-1 Result:Outflow

ATTACHMENT F–3

RIP-RAP SIZING FOR POST-CLOSURE PERIMETER SWALE

Riprap Sizing Calculations

Given:

Q=	3	cfs
B=	2	ft
z1=	2	H;1V
z2=	2	H;1V
So=	0.01	ft/ft
D50=	0.075	ft

Assume:

d (Initial trial depth, mid channel)=	0.50	ft

A (Area of Swale)=	$Bd+z_1d^2/2+z_2d^2/2$	1.50	ft^2
Pw (Wetted Perimeter)=	$B+(dz_1^2+d^2)^{0.5}+(dz_1^2+d^2)^{0.5}$	4.24	ft
R (Hydraulic Radius)=	A/Pw	0.35	ft
T (Top of Swale Width)=	$B+dz_1+dz_2$	4.00	ft
da (Average Depth)=	A/T	0.38	ft
Velocity	Q/A	1.99	ft/sec

Mannings n-value

$d_a/D50$ = 5.0

Blodgett Equation (calculate n)

$n=\alpha d_a^{1/6}/(2.25+5.23\log(d_a/D_{50}))$

Where:

α = 0.262

n = **0.038**

Q = 3.00 cfs

Check

Check of D50 based on Shear

Re =	2.5E+03	Reynolds number
F* =	0.047	Shields number
SF =	1.00	Safety Factor
SG =	2.64	Specific Gravity

F and SF Interpolation		
Re	F*	SF
4.0E+04	0.047	1.00
2.5E+03	-	-
2.0E+05	0.150	1.50

"-" indicates that Re is <4e4 and the default minimum values of F and SF have been used.*

Rip Rap sizing based on permissible shear

D50 > (SF * d *So) / (F* (SG-1))

D50 > 0.065 ft (Minimum stable riprap size)

ATTACHMENT F–4

RIP-RAP SIZING FOR NORTH DISCHARGE SWALE

Riprap Sizing Calculations

Given:

Q=	3.5	cfs
B=	2	ft
z1=	3	H;1V
z2=	3	H;1V
So=	0.25	ft/ft
D50=	0.5	ft

Assume:

d (Initial trial depth, midchannel)= 0.23 ft

A (Area of Swale)=	$Bd+z_1d^2/2+z_2d^2/2$	0.62	ft^2
Pw (Wetted Perimeter)=	$B+(dz_1^2+d^2)^{0.5}+(dz_1^2+d^2)^{0.5}$	3.45	ft
R (Hydraulic Radius)=	A/Pw	0.18	ft
T (Top of Swale Width)=	$B+dz_1+dz_2$	3.38	ft
da (Average Depth)=	A/T	0.18	ft
Velocity	Q/A	5.66	ft/sec

Mannings n-value

$d_a/D50$ = 0.4

Blodgett Equation (calculate n)

$n=\alpha d_a^{1/6}/(2.25+5.23 \log(d_a/D_{50}))$

Where:

α = 0.262

n = **-6.092**

Q = -0.02

Check

Bathurst Equation (calculate n)

$n=\alpha d_a^{1/6}/((32.2)^{1/2} f(Fr) f(REG) f(CG))$

Where:

α =	1.49	
d_a =	0.18	ft
g=	32.2	ft / sec^2
Fr =	2.33	
b =	0.212	
f(Fr) =	1.8619	
f(REG) =	4.68	
f(CG) =	0.54	

n = **0.042** Using Bathurst Equation

Q = 3.49 cfs

Check of D50 based on Shear

Re =	5.6E+04	Reynolds number
F* =	0.057	Shields number
SF =	1.05	Safety Factor
SG =	2.64	Specific Gravity

F and SF Interpolation		
Re	F*	SF
4.0E+04	0.047	1.00
5.6E+04	0.057	1.05
2.0E+05	0.150	1.50

Rip Rap sizing based on permissible Shear

D50 > (SF * d *So) / (F* (SG-1)

D50 > 0.643 ft

(Minimum stable riprap size)

Rip Rap sizing based on Simons and Senturk

D50>/= SF*D*S*△/(F*(SG-1))

Where

$\triangle = (K_1(1+\sin(\alpha+\beta)\tan\phi)/2(\cos\theta\tan\phi - SF\sin\theta\cos\beta)$

α=	14.04	deg	τd =	3.6	lb/ft^2
ϕ=	39.5	deg	τs =	2.88	lb/ft^2
θ=	18.43	deg	η =	1.0	
β=	43.4	deg			
K1 =	0.802		Δ =	1.13	

D50 > 0.72 ft (Minimum stable riprap size)

APPENDIX G

FIRE WATER LINE RELOCATION

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5.1 Option 1.....2

5.2 Option 2.....2

6.0 CONSTRUCTION MATERIALS.....3

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G-1 Firewater Relocation Plan and Details for Option 1

G-2 Firewater Relocation Plan and Details for Option 2

LIST OF ATTACHMENTS

G-1 Main Yard Firewater System Drawing

G-2 Existing Firewater Line Photographs

G-3 Vendor Information

1.0 INTRODUCTION

An active fire water line exists within the footprint of the proposed CAMU at the Chevron Perth Amboy facility (Facility) in New Jersey. The existing fire water line within the CAMU footprint will be disconnected from the fire water system and abandoned in place prior to construction of the CAMU. A new fire water line is currently being constructed as part of the fire water line relocation. This appendix provides details for the fire water line relocation.

2.0 EXISTING SYSTEM

The existing fire water line in the CAMU area served as a loop system around Tank Basins 312, 313 and 318. These tanks have been removed and the area is proposed to be used for the CAMU. The loop system around the proposed CAMU area provided protection for the tanks in the past and continues to serve other facilities that are operating in the Main Yard. The loop also acts as a back feed to the main line and provides redundancy in the existing fire water system in the Main Yard. As a result, the fire water line cannot be removed. It needs to be relocated to maintain the integrity of the system as it was designed and approved.

Information on the existing system was obtained from a drawing titled *Fire Fighting Facilities – Main Yard* that was provided by Chevron. The drawing is included in Attachment G-1. It provides a schematic layout of the fire water system in the Main Yard including the pipe sizes and information for hydrants, post indicator valves (PIV) etc. This drawing provides the most up to date information for the fire water system in the Main Yard.

3.0 REGULATORY REQUIREMENTS

In accordance with the New Jersey Department of Consumer Affairs, Codes and Regulations, the International Building Code, New Jersey Edition 2009, is the applicable code for the project. The 2009 International Fire Code, in particular Appendix C, (Minimum hydrant spacing) was also reviewed to verify that the current code requirements are being met for the proposed design.

Section 3404.2.9.1 of the 2009 International Fire Code states “Existing above ground tanks shall be maintained in accordance with the code requirements that were applicable at the time of installation”. Since the existing fire water line continues to serve some above ground tanks, the line will need to be replaced “in kind”.

4.0 SITE VISIT

Parsons conducted a site visit on July 26, 2012 to perform a reconnaissance of the existing fire water system in the CAMU area. The existing fire water lines along the relevant loops were field located using a geophysical survey in 2011. During the site visit, the existing fire water loops were reviewed; the existing hydrants and valves along the loops were located; and the information on the existing *Fire Fighting Facilities* drawing for the Main Yard was verified.

Options for fire water line relocation were evaluated and potential issues with the options were identified. Some of the pertinent photographs taken during the site visit are included in Attachment G-2. It is noted that only above grade features of the fire water system were observed during the site visit and no excavation was conducted.

5.0 PROPOSED MODIFICATIONS

The existing fire water line within the CAMU area will be replaced with a new fire water line that will be installed outside the CAMU footprint. The existing line will be physically disconnected from the fire water system and will be abandoned in place. The new line will replace the existing line "in kind". The new pipe that will be installed will be of the same size as the existing pipe, i.e., 8 inch fire water line. The existing hydrants and valves will be relocated and/or new hydrants and valves will be installed. As noted, the existing size, function, and usage of the fire water system will be maintained.

Two options were proposed for relocating the existing fire water loop as discussed below.

5.1 Option 1

The first option for relocating the existing fire water line is presented in Figure G-1. As noted, Option 1 includes a new fire water line on north side of the CAMU footprint, just beyond the north edge of the existing paved road on top of the perimeter berm. There are two existing hydrants along this loop. These two hydrants will be relocated to a new location on the north side of the road. This option most closely replaces the existing loop. The primary issues with this option include limited right of way beyond the paved road and the proximity to the wetlands during construction.

5.2 Option 2

The second option for relocating the existing fire water line is presented in Figure G-2. As noted, Option 2 includes a new fire water line on south side of the CAMU footprint, beyond the southern limits of the CAMU. The two existing fire hydrants will be replaced with new hydrants. New tie-ins to the existing system will be installed with new valves to control the operation of the loop. New post indicating valves will also be installed as indicated in Figure G-2.

The intent of the proposed options for the fire water line relocation is to not impact the design or operational function of the existing fire water system. As noted on Figures G-1 and G-2, temporary shutdowns of sections of the system will be required to install tie-in connections for the new line. The tie-ins will then be used to install the new line and demolish the existing line with the full system in operation.

Option 2 was selected for relocating the existing fire water line segment. As noted earlier, the fire water line is currently being relocated. The construction of the new fire water line segment is expected to be completed in November 2013.

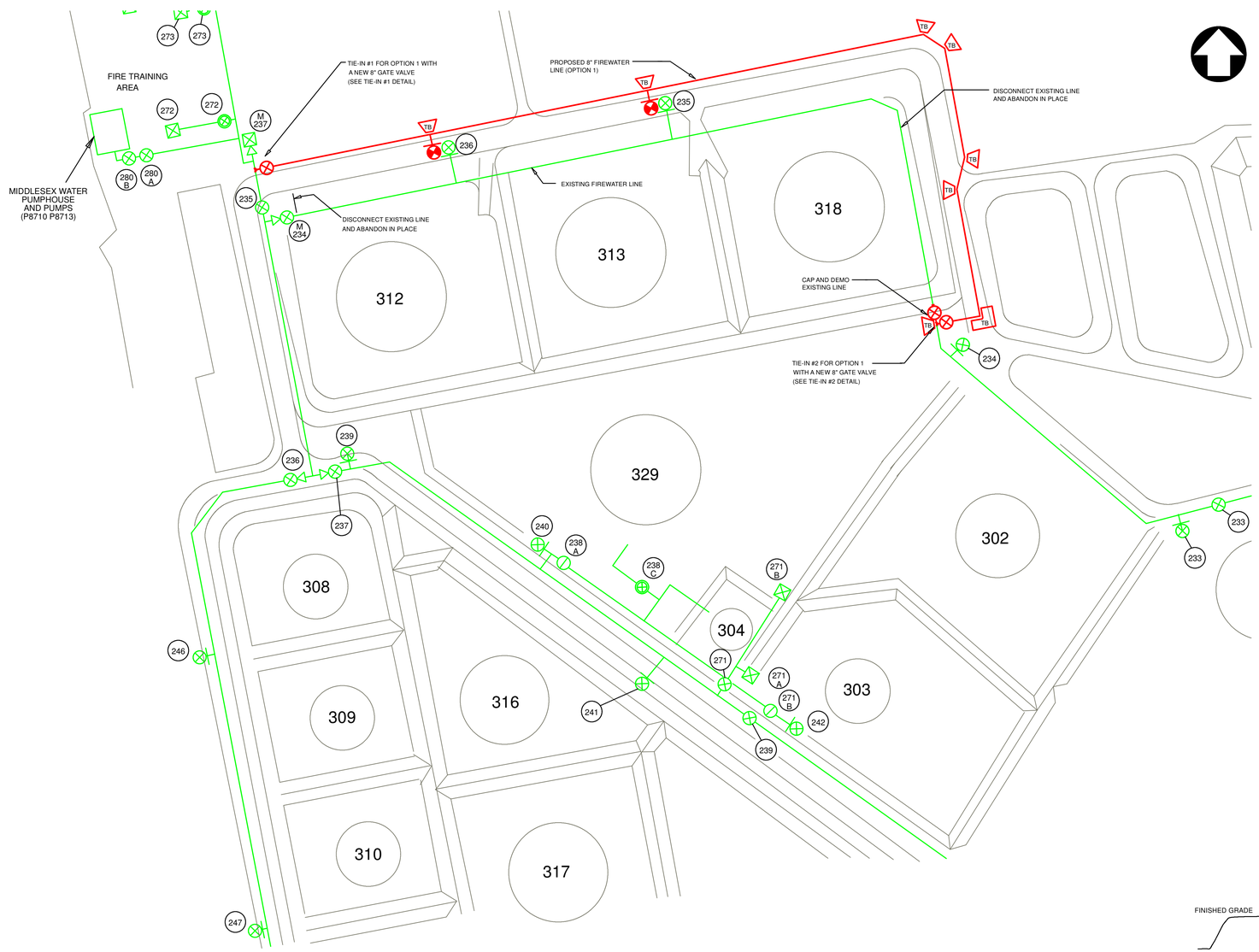
6.0 CONSTRUCTION MATERIALS

As noted on Figures G-1 and G-2, the following materials are being used in the construction of the new fire water line segment. The existing system will be replaced with new code-approved materials of similar design to maintain the system integrity.

- Pipe - Carbon Steel Pipe
- Valves - American Series 2500 Resilient wedge gate valve
- Hydrants - American B-84-B-5 (see Attachment G-3 for vendor information)
- Post Indicators - American IP-71 (see Attachment G-3 for vendor information)

APPENDIX G

FIGURES



LEGEND

- EXISTING HOSE REEL STATION
- EXISTING FIRE HYDRANT
- EXISTING POST INDICATOR VALVE
- EXISTING FLUSH VALVE
- EXISTING DELUGE VALVE
- PROPOSED FIRE HYDRANT (SEE FIRE HYDRANT DETAIL)
- PROPOSED POST INDICATOR VALVE
- PROPOSED THRUST BLOCK

OPTION 1 SYSTEM NOTES:

1. PLACEMENT OF TIE-IN #1 AND #2 ARE SHOWN SCHEMATICALLY. CHOOSE BEST LOCATION AT SIDE OF ACCESS ROAD.
2. LOCATE NEW VALVE WITH POST INDICATOR AT SHOULDER OF ROAD.
3. NEW VALVES TO BE AMERICAN SERIES 2500 DUCTILE IRON 250 PSIG AWWA RESILIENT WEDGE GATE VALVE.
4. NEW HYDRANTS TO BE AMERICAN 5 1/4"-B-84-B-5.
5. NEW POST INDICATORS TO BE AMERICAN IP-71.
6. NEW PIPE TO BE 8"-CONCRETE LINED DUCTILE IRON PIPE.
7. PROVIDE GUARD POSTS AROUND PIV TO PROTECT FROM DAMAGE.
8. NEW FIREWATER LINE TO BE BURIED MINIMUM OF 5' BELOW GROUND SURFACE.

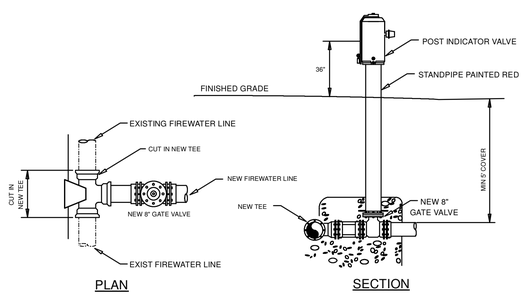
CONSTRUCTION NOTES:

WITH SHUTDOWN

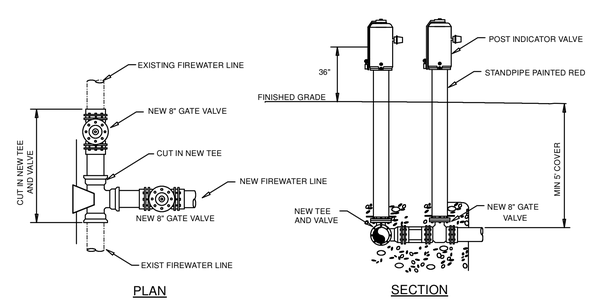
1. CLOSE VALVES 280A & 235
2. MAKE TIE-IN #1
3. TEST SYSTEM
4. CLOSE VALVES 234M AND 233
5. MAKE TIE-IN #2
6. TEST SYSTEM
7. RE-ENERGIZE SYSTEM

WITHOUT SHUTDOWN

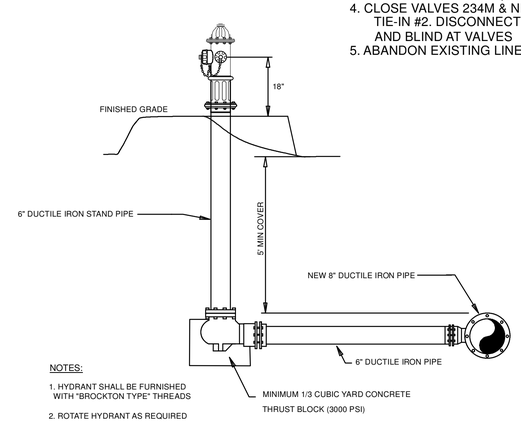
1. INSTALL NEW FIREWATER LINE (OPTION 1) FROM TIE-IN #1 TO TIE-IN #2
2. TEST LINE
3. ENERGIZE NEW LINE (OPTION 1)
4. CLOSE VALVES 234M & NEW VALVE AT TIE-IN #2. DISCONNECT EXISTING LINE AND BLIND AT VALVES
5. ABANDON EXISTING LINE IN-PLACE



TIE-IN #1 DETAIL



TIE-IN #2 DETAIL



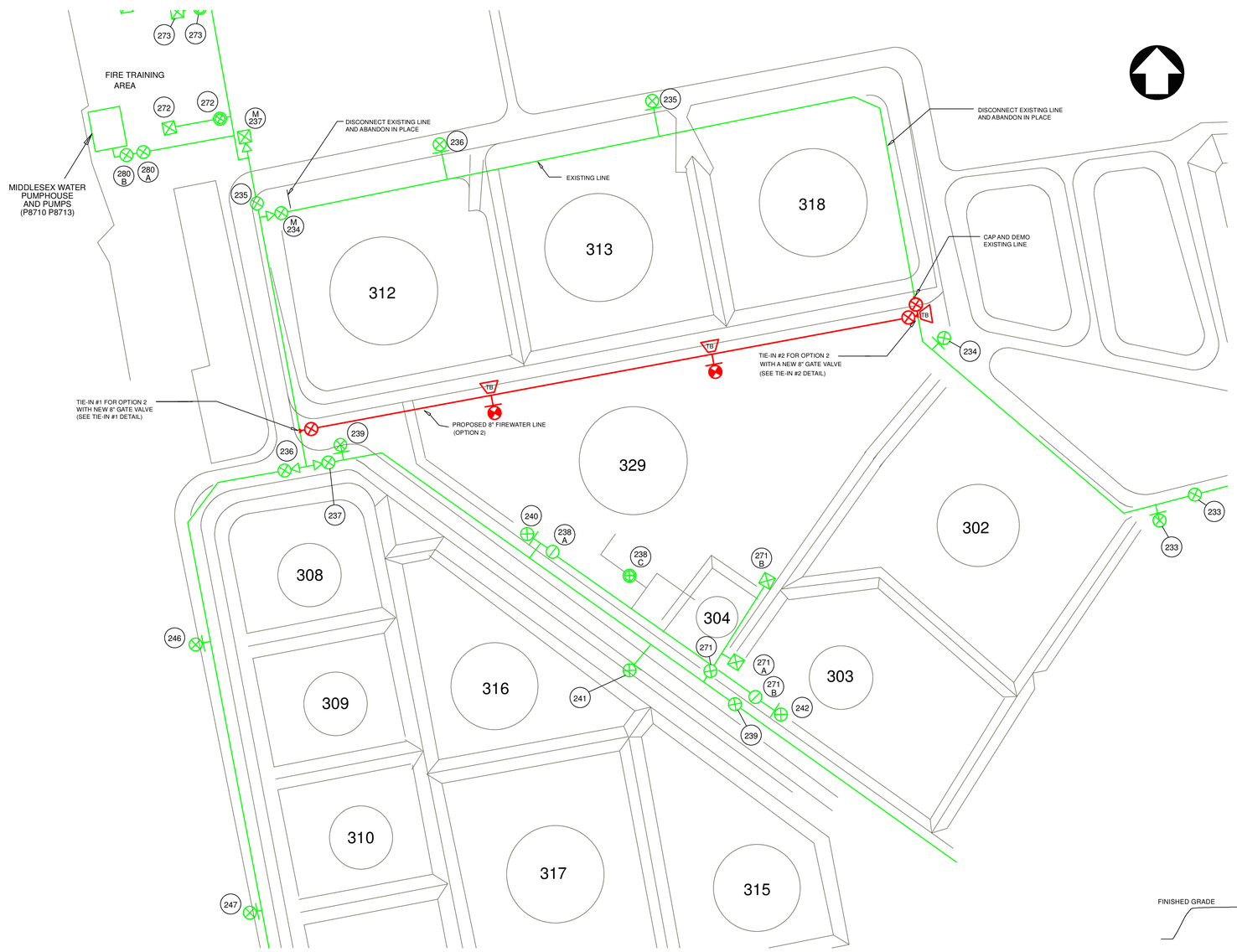
NOTES:

1. HYDRANT SHALL BE FURNISHED WITH "BROCKTON TYPE" THREADS
2. ROTATE HYDRANT AS REQUIRED

FIRE HYDRANT DETAIL

TITLE: **FIREWATER RELOCATION PLAN AND DETAILS FOR OPTION 1**

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: G-1	FILE NAME: Firewater Option 1



LEGEND

- EXISTING HOSE REEL STATION
- EXISTING FIRE HYDRANT
- EXISTING POST INDICATOR VALVE
- EXISTING FLUSH VALVE
- EXISTING DELUGE VALVE
- PROPOSED FIRE HYDRANT (SEE FIRE HYDRANT DETAIL)
- PROPOSED POST INDICATOR VALVE
- PROPOSED THRUST BLOCK

OPTION 2 SYSTEM NOTES:

1. PLACEMENT OF TIE-IN #1 AND #2 ARE SHOWN SCHEMATICALLY. CHOOSE BEST LOCATION AT SIDE OF ACCESS ROAD.
2. LOCATE NEW VALVE WITH POST INDICATOR AT SHOULDER OF ROAD.
3. NEW VALVES TO BE AMERICAN SERIES 2500 DUCTILE IRON 250 PSIG AWWA RESILIENT WEDGE GATE VALVE.
4. NEW HYDRANTS TO BE AMERICAN 5 1/4"-B-84-B-5.
5. NEW POST INDICATORS TO BE AMERICAN IP-71.
6. NEW PIPE TO BE 8"-CONCRETE LINED DUCTILE IRON PIPE.
7. PROVIDE GUARD POSTS AROUND PIV TO PROTECT FROM DAMAGE.
8. NEW FIREWATER LINE TO BE BURIED MINIMUM OF 5' BELOW GROUND SURFACE.

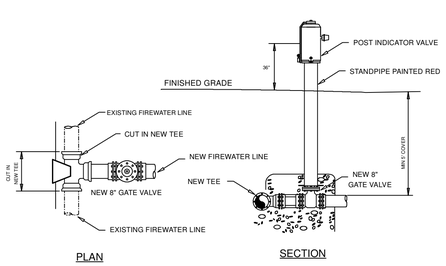
CONSTRUCTION NOTES:

WITH SHUTDOWN

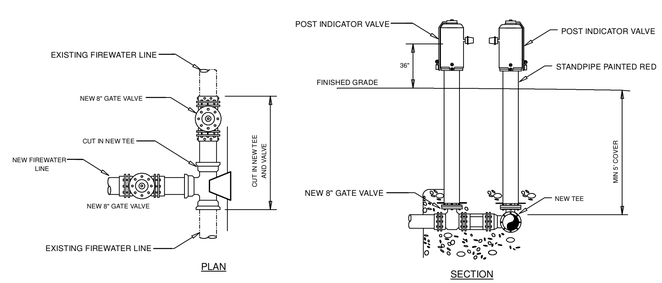
1. CLOSE VALVES 235, 236, 237
2. MAKE TIE-IN #1
3. TEST SYSTEM
4. AT THE SAME TIME, CLOSE VALVES 234M AND 233
5. MAKE TIE-IN #2
6. TEST SYSTEM
7. RE-ENERGIZE SYSTEM

WITHOUT SHUTDOWN

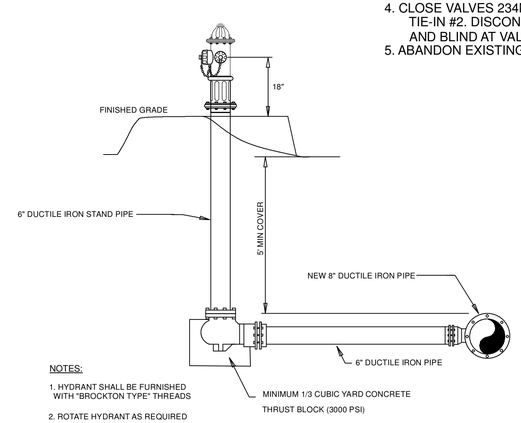
1. INSTALL NEW FIREWATER LINE (OPTION 2) FROM TIE-IN #1 TO TIE-IN #2
2. TEST LINE
3. ENERGIZE NEW LINE (OPTION 2)
4. CLOSE VALVES 234M & NEW VALVE AT TIE-IN #2. DISCONNECT EXISTING LINE AND BLIND AT VALVES
5. ABANDON EXISTING LINE IN-PLACE



TIE-IN #1 DETAIL



TIE-IN #2 DETAIL



NOTES:

1. HYDRANT SHALL BE FURNISHED WITH "BROCKTON TYPE" THREADS
2. ROTATE HYDRANT AS REQUIRED

FIRE HYDRANT DETAIL

TITLE: **FIREWATER RELOCATION PLAN AND DETAILS FOR OPTION 2**

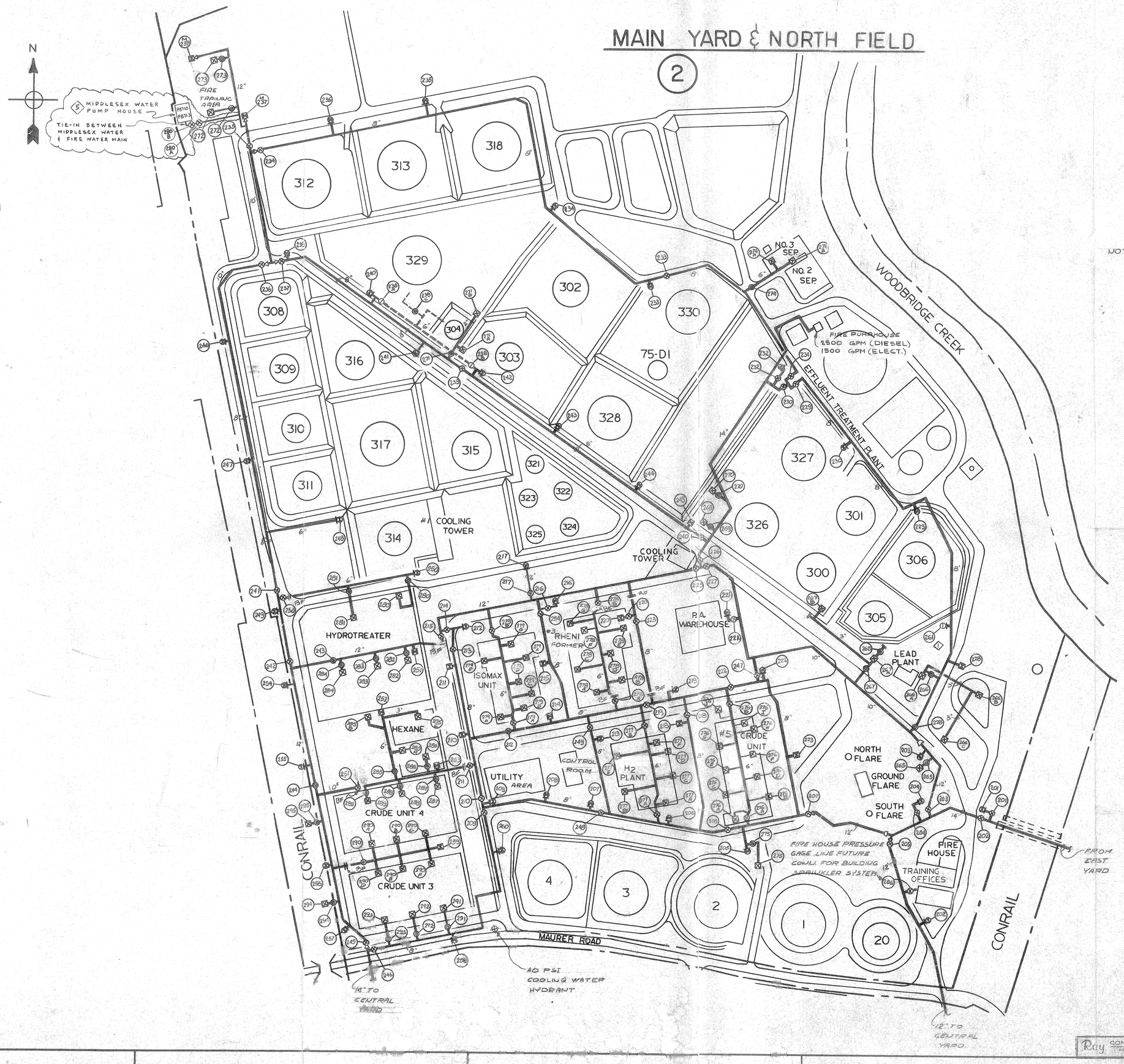
Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: **G-2**	FILE NAME: Firewater Option 2

ATTACHMENT G-1

MAIN YARD FIREWATER SYSTEM DRAWING

MAIN YARD & NORTH FIELD

2



LEGEND

- FIRE WATER
- FIRE HYDRANT
- POST INDICATOR VALVE
- FLUSH VALVE
- HOSE REEL STATION
- DRY LINE
- DELUGE VALVE
- FIRE HYDRANT WITH MONITOR

NOTE

VALVES 238 A AND 238 B SUPPLY DELUGE COOLING WATER TO SPHRE 304
VALVE 238 C IS FOR DRAINING SYSTEM AFTER USE
ALL THREE VALVES SHOULD BE IN THE NORMALLY CLOSED POSITION, WITH THE DRAIN VALVE (238 C) TWO TURNS TO WARD OPEN

NORTH FIELD FIRE SYSTEM REF. DWG'S.

886-1 Piping Plan & Detail	BA-88L-11663
Fire Hydrant Near Tk. 325	BD-88L-14590
Salt Water Fire Line	BA-88L-4737

MAIN YARD
REFINERY FIRE EQUIPMENT NUMBERS

FIRE HYDRANTS	POST INDICATOR VALVES	FLUSH VALVES & SLEEVED VALVES	HOSE REEL STATIONS
201, 202, 203	201, 202, 203	228, 238C, 243	265, 266A, 266B
204, 205, 206	204, 205, 206	244, 265, 266	266C, 267A, 267B
207, 208, 209	207, 208, 209	267, 268, 269	269, 270, 271A
210, 211, 212	210, 211, 212	270, 271, 272	271B, 272, 273
213, 214, 215	213, 214, 215	273, 274, 275	274A, 274B, 275
216, 217, 218	216, 217, 218	280, 281, 282	276A, B, C, D, E, F, G, H, I, J
219, 220, 221	219, 220, 221	283, 284, 285	277A, B, C, D, E, F, 278A, B, C, D, E, F, G
222, 223, 228	222, 223, 224	286, 287, 288	279A, B, C, D, E, F, G, 280, 281, 282, 283
229, 230, 231	225, 226, 227	289, 290, 291	284, 285A, B, C, 286, 287, 288
232, 233, 234	229, 230, 231	292, 293, 294	289, 290A, B, C, D, E, F, 291
235, 236, 237M	232, 233, 234	295	292, 293, 294
238M, 239, 240	235, 236, 237		295
241, 242, 243	238A, 238B		
244, 245, 246	239, 240, 241		
247, 248, 249	242, 245, 246		
250, 251, 252	247, 248, 249		
253, 254, 255	250, 251, 276A		
256, 257, 258	277A, 277B, 278A		
259, 260, 261	278B, 279A, 279B		
	280A, 280B		

MAIN YARD FIRE SYSTEM REF. DWG'S

8" Main Fire Line Piping Plan	BA-88L-14546
12" Main Fire Line Piping Plan	BA-88L-14530
12", 10" and 8" Main Fire Line Piping Plan	BA-88L-14542
14" Main Fire Line Piping Plan	BA-88L-14545
Main Yard Fire Water System	BA-88L-14528
Main Yard Fire Water System	BA-88L-14529
Block Valves Fire Mains	BE-88L-11264
Bulk Station Fire Line Bypass	BE-88L-14547
Fire Hydrant South of Maurer Road	BD-88L-14589
Hose Reel Near Tk. No. 2	BD-88L-14588
PARM Fire Lane Location Plan	BB-88A-14943
No. 4 Crude Unit Fire Fighting Facilities	BB-88A-8509
No. 3 Crude Unit Fire Fighting Facilities	BA-88A-8508
14" Fire Main Piping Plan	BA-88L-14536
Salt Water Fire Lines Plot Plan	BA-88L-4737

REVISIONS

4	ADDED MONITORS TO FIRE HYDRANTS & REVISED LEGEND.	DPM 8/8/79	
3	ADDED FIRE SYSTEM REF. DWG'S. 9-24-80	BDB 4/10/80 KPZ 9-24-80	DPM 9-24-80 JCK
2	ADDED LIST OF REFINERY FIRE EQUIPMENT NUMBERS & REVISED LEGEND.	KPZ 10/3/78	DPM 10/3/78
1	ADDED PIV 280A, 280B, MIDDLESEX WATER PUMP HOUSE & PUMP DESIGNATIONS P8710, P8713	KS 10/4/78 JTM 8/28/78	DPM 10/4/78 KVS A.R. 10/4/78

CHEVRON U.S.A. INC.

ENGINEERING — PERTH AMBOY, N.J.

SCALE 1" = 100'-0" DATE 8-5-77
DR. B. BJORKMAN REV. JOB ENG'R. JCK
OPR'G. APPROVALS
ENG. APPROVALS

FIRE FIGHTING FACILITIES
MAIN YARD
PLAN OF FIRE WATER LINES
HYDRANTS, VALVES & HOSE REELS

Ray CONSULTING CO., INC. HIGHLAND PARK, N.J. PROJECT NO. 2009

W.O.
B.O.
BA-88L-15581-5

FOLD

ATTACHMENT G-2

EXISTING FIREWATER LINE PHOTOGRAPHS

Photograph 1	
Date: July 26, 2012	
Direction: Looking west standing on north perimeter berm	
Comments: Hydrant 236. On road to north side of fill basin. This hydrant will be relocated or demolished, depending on option selected	

Photograph 2	
Date: July 26, 2012	
Direction: Looking south	
Comments: See photograph 1 above	

Photograph 3	
Date: July 26, 2012	
Direction: Looking south	
Comments: PIV 234 and 235 at the intersection of line needing to be relocated and main north-south firewater header.	

Photograph 4	
Date: July 26, 2012	
Direction: Looking south	
Comments: PIV -234 is located on line to be demolished/or relocated. Existing fire water line east (left) from this valve.	

Photograph 5	
Date: July 26, 2012	
Direction: Looking east	
Comments: Existing 8" firewater line runs east from this PIV to east end of existing basin. This section of line will be abandoned in place after being disconnected.	

Photograph 6	
Date: July 26, 2012	
Direction: Looking east	
Comments: Blow up of standard PIV used at site. IP-71 by American.	

Photograph 7	
Date: July 26, 2012	
Direction: Looking north	
Comments: Hydrant 237M to be used in shutdown procedures for installing new tie-ins.	

Photograph 8	
Date: July 26, 2012	
Direction: Looking east	
Comments: Close view of hydrant 237M to verify manufacturer - “American Darling Co”, now called “American”.	

Photograph 9	
Date: July 26, 2012	
Direction: Looking south	
Comments: Hydrant 239 and PIV's 236 & 237. This location will be used during installation of tie-ins for new loop.	

ATTACHMENT G-3

VENDOR INFORMATION

AMERICAN FLOW CONTROL 5 1/4" B-84-B-5

FIRE HYDRANT

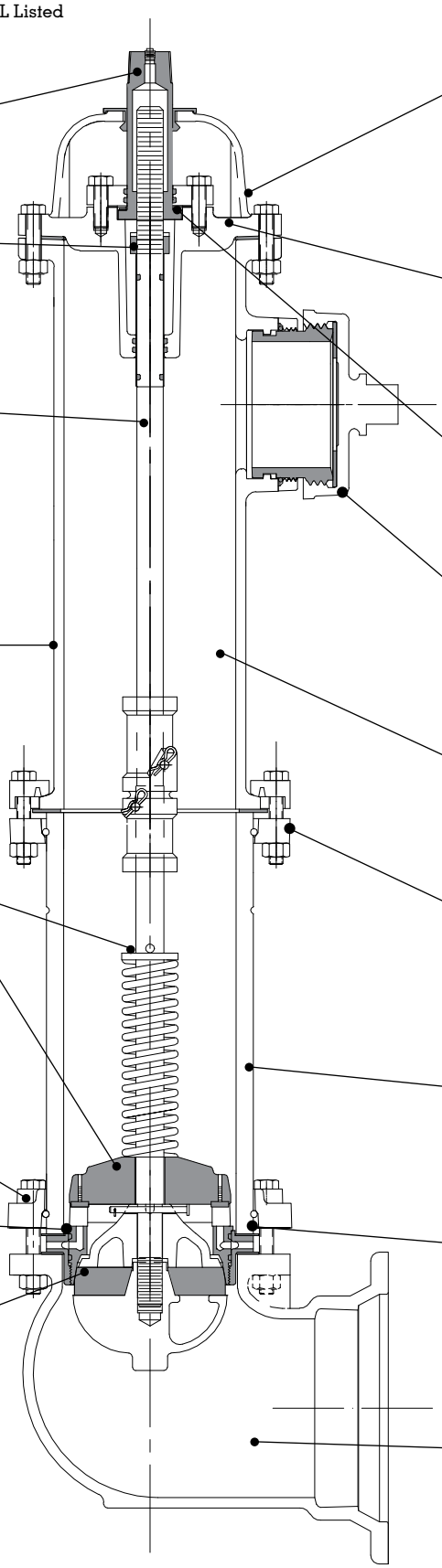
AMERICAN

FLOW CONTROL

THE RIGHT WAY

CONSTRUCTION

Fully complies with AWWA C502 and is available UL Listed and FM Approved in applicable configurations.



ONE-PIECE BRONZE OPERATING NUT
Has a removable pipe plug to allow lubrication of operating threads.

TOP TRAVEL STOP NUT
Provides a positive limit to main rod travel. Eliminates contact of valve bottom with interior of base, thereby protecting coating.

HYDRANT ROD
Furnished in two sections of high-tensile steel. Upper section has bronze sleeve where it passes through O-rings. Upper and lower sections are connected by cast iron coupling using stainless steel pins.

EPOXY PRIMER AND POLYURETHANE COATING SYSTEM
Upper barrel is provided with an e-coat primer and a two-part polyurethane top coat for improved durability, color and gloss retention.

HYDRANT SPRING
Assures quick drain closure and allows throttling.

DRAIN LEVER
Rugged bronze lever performs dual function as carrier for drain lever pads and as wrench to remove working parts.

BASE BOLTS AND NUTS
Are stainless steel for corrosion resistance.

HYDRANT SEAT
Made of bronze, with accurately machined seat for hydrant valve with two drain ports.

HYDRANT VALVE
Consists of an iron valve top and bottom. Hydrant valve rubber constructed of EPDM rubber. Valve has a near vertical seat taper to minimize entrapment of debris while sealing against an all-bronze hydrant seat. Spherical design provides minimal flow loss.

WEATHER COVER
The word "open" and an arrow show direction to turn the operating nut. The rubber weather shield helps prevent water and debris from entering the housing area.

HOUSING AND HOUSING COVER
Retain operating nut and thrust washer. Rugged construction helps withstand operating forces.

THRUST WASHER
Takes upward thrust when opening hydrant valve and reduces operating torque.

NOZZLES
Patented design allows field replacement of damaged nozzles in minutes by one person. Uses no pins or set screws that can become dislodged or lost.

UPPER BARREL
Ductile iron with markings identifying size, model and year of manufacture.

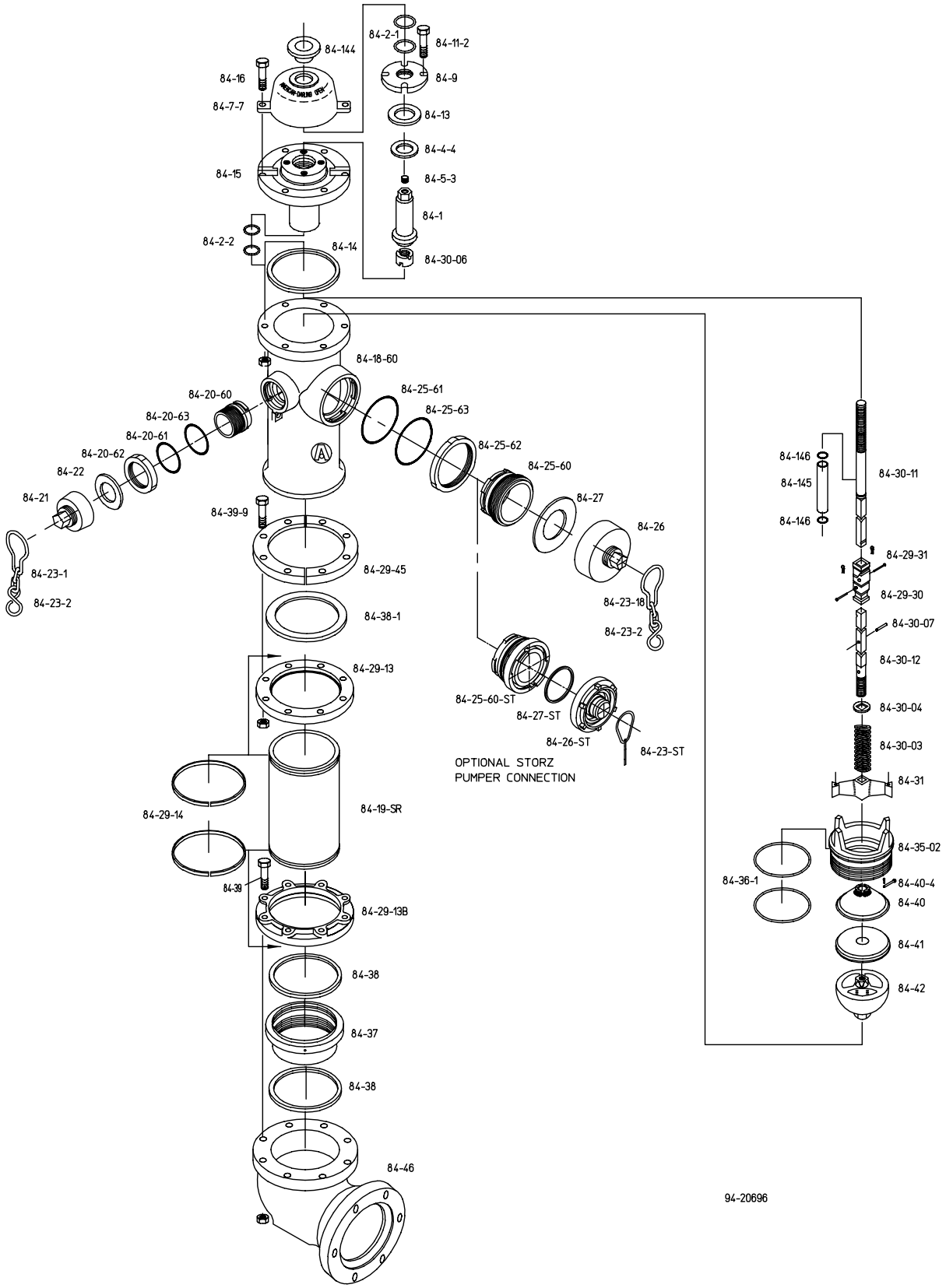
TRAFFIC FEATURE
Upper barrel is connected to lower barrel with breakable traffic flange and eight bolts and nuts. This feature allows 360° rotation of upper nozzle section.

LOWER BARREL
The ductile iron lower barrel provides extra strength against traffic impact damage.

HYDRANT DRAIN RING
Securely held between barrel and base flange, provides bronze-to-bronze threaded connection for hydrant seat. Serves as four noncorrosive multiport drain channels.

BASE
Spherical-shaped base has no projections or cavities to obstruct flow or collect sediment. Base is epoxy-coated ductile iron.

EXPLODED DRAWINGS



PARTS LIST

REF NO.	QTY.	DESCRIPTION	MATERIAL
84-1	1	Operating Nut	Bronze
84-2-1	2	Cover O-ring	Buna-N
84-2-2	2	Housing O-ring	Buna-N
84-4-4	1	Thrust Washer	Nylatron
84-5-3	1	Pipe Plug	Stainless Steel
84-7-7	1	Weather Cover	Gray Iron
84-9	1	Housing Cover	Gray Iron
84-11-2	4	Housing Cover Cap Screw	Zinc Plated Steel
84-13	1	Housing Cover Gasket	Fiber
84-14	1	Housing Gasket	Rubber
84-15	1	Housing	Ductile Iron
84-16	6	Housing Bolt and Nut	Zinc Plated Steel
84-18-60	1	Upper Barrel	Ductile Iron
84-19-SR	1	Lower Barrel	Ductile Iron
84-20-60	2	Hose Nozzle	Bronze
84-20-61	2	Hose Nozzle Seal	Buna-N
84-20-62	2	Hose Nozzle Retainer	Ductile Iron
84-20-63	2	Hose Nozzle Retainer Washer	Teflon
84-21	2	Hose Cap	Gray Iron
84-22	2	Hose Cap Gasket	Rubber
84-23-1	1 Per Nozzle	Hose Cap Chain	Steel
84-23-2	1 Per Nozzle	S-Hook	Steel
84-23-18	1 Per Nozzle	Pumper Cap Chain	Steel
84-25-60	1 or 0	Pumper Nozzle	Bronze
84-25-60	1	Storz Nozzle	Bronze/Aluminum
84-25-61	1 Per Nozzle	Pumper Nozzle Seal	Buna-N
84-25-62	1 Per Nozzle	Pumper Nozzle Retainer	Ductile Iron
84-25-63	1	Pumper Nozzle Retainer Washer	Teflon
84-26	1 Per Nozzle	Pumper Cap	Gray Iron
84-26-ST	1	Storz Nozzle Cap	Aluminum
84-27	1 Per Nozzle	Pumper Cap Gasket	Rubber
84-27-ST	1	Storz Cap Gasket	Rubber
84-29-13	1	Barrel Flange	Ductile Iron
84-29-13B	1	Base Flange	Ductile Iron
84-29-14	2	Snap Ring	Stainless Steel
84-29-30	1	Rod Coupling	Gray Iron
84-29-31	2	Coupling Clip Pins	Stainless
84-29-45	1	2-Piece Breakable Flange	Gray Iron
84-30-03	1	Hydrant Spring	Spring Steel
84-30-04	1	Spring Plate	Steel
84-30-06	1	Travel Stop Nut	Bronze
84-30-07	1	Spring Plate Pin	Stainless
84-30-11	1	Upper Hydrant Rod	Steel
84-30-12	1	Lower Hydrant Rod	Steel
84-31	1	Drain Lever	Bronze
84-35-02	1	Hydrant Seat	Bronze
84-36-1	2	Seat O-ring	Buna-N
84-37	1	Drain Ring	Bronze
84-38	2	Drain Ring Gasket	Composition Rubber
84-38-1	1	Barrel Gasket	Rubber
84-39	8	Base Bolt and Nut	Stainless Steel
84-39-9	8	Barrel Bolt and Nut	Zinc Plated Steel
84-40	1	Hydrant Valve Top	Gray Iron
84-40-4	1	Clevis & Clip Pin	Stainless Steel
84-41	1	Hydrant Valve	Rubber
84-42	1	Hydrant Valve Bottom	Ductile Iron
84-46-2	1	Flanged Base	Ductile Iron
84-46-5	1	Mechanical Joint Base	Ductile Iron
84-46-TY	1	Tyton Base	Ductile Iron
84-144	1	Weather Shield	Rubber
84-145	1	Rod Sleeve	Bronze
84-146	2	Sleeve O-ring	Buna-N

NOTES

1. Size and shape of nut on operating nut and cap, threading on nozzles and caps, and the direction of opening made to specifications.
2. Cap chains are not furnished unless specified.
3. Gray Cast Iron parts are ASTM A126 class B.
4. Bolts and nuts are rustproofed steel ASTM A307 in accordance with AWWA C502.
5. Working pressure 250 psig, test pressure 500 psig.
6. Hydrant conforms to ANSI/AWWA C502 standard.
7. Upper barrel can be rotated 360°.
8. Factory Mutual Approved and Underwriters Laboratories Listed at 200 psig in allowable configurations.
9. Base is ductile iron.
10. Nominal turns to open is 19-1/2.

AMERICAN Flow Control strongly recommends that you follow routine maintenance on fire hydrants as outlined in AWWA Manual M-17 for Installation, Field Testing and Maintenance of Fire Hydrants. The ease of operation and the frequency of repair depends on the condition of the water system and the maintenance given. Dirt, gravel and other foreign material in the hydrant may prevent it from closing or draining properly, which may result in damage to the hydrant main valve. Under most operating conditions AMERICAN Flow Control recommends semi-annual lubrication and inspection of fire hydrants.

FEATURES

AMERICAN Flow Control's American-Darling 5-1/4" B-84-B-5 hydrant incorporates more than 80 years of experience in design, manufacture and field experience. This means dependable and efficient operation when needed.

Introduced in 1984, the 5-1/4" B-84-B-5 hydrant is rated at 250 psig and is seat tested at 500 psig. This hydrant meets or exceeds all requirements of AWWA C502 for dry-barrel hydrants.

The 5-1/4" B-84-B-5 is manufactured with the features you expect from a high-quality fire hydrant. The all-bronze seat and drain ring ensure that the 5-1/4" B-84-B-5 hydrant is easily repaired by just one person.

Optional UL-FM

In applicable configurations, the 5-1/4" B-84-B-5 hydrant is Listed by Underwriters Laboratories Inc. as meeting its standard UL 246, latest version. The Factory Mutual Research Corp. has Approved the 5-1/4" B-84-B-5 in applicable configurations. Both Underwriters Laboratories and Factory Mutual Research require that we consistently manufacture and test our hydrants in full compliance with their stringent standards. Our facilities are subject to periodic inspections to ensure we are in compliance with their standards.

5-1/4" B-84-B-5 Standard Features:

- Upper barrel is furnished with an E-coat primer and a two-part polyurethane top coat for durability, gloss and color retention
- Ductile iron upper and lower barrels and base
- Easy 360° rotation of nozzle section
- 250 psig rated working pressure
- Shell tested at 500 psig
- Lubrication chamber
- Stainless steel bolting below grade
- Bronze-to-bronze seating
- Short, lightweight disassembly wrench
- Travel stop nut located in top of hydrant
- Positive compression, fast-closing drains

BENEFITS

Spring-Loaded Multiport Drains

Two port drains and four drain outlets are standard features on the 5-1/4" B-84-B-5. The rod spring helps assure drains close after approximately three turns of the operating nut. This important safety feature helps prevent washouts.

Near Vertical Hydrant Valve

Minimal taper on the 5-1/4" B-84-B-5 hydrant valve helps prevent entrapment of debris in the hydrant seating area.

Lubrication Chamber

Seals operating threads from water and debris. Proper maintenance required.

Top Travel Stop Nut

Helps prevent stem buckling and damage to bronze components that may occur if excessive torque is applied in the full open position.

SPECIFICATIONS

Fire hydrants shall meet or exceed AWWA C502, latest revision. Rated working pressure shall be 250 psig, test pressure shall be 500 psig and hydrants shall include the following specific design criteria:

The main valve closure shall be of the compression type. Traffic feature to be designed for easy 360° rotation of nozzle section during field installation.

The main valve opening shall not be less than 5-1/4" and be designed so that removal of all working parts can be accomplished without excavating. The hydrant valve shall be constructed of EPDM rubber and have a vertical taper of 20° or less. The bronze seat shall be threaded into mating threads of bronze. The draining system of the hydrant shall be bronze and positively activated by the main operating rod. Hydrant drains shall close completely after no more than three turns of the operating nut. There shall be a minimum of two internal ports and four outlets to the exterior of the hydrant. Drain shutoff to be by direct compression closure. Sliding drains are not permitted.

Hydrant barrels shall be made of ductile iron.

Hydrant upper barrel shall be factory coated with Electrodeposition (E-coat) epoxy primer and catalyzed two-part polyurethane top coating.

Friction loss not to exceed 3.0 psig at 1000 gpm through 4-1/2" pumper nozzle. Hydrants shall be equal to AMERICAN Flow Control's American-Darling 5-1/4" B-84-B-5.

AMERICAN

FLOW CONTROL

THE RIGHT WAY

AMERICAN Flow Control

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Birmingham, AL 35202-2727
Phone: 1-800-326-8051
Fax: 1-800-610-3569
E-mail: afcsales@american-usa.com

Waterous Company

125 Hardman Avenue South
South St. Paul, MN 55075-1191
Phone: 1-888-266-3686
Fax: 1-800-601-2809
E-mail: afcsales@american-usa.com

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Distributed By:

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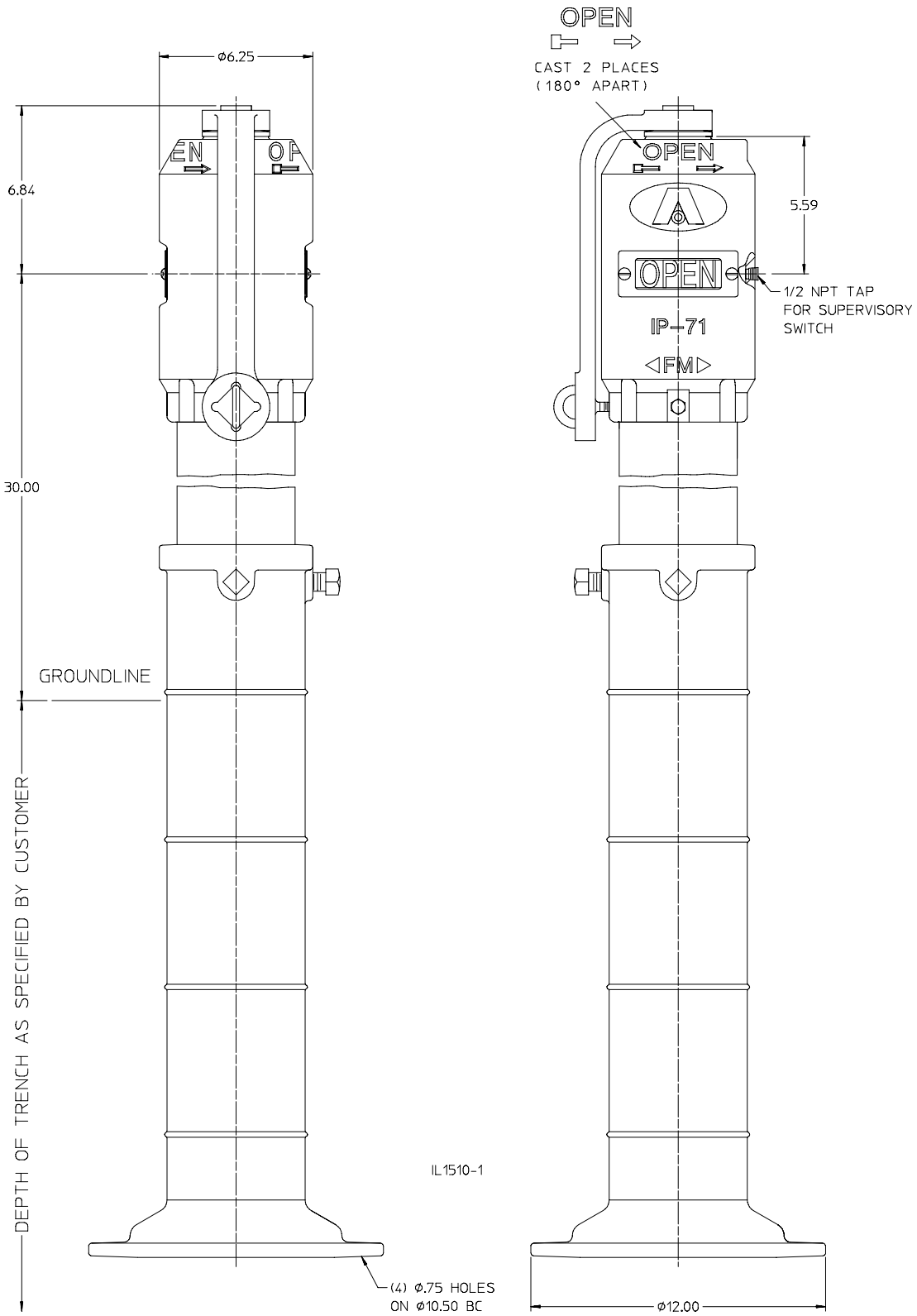
IP-71 INDICATOR POST

AMERICAN Flow Control offers a full line of “open-shut” indicator posts that are Approved by Factory Mutual Approvals and Listed by Underwriters Laboratories, Inc. for use with 3"-18" gate valves.

Indicator posts are used to actuate and indicate open/shut status of buried gate valves. They are recommended for use in fire protection systems or installations where it is critical that valve status be known.

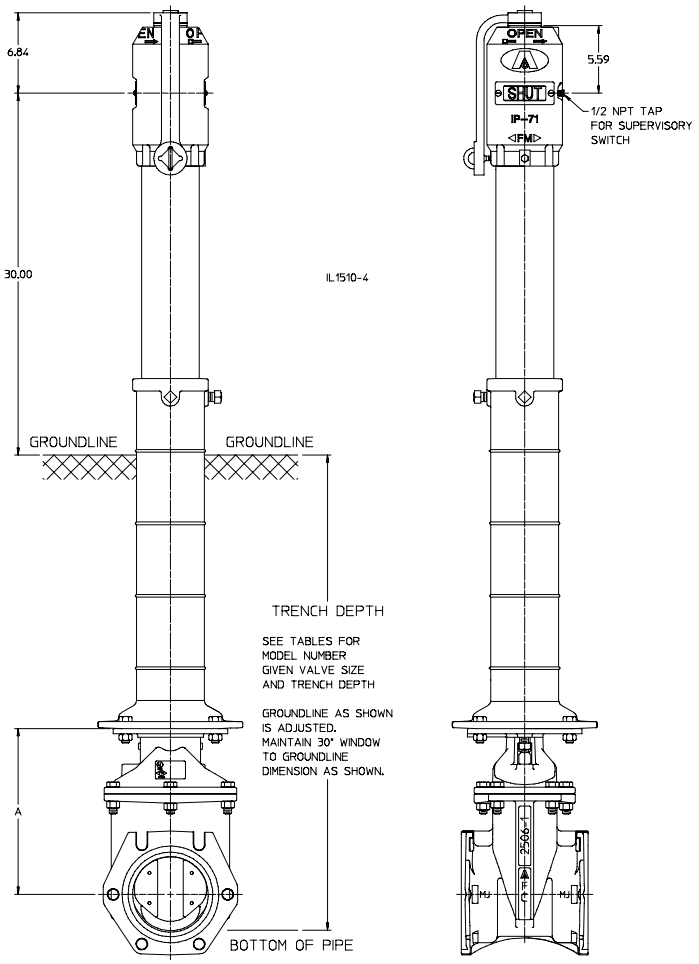
IP-71 DIMENSIONS



NOTE:

1. Listed by Underwriters Laboratories, Inc. and Approved by Factory Mutual Approvals.

IP-71 DIMENSIONS

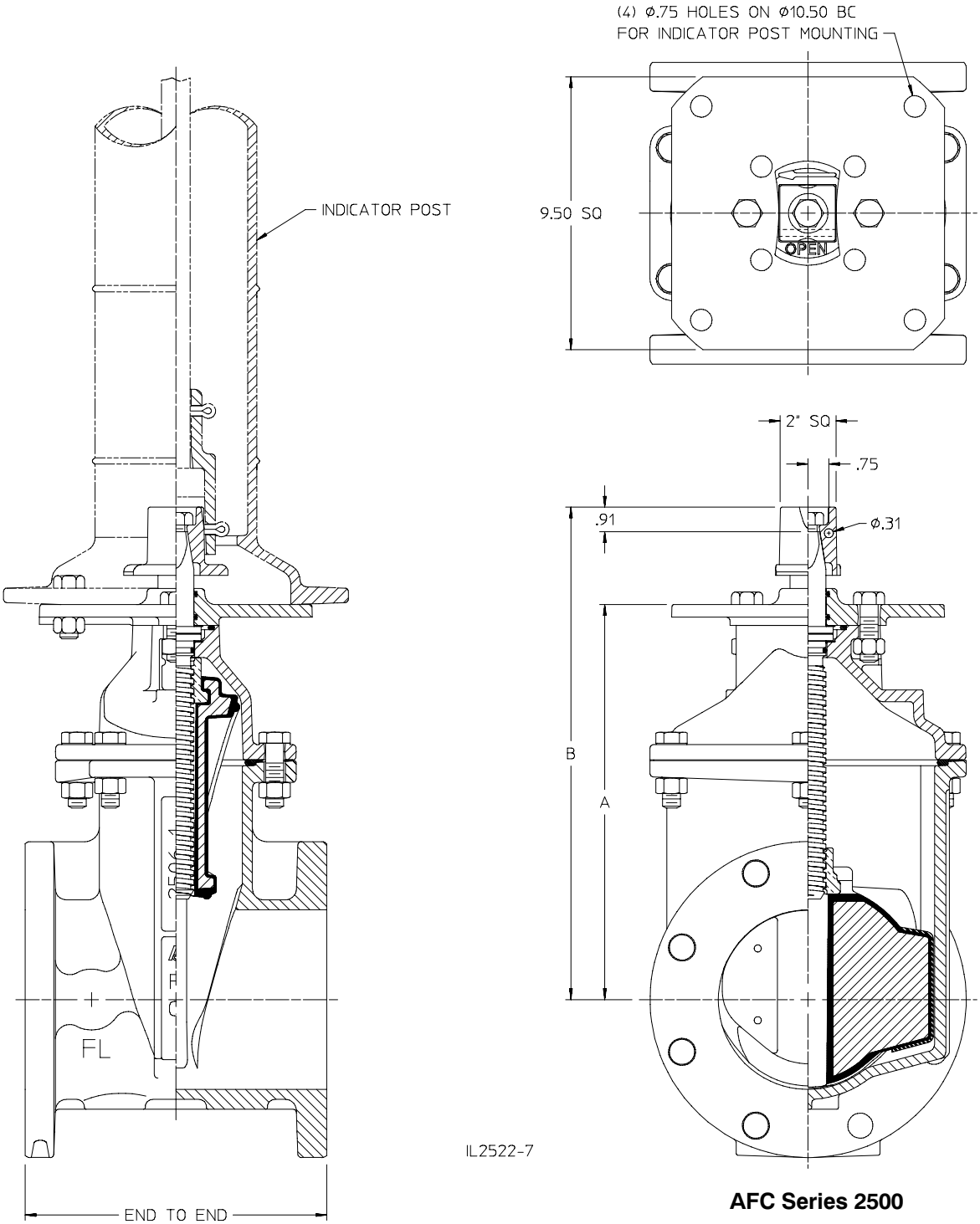


Model Number	Valve Size				
	3" & 4"	6"	8"	10"	12"
	Trench Depth	Trench Depth	Trench Depth	Trench Depth	Trench Depth
1A	2'0" - 3'0"	2'0" - 3'6"	2'6" - 4'0"	3'0" - 4'6"	3'6" - 4'6"
2A	3'6" - 5'0"	4'0" - 5'6"	4'6" - 6'0"	5'0" - 6'6"	5'0" - 6'6"
3A	5'6" - 7'0"	6'0" - 7'6"	6'6" - 8'0"	7'0" - 8'6"	7'0" - 8'6"
4A	7'6" - 9'0"	8'0" - 9'6"	8'6" - 10'0"	9'0" - 10'6"	9'0" - 10'6"
5A	9'6" - 11'0"	10'0" -11'6"	10'6" - 12'0"	11'0" - 12'6"	11'0" - 12'6"
6A	11'6" - 13'0"	12'0" - 13'6"	12'6" - 14'0"	13'0" - 14'6"	13'0" - 14'6"
7A	13'6" - 15'0"	14'0" - 15'6"	14'6" - 16'0"	15'0" - 16'6"	15'0" - 16'6"
8A	15'6" - 17'0"	16'0" - 17'6"	16'6" - 18'0"	17'0" - 18'6"	17'0" - 18'6"

Model Number	Valve Size		
	14"	16"	18"
	Trench Depth	Trench Depth	Trench Depth
1B	4'0" - 5'0"	4'6" - 5'6"	4'6" - 6'0"
2B	5'6" - 7'0"	6'0" - 7'6"	6'6" - 8'0"
3B	7'6" - 9'0"	8'0" - 9'6"	8'6" - 10'0"
4B	9'6" - 11'0"	10'0" - 11'6"	10'6" - 12'0"
5B	11'6" - 13'0"	12'0" - 13'6"	12'6" - 14'0"
6B	13'6" - 15'0"	14'0" - 15'6"	14'6" - 16'0"
7B	15'6" - 17'0"	16'0" - 17'6"	16'6" - 18'0"
8B	17'6" - 19'0"	18'0" - 19'6"	18'6" - 20'0"

Dimension	Valve Size								
	Series 2500	Series 2500-1					Series 2500		
	3"	4"	6"	8"	10"	12"	14"	16"	18"
A	8.97	10.38	13.75	16.94	20.34	23.78	29.25	32.75	35.62

IP-71 DIMENSIONS



AFC Series 2500
Resilient Wedge Gate Valve

Dimension	Valve Size								
	Series 2500	Series 2500-1					Series 2500		
	3"	4"	6"	8"	10"	12"	14"	16"	18"
A	8.97	10.38	13.75	16.94	20.34	23.78	29.25	32.75	35.62
B	11.84	13.91	17.12	20.47	24.06	27.59	33.25	36.75	39.62
End to End - FL x FL (Class 125)	8.00	9.00	10.50	11.50	13.00	14.00	15.00	16.00	17.00
End to End - MJ x MJ	8.62	10.00	10.50	11.50	12.50	13.50	20.50	20.88	23.00

IP-71 WEIGHTS

Model Number	Weight
1A & 1B	146 LBS
2A & 2B	178 LBS
3A & 3B	211 LBS
4A & 4B	244 LBS
5A & 5B	277 LBS
6A & 6B	310 LBS
7A & 7B	344 LBS
8A & 8B	375 LBS

AMERICAN Flow Control®

IP-71 (UNDERGROUND) INDICATOR POST

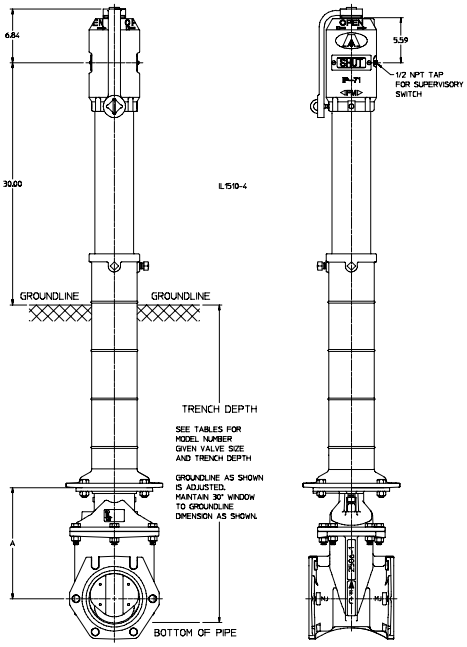
SUBMITTAL SHEET

Quantity: _____	
Direction to Open: ❑ Left (C.C.W.) ❑ Right (C.W.)	
Valve Size Post Used On: ❑ 3" ❑ 4" ❑ 6" ❑ 8" ❑ 10" ❑ 12" ❑ 14" ❑ 16" ❑ 18"	
Model Number: _____	
Other Requirements (List):	

AMERICAN Flow Control®

American-Darling Valve and Waterous

A Division of AMERICAN



Model Number	Valve Size				
	3" & 4"	6"	8"	10"	12"
	Trench Depth	Trench Depth	Trench Depth	Trench Depth	Trench Depth
1A	2'0" - 3'0"	2'0" - 3'6"	2'6" - 4'0"	3'0" - 4'6"	3'6" - 4'6"
2A	3'6" - 5'0"	4'0" - 5'6"	4'6" - 6'0"	5'0" - 6'6"	5'0" - 6'6"
3A	5'6" - 7'0"	6'0" - 7'6"	6'6" - 8'0"	7'0" - 8'6"	7'0" - 8'6"
4A	7'6" - 9'0"	8'0" - 9'6"	8'6" - 10'0"	9'0" - 10'6"	9'0" - 10'6"
5A	9'6" - 11'0"	10'0" -11'6"	10'6" - 12'0"	11'0" - 12'6"	11'0" - 12'6"
6A	11'6" - 13'0"	12'0" - 13'6"	12'6" - 14'0"	13'0" - 14'6"	13'0" - 14'6"
7A	13'6" - 15'0"	14'0" - 15'6"	14'6" - 16'0"	15'0" - 16'6"	15'0" - 16'6"
8A	15'6" - 17'0"	16'0" - 17'6"	16'6" - 18'0"	17'0" - 18'6"	17'0" - 18'6"

Model Number	Valve Size		
	14"	16"	18"
	Trench Depth	Trench Depth	Trench Depth
1B	4'0" - 5'0"	4'6" - 5'6"	4'6" - 6'0"
2B	5'6" - 7'0"	6'0" - 7'6"	6'6" - 8'0"
3B	7'6" - 9'0"	8'0" - 9'6"	8'6" - 10'0"
4B	9'6" - 11'0"	10'0" - 11'6"	10'6" - 12'0"
5B	11'6" - 13'0"	12'0" - 13'6"	12'6" - 14'0"
6B	13'6" - 15'0"	14'0" - 15'6"	14'6" - 16'0"
7B	15'6" - 17'0"	16'0" - 17'6"	16'6" - 18'0"
8B	17'6" - 19'0"	18'0" - 19'6"	18'6" - 20'0"

Dimension	Valve Size								
	Series 2500	Series 2500-1					Series 2500		
	3"	4"	6"	8"	10"	12"	14"	16"	18"
A	8.97	10.38	13.75	16.94	20.34	23.78	29.25	32.75	35.62

Visit our web site at http://www.american-usa.com/afc

NOTE:

1. Approved by Factory Mutual Approvals and Listed by Underwriters Laboratories, Inc. to UL-789.

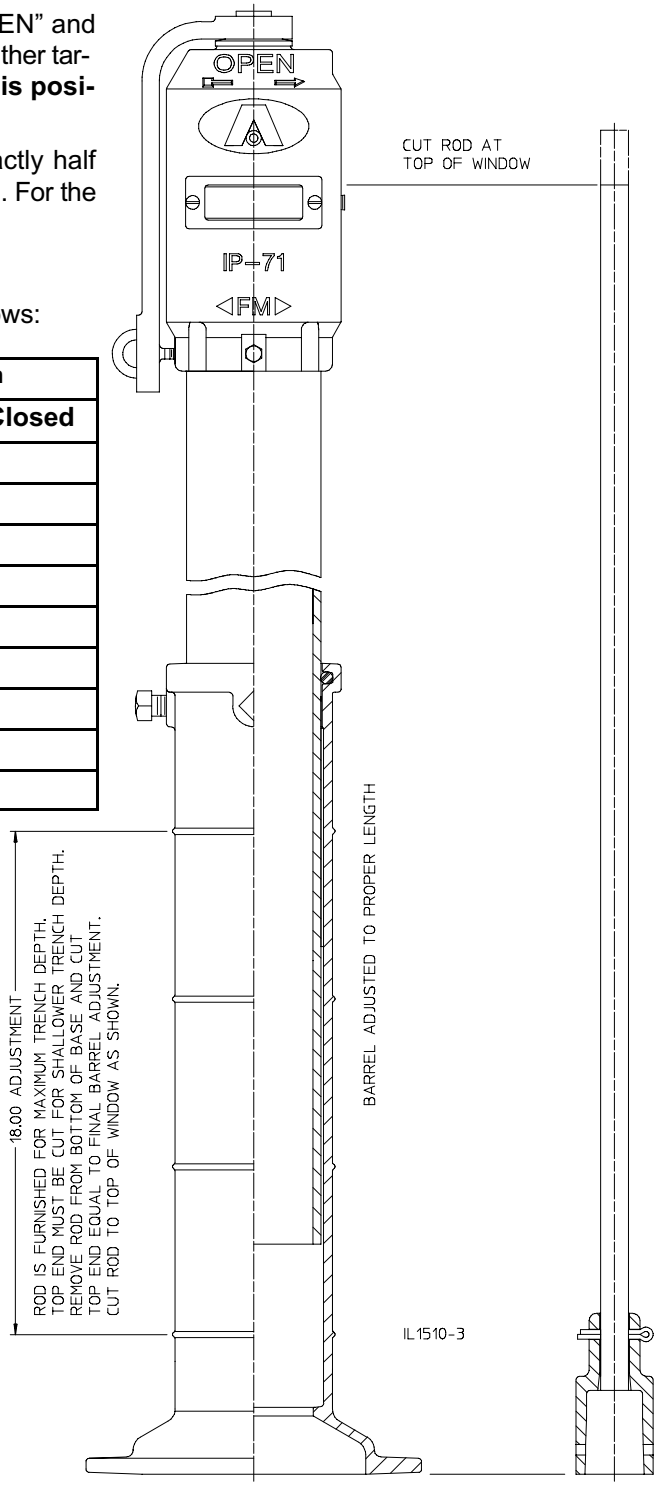
IP-71 INSTALLATION

Installation

1. The IP-71 Indicator Post is shipped with the “OPEN” and “SHUT” targets in the exact mid position so that neither target is centered in the window. **Do not change this position until the post is mounted on the valve**.
2. The valve must be positioned so the gate is exactly half way between the full open and full closed positions. For the AFC valve, use the following procedure:
   a. Open the valve to the full open position.
   b. Turn the valve in the closing direction as follows:

To Position Valve in 1/2-Open Position	
Valve Size	**Turns Toward Closed**
3"	6-1/2
4"	7
6"	10
8"	13
10"	16
12"	19
14"	22
16"	25
18"	28

3. Slide the indicator post rod out of the IP-71 post through the base.
4. Adjust the IP-71 barrel and base for the proper trench depth.
5. Lay the rod beside the properly adjusted IP-71 post with the bottom of the rod coupling even with the bottom of the flange on the base.
6. Cut the upper end of the rod even with the top of the target window.
7. Re-insert the rod, cut to the proper length, back into the IP-71 post, making sure the square rod is inserted into the square recess in the operating nut.
8. Attach the wrench nut coupling on the IP-71 stem to the 2" wrench nut on the gate valve using the cotter pin provided.
9. Mount the IP-71 Indicator Post on the post flange on the gate valve.
10. Operate the gate valve to the full open and full closed positions to make sure the “OPEN” and “SHUT” signs are shown in the windows of the indicator post.



IP-71 OPERATION AND MAINTENANCE

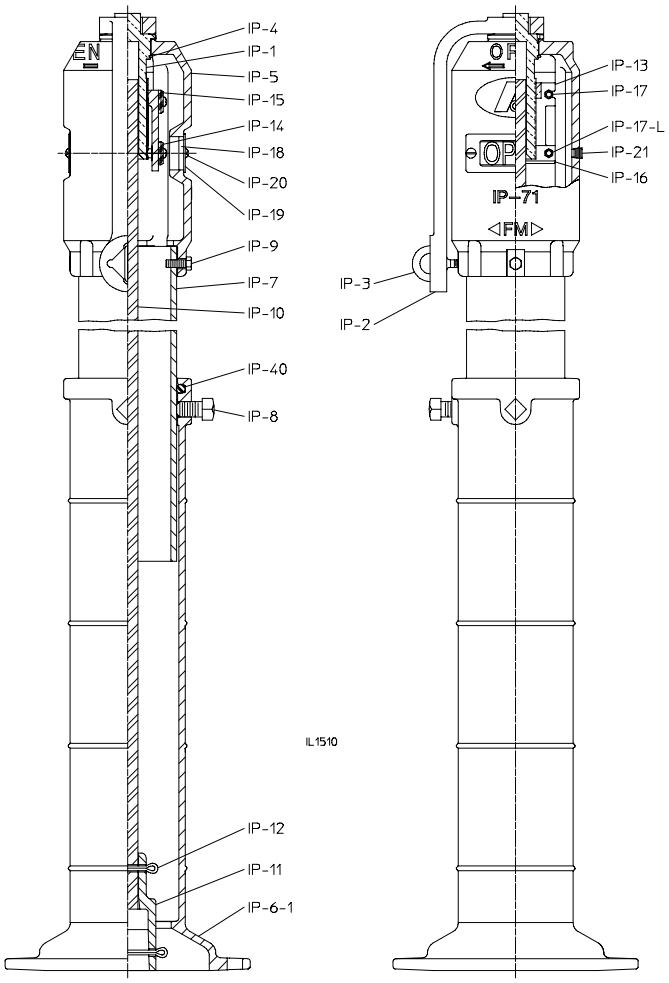
Operation

1. Direction of opening is indicated by an arrow cast on to part of the indicator post body.
2. Fully open and close valve before applying pressure, using the wrench supplied as part of the indicator post. Longer wrenches or “cheaters” should not be used as excessive leverage may damage the indicator post or the gate valve to which it is connected.
3. Regarding gate valve operating instructions, refer to Section 3A of the Valve and Hydrant Manual, for use with AMERICAN 2500 Gate Valves. For all other manufacturers be sure to refer to that individual manufacturer's instructions.

Maintenance

1. Inspect indicator post a minimum of four times per year, or more, if conditions warrant. During inspection, place 3-4 drops of lubricating oil in hole located on top of the operating stem nut. Turn operating stem nut to distribute oil.
2. If for any reason it becomes necessary to replace the operating stem nut, proceed in the following manner:
   a. Remove eye bolt IP-3 and hex head bolt IP-9 and lift off entire indicator post head.
   b. Turn operating stem nut in closing direction until target carrier becomes disengaged.
   c. Remove TRUARC retaining ring IP-4, using a pair of TRUARC pliers, external type.
   d. Lift operating stem nut out of body.
   e. To install operating stem nut, reverse above procedure.
3. Regarding gate valve maintenance instructions, refer to Section 3A of the Valve and Hydrant Manual, for use with AMERICAN 2500 Gate Valves. For all other manufacturers be sure to refer to that individual manufacturer's instructions.

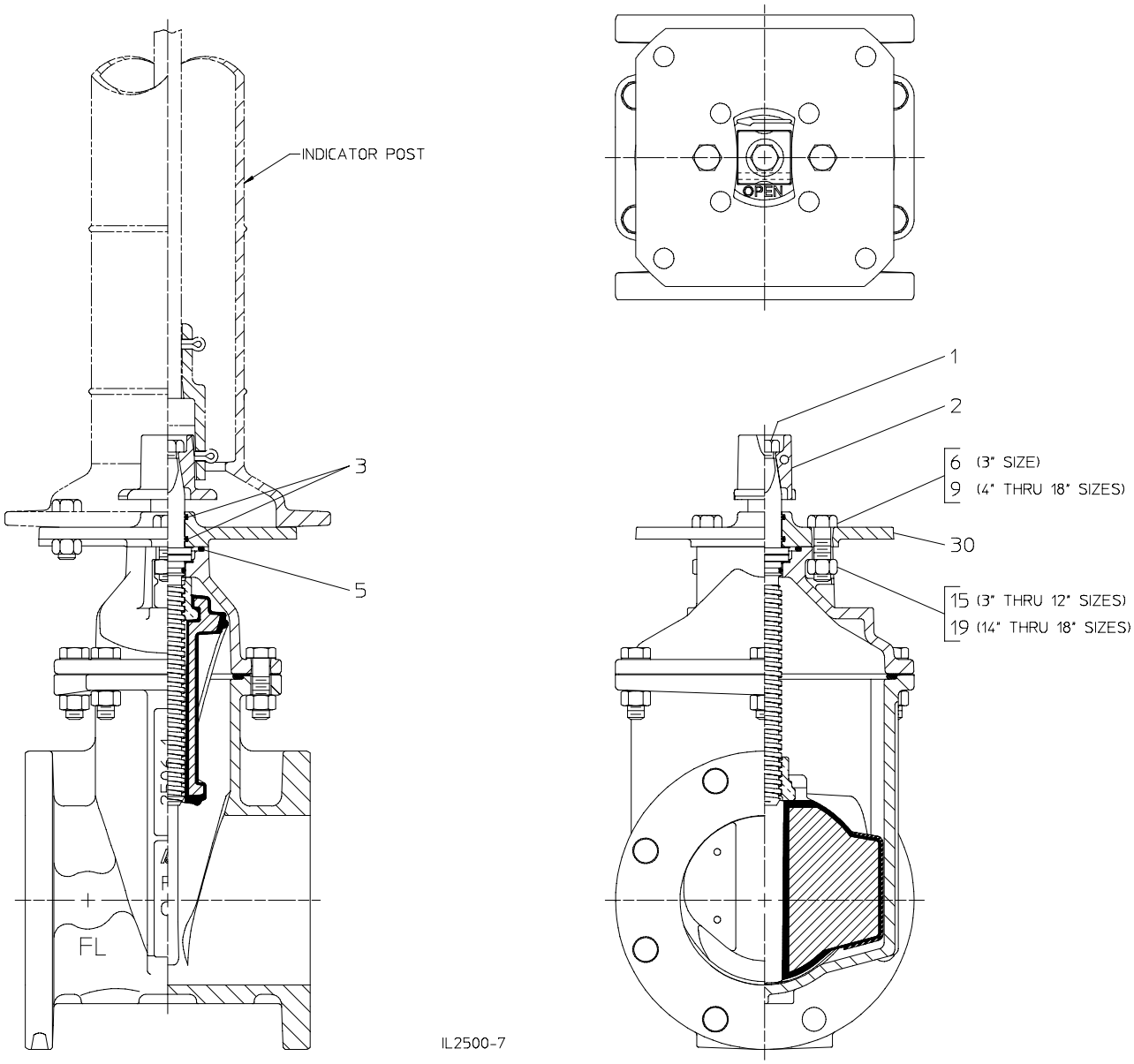
IP-71 PARTS LIST



Ref No.	Description	Material	Quantity
IP-1	Operating Stem Nut	Bronze	1
IP-2	Operating Wrench	Gray Iron	1
IP-3	Eye Bolt	Steel	1
IP-4	Retaining Ring	Steel	1
IP-5	Body	Gray Iron	1
IP-6-1	Base	Ductile Iron	1
IP-7	Extension Barrel	Ductile Iron	1
IP-8	Set Screw	Steel	2
IP-9	Hex Head Bolt	Plated Steel	1
IP-10	Extension Rod	Steel	1
IP-11	Coupling	Gray Iron	1
IP-12	Cotter Pin	Steel	2
IP-13	Target Carrier	Bronze	1
IP-14	Target Plate - Open	Aluminum	2
IP-15	Target Plate - Shut	Aluminum	2
IP-16	Target Clamp	Stainless Steel	2
IP-17	Target Screw and Nut	Aluminum	7
IP-17-L	Target Screw and Nut	Aluminum	1
IP-18	Window	Glass	2
IP-19	Ferrule	Stainless Steel	2
IP-20	Ferrule Screw	Stainless Steel	4
IP-21	Pipe Plug	Steel	1
IP-40	O-ring	Rubber	1

NOTE: When ordering repair parts, please specify valve size, depth of trench and open direction.

IP-71 PARTS LIST



Ref No.	Description	Material	Quantity								
			Series 2500	Series 2500-1					Series 2500		
			3"	4"	6"	8"	10"	12"	14"	16"	18"
1	Hex Hd Bolt, 5/8-11 x 1"	Stainless Steel	1	1	1	1	1	1	-	-	-
1	Hex Hd Bolt, 5/8-11 x 1-3/4"	Stainless Steel	-	-	-	-	-	-	1	1	1
2	Operating Nut, 2" Sq	Ductile Iron	1	1	1	1	1	1	1	1	1
3	O-ring	Nitrile Rubber	2	2	2	2	2	2	2	2	2
5	Stuffing Box Gasket	Nitrile Rubber O-ring	1	1	1	1	1	1	1	1	1
6	Hex Hd Bolt, 5/8-11 x 1-3/4"	Stainless Steel	2	-	-	-	-	-	-	-	-
9	Hex Hd Bolt, 5/8-11 x 2"	Stainless Steel	-	2	2	2	4	4	-	-	-
9	Hex Hd Bolt, 7/8-9 x 3"	Stainless Steel	-	-	-	-	-	-	4	4	4
15	Hex Nut, 5/8-11	Stainless Steel	2	2	2	2	4	4	-	-	-
19	Hex Nut, 7/8-9	Stainless Steel	-	-	-	-	-	-	4	4	4
30	Indicator Plate	Ductile Iron	1	1	1	1	1	1	1	1	1

APPENDIX H

OPERATIONS PLAN

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1.0 INTRODUCTION

1.1 Purpose and Scope

The waste generated as part of the Corrective Measure Implementation (CMI) at Chevron's Perth Amboy Facility in Perth Amboy, New Jersey (Facility) will be disposed in an on-site Corrective Action Management Unit (CAMU). This Operations Plan provides description of operation requirements and procedures that will be followed during the active life of the CAMU cells, i.e., during the disposal of stabilized soils/waste in the cells prior to closure of the cells. The primary purpose of the Operations Plan is to describe the operation requirements and procedures to ensure that the CAMU is operated and managed in accordance with the design and permit requirements.

Chevron's Perth Amboy Facility is located at 1200 State Street in Perth Amboy, New Jersey. The Facility is divided into three different yards: Main Yard, Central Yard, and East Yard. The CAMU will be constructed in the Main Yard of the Facility in former Tank Basins 312, 313, and 318. The disposal of stabilized soils and remediation waste will occur in three distinct cells, Cell 1 through Cell 3. Cell 1 will be constructed in Tank Basin 312 (T312), Cell 2 in Tank Basin 313 (T313) and Cell 3 in Tank Basin 318 (T318). The CAMU will be constructed in phases and only one cell will be constructed at a time. The CAMU will be developed from the west end of the footprint (starting with Cell 1) towards the east end (with Cell 3 as the last cell to be constructed during the phased development of the CAMU).

1.2 Operations Plan Organization

The remainder of this Operations Plan is organized as described below:

- Section 2 describes the personnel and equipment requirements, traffic routing and other facilities;
- Section 3 details the CAMU operations including basic filling procedures, requirements for the cover and the general maintenance requirements;
- Section 4 briefly discusses environmental controls for the CAMU systems including leachate and storm water controls, and the inspection plans; and
- Section 5 includes the contingency plan for CAMU-specific emergencies.

2.0 PERSONNEL AND FACILITIES

2.1 Personnel Requirements

The Contactor will have at least one trained operator with relevant experience and one spotter during the active filling of stabilized soils/waste in the CAMU cells. The operator will be familiar with the filling and grading requirements as well as the operations of the CAMU systems (such as the leachate and storm water management systems). The Contract will have at least one qualified person responsible for workers' health and safety at all times during CAMU operations. All personnel will comply with Chevron's health and safety (H&S) requirements.

2.2 Personnel Training

All employees working at the CAMU shall meet the training and other requirements specified by Chevron for working at the Facility. In addition, the Contractor's employees will complete a CAMU-specific safety training prior to commencement of work. As a minimum, this training will cover the following:

- Overview of the CAMU Operations Plan;
- Review of pertinent design, permits and regulatory requirements;
- Operation procedures for operator, spotter and other key personnel; and
- Specific safety hazards and mitigation measures related to active filling of stabilized soils/waste in the CAMU.

A list of employees who have successfully completed the minimum training requirements will be documented and maintained at the Facility by the Contractor.

2.3 Equipment

Heavy equipment that will be used during active filling of the CAMU will include dump trucks, dozer, compactor, excavator, and/or water truck. Heavy equipment will primarily be used for placing, spreading, and compacting waste in the cells.

2.4 Traffic Routes

CAMU eligible waste will be generated during on-site remedial activities that will be performed as part of the CMI. The CAMU eligible waste will be processed in the designated treatment and storage areas (primary and/or secondary storage and treatment only areas) prior to disposal in the CAMU. The dump trucks will be allowed to travel between the treatment/storage areas and the CAMU only along designated roads. Truck traffic will be restricted to the on-site paved roads.

Trucks will enter and exit each cell using an ingress/egress ramp that will be located near the northwest end of each cell. Directions and signs will be posted along the haul roads, at the entrance ramp, and within the active cell, as needed. Temporary barricades, bollards, tapes and other visual markers will be used by the Contractor on an as-needed basis.

2.5 Communication Facilities

Cellular and/or conventional telephones as well as two-way radios will be provided for routine communication and for use during emergencies at the Facility.

3.0 CAMU OPERATIONS

This section describes the proposed filling and compaction requirements for the stabilized soils/waste in the CAMU cells.

3.1 Method of Operations

The filling of the CAMU cells will generally progress from west to east and from north to south. At the start of waste deposition in a cell, the waste filling will be sequenced such that waste is first placed in the entire cell up to the elevation of the perimeter berm to reduce leachate generation, prior to raising the waste to higher elevations.

The truck traffic will be effectively managed to facilitate proper placement, spreading and compaction of the waste. During construction of the first lift, trucks will be positioned on a lift of previously compacted waste in an area adjacent to the area where first lift being placed. Stabilized soils/waste will be spread in thin lifts and tracked with dozer to aid compaction. Dump trucks will be routed over previously filled areas to the extent practical to promote compaction of waste. Disposal vehicles will not be routed over a lined area before a lift of waste has been placed to prevent damage to the bottom liner system. Vehicles will not be routed over areas with interim or final cover unless a road is specifically constructed for hauling waste.

Signs will also be posted in the operational areas on an as-needed basis. Signs may be used for directing traffic, specifying types of materials that may be disposed in particular areas, and/or for identifying safety requirements.

3.1.1 Start-Up and First Lift

To assure protection of the bottom liner system, no disposal vehicles will be operated directly on the liner protective cover. Soil platforms or similar protective measures will be placed adjacent to the working face to keep vehicles off the liner protective cover. Trained personnel will be positioned at the working face during start-up of each new area to direct vehicles to appropriate unloading points.

The first lift of waste on the liner protective cover will be placed with great care, using special methods to protect the liner from damage. The first lift of stabilized soils/waste will be a minimum of 3 feet in compacted thickness and consist of select wastes containing no large rigid objects that may damage the liner or leachate collection system. Equipment will not be allowed on the liner protective cover and equipment will not spread waste in a manner that displaces the liner protective cover soil. Trained personnel will closely monitor the placement, spreading and compaction of the first layer of waste. Inadvertent damage or suspected damage to the liner system will be immediately reported to Chevron's Construction Manager and restored prior to proceeding with the filling in the damaged area.

To protect the liner system, a dozer will normally be used as the primary spreading and compacting machine for the first lift. The compactor, if used, will only be operated on top of the waste and not on the cell base or on the waste side slopes. The equipment operators will also make sure that no bulky waste or other material, which could damage the liner system is placed as part of the first lift.

3.1.2 Subsequent Lifts

After the first lift is placed properly, normal operating procedures will be used for the second lift and the subsequent lifts. Typical filling procedures and equipment will be used for these lifts. Bulky or rigid wastes may be placed as part of these lifts. The typical operating procedures including truck routing, placing, spreading and compaction of stabilized soils/waste, erosion and sediment control, and general site maintenance activities will be followed during filling of the cells until the final design grades are reached.

3.1.3 Filling Procedures

CAMU cell construction will involve pushing, spreading, and compacting stabilized soils/waste. These tasks will be accomplished with a dozer and/or a compactor. Pushing the stabilized soils/waste is the action of moving the waste from the discharge location in the cell to the working face/area.

Spreading will be done by a dozer. The purpose of the spreading action is to distribute the stabilized soils/waste in thin loose lifts approximately 2 feet in thickness. A high in-place compacted unit weight of the waste can be achieved by spreading the soils/waste in thin layers prior to compaction.

Compaction will be done by a compactor (i.e. vibratory roller) and/or a dozer. Compaction will involve operating the compactor or dozer over the stabilized soils/waste that has been spread in thin layers. Proper compaction of the waste will optimize the airspace in the cells. To maximize compaction of the stabilized soils/waste, the working face and the inside temporary slopes will

be no steeper than 3H:1V. The Contractor will verify the compaction procedures periodically and make necessary adjustments or corrections.

3.2 Cover Soils

3.2.1 Daily Cover

No daily cover will be placed over the stabilized soils/waste.

3.2.2 Intermediate Cover

An intermediate cover consisting of the leveling layer soils (proposed as part of the final cover system) will be applied on waste areas that will be exposed for more than 180 days. The intermediate cover will meet the requirements specified for the leveling layer soils. To conserve soils and maximize filling space, the intermediate cover may be scraped back before filling and compaction of additional stabilized soils/waste on top of the current lift. The materials scraped back will be reused as leveling layer material, if appropriate. The intermediate cover will be graded to shed runoff away from the active working area.

3.3 Maintenance of Roads

The unpaved roads within the cell footprint that are being used for filling operations will be maintained by the Contractor. The Contractor may apply gravel, rock or recycled crushed concrete to the surface of the unpaved roads for maintenance.

3.4 Drainage Features

The drainage features during active life of the cells will include the perimeter swale and the storm water structures that will be located near the leachate sump risers. The drainage features will be routinely inspected. The perimeter swale and the storm water structures will be cleaned of debris as soon as practical after problems are identified to prevent ponding. If the perimeter swale silts up, routine cleaning will be performed to restore the original capacity of the swale. If the storm water structures are damaged, structures will be permanently repaired during dry weather periods. During rainy periods, temporary repairs may be made to prevent further damage to the structures.

3.5 Salvaging/Recycling

Salvaging or recycling of the stabilized soils/waste disposed in the CAMU will be strictly prohibited.

4.0 ENVIRONMENTAL CONTROLS

This section presents the environmental controls, inspection plans, and the recordkeeping requirements that will be followed during active life of the CAMU cells.

4.1 Environmental Control Systems

The purpose and function of each of the major environmental control systems are described below. Specific design details are presented in the Permit Drawings.

4.1.1 Leachate Containment and Control

The CAMU will be equipped with a single-composite liner system, which will direct any liquid that will come in contact with the stabilized soils/waste to a Leachate Collection System (LCS). The LCS in each cell will drain the leachate collected on the liner to two sumps. Leachate in the sump will be pumped to an on-site effluent treatment plant (ETP) or trucked to an offsite facility. The quantities of leachate collected by the LCS will be recorded in gallons per day and maintained as part of the CAMU operating record. Precipitation records obtained from the nearest weather station will be used to compare with leachate generation rates.

4.1.2 Storm Water Controls

During operation of the CAMU cells, the runoff from the side slopes of the stabilized soils/waste will be intercepted using a swale at the perimeter of each cell. The perimeter swale is designed to have an invert width of 5 feet, minimum depth of 3 feet, and a constant invert elevation of 15.5 feet (NGVD). The perimeter swale will direct the storm water runoff (prior to installation of the final cover system) to storm water structures that will be located adjacent to the leachate sump risers. The storm water structures will convey the runoff from the swale directly to the leachate transmission line and pumped along with the leachate. During the active life of each cell, all storm water will be mixed with the leachate and managed (treated and disposed) as leachate.

4.2 CAMU Inspection Plans

4.2.1 Leachate Collection System (LCS)

The LCS will be water pressure cleaned and inspected after construction and prior to placement of any stabilized soils/waste. The pump(s) will be tested in the sump to assure that the system operates properly. Deficiencies will be repaired prior to initiating deposition of waste.

The LCS pumps will be removed and inspected every 2 years. This 2-year inspection will consist of pressure testing of the pump. Pumps located in active areas, or areas without final cover, will be inspected on a monthly basis to confirm normal operation. Additional inspection, preventative maintenance, and checking of the electrical components will be performed in a manner and frequency in accordance with manufacturer's recommendations. The manholes along the leachate transmission line will be inspected monthly for accumulation of leachate in the manhole and to verify integrity of the transmission line.

The electrical controls, pumps, flow meters, valves, and couplings will be maintained at least on a biennial basis (i.e., every two years). In addition, parts that tend to wear out on a regular basis, including bearings on pumps, seals, and gaskets, will be replaced during regular maintenance. After replacing parts, the equipment will be tested to assure proper performance.

4.2.2 Storm Water Control System

Perimeter drainage swales and storm water management structures will be visually inspected monthly or following major storm events. The frequency of dry inspections may be modified as appropriate based on progressive experience with the drainage system, however, in no case will inspections be less frequent than quarterly. Regardless of the inspection frequency, the system will be inspected after a 25-year 24-hour storm event (i.e., more than 6 inches of rain in 24 hour period) or greater storm event.

Perimeter drainage swales and storm water management structures will be cleared of obstructing debris as soon as practical after a problem is identified. If channels become filled with an accumulation of debris or soil, cleaning will be performed to restore original flow capacity.

Erosion control measures will be employed to correct any erosion that causes malfunctioning of the storm water management system. These measures may include use of temporary erosion control mattresses during cell operations and/or construction of berms along the slope crest to prevent runoff from the top of the waste grade.

4.2.3 Intermediate Cover

Areas that have received intermediate cover will be visually inspected periodically for signs of erosion, cracks and depressions due to settlement, and leachate seeps. Areas where waste or geosynthetics have been exposed by erosion will be filled and regraded to minimize any subsequent erosion. Significant depressions (1 ft or more) will be filled with soil, compacted, and regraded to promote positive drainage. If leachate seeps appear in an area with intermediate cover, the seep area will be excavated and backfilled with highly permeable material to promote seepage through the CAMU. The intermediate cover will be reworked to cover the area.

4.2.4 CAMU Inspection Schedule

Monthly	Leachate collection pumps
(Visual)	Surface-water management system
	Cover in completed areas
	Leachate transmission line and manholes
Quarterly	Surface-water control system (or after a 25 year storm event)
Annually	CAMU grades or topographic survey
Biennially	LCS pumps and pipelines
(every 2 years)	LCS flow meters, valves, and risers

4.3 Active Area Controls

4.3.1 Litter Control

The CAMU eligible waste will be effectively managed and not allowed to litter on the haul roads or in the CAMU area (outside the lined footprint). Any waste accidentally littered along the haul roads or in the CAMU area will be immediately picked-up and the area will be cleaned.

4.3.2 Dust Control

Dust control will be practiced during operation of the CAMU by the application of water sprays from a water truck. The frequency of application of water for dust control will depend on site conditions and specific operation being performed. When necessary, water will be sprinkled on all heavily used roads. The haul roads and the cell access ramp will be regularly sprayed to control dust when required.

4.4 Recordkeeping

An operating record will be maintained at the Facility including all records, reports, analytical results, notifications; construction, operation, and closure permits, including all modifications to those permits, along with the engineering drawings and supporting information.

As part of the operating record, waste records will be maintained. These waste records will indicate the amount of waste disposed in the CAMU and will be used to estimate the remaining life and capacity of the constructed cell and remaining life and capacity of the cells yet to be constructed.

5.0 EMERGENCY CONTINGENCY PLAN

The Facility maintains an emergency contingency plan, which will be followed in case of an emergency such as fire, accident or injury, release of contamination to the environment, etc. This

section identifies emergencies that are specific to the CAMU and may not be covered in the Facility's emergency contingency plan.

5.1 Ineligible Waste

Only CAMU eligible waste shall be disposed in the CAMU. In the event, ineligible or unacceptable waste is disposed in the CAMU, Chevron Construction Manger will be immediately notified. The source of the ineligible waste will be determined and the waste will be removed from the CAMU and transported to an appropriate disposal facility.

5.2 Inclement Weather

5.2.1 Operation in Wet Weather

Problem		Solution
Saturated Unloading Area	1)	Stockpile well-drained soil and apply as necessary.
	2)	Keep compactors off area; use dozers on unloading area. Unload and push waste perpendicular to area.
	3)	Grade unloading area slightly to shed runoff.
Mud Carried Onto Haul Roads	1)	Carefully scrape mud from the haul roads and dispose in CAMU.
	2)	Provide clean rock dressing to internal road and cell access ramp.

5.2.2 Preparation for Inclement Weather

The following preparations will be made for inclement weather:

- Access roads to the CAMU will be maintained as necessary. These roads will be maintained in a serviceable condition with the use of the available equipment on site, such as grader, water truck, dozer and loader. Major repairs will be scheduled, if required.

- Drainage structures, ditches, and sediment control will be checked to ensure that they are in good condition and free of significant debris prior to anticipated heavy rains.

- Temporary drainage control including temporary berms, erosion control mattresses or cover materials may be used in emergency situations.

- All machines and equipment shall be parked close together at ground level, i.e., off the top of the CAMU.

- After a severe weather event, clean-up will be performed (as needed) and inspection of all major systems will be performed prior to resuming limited or complete operations.

5.3 Problems Affecting the Leachate Collection System

5.3.1 Interruption of Power Service to the CAMU

In the event that the main power service to the CAMU is interrupted for more than 24 hours, the active CAMU cells (cells without the final cover) will be switched over to a secondary power supply system consisting of diesel generators. Switching over to a secondary power supply will allow the leachate collection and removal systems to continue operating.

5.3.2 Interruption of Flow to ETP

In the event that leachate flow to the on-site ETP is temporarily interrupted, the leachate will be stored in the active cell(s). If the system cannot be restored within a reasonably acceptable period of time, leachate will be pumped directly from the sump into tanker trucks and trucked offsite for disposal.

5.3.3 Leachate Sump Alarm Level Switch

An alarm level switch will be installed in the primary sumps to notify the operator in the event that leachate levels in a sump reaches this level. The intent of the alarm is to notify the operator of a potential problem with the leachate management system. The alarm will indicate that the leachate pumps have stopped working, or the pump capacity has been exceeded, or there is possible blockage in the leachate transmission line. The operator shall examine the leachate management system to determine the cause of the leachate build-up and to troubleshoot the problem.

APPENDIX I

LEACHATE AND GROUND WATER MONITORING PLAN

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1.0 INTRODUCTION

Chevron Environmental Management Company (Chevron) has submitted a Corrective Measures Study (CMS) Report for the Chevron Perth Amboy Facility (hereafter referred to as the Facility – Figure I-1) in which a Corrective Action Management Unit (CAMU) was proposed to manage remediation wastes that will be generated during the implementation of various corrective actions at the Facility (40 Code of Federal Regulation [CFR] 260.10). The Facility is located at 1200 State Street in Perth Amboy, New Jersey, and is divided into three areas: Main Yard, Central Yard, and East Yard (Figure I-2). This document presents the Leachate and Ground Water Monitoring Plan (LGMP) that will be implemented during the operation and after closure of the CAMU in accordance with the federal CAMU regulation (i.e., 40 CFR 264.552 [e][5] and [e][6]). .

The Facility has received a Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) Permit Renewal (USEPA ID No. NJD081982902) which is effective on September 3, 2013. The proposed CAMU was approved by USEPA as part of the HSWA Permit Renewal. Federal regulations authorize the USEPA Regional Administrator to designate one or more areas of a RCRA-regulated facility as a CAMU (40 CFR 264.552).

As discussed in the CAMU Application, Revision 2.0 (Chevron, 2011) and Final Design Report (CAMU FDR) for the CAMU (Chevron, 2012), the proposed CAMU area is located in the Facility's Main Yard as a permanent disposal repository for remediation wastes (such as contaminated soil and debris) from corrective measures performed by Chevron under the RCRA Corrective Action Program. Chevron presented a general approach for the ground water monitoring in the 2011 CAMU Application and indicated that a LGMP will be submitted with the CAMU FDR. This LGMP also presents a statistical evaluation of existing background ground water quality of the proposed CAMU area and recommends statistical limits of principal constituents of concern (PCOCs) and other key constituents that will be used to evaluate if a leak is occurring from CAMU during the leak detection monitoring program.

1.1 Site History

1.1.1 Operational History

Chevron purchased the Facility in 1946 from Barber Asphalt Company, which had owned and operated the Facility since 1911. The Facility operated as a full-scale petroleum refinery from 1946 to 1983, producing liquefied petroleum gas, gasoline, fuel oil, and asphalt. In 1983, Chevron reduced its operations to refining asphalt and continued petroleum storage operations. Chevron recently transferred the ownership of most of the Facility to Buckeye Perth Amboy Terminal, LLC, along with the petroleum operations. Chevron continues to retain ownership of the parcel which will contain the CAMU. A more detailed description and history of the Facility can be found in the CMS, and historical use of the proposed CAMU area is discussed in Section

2.1 of this document. The Facility is primarily located in the industrial zone of Perth Amboy and is bounded to the east by the Arthur Kill (Figure I-1). A small portion of the Facility extends into Woodbridge Township.

1.1.2 Regulatory History

The Facility has received a RCRA HSWA Permit Renewal (USEPA ID No. NJD081982902). The HSWA Permit contains Corrective Action Requirements pursuant to Section 3004(u) of the HSWA. Chevron submitted a CMS to the USEPA and the NJDEP that proposed various corrective measures for 45 SWMUs and 49 AOCs, including a CAMU area at the Facility. Chevron also received an approval of the CAMU application as part of this HSWA Permit.

Chevron submitted an original CAMU Application, Class-3 Permit Modification Request (PMR), to USEPA and NJDEP. USEPA/NJDEP issued comments and requested that monitoring requirements for ground water be presented in the CAMU Application. Chevron modified the February 2009 CAMU Application PMR and proposed 6 locations for ground water monitoring, and submitted a modified CAMU Application, Revision 1.0 to USEPA and NJDEP on December 3, 2010. On June 1, 2011, NJDEP issued comments on the December 2010 CAMU Application pertaining to ground water monitoring. USEPA issued comments on July 25, 2011 for the remaining sections (i.e., not for ground water monitoring) of the application.

NJDEP made the following requests related to ground water monitoring in its June 2011 comment letter:

- Installation of additional monitoring wells and quarterly monitoring of ground water for a period of 2 years to establish baseline contamination in the proposed CAMU area, prior to placing any contaminated material in the CAMU (New Jersey Administrative Code [N.J.A.C.] N.J.A.C. 7:14A-10.1[b] and N.J.A.C. 7:14A-10.12);
- Provision of analytical parameter lists for the detection monitoring program (N.J.A.C. 7:14A-10.11); and
- Determination of the ground water flow direction to facilitate identification of background and compliance monitoring wells (NJAC 7:14A-10.9[a]).

Chevron submitted responses to USEPA and NJDEP comments and presented a ground water monitoring program in the revised CAMU Application, Revision 2.0, dated September 8, 2011. In the 2011 CAMU Application, Chevron proposed quarterly monitoring for a period of one year at six clustered (i.e., paired) monitoring wells for volatile organic compounds (VOCs), semi-VOCs (SVOCs), and metals. In addition, Chevron identified three well clusters (#1, 5, and 6) as background/upgradient and the remaining three clusters (#2, 3, and 4) as compliance/downgradient monitoring wells as indicated below:

- Upgradient/Background wells
  - Cluster # 1 – MW-114/MW-115
  - Cluster # 5 – MW-322/MW-323
  - Cluster # 6 – MW-233/MW-328
- Downgradient/Compliance wells
  - Cluster # 2 – MW-324/MW-325
  - Cluster # 3 – MW-0057/MW-326
  - Cluster # 4 – MW-120/MW-327

A copy of the 2011 CAMU Application and Chevron's responses to USEPA and NJDEP comments are included on the CD in Attachment A-1.

NJDEP approved the proposed ground water monitoring approach on August 1, 2012 and requested that well cluster # 1 (i.e., MW-114 and MW-115) be included on the site map. Figure I-3 depicts the locations of the six monitoring well clusters.

1.2 Regulatory Requirements – Ground Water Monitoring

Federal regulations applicable to the CAMU include 40 CFR 264.550 through 264.552, as discussed in the 2011 CAMU Application. These regulations provide requirements for the applicability, definition, design, construction, and use of a CAMU for management of remediation waste during the implementation of a RCRA corrective action. NJDEP does not have regulations pertaining to a CAMU constructed as part of a RCRA corrective action in New Jersey. However, New Jersey Pollution Discharge Elimination Systems (NJPDES) Rule N.J.A.C. 7:14A Subchapter 10 (NJAC 7:14A-10) pertains to ground water monitoring requirements for hazardous waste landfills. The detection ground water monitoring provisions found in NJAC 7:14A-10 have been used as guidance in the preparation of this monitoring program. This regulation was also referenced by NJDEP in their comment letter dated June 2011.

It is noted that 40 CFR 264.552(e)(5) states that a ground water monitoring program is required to detect and to characterize releases of hazardous constituents to ground water from sources located within a CAMU. However, no detailed guidance on the requirements for a ground water monitoring program is included in 40 CFR 264.552. Chevron has used 40 CFR 264.90 through 40 CFR 264.101 and NJAC 7:14A-10 as guidance in preparing the proposed detection ground water monitoring portion of this Plan. A comparison between the requirements included in NJAC 7:14A-10 and 40 CFR 264.90 through 40 CFR 264.101 indicates no major differences in the ground water monitoring, detection, or compliance monitoring requirements for a CAMU-related discharge to ground water.

1.3 LGMP Objectives

The primary objective of the leachate and ground water monitoring program is to provide the data needed to determine if a leak may be occurring from the CAMU. As discussed in the 2011 CAMU Application, this LGMP is developed to:

- Present a leachate monitoring plan that will assist in evaluation of leachate quality generated from each cell of the CAMU;
- Present a plan to monitor the ground water quality upgradient, crossgradient, and downgradient of the proposed CAMU area that will be used during the leak detection monitoring program;
- Establish the current baseline ground water quality conditions;
- Present ground water quality monitoring requirements during the operation and post-closure periods; and,
- Identify compliance point(s) that will be used to monitor ground water quality.

The success of the leak detection monitoring strategy for the CAMU is dependent upon understanding how a leak might occur from the CAMU, and documenting pre-existing background concentrations within the CAMU area and at the compliance point(s). If evidence of contamination from CAMU-related waste is identified in ground water at the compliance point(s), it may trigger a compliance monitoring programs discussed in NJAC 7:14A-10.13.

2.0 BACKGROUND

2.1 CAMU Area Historical Use

Three above ground storage tanks (ASTs - Tanks 312, 313 and 318) were historically located within the CAMU footprint and have been demolished (Figure I-3). Tank 312 historically held sodium hydrosulfide (NaHS) (spent caustic) and Rheniformer feedstock. Tank 313 historically held gasoline, No. 2 fuel, jet fuel, and NaHS. Tank 318 historically held gasoline blend stock (light cycle oil), No. 2 fuel and NaHS. Tank 329 located south of CAMU footprint historically held light cycle fuel, which is a middle distillate product. Tank 308 located southwest of the CAMU footprint historically held Rheniformer feedstock and a blend of aliphatic hydrocarbons. A pump station was located roughly equidistant from Tanks 308, 312, and 329. The pump station has been removed.

2.2 Subsurface Geology/Hydrogeology

The overburden within the CAMU footprint generally consists of fill underlain by native peat/organic clays (meadow mat), clay with sand, and then till. The thickness of the fill layer ranges approximately from 6 to 12 feet (ft) and consists of sand and clay with gravel and occasional layers of fly ash and/or catalyst beads. Layers of fly ash and/or catalyst beads were

observed from 2 to 8 ft below ground surface (bgs) in several borings and test pits. Odors and dark liquid globules were observed predominantly within the fly ash layers. The thickness of native meadow mat ranges from 2 to 9 ft, and was observed to decrease from northeast to southwest in the CAMU area.

Ground water was observed within the fill layer at depths ranging from 2 to 7 ft bgs during test pit excavation, and at depths ranging from 0.5 to 2 ft bgs in the monitoring wells located within the CAMU footprint. The native meadow mat provides hydraulic isolation between the shallow water-bearing zone and the native water-bearing zone within the CAMU footprint. General ground water flow in this area is to the northeast towards Woodbridge Creek. The hydraulic conductivity of the fill material was estimated to be $1x10^{-6}$ centimeters per second (cm/sec) at MW-116R using a bail down test conducted during previous studies. The lateral hydraulic gradient for ground water flow ranges from 0.007 to 0.07 ft/ft with an average gradient of 0.02 ft/ft.

The low permeability of the fill material and low lateral hydraulic gradients results in a medium to low seepage velocity for shallow ground water. An upward vertical hydraulic gradient between the fill layer and the till at monitoring well pair RW-02/MW-240 ranged from 0.03 to 0.14 ft/ft. The gradients are based on ground water elevation data collected during quarterly gauging events between 2009 and 2011. The potentiometric surface contour maps for the quarterly gauging events completed during the years 2009, 2010, and 2011 are presented on the CD included in Attachment A-1**.**

2.3 Historical Environmental Investigations in CAMU Area

2.3.1 Soil

During the historical investigations, soil samples were collected from various soil borings located within the CAMU footprint. Analytical results for four PCOCs were compared to the soil criteria established in the CMS (Chevron, 2009). The soil criteria for the four PCOCs are listed below:

- Benzene – 13 mg/kg
- Benzo[a]pyrene – 10 mg/kg
- Arsenic – 20 mg/kg
- Lead – 800 mg/kg

Exceedances of the above-listed CMS soil criteria in the soil borings located within the CAMU footprint are discussed below.

- 27 soil samples (18 from the vadose zone) were collected for VOC analysis from 16 soil borings. Benzene was either not detected or detected below the CMS criterion in the soil

samples collected from the vadose zone except at soil boring S2173 (28 mg/kg at 8-8.5 ft bgs).

- 34 soil samples (27 from vadose zone) were collected for SVOC analysis from 20 soil borings. Benzo[a]pyrene was detected slightly above the CMS criterion in the soil sample collected from the vadose zone at soil boring S2588 (12J mg/kg at 8-8.5 ft, bgs). Benzo[a]pyrene was not detected in the sample collected from 12.5-13 ft bgs.
- 3 surface soil samples (0-2 ft bgs) were collected for metals analysis from 3 soil borings. Arsenic was not detected above the CMS criterion of 20 mg/kg.
- 21 soil samples (12 from the vadose zone) were collected for metals analysis from 12 soil borings. Lead was not detected above the CMS criterion of 800 mg/kg.

The soil quality data described above are illustrated on Figure I-4. In addition, light nonaqueous-phase liquid (LNAPL) was detected in the southwest side of the proposed CAMU area in the vicinity of the oily water sewer system. Soil containing LNAPL was recently removed from this area. The extent of the excavation is shown on Figure I-5.

2.3.2 Ground Water

As part of historical investigations, compounds present in ground water that exceeded NJDEP Ground Water Quality Standards (GWQS) were identified. These compounds were listed in Table 2 of the CAMU Application and were used to determine compounds detected above GWQS. The dissolved phase ground water plume included areas of contiguous exceedances in ground water of chemicals that are related to historic Facility operations. The historical analytical results for ground water are included in Tables I-1 through I-3. Benzene was identified as the most widely distributed compound in ground water at the Facility. The extent of the benzene plume in groundwater in the CAMU area is generally representative of the maximum extents of the other site-related ground water PCOCs in this area (Chevron, 2011). As established in the CMS report, monitored natural attenuation (MNA) will be implemented for ground water containing benzene concentrations between 1 microgram per liter (µg/L) and 100 µg/L.

Since 2001, ground water samples have been collected from monitoring wells located within the CAMU footprint (MW-116R, MW-210, MW-211, MW-269, MW-315 and NF-11), upgradient of the CAMU footprint (MW-2, MW-114, MW-115, MW-233, MW-234, MW-240 and MW-262), cross-gradient of the CAMU footprint (MW-20 and MW-120), and downgradient of the CAMU footprint (MW-0057) (Figure I-6). The following observations are based on the analytical results:

- Sporadic exceedances for aluminium, aluminum, antimony, barium, cadmium, chromium, cobalt, iron, manganese, mercury, selenium, silver, sodium, thallium were

detected above their respective GWQS in the monitoring wells located within the CAMU footprint.

- SVOCs were not detected within the CAMU footprint, or were detected below the NJDEP GWQS.
- For the monitoring wells located within the CAMU footprint, benzene concentrations in MW-116R, MW-234 and NF-11 were less than 100 µg/L, and benzene was detected at 84 µg/l and 120 µg/l in MW-315. Benzene concentrations were below the NJDEP GWQS in MW-210, MW-211, and MW-269.
- For the shallow monitoring wells upgradient of the CAMU footprint, benzene was not detected in MW-262; was generally not detected in MW-2 and MW-114; and was detected at 88 µg/L to 200 µg/L in RW-02 and at 280 to 1,400 µg/L in MW-233.
- Benzene was not detected in deep monitoring wells MW-115 and MW-240 located upgradient of the CAMU footprint.
- Benzene was detected below the NJDEP GWQS in cross-gradient monitoring wells MW-20 and MW-120.
- Benzene was not detected in downgradient monitoring well MW-0057.

2.4 Current Ground Water Monitoring Program in CAMU Area

As discussed in the 2011 CAMU Application, Chevron is currently conducting quarterly ground water monitoring of the six monitoring well pairs (12 wells total) to evaluate the baseline ground water quality. These six well pairs are:

- Upgradient/Background wells
  - Cluster # 1 – MW-114/MW-115
  - Cluster # 5 – MW-322/MW-323
  - Cluster # 6 – MW-233/MW-328
- Downgradient/Compliance wells
  - Cluster # 2 – MW-324/MW-325
  - Cluster # 3 – MW-0057/MW-326
  - Cluster # 4 – MW-120/MW-327

The above wells are sampled for Targeted Compound Lists (TCL) VOCs, TCL SVOCs, and targeted analyte lists (TAL) metals.

3.0 PROPOSED LEACHATE AND GROUND WATER SAMPLING PLAN

The following sections outline a proposed leachate and ground water monitoring plan utilizing existing information, the guidelines established in the 2011 CAMU Application, and NJAC 7:14A-10.

3.1 Leachate Monitoring Plan

The proposed CAMU will be constructed in a phased approach and will be divided into three cells. As discussed in the 2011 CAMU Application, a composite liner and a leachate collection system (LCS) have been designed to meet the minimum design requirements of 40 CFR 264.552[e][3]. The CAMU composite liner system will underlie the waste materials, providing a barrier to the underlying native soils and ground water, and includes bottom and sidewall liner system components. For leachate to enter into the ground water, a composite liner breach must occur, and there must be sufficient hydraulic head to cause the leachate to migrate through the breached liner and into ground water.

In order to meet the objectives described in Section 1.2 and to facilitate early detection of a potential release from the CAMU into the shallow water-bearing zone, the following leachate monitoring program elements have been identified:

- Leachate volume monitoring, and
- Leachate sample collection and analysis.

These elements are further discussed below.

3.1.1 Leachate Volume Monitoring

Leachate volume will be monitored on a continuous basis using flow totalizers. This quantity will be recorded continuously and will be trended to provide an indication of changes in the volume of leachate being generated.

3.1.2 Leachate Sample Collection and Proposed Analytical Parameters

As discussed in the 2011 CAMU Application, Chevron will conduct quarterly sampling of any leachate generated from the stabilized soils/waste concurrently with the CAMU ground water monitoring events (Section 3.2). The leachate samples will be collected from a sampling port located at the discharge side of each sump pump. The leachate will be analyzed for following parameters:

- Target compound list (TCL) VOCs
- TCL SVOCs
- Target analyte list (TAL) Metals
- Ammonia - Nitrogen
- pH and dissolved oxygen (i.e., water quality parameters)

The above-listed parameters were selected based on the nature of the waste material that will be placed in the CAMU and the proposed analytes for the ground water monitoring program. The proposed leachate monitoring program is summarized in Table I-5.

Prior to sample collection, the volume contained in each sump will be estimated in order to determine whether sufficient volume is present for the full suite of analyses. Based on anticipated sample volume requirements, approximately 1 gallon of leachate will be required for the above-listed analytical parameters. The water quality parameters will be analyzed in the field using an appropriate direct-reading meter. Samples for TCL VOCs, TCL SVOCs, TAL Metals and Ammonia-Nitrogen will be sent to a laboratory certified by the State of New Jersey for analyses under chain-of-custody procedures. Results of analytical testing will be provided to USEPA/NJDEP during routine reporting as specified in Section 4.

3.2 Ground Water Sampling Plan

As per 40 CFR 264.552[e] [5], a ground water monitoring program is required for the CAMU to detect any release of constituents from the CAMU into the shallow water-bearing zone (i.e., into ground water). The objective of the ground water leak detection monitoring program for the CAMU area is to determine whether a specific chemical compound or hazardous constituent detected in ground water is indicative of a leak from the CAMU. In order to achieve this objective and comply with applicable regulatory requirements, the following ground water monitoring program elements have been identified:

- Establish baseline quality of ground water beneath the CAMU area;
- Monitor ground water quality upgradient, crossgradient, and downgradient of the CAMU; and
- Identify compliance well(s).

Chevron established a ground water monitoring plan in the 2011 CAMU Application and proposed to monitor six clusters of monitoring wells (i.e., 12 monitoring wells total) to monitor ground water quality in the fill unit (i.e., uppermost water-bearing zone) and underlying glacial till. The locations of the 12 monitoring wells are shown on Figure I-7.

3.2.1 Baseline Ground Water Quality

As discussed in NJAC 7:14A-10.1(b), the baseline ground water monitoring program for the CAMU should provide adequate data over a sufficient period of time to accurately represent ground water quality and the magnitude and direction of hydraulic gradients in the CAMU area. As discussed in the 2011 CAMU Application, Chevron proposed one year of quarterly, baseline monitoring of ground water to support statistical evaluation of baseline concentrations using the methodology presented in the document titled *Statistical Analysis of Ground water Monitoring Data at RCRA Facilities, Unified Guidance* (Unified Guidance) (USEPA, 2009).

A statistical evaluation was conducted for the ground water data of the proposed CAMU area in accordance with methods described in NJAC 7:14A-10 and 40 CFR 264.552. The prediction interval procedure was used in the statistical evaluation and this statistical method was used for

data evaluation based on the *Unified Guidance*. A technical memorandum is included in Attachment I-2 which presents following:

- Proposed PCOCs for the leak detection monitoring program
- Proposed background 99% Upper Prediction Limit (UPLs) for PCOCs and 14 constituents in the CAMU area
- Results of the statistical evaluation
- Conclusions and recommendations

The proposed UPLs for the PCOCs are below and are also provided in Attachment I-2 (Table IA2-3).

- Arsenic – 133 µg/L
- Benzene – 23 µg/L
- Benzo(a)pyrene – reporting limit
- Lead – 33.1 µg/L

The above UPLs were derived based on historical monitoring data for all wells in the shallow water-bearing zone in the vicinity of the proposed CAMU. The above UPLs were calculated at 99% confidence for the uppermost water-bearing zone. The above UPLs will be used to compare the future ground water sampling results that will be generated as part of the leak detection monitoring program.

3.2.2 Proposed Ground Water Sampling Program

In accordance with NJAC 7:14A-10.11, the ground water monitoring program shall consist of a sufficient number of wells that (i) represent the quality of baseline ground water that has not been affected by leakage from the CAMU; (ii) represent the quality of ground water passing the relevant point(s) of compliance; and (iii) allow detection of COCs that has potential to migrate from the CAMU to the uppermost water-bearing zone (i.e., fill unit). The following six cluster well locations were proposed for ground water monitoring in the 2011 CAMU Application:

- Upgradient/Background wells
  - Cluster # 1 – MW-114/MW-115
  - Cluster # 5 – MW-322/MW-323
  - Cluster # 6 – MW-233/MW-328
- Downgradient/Compliance wells
  - Cluster # 2 – MW-324/MW-325
  - Cluster # 3 – MW-0057/MW-326
  - Cluster # 4 – MW-120/MW-327

Table I-4 provides construction information for the above wells and other monitoring wells (MW-333, MW-211, MW-334 and NF-11) that are located in the CAMU area. In order to meet the objectives and the sequence of CAMU construction, Chevron reviewed ground water quality

data, the geology and hydrogeology of the CAMU area, and the monitoring design basis established in the 2011 CAMU Application in order to select an appropriate and protective monitoring well network, monitoring frequency, and analytical suite.

It is expected that the three CAMU cells will be constructed using a phased approach with Cell 1 and associated sumps installed first before Cells 2 and 3. Therefore, it is likely that monitoring well MW-210 (Figure I-3) will be removed prior to Cell 1 construction. It is likely that monitoring wells located downgradient of Cell 1 will be useful to evaluate the leak detection until the Cell 2 is constructed. Considering this, Chevron is proposing to use three monitoring wells (MW-211, MW-333, and MW-334) for ground water monitoring for the CAMU area until all cells are constructed and the entire CAMU is closed. Chevron will monitor the following monitoring wells on a quarterly basis.

- Upgradient/Background wells
  - Cluster # 1 – MW-114/MW-115
  - Cluster # 5 – MW-322/MW-323
  - Cluster # 6 – MW-233/MW-328
- Downgradient/Compliance wells
  - Cluster # 2 – MW-324/MW-325
  - Cluster # 3 – MW-0057/MW-326
  - MW-211, MW-333 (until Cell 2 is constructed)
  - MW-334 (until Cell 3 is constructed)
- Crossgradient Wells (Long-term monitoring)
  - Cluster # 4 – MW-120/MW-327

Sampling of above upgradient/background wells will assist in understanding of the ground water background quality of the CAMU area. Please note that MW-120 and MW-327 monitoring wells (i.e., Cluster # 4) were identified as compliance/downgradient wells in the 2011 CAMU Application. These two wells were proposed as downgradient wells for the short term when the CAMU is in operation. Once the remediation waste is placed in the CAMU, it has potential to change ground water flow direction (due to compression of soils beneath the CAMU) for a short term. Once the equilibrium condition is established after placement of the waste, it is expected that ground water flow may return to its original condition. Additionally, a review of the ground water contour maps indicate that these two wells are located cross-gradient of the CAMU area and cannot be considered as downgradient wells for the long-term monitoring program. Therefore, Chevron will refer to these wells as crossgradient wells for the long-term monitoring program.

Of the remaining wells proposed for leak detection monitoring, Chevron is proposing MW-324 and MW-0057 (shallow zone) as compliance monitoring wells as discussed in NJAC 7:14A-10.9. In accordance with NJAC 7:14A-10.9, the compliance point should be located on

Chevron's property, hydraulically downgradient of the CAMU, and within 150 meters (approximately 500 ft) of the CAMU boundary. Therefore, based on the ground water flow direction in the CAMU area, Chevron is proposing MW-324 and MW-0057 as compliance point(s) because they are located between the CAMU boundary and the Facility boundary. The closest downgradient well to the edge of CAMU Cell 3 that is screened in the uppermost aquifer is MW-324 (approximately 15 feet north of the CAMU boundary). The next closest downgradient well to the edge of CAMU cell 3 is MW-0057 (approximately 25 feet east of the CAMU boundary). Using an estimated average seepage velocity of 0.4 ft/day, a constituent released from the edge of the CAMU Cell 3 has a potential to detect within a three month timeframe.

Based on our current understanding of the behavior of constituents upgradient and beneath the CAMU Area, Chevron proposed the following monitoring frequencies during the leak detection monitoring program for the wells that are located upgradient, corssgradient, and downgradient of the CAMU area:

1. The six monitoring well clusters identified in the 2011 CAMU Application and listed above will be sampled on a quarterly basis for at least two years after initiation of waste disposal in Cell 1. The frequency of monitoring will be revisited after analyzing two years of monitoring data. The ground water samples from the monitoring wells will be collected concurrently with the CAMU leachate samples (Section 3.1).
2. Three wells (MW-211, MW-333, and MW-334) located within the CAMU area will be sampled on a quarterly basis after Cell 1 is complete and being filled. Since MW-327 is screened in a deeper (glacial till) unit, it will be sampled on an annual basis.

The proposed ground water monitoring program is summarized in Table I-6.

3.2.3 Proposed Analytical Parameters

In the 2011 CAMU Application, Chevron proposed one year of quarterly monitoring at six monitoring well clusters for the following parameters:

- Field Parameters - Ground water elevation, pH, specific conductance, temperature, turbidity
- Laboratory Parameters - TAL metals, TCL VOCs including tentatively identified compounds (TICs), and TCL SVOCs.

As discussed in Section 1.3, Chevron is currently conducting quarterly monitoring of ground water quality in selected wells in the CAMU area. The ground water samples are being analyzed for the parameters listed above and ammonia-nitrogen for the period of one year.

For QA/QC purposes, field duplicates and matrix spike/matrix spike duplicate samples will be collected for and analyzed for VOCs, SVOCs and metals at a frequency of 1 per every 20 primary ground water samples. One ambient field blank sample will be collected per each day throughout the sampling event, and one trip blank sample will be submitted in each sampling cooler that contains VOC samples.

3.3 Ground Water Sample Collection Procedure

Prior to the start of each ground water sampling event, the depth to ground water and LNAPL (if present) in each well will be measured and recorded prior to well purging using an interface probe. Measurements will be taken in as short amount of time as possible to obtain an accurate "snapshot" of ground water elevations and minimize the impact of temporal (within one field day) fluctuations in ground water levels. Ground water elevations will be utilized to prepare a potentiometric surface map, indicating flow direction and gradients.

Detailed procedures for collection of ground water samples are described in the CMI Field Sampling and Analysis Plan (FSP) and Quality Assurance Project Plan (Chevron, 2013). Facility specific low-flow ground water sampling techniques described in CMI FSP will be used to obtain the most representative ground water samples possible. Low-flow techniques are used to minimize volatilization, turbidity, waste generation, and potential exposure of the sampling crew to contaminated purge water. Field parameters will be recorded until stabilization has occurred. After field parameter stabilization, the pump discharge tubing will be detached from the flow-through cell, and the sample containers will be filled directly from the tubing.

To ensure a representative sample, the pump intake position will remain constant throughout the sampling process. The sampling flow rate will not exceed the purging flow rate. The pump bladder (if using a submersible bladder pump) and tubing will be disposed of after use at each sample location to minimize the possibility of cross contamination.

3.4 Decontamination

To minimize cross contamination, all field equipment (e.g., electronic water level indicator, interface probe, submersible pump) will be washed using Alconox® detergent and rinsed with de-ionized water. The equipment will be allowed to air dry prior to re-use. Disposable equipment (e.g. pump tubing, bladders) will be discarded in accordance with the Facility Waste Management Plan (WMP; Parsons, 2012) and will not be reused.

3.5 Investigation Derived Waste

Waste generated during this project will be managed and disposed in compliance with applicable state and federal regulations and in accordance with the Facility WMP. The leachate generated

will primarily be pumped to the on-site effluent treatment plant (ETP). The following types of waste are anticipated:

- Decontamination and purge water - Decontamination and purge water will be generated during equipment cleaning and ground water sampling.
- Used personal protective equipment (PPE) and disposable sampling equipment - Small quantities of used PPE and disposable sampling equipment will be generated during field activities.
- General refuse – site activities will result in generation of general refuse such as paper towels and plastic bags.

3.6 Monitoring Well Maintenance

To ensure that wells selected for approved remedy monitoring are available and remain in good operating condition for the long-term, it is necessary to have an effective maintenance program in place. It is important that the structural integrity of the monitoring well casing, seals, and well cap be maintained to prevent surface water from entering the monitoring well.

To avoid surface runoff entering the subsurface via site monitoring wells and to ensure that site wells remain in good condition, exterior maintenance checks are necessary. A monitoring well inspection checklist (see Attachment I-1) has been developed for visual inspection of the exterior of the monitoring wells to identify such potential problems as: 1) cracked or corroded well casings; 2) broken or missing well caps or locks; 3) damage to protective casings; and 4) settling and cracking of surface seals.

If necessary repairs to monitoring wells are not minor (e.g., replacement of a well cap, lock, bolts, or cover), then a NJ-licensed well driller will complete the work.

4.0 DATA MANAGEMENT, ANALYSIS AND REPORTING REQUIREMENTS

4.1 Data Management

As part of the HSWA permit, a site-specific Data Management Plan (DMP) was prepared that is intended to serve as a general standard and guideline for all data management practices (Parsons, 2011). This DMP establishes procedures to manage the collected data.

The data management process includes procedures necessary to track laboratory analytical data and data validation status, consistent and timely production of electronic data deliverables (EDDs) from participating laboratories, and accurate and timely entry of EDDs into the Environmental Information Management (EIM) Database. The EIM database is a computerized database management system that will be employed to manage and organize the large amounts of

field and analytical data that will be generated during the life-cycle of the CAMU monitoring program.

4.2 Documentation Reporting Requirements

Parsons will document field activities in field log books dedicated to the CAMU. A field sampling record of information collected during each sampling event will be developed to provide information needed to analyze and assess the results of the fieldwork. Information will be recorded in a field notebook to document the procedures used and the prevailing conditions during field sampling activities. Sampling records will be labeled and recorded in a consistent manner to facilitate future data analysis. For each sample collected, the following information will be provided:

- Name of sampler
- Purpose of sampling
- Date and time of sampling
- Sample type
- Sampling location name and description
- Sampling method, sample containers, and preservatives used (if applicable)
- Sample weight or volume
- Unique sample identification number
- Field observations (prevailing weather conditions and other relevant factors that might influence sample integrity)
- Field measurements conducted

During the leak detection monitoring program, Chevron will conduct evaluation of a statistically significance evidence of a PCOC release after each quarterly groundwater sampling. If there is evidence of a PCOC release based on the statistical test and confirmed by resampling, Chevron will notify USEPA within 30-days of the release.

Reports summarizing annual activities for the CAMU monitoring program will be submitted annually to USEPA and NJDEP. At a minimum the annual monitoring reports will include:

- Summary of activities performed since the previous report
- Volume of leachate generated
- Quality of leachate
- Ground water contour maps
- Ground water quality data
- Inspection and preventative maintenance check lists for monitoring wells
- Required and implemented repair, replacement, and rehabilitation activities

- Leak Detection monitoring results and comparison against the background UPLs for PCOCs (Table IA2-3 in Attachment I-2) including data collected since the previous report, and a cumulative presentation (in tabular form) of all data collected to date.

The annual report will also include evaluation of the monitoring data and will, if appropriate, propose necessary corrective actions or recommended optimizations to the monitoring program.

5.0 REFERENCES

- Chevron. 2003. Full RCRA Facility Investigation (RFI) Report. November.
- Chevron. 2008. Corrective Measures Study Report for the Main Yard, East Yard and Central Yard, prepared by URS Corporation, November.
- Chevron. 2008. Supplemental RCRA RFI Report. Prepared by SAIC, February.
- Chevron. 2010. Draft Conceptual Site Model Report. Prepared by SAIC, October.
- Chevron 2011a. CAMU Application, Revision 2.0. Prepared by TRC, September.
- Chevron. 2011b. Data Management Plan. Prepared by Parsons, October.
- NJDEP. 2009. New Jersey Pollutant Discharge Elimination System (NJPDES). NJAC 7:14A-10. Updated January 5.
- NJDEP. 2012a. Technical Requirements for Site Remediation (TRSR). NJAC 7:26E. May 7.
- NJDEP. 2012b. Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C. May 7.

APPENDIX I

TABLES

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-0057**																**MW-114**	
Sample Date		10/30/2002	09/28/2004	06/07/2005	11/02/2005	05/31/2006	12/01/2006	06/05/2007	07/31/2008	05/18/2009	06/08/2010	08/18/2011	03/13/2012	05/23/2012	05/24/2012	07/25/2012	07/26/2012	10/17/2002	02/10/2003
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U	3U			3U			3U	3U	3U	3U	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U	3U			3U			3U	3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U			3U			3U	3U	3U	3U	3U	3U	3U
Acetone	6000	6U	6U	6U	18J	6U	6U			6U			6U	6U	6U	6U	6U	6U	6U
Benzene	1	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Methyl acetate	7000	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5J	0.5U	0.5U	0.5U	0.5U	0.5U			0.5U			0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U			2U			2U	2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U			1U			1U	1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-114**																	**MW-115**
Sample Date		09/10/2003	05/18/2004	09/22/2004	05/25/2005	10/26/2005	05/24/2006	11/09/2006	06/01/2007	07/30/2008	05/08/2009	04/29/2010	07/20/2011	03/16/2012	05/14/2012	05/15/2012	07/24/2012	07/25/2012	10/22/2002
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1J
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	3U
Acetone	6000	6U	6U	6U	6U	6U	6U	6U						6U	6U	6U	6U	6U	6U
Benzene	1	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	**[6]**
Bromoform	4	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	24
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1J
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Methyl acetate	7000	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U						0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-115**														**MW-120**			
Sample Date		02/26/2003	09/09/2003	07/31/2008	11/06/2008	11/06/2008	05/08/2009	11/06/2009	04/29/2010	07/20/2011	03/16/2012	05/14/2012	05/15/2012	07/24/2012	07/25/2012	11/27/2002	02/26/2003	10/01/2003	05/20/2004
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U	3U	3U	3U		3U	3U	3U	3U	3U	3U	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U	3U	3U	3U		3U	3U	3U	3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U	3U	3U		3U	3U	3U	3U	3U	3U	3U	3U	3U
Acetone	6000	6U	6U	6U	6U	6U	6U	6U	6U		6U	6U	6U	6U	6U	6U	6U	6U	6U
Benzene	1	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.7J	0.5U
Bromodichloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Chloroform	70	1J	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl acetate	7000	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U		0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	4J	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U		0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U	2U	2U		2U	2U	2U	2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U	1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-120**															**MW-210**		
Sample Date		09/24/2004	06/03/2005	11/04/2005	06/01/2006	12/05/2006	06/05/2007	08/13/2008	07/01/2009	06/08/2010	06/16/2011	03/14/2012	05/29/2012	05/30/2012	07/31/2012	08/01/2012	02/01/2005	06/01/2005	10/28/2005
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	15U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	15U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U						3U	3U	3U	3U	3U	15U	3U	3U
Acetone	6000	6U	6U	6U	10J	6U						6U	6U	6U	6U	6U	30U	12J	10J
Benzene	1	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	3U	0.8J	0.7J
Bromodichloromethane	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Methyl acetate	7000	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U						0.5U	0.5U	0.5U	0.5U	0.5U	3U	0.5U	0.5U
Methylcyclohexane	NA	2J	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
Styrene	100	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	4U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U						0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U						2U	2U	2U	2U	2U	10U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U						1U	1U	1U	1U	1U	5U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	4U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-210**												**MW-211**					
Sample Date		05/31/2006	11/07/2006	05/24/2007	12/18/2007	08/12/2008	11/06/2008	07/24/2009	11/24/2009	06/08/2010	09/23/2010	06/16/2011	03/14/2012	02/01/2005	06/01/2005	10/27/2005	05/25/2006	11/07/2006	05/24/2007
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	15U	15U	3U	3U	3U	3U			3U	3U	4J	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	15U	15U	3U	3U	3U	3U			3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	15U	15U	3U	3U	3U	3U			3U	3U	3U	3U	3U	3U
Acetone	6000	9J	15J	12J	94	30U	30U	7J	9J	6U	11J			7J	7J	52	21	18J	15J
Benzene	1	0.8J	0.5U	0.5U	0.5U	3U	3U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.9J	0.5U	0.5U	0.5J
Bromodichloromethane	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	1J	0.8U	4J	2J	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			53	1U	3J	10	34	30
Methyl acetate	7000	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	3U	3U	0.5U	0.5U	0.5U	0.5U			0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			2J	1U	1U	1U	1U	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	4U	4J	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	10U	10U	2U	2U	2U	2U			2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U			1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	4U	4U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	1J	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-211**									**MW-233**								
Sample Date		12/18/2007	06/24/2008	10/30/2008	05/19/2009	11/24/2009	06/08/2010	09/23/2010	06/16/2011	03/14/2012	06/02/2006	12/12/2006	05/24/2007	12/19/2007	06/24/2008	11/11/2008	05/29/2009	11/20/2009	05/14/2010
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	20U	2U	2U	2U			2U	2U	2U	2U	2U	5U	4U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	20U	2U	2U	2U			2U	2U	2U	2U	2U	5U	4U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	30U	3U	3U	3U			3U	6J	11	15	4J	22J	19J	3U	21
2-Hexanone	NA	3U	3U	3U	30U	3U	3U	3U			3U	3U	3U	3U	3U	8U	6U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	30U	3U	3U	3U			3U	3U	3U	3U	3U	8U	6U	3U	3U
Acetone	6000	10J	8J	6U	60U	12J	11J	11J			11J	15J	38	45	11J	71	56	31	56
Benzene	1	0.5U	0.5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	**[59]**	**[300]**	**[350]**	**[280]**	**[540]**	**[730]**	**[1300]**	**[820]**	**[1000]**
Bromodichloromethane	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Bromoform	4	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Carbon Disulfide	700	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Cyclohexane	NA	2U	2U	2U	20U	2U	2U	2U			12	120	120	130	140	130	99	140	170
Dibromochloromethane	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	20U	2U	2U	2U			2U	2U	2U	2U	2U	5U	4U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U	0.8U	0.8U	28	29	32	26	0.8U	57	230	12	98
Isopropylbenzene	700	52	3J	16	10U	22	11	7			4J	21	43	21	1U	22	25	2J	21
Methyl acetate	7000	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	5U	0.5U	0.5U	0.5U			0.5U	0.5U	0.5U	0.5U	0.5U	1U	1U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	10U	1U	1U	1U			10	110	110	140	150	160	110	130	210
Methylene chloride (Dichloromethane)	3	2U	2U	2U	20U	2U	2U	2U			2U	2U	2U	2U	2U	5U	4U	2U	2U
Styrene	100	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	7U	0.7U	0.7U	0.7U	0.7U	0.7U	10	55	73	59	46	71	130	74	140
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U			0.8U	0.8U	0.8U	0.8U	0.8U	2U	2U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	20U	2U	2U	2U			2U	2U	2U	2U	2U	5U	4U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	10U	1U	1U	1U			1U	1U	1U	1U	1U	3U	2U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	8U	0.8U	0.8U	0.8U	0.8U	0.9J	17	120	110	120	240	300	460	320	480

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-233**							**MW-240**									**MW-322**	
Sample Date		09/23/2010	06/21/2011	03/21/2012	05/24/2012	05/25/2012	07/25/2012	07/26/2012	12/01/2006	05/11/2007	12/06/2007	07/29/2008	10/30/2008	05/27/2009	10/27/2009	06/23/2011	03/15/2012	03/15/2012	05/16/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
1,1,2,2-Tetrachloroethane	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,1,2-Trichloroethane	3	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	4U	4U	4U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U			20U	2U
1,1-Dichloroethane	50	2U	2U	2U	1U	1U	1U	1J	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,1-Dichloroethene (Dichloroethylene)	1	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
1,2,4-Trichlorobenzene	9	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	4U	4U	4U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U			20U	2U
1,2-Dibromoethane	0.03	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,2-Dichloroethane	2	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,2-Dichloropropane	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,3-Dichlorobenzene	600	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
1,4-Dichlorobenzene	75	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
2-Butanone (Methyl ethyl ketone)	300	7J	13J	6U	5J	9J	15	23	3U	3U	3U	3U	3U	3U	3U			30U	3U
2-Hexanone	NA	6U	6U	6U	3J	3U	3U	7J	3U	3U	3U	3U	3U	3U	3U			30U	3U
4-Methyl-2-pentanone	NA	6U	6U	6U	3U	3U	10J	4J	3U	3U	3U	3U	3U	3U	3U			30U	3U
Acetone	6000	18J	40J	12U	15J	24	42	53	6U	6U	6U	6U	6U	6U	6U			60U	6U
Benzene	1	**[280]**	**[1400]**	**[430]**	**[1300]**	**[860]**	**[270]**	**[220]**	0.5U	0.5U	**[180]**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	5U	**[9]**
Bromodichloromethane	1	2U	2U	2U	1U	1U	1U	1U	**[6]**	1U	1U	1U	1U	1U	1U			10U	1U
Bromoform	4	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Bromomethane (Methyl bromide)	10	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Carbon Disulfide	700	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Carbon Tetrachloride	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Chlorobenzene	50	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
Chloroethane	NA	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Chloroform	70	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	37	3J	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
Chloromethane (Methyl chloride)	NA	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
cis-1,2-Dichloroethene	70	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
cis-1,3-Dichloropropene	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Cyclohexane	NA	120	100	130	160	150	65	140	2U	2U	2U	2U	2U	2U	2U			20U	2U
Dibromochloromethane	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Dichlorodifluoromethane (Freon 12)	1000	4U	4U	4U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U			20U	2U
Ethylbenzene	700	20	390	45	250	100	5	12	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	8U	0.8U
Isopropylbenzene	700	45	34	24	20	19	7	18	1U	1U	1U	1U	1U	1U	1U			10U	1U
Methyl acetate	7000	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Methyl-t-butyl ether	70	1U	1U	1U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U			5U	0.5U
Methylcyclohexane	NA	100	140	130	150	170	63	130	1U	1U	1U	1U	1U	1U	1U			10U	1U
Methylene chloride (Dichloromethane)	3	4U	4U	4U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U			20U	2U
Styrene	100	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Tetrachloroethene	1	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
Toluene	1,000	41	180	51	170	120	22	32	0.7U	0.7U	5	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	7U	0.7U
trans-1,2-Dichloroethene	100	2U	2U	2U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U			8U	0.8U
trans-1,3-Dichloropropene	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Trichloroethene (Trichloroethylene)	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Trichlorofluoromethane (Freon 11)	2000	4U	4U	4U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U			20U	2U
Vinyl chloride (Chloroethene)	1	2U	2U	2U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U			10U	1U
Xylenes, Total	1000	79	600	170	540	410	28	47	0.8U	0.8U	1J	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	8U	1J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-322**			**MW-323**					**MW-324**					**MW-325**				
Sample Date		05/17/2012	07/30/2012	07/31/2012	03/15/2012	05/16/2012	05/17/2012	07/30/2012	07/31/2012	03/13/2012	05/17/2012	05/18/2012	07/30/2012	07/31/2012	3/13/2012	03/13/2012	05/17/2012	05/18/2012	07/26/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3J	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
Acetone	6000	13J	6U	6U	12J	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U
Benzene	1	0.7J	**[6]**	**[1J]**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	**[2J]**	**[4J]**	**[3J]**	**[2J]**	**[4J]**	**[4J]**	0.5U	0.5U	0.5U
Bromodichloromethane	1	1U	1U	1U	**[4J]**	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	3J	1U	1U	1U	1J	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	15	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl acetate	7000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-325**	**MW-326**					**MW-327**					**MW-328**					**MW-333**	
Sample Date		07/27/2012	03/13/2012	05/23/2012	05/24/2012	07/26/2012	07/27/2012	03/14/2012	05/18/2012	05/18/2012	07/31/2012	08/01/2012	03/21/2012	05/23/2012	05/24/2012	07/25/2012	07/26/2012	05/16/2012	05/17/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	8	6	5J	5	4J	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	9J	3U	3U	3U	3U	3U
2-Hexanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
Acetone	6000	6U	15J	6U	16J	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	6U	22	21
Benzene	1	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.9J	0.5U
Bromodichloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	3J	0.8U	0.8U	0.8U	0.8U	14	1J	2J	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	6	4J
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Isopropylbenzene	700	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	2J	2J
Methyl acetate	7000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	4J	1U	1U	2J	4J	3J
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	1J	0.8U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-1

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR VOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-333**		**MW-334**				**RW-02**										
Sample Date		07/24/2012	07/25/2012	05/17/2012	05/18/2012	07/31/2012	08/01/2012	05/27/2005	10/26/2005	05/25/2006	12/01/2006	05/15/2007	08/13/2008	05/27/2009	06/23/2011	03/15/2012	09/16/2003	09/22/2004
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	30	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2,2-Tetrachloroethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1,2-Trichloroethane	3	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,1,2-Trichlorotrifluoroethane (Freon 113)	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,1-Dichloroethane	50	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,1-Dichloroethene (Dichloroethylene)	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
1,2,4-Trichlorobenzene	9	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dibromo-3-chloropropane (DBCP)	0.02	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
1,2-Dibromoethane	0.03	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichlorobenzene (o-Dichlorobenzene)	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloroethane	2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,2-Dichloropropane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,3-Dichlorobenzene	600	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
1,4-Dichlorobenzene	75	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
2-Butanone (Methyl ethyl ketone)	300	3U	3U	3U	3U	3U	3U	7J	9J	14	3U	50	12	9J	3J	8J	3U	34
2-Hexanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
4-Methyl-2-pentanone	NA	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U	3U
Acetone	6000	10J	6U	6U	7J	6U	6U	16J	18J	27	9J	96	36	26	10J	11J	6U	60
Benzene	1	0.7J	0.5U	**[69]**	**[57]**	**[14]**	**[27]**	**[100]**	**[88]**	**[120]**	**[100]**	**[190]**	**[200]**	**[170]**	**[210]**	**[61]**	**[110]**	**[130]**
Bromodichloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromoform	4	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Bromomethane (Methyl bromide)	10	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Disulfide	700	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Carbon Tetrachloride	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chlorobenzene	50	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloroethane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Chloroform	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Chloromethane (Methyl chloride)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
cis-1,2-Dichloroethene	70	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
cis-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Cyclohexane	NA	2U	2U	6	4J	2U	3J	130	60	86	57	120	130	89	82	18	180	110
Dibromochloromethane	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Dichlorodifluoromethane (Freon 12)	1000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Ethylbenzene	700	0.8U	0.8U	4J	2J	0.8U	2J	16	48	18	53	47	20	19	25	4J	73	29
Isopropylbenzene	700	1U	1J	2J	1J	1U	1U	28	22	26	28	32	31	26	13	9	42	28
Methyl acetate	7000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Methyl-t-butyl ether	70	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Methylcyclohexane	NA	1U	2J	4J	2J	1U	2J	170	120	85	92	150	130	77	49	13	270	150
Methylene chloride (Dichloromethane)	3	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Styrene	100	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Tetrachloroethene	1	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
Toluene	1,000	0.7U	0.7U	9	6	2J	3J	10	14	11	12	21	22	18	29	4J	19	15
trans-1,2-Dichloroethene	100	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U	0.8U
trans-1,3-Dichloropropene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichloroethene (Trichloroethylene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Trichlorofluoromethane (Freon 11)	2000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Vinyl chloride (Chloroethene)	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Xylenes, Total	1000	0.8U	0.8U	10	10	2J	5	19	21	17	29	33	34	29	35	4J	40	25

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-2

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR SVOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-0057						MW-114								MW-115								MW-120
Sample Date		10/30/2002	03/13/2012	05/23/2012	05/24/2012	07/25/2012	07/26/2012	10/17/2002	02/10/2003	09/10/2003	03/16/2012	05/14/2012	05/15/2012	07/24/2012	07/25/2012	10/22/2002	02/26/2003	09/09/2003	03/16/2012	05/14/2012	05/15/2012	07/24/2012	07/25/2012	11/27/2002
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2,4,5-Trichlorophenol	700	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2,4,6-Trichlorophenol	20	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2,4-Dichlorophenol	20	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2,4-Dimethylphenol	100	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2,4-Dinitrophenol	40	21U	10U	11U	11U	12U	11U	20U	20U	19U	10U	11U	11U	11U	10U	21U	20U	21U	10U	11U	10U	12U	10U	21U
2,4-Dinitrotoluene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
2,6-Dinitrotoluene	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2-Chloronaphthalene	600	1U	0.4U	0.4U	0.4U	0.5U	0.4U	1U	1U	1U	0.4U	0.4U	0.4U	0.5U	0.4U	1U	1U	1U	0.4U	0.4U	0.4U	0.5U	0.4U	1U
2-Chlorophenol (o-Chlorophenol)	40	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2-Methyl-naphthlalene	NA	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1J	1U
2-Methylphenol (o-Cresol)	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2-Nitroaniline (o-Nitroaniline)	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
2-Nitrophenol (o-Nitrophenol)	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
3,3'-Dichlorobenzidine	30	1U	2U	2U	2U	2U	2U	1U	1U	1U	2U	2U	2U	2U	2U	1U	1U	1U	2U	2U	2U	2U	2U	1U
3-Nitroaniline	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	NA	5U	5U	6U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U
4-Bromophenylphenylether	NA		0.5U	0.6U	0.5U	0.6U	0.5U			1U	0.5U	0.5U	0.5U	0.6U	0.5U			1U	0.5U	0.5U	0.5U	0.6U	0.5U	
4-Chloroaniline	30	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
4-Chlorophenyl phenyl ether	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
4-Nitroaniline	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
4-Nitrophenol	NA	10U	10U	11U	11U	12U	11U	10U	10U	10U	10U	11U	11U	11U	10U	10U	10U	10U	10U	11U	10U	12U	10U	10U
Acenaphthene	400	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Acenaphthylene	NA	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Acetophenone	700	2U	0.5U	0.6U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U
Anthracene	2000	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Atrazine	3	1U	2U	2U	2U	2U	2U	1U	1U	1U	2U	2U	2U	2U	2U	1U	1U	1U	2U	2U	2U	2U	2U	1U
Benzaldehyde	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Benzo(a)anthracene	0.1	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(a)Pyrene	0.1	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(b)Fluoranthene	0.2	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(g,h,i)perylene	NA	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(k)Fluoranthene	0.5	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
bis(2-Chloroethoxy)methane	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
bis(2-Chloroethyl) ether	7	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Bis(2-chloroisopropyl) ether	300	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
bis(2-Ethylhexyl)phthalate	3	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Butylbenzylphthalate	100	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Caprolactam	NA	5J	5U	6U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U
Carbazole	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Chrysene	5	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Di-n-butylphthalate	700	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Di-n-octylphthalate	100	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Dibenz(a,h)anthracene	0.3	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Dibenzofuran	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Diethylphthalate	6000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Dimethylphthalate	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Diphenyl (Biphenyl, Phenyl benzene)	400	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Fluoranthene	300	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Fluorene	300	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Hexachlorobenzene	0.02	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Hexachlorobutadiene	1	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Hexachlorocyclopentadiene	40	5U	5U	6U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	5U	5U	6U	5U	5U
Hexachloroethane	7	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U
Indeno(1,2,3-cd)pyrene	0.2	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Isophorone	40	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
N-Nitrosodi-n-propylamine	10	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
N-Nitrosodiphenylamine (Diphenylamine)	10	2U	0.5U	0.6U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U
Naphthalene	300	1U	0.1U	0.1J	0.1J	0.1U	0.1U	1U	1U	1U	0.1J	0.1U	0.3J	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Nitrobenzene	6	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
p-Chloro-m-cresol	NA	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
p-Cresol	NA	2U	0.5U	0.6U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U	2U	2U	0.5U	0.5U	0.5U	0.6U	0.5U	2U
Pentachlorophenol	0.3	3U	1U	1U	1U	1U	1U	3U	3U	3U	1U	1U	1U	1U	1U	3U	3U	3U	1U	1U	1U	1U	1U	3U
Phenanthrene	NA	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Phenol	2000	1U	0.5U	0.6U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U	1U	1U	0.5U	0.5U	0.5U	0.6U	0.5U	1U
Pyrene	200	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U	1U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-2

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR SVOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-120																MW-211		MW-233				
Sample Date		02/26/2003	10/01/2003	05/20/2004	09/24/2004	06/03/2005	11/04/2005	06/01/2006	12/05/2006	08/13/2008	07/01/2009	06/08/2010	03/14/2012	05/29/2012	05/30/2012	07/31/2012	08/01/2012	10/27/2005	05/25/2006	06/02/2006	03/21/2012	05/24/2012	05/25/2012	07/25/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2,4,5-Trichlorophenol	700	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2,4,6-Trichlorophenol	20	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2,4-Dichlorophenol	20	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2,4-Dimethylphenol	100	1U	1U	1U	1U	3U	3U	3U	3U	3U	4U	3U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	33	1
2,4-Dinitrophenol	40	20U	20U	20U	19U	20U	19U	20U	20U	21U	24U	12U	10U	10U	11U	10U	10U				9U	11U	9U	10U
2,4-Dinitrotoluene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U				0.9U	1U	0.9U	1U
2,6-Dinitrotoluene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2-Chloronaphthalene	600	1U	1U	1U	1U	1U	1U	2U	2U	2U	2U	2U	0.4U	0.4U	0.5U	0.4U	0.4U				0.4U	0.4U	0.4U	0.4U
2-Chlorophenol (o-Chlorophenol)	40	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2-Methyl-naphthlalene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				12	10	20	0.1U
2-Methylphenol (o-Cresol)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2-Nitroaniline (o-Nitroaniline)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
2-Nitrophenol (o-Nitrophenol)	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
3,3'-Dichlorobenzidine	30	1U	1U	1U	1U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
3-Nitroaniline	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	NA	5U	5U	5U	5U	5U	5U	5U	5U	5U	6U	6U	5U	5U	6U	5U	5U				5U	6U	5U	5U
4-Bromophenylphenylether	NA		1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
4-Chloroaniline	30	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
4-Chlorophenyl phenyl ether	NA	1U	1U	1U	1U	1U	1U	2U	2U	2U	2U	2U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
4-Nitroaniline	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
4-Nitrophenol	NA	10U	10U	10U	10U	10U	10U	10U	10U	10U	12U	12U	10U	10U	11U	10U	10U				9U	11U	9U	10U
Acenaphthene	400	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				2	2	3	0.9
Acenaphthylene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Acetophenone	700	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	2	0.5U
Anthracene	2000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.2J	0.1U	0.4J	0.1U
Atrazine	3	1U	1U	1U	1U	1U	1U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Benzaldehyde	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U				0.9U	4J	0.9U	1U
Benzo(a)anthracene	0.1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Benzo(a)Pyrene	0.1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Benzo(b)Fluoranthene	0.2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.1J	0.1U
Benzo(g,h,i)perylene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Benzo(k)Fluoranthene	0.5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
bis(2-Chloroethoxy)methane	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
bis(2-Chloroethyl) ether	7	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Bis(2-chloroisopropyl) ether	300	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
bis(2-Ethylhexyl)phthalate	3	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Butylbenzylphthalate	100	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Caprolactam	NA	5U	5U	5U	5U	5U	5U	5U	5U	5U	6U	6U	5U	5U	6U	5U	5U				5U	6U	5U	5U
Carbazole	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Chrysene	5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Di-n-butylphthalate	700	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Di-n-octylphthalate	100	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Dibenz(a,h)anthracene	0.3	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Dibenzofuran	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6J	0.9J	0.5U
Diethylphthalate	6000	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	5J	2U	2U
Dimethylphthalate	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U				2U	2U	2U	2U
Diphenyl (Biphenyl, Phenyl benzene)	400	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Fluoranthene	300	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.1J	0.1U	0.3J	0.1U
Fluorene	300	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				1	1	2	0.6
Hexachlorobenzene	0.02	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Hexachlorobutadiene	1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Hexachlorocyclopentadiene	40	5U	5U	5U	5U	5U	5U	5U	5U	5U	6U	6U	5U	5U	6U	5U	5U				5U	6U	5U	5U
Hexachloroethane	7	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U				0.9U	1U	0.9U	1U
Indeno(1,2,3-cd)pyrene	0.2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.09U	0.1U
Isophorone	40	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
N-Nitrosodi-n-propylamine	10	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
N-Nitrosodiphenylamine (Diphenylamine)	10	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Naphthalene	300	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.5U	0.1U	26J	7J	25J	16	10	17	0.1U
Nitrobenzene	6	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
p-Chloro-m-cresol	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
p-Cresol	NA	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	0.6U	0.5U	0.5U
Pentachlorophenol	0.3	3U	3U	3U	3U	3U	3U	3U	3U	3U	4U	3U	1U	1U	1U	1U	1U				0.9U	1U	0.9U	1U
Phenanthrene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				1	1	2	0.1U
Phenol	2000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.5U	0.5U	0.6U	0.5U	0.5U				0.5U	13	28	6
Pyrene	200	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	0.1U	0.1U	0.1U	0.1U				0.09U	0.1U	0.3J	0.1J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-2

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR SVOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-233	MW-240							MW-322					MW-323		MW-323			MW-324				
Sample Date		07/26/2012	12/01/2006	05/11/2007	12/06/2007	07/29/2008	10/30/2008	05/27/2009	10/27/2009	03/15/2012	05/16/2012	05/17/2012	07/30/2012	07/31/2012	03/15/2012	05/16/2012	05/17/2012	07/30/2012	07/31/2012	03/13/2012	05/17/2012	05/18/2012	07/30/2012	07/31/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2,4,5-Trichlorophenol	700	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2,4,6-Trichlorophenol	20	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2,4-Dichlorophenol	20	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2,4-Dimethylphenol	100	5U	3U	3U	6J	3U	3U	3U	3U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2,4-Dinitrophenol	40	110U	21U	19U	19U	20U	19U	20U	19U	100U	100U	10U	100U	98U	10U	11U	10U	15U	10U	10U	11U	10U	11U	10U
2,4-Dinitrotoluene	NA	11U	1U	1U	1U	1U	1U	1U	1U	10U	10U	1U	10U	10U	1U	1U	1U	2U	1U	1U	1U	1U	1U	1U
2,6-Dinitrotoluene	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2-Chloronaphthalene	600	4U	2U	2U	2U	2U	2U	2U	2U	4U	4U	0.4U	4U	4U	0.4U	0.5U	0.4U	0.6U	0.4U	0.4U	0.5U	0.4U	0.4U	0.4U
2-Chlorophenol (o-Chlorophenol)	40	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2-Methyl-naphthlalene	NA	2J	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
2-Methylphenol (o-Cresol)	NA	5U	1U	1U	3J	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2-Nitroaniline (o-Nitroaniline)	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
2-Nitrophenol (o-Nitrophenol)	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
3,3'-Dichlorobenzidine	30	21U	2U	2U	2U	2U	2U	2U	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
3-Nitroaniline	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	NA	53U	5U	5U	5U	5U	5U	5U	5U	51U	50U	5U	50U	49U	5U	6U	5U	8U	5U	5U	6U	5U	5U	5U
4-Bromophenylphenylether	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
4-Chloroaniline	30	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
4-Chlorophenyl phenyl ether	NA	5U	2U	2U	2U	2U	2U	2U	2U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
4-Nitroaniline	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
4-Nitrophenol	NA	110U	10U	10U	10U	10U	10U	10U	10U	100U	100U	10U	100U	98U	10U	11U	10U	15U	10U	10U	11U	10U	11U	10U
Acenaphthene	400	3J	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.3J	0.6	0.5J	0.4J
Acenaphthylene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Acetophenone	700	5U	2U	2U	2U	2U	2U	2U	2U	5U	5U	0.5U	5U	5U	1J	0.6U	0.5U	0.8U	0.7J	0.5U	0.6U	0.5U	0.5U	0.5U
Anthracene	2000	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Atrazine	3	21U	2U	2U	2U	2U	2U	2U	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Benzaldehyde	NA	11U	1U	1U	1U	1U	1U	1U	1U	10U	10U	1U	10U	10U	1U	1U	2J	2U	1U	1U	1U	1U	1U	1U
Benzo(a)anthracene	0.1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(a)Pyrene	0.1	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(b)Fluoranthene	0.2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(g,h,i)perylene	NA	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(k)Fluoranthene	0.5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
bis(2-Chloroethoxy)methane	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
bis(2-Chloroethyl) ether	7	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Bis(2-chloroisopropyl) ether	300	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
bis(2-Ethylhexyl)phthalate	3	21U	2U	2U	2U	2U	2U	3J	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Butylbenzylphthalate	100	21U	2U	2U	2U	2U	2U	2U	2U	20U	49J	2U	33J	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Caprolactam	NA	53U	5U	5U	5U	5U	5U	5U	5U	51U	50U	5U	50U	49U	5U	6U	5U	8U	5U	5U	6U	5U	5U	5U
Carbazole	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Chrysene	5	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Di-n-butylphthalate	700	21U	2U	2U	2U	2U	2U	2U	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Di-n-octylphthalate	100	21U	2U	2U	2U	2U	2U	2U	2J	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Dibenz(a,h)anthracene	0.3	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Dibenzofuran	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Diethylphthalate	6000	21U	2U	2U	2U	2U	2U	2U	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Dimethylphthalate	NA	21U	2U	2U	2U	2U	2U	2U	2U	20U	20U	2U	20U	20U	2U	2U	2U	3U	2U	2U	2U	2U	2U	2U
Diphenyl (Biphenyl, Phenyl benzene)	400	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Fluoranthene	300	1J	1U	1U	1J	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.2J	0.1J	0.1J
Fluorene	300	3J	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.2J	0.3J	0.3J	0.3J
Hexachlorobenzene	0.02	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Hexachlorobutadiene	1	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Hexachlorocyclopentadiene	40	53U	5U	5U	5U	5U	5U	5U	5U	51U	50U	5U	50U	49U	5U	6U	5U	8U	5U	5U	6U	5U	5U	5U
Hexachloroethane	7	11U	1U	1U	1U	1U	1U	1U	1U	10U	10U	1U	10U	10U	1U	1U	1U	2U	1U	1U	1U	1U	1U	1U
Indeno(1,2,3-cd)pyrene	0.2	1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Isophorone	40	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
N-Nitrosodi-n-propylamine	10	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
N-Nitrosodiphenylamine (Diphenylamine)	10	5U	2U	2U	2U	2U	2U	2U	2U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Naphthalene	300	1U	1U	1U	1U	1U	1U	1U	1U	1U	2J	0.1U	1U	1U	0.1U	0.1U	0.3J	0.2U	0.1U	0.2J	0.1U	0.3J	0.2J	0.2J
Nitrobenzene	6	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
p-Chloro-m-cresol	NA	5U	1U	1U	1U	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
p-Cresol	NA	5U	2U	2U	2J	2U	2U	2U	2U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Pentachlorophenol	0.3	11U	3U	3U	3U	3U	3U	3U	3U	10U	10U	1U	10U	10U	1U	1U	1U	2U	1U	1U	1U	1U	1U	1U
Phenanthrene	NA	4J	1U	1U	1U	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.2J	0.1J	0.2J
Phenol	2000	7J	1U	1U	4J	1U	1U	1U	1U	5U	5U	0.5U	5U	5U	0.5U	0.6U	0.5U	0.8U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U
Pyrene	200	2J	1U	1U	1J	1U	1U	1U	1U	1U	1U	0.1U	1U	1U	0.1U	0.1U	0.1U	0.2U	0.1U	0.1U	0.1U	0.2J	0.1J	0.2J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-2

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR SVOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-325					MW-326					MW-327					MW-328					MW-333		
Sample Date		03/13/2012	05/17/2012	05/18/2012	07/26/2012	07/27/2012	03/13/2012	05/23/2012	05/24/2012	07/26/2012	07/27/2012	03/14/2012	05/18/2012	05/18/2012	07/31/2012	08/01/2012	03/21/2012	05/23/2012	05/24/2012	07/25/2012	07/26/2012	05/16/2012	05/17/2012	07/24/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2,4,5-Trichlorophenol	700	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2,4,6-Trichlorophenol	20	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2,4-Dichlorophenol	20	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2,4-Dimethylphenol	100	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2,4-Dinitrophenol	40	10U	12U	9U	11U	10U	10U	11U	100U	11U	100U	10U	10U	10U	11U	9U	10U	11U	9U	11U	10U	11U	10U	11U
2,4-Dinitrotoluene	NA	1U	1U	0.9U	1U	1U	1U	1U	10U	1U	10U	1U	1U	1U	1U	0.9U	1U	1U	0.9U	1U	1U	1U	1U	1U
2,6-Dinitrotoluene	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2-Chloronaphthalene	600	0.4U	0.5U	0.4U	0.5U	0.4U	0.4U	0.4U	4U	0.4U	4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
2-Chlorophenol (o-Chlorophenol)	40	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2-Methyl-naphthlalene	NA	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1J	0.09U	0.1U	0.1U	1	0.6	0.1U
2-Methylphenol (o-Cresol)	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2-Nitroaniline (o-Nitroaniline)	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
2-Nitrophenol (o-Nitrophenol)	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
3,3'-Dichlorobenzidine	30	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
3-Nitroaniline	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	NA	5U	6U	5U	6U	5U	5U	6U	50U	5U	50U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	6U
4-Bromophenylphenylether	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
4-Chloroaniline	30	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
4-Chlorophenyl phenyl ether	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
4-Nitroaniline	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
4-Nitrophenol	NA	10U	12U	9U	11U	10U	10U	11U	100U	11U	100U	10U	10U	10U	11U	9U	10U	11U	9U	11U	10U	11U	10U	11U
Acenaphthene	400	0.6	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	1	0.09U	1	0.9	2	3	0.1U
Acenaphthylene	NA	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Acetophenone	700	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Anthracene	2000	0.2J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.8	0.7	0.9
Atrazine	3	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Benzaldehyde	NA	1U	1U	0.9U	1U	1U	1U	1U	10U	1U	10U	1U	1U	1U	1U	0.9U	1U	1U	0.9U	1U	1U	1U	1U	1U
Benzo(a)anthracene	0.1	0.1J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(a)Pyrene	0.1	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(b)Fluoranthene	0.2	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(g,h,i)perylene	NA	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Benzo(k)Fluoranthene	0.5	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
bis(2-Chloroethoxy)methane	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
bis(2-Chloroethyl) ether	7	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Bis(2-chloroisopropyl) ether	300	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
bis(2-Ethylhexyl)phthalate	3	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Butylbenzylphthalate	100	2U	2U	2U	2U	2U	2U	2U	20U	2U	88	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Caprolactam	NA	5U	6U	5U	6U	5U	5U	6U	50U	5U	50U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	6U
Carbazole	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.6J	0.5U	0.6U
Chrysene	5	0.2J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Di-n-butylphthalate	700	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Di-n-octylphthalate	100	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Dibenz(a,h)anthracene	0.3	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Dibenzofuran	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.7J	0.5U	0.6U
Diethylphthalate	6000	2U	2U	2U	2J	2J	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Dimethylphthalate	NA	2U	2U	2U	2U	2U	2U	2U	20U	2U	20U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
Diphenyl (Biphenyl, Phenyl benzene)	400	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Fluoranthene	300	0.4J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Fluorene	300	0.4J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.2J	0.09U	0.1J	0.2J	1	1	0.1U
Hexachlorobenzene	0.02	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Hexachlorobutadiene	1	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Hexachlorocyclopentadiene	40	5U	6U	5U	6U	5U	5U	6U	50U	5U	50U	5U	5U	5U	5U	5U	5U	6U	5U	5U	5U	5U	5U	6U
Hexachloroethane	7	1U	1U	0.9U	1U	1U	1U	1U	10U	1U	10U	1U	1U	1U	1U	0.9U	1U	1U	0.9U	1U	1U	1U	1U	1U
Indeno(1,2,3-cd)pyrene	0.2	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U
Isophorone	40	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
N-Nitrosodi-n-propylamine	10	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
N-Nitrosodiphenylamine (Diphenylamine)	10	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Naphthalene	300	0.4J	0.1U	0.09U	0.1U	0.1U	0.5	0.2J	1U	0.1U	1U	0.1U	0.2J	0.1U	0.1U	0.1J	0.5	0.9	0.09U	0.4J	0.2J	0.6	0.8	0.1U
Nitrobenzene	6	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
p-Chloro-m-cresol	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
p-Cresol	NA	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Pentachlorophenol	0.3	1U	1U	0.9U	1U	1U	1U	1U	10U	1U	10U	1U	1U	1U	1U	0.9U	1U	1U	0.9U	1U	1U	1U	1U	1U
Phenanthrene	NA	0.4J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.09U	0.1U	0.1U	0.09U	0.1J	0.1U	0.9	0.1U	0.1U
Phenol	2000	0.5U	0.6U	0.5U	0.6U	0.5U	0.5U	0.6U	5U	0.5U	5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U	0.5U	0.5U	0.5U	0.5U	0.5U	0.6U
Pyrene	200	0.4J	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	1U	0.1U	1U	0.1U	0.1U	0.1U	0.1U	0.1J	0.1U	0.1U	0.09U	0.1U	0.1U	0.1U	0.1U	0.1U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-2

HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR SVOCs – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-333**	**MW-334**				**RW-02**
Sample Date		07/25/2012	05/17/2012	05/18/2012	07/31/2012	08/01/2012	09/16/2003
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2,4,5-Trichlorophenol	700	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2,4,6-Trichlorophenol	20	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2,4-Dichlorophenol	20	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2,4-Dimethylphenol	100	0.5U	39	51	4	4	1U
2,4-Dinitrophenol	40	10U	10U	10U	10U	10U	21U
2,4-Dinitrotoluene	NA	1U	1U	1U	1U	1U	1U
2,6-Dinitrotoluene	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2-Chloronaphthalene	600	0.4U	0.4U	0.4U	0.4U	0.4U	1U
2-Chlorophenol (o-Chlorophenol)	40	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2-Methyl-naphthlalene	NA	0.1U	6J	6J	0.5	5J	2J
2-Methylphenol (o-Cresol)	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2-Nitroaniline (o-Nitroaniline)	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
2-Nitrophenol (o-Nitrophenol)	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
3,3'-Dichlorobenzidine	30	2U	2U	2U	2U	2U	1U
3-Nitroaniline	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	NA	5U	5U	5U	5U	5U	5U
4-Bromophenylphenylether	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
4-Chloroaniline	30	0.5U	0.5U	0.5U	0.5U	0.5U	1U
4-Chlorophenyl phenyl ether	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
4-Nitroaniline	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
4-Nitrophenol	NA	10U	10U	10U	10U	10U	10U
Acenaphthene	400	3	0.6	1	0.1J	0.4J	1U
Acenaphthylene	NA	0.2J	0.1U	0.1U	0.1U	0.1U	1U
Acetophenone	700	0.5U	0.5U	0.5U	0.5U	0.5U	2U
Anthracene	2000	1	0.1U	0.2J	0.2J	0.1J	1U
Atrazine	3	2U	2U	2U	2U	2U	1U
Benzaldehyde	NA	1U	1U	1U	1U	1U	1U
Benzo(a)anthracene	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(a)Pyrene	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(b)Fluoranthene	0.2	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(g,h,i)perylene	NA	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Benzo(k)Fluoranthene	0.5	0.1U	0.1U	0.1U	0.1U	0.1U	1U
bis(2-Chloroethoxy)methane	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
bis(2-Chloroethyl) ether	7	0.5U	0.5U	0.5U	0.5U	0.5U	1U
Bis(2-chloroisopropyl) ether	300	0.5U	0.5U	0.5U	0.5U	0.5U	1U
bis(2-Ethylhexyl)phthalate	3	2U	2U	2U	2U	2U	2U
Butylbenzylphthalate	100	2U	2U	2U	2U	2U	2U
Caprolactam	NA	5U	5U	5U	5U	5U	5U
Carbazole	NA	0.6J	0.5U	0.6J	0.5U	0.5U	1U
Chrysene	5	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Di-n-butylphthalate	700	2U	2U	2U	2U	2U	2U
Di-n-octylphthalate	100	2U	2U	2U	2U	2U	2U
Dibenz(a,h)anthracene	0.3	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Dibenzofuran	NA	0.6J	0.5U	0.5U	0.5U	0.5U	1U
Diethylphthalate	6000	2U	2U	2U	2U	2U	2U
Dimethylphthalate	NA	2U	2U	2U	2U	2U	2U
Diphenyl (Biphenyl, Phenyl benzene)	400	0.5U	0.5U	0.5U	0.5U	0.5U	1U
Fluoranthene	300	0.2J	0.1U	0.1U	0.1J	0.1J	1U
Fluorene	300	1	0.6	0.9	0.1J	0.4J	1U
Hexachlorobenzene	0.02	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Hexachlorobutadiene	1	0.5U	0.5U	0.5U	0.5U	0.5U	1U
Hexachlorocyclopentadiene	40	5U	5U	5U	5U	5U	5U
Hexachloroethane	7	1U	1U	1U	1U	1U	1U
Indeno(1,2,3-cd)pyrene	0.2	0.1U	0.1U	0.1U	0.1U	0.1U	1U
Isophorone	40	0.5U	0.5U	0.5U	0.5U	0.5U	1U
N-Nitrosodi-n-propylamine	10	0.5U	0.5U	0.5U	0.5U	0.5U	1U
N-Nitrosodiphenylamine (Diphenylamine)	10	0.5U	0.5U	0.5U	0.5U	0.5U	2U
Naphthalene	300	0.1U	2	2	0.5	1	38
Nitrobenzene	6	0.5U	0.5U	0.5U	0.5U	0.5U	1U
p-Chloro-m-cresol	NA	0.5U	0.5U	0.5U	0.5U	0.5U	1U
p-Cresol	NA	0.5U	2	0.6J	0.5U	0.5U	2U
Pentachlorophenol	0.3	1U	1U	1U	1U	1U	3U
Phenanthrene	NA	0.1U	0.1U	0.7	0.4J	0.5	1U
Phenol	2000	0.5U	0.5U	0.5U	0.5U	0.5U	1U
Pyrene	200	0.3J	0.1U	0.1U	0.1J	0.2J	1U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion
Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-0057													MW-114						
Sample Date		09/27/2004	06/06/2005	11/01/2005	05/30/2006	11/30/2006	06/04/2007	07/30/2008	05/18/2009	06/07/2010	08/17/2011	03/12/2012	05/23/2012	07/25/2012	10/17/2002	02/10/2003	09/10/2003	07/29/2008	03/15/2012	05/14/2012	07/24/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200							**[3230]**	**[1960]**			**[251]**	**[7520]**	**[1110]**	47.7U	**[440]**	**[793]**		80.1U	173J	74.3U
Antimony	6							9.7U	9.7U			5.8U	5.8U	3.5U	9.9U	9.9U	8.5U		5.8U	5.8U	3.5U
Arsenic	3							10.2U	10.0U	7.2U	5.1U	5.1U	5.1U	6.8U	4.9U	4.9U	**[7.0J]**	10.2U	5.1U	5.1U	6.8U
Barium	2000							133	254			157	118	149	191	190	183		60.9	66.7	54.2
Beryllium	1							0.90U	0.90U			0.24U	0.24U	0.67U	0.50U	0.50U	0.34U	0.90U	0.24U	0.24U	0.67U
Cadmium	4							2.0U	2.0U			0.27U	1.5J	0.36U	0.94U	0.94U	0.87U	2.0U	0.27U	0.91J	0.36U
Calcium	NA							40200	128000			96700	43500	57600	93400	90700	80200		81900	82000	81400
Chromium	70							5.5J	3.9J			1.5J	13.2J	3.5J	2.0U	2.0U	2.2U		1.5J	1.1U	1.1U
Cobalt	NA							3.9J	2.4J	2.1U	1.3J	1.8J	4.1J	2.7J	4.8J	4.2J	3.8J		1.2J	0.62U	0.66U
Copper	1300							27.8	17.2			4.3J	37.1	12.9	2.6U	2.6U	2.1U		0.94U	1.8J	2.1U
IRON	300	247	**[908]**	**[7680]**	52.2U	52.2U	**[6140]**	61.7J	52.2U	177J		**[5850]**	**[11000]**	**[4330]**	**[5170]**	**[6000]**	**[8760]**		52.7J	**[710]**	89.0J
Lead	5							6.9U	6.9U	6.9U	3.3J	2.2U	**[7.7J]**	5.1U	8.9U	8.9U	9.3U		2.2U	2.2U	5.1U
Magnesium	NA							11200	25900			28700	13400	16100	26000	27300	23300		21200	22200	20900
Manganese	50							**[1750]**	**[622]**			**[255]**	**[1040]**	**[456]**	**[5430]**	**[4700]**	**[4090]**		**[288]**	**[590]**	**[535]**
Mercury	2							0.056U	0.056U			0.026U	0.035J	0.029J	0.079J	0.080U	0.16U		0.026U	0.026U	0.066J
Nickel	100							6.0J	5.6U			2.5J	10.8	3.6J	4.4J	5.6J	3.8U		3.3J	4.1J	3.6J
Potassium	NA							9930	7330			6400	5340	7370	4160	2800	4050		1410	1580	1510
Selenium	40							10.7U	10.7U			6.9U	6.9U	7.5U	4.8U	4.8U	4.7U		6.9U	6.9U	7.5U
Silver	40							2.2U	2.2U			0.91U	0.91U	1.2U	1.4U	1.4U	1.8U		0.91U	1.8J	1.2U
Sodium	50000							**[516000]**	**[846000]**			**[564000]**	**[345000]**	**[494000]**	**[69300]**	**[62000]**	**[62400]**		**[69400]**	**[71000]**	**[70300]**
Thallium	2							14.0U	14.0U	14.0U	4.2U	**[7.1J]**	4.2U	5.7U	9.5U	9.5U	8.9U		4.2U	4.2U	5.7U
Vanadium	NA							15	4.6J			1.4J	20.3	6.3	1.7U	1.7U	2.3J		0.96U	0.96U	1.3U
Zinc	2000							22.2	21.6			3.2U	37.8	12.0J	4.9U	6.9J	4.1U		3.2U	6.2J	5.7J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-115													MW-120					
Sample Date		10/22/2002	02/26/2003	09/09/2003	07/30/2008	11/5/2008	11/05/2008	05/08/2009	11/05/2009	04/29/2010	07/19/2011	03/15/2012	05/14/2012	07/24/2012	11/27/2002	02/25/2003	10/01/2003	05/19/2004	09/24/2004	06/02/2005
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200	47.7U	48U	72.9J	**[208]**	80.2U	80.2U					124J	80.1U	74.3U	47.7U	48U	74.0J			
Antimony	6	9.9U	9.9U	8.5U	9.7U	9.7U	9.7U					5.8U	5.8U	3.5U	9.9U	9.9U	8.5U			
Arsenic	3	4.9U	4.9U	4.9U	10.2U	10.0U	10.0U					5.1U	5.1U	6.8U	4.9U	4.9U	4.9U			
Barium	2000	38.2J	39J	31.8	26.6	22.6	23.4					19	27.5	24.4	136	130	159			
Beryllium	1	0.50U	0.50U	0.34U	0.90U	0.90U	0.90U					0.24U	0.24U	0.67U	0.50U	0.50U	0.34U			
Cadmium	4	0.94U	0.94U	1.1J	2.2J	2.0U	2.0U					1.1J	1.3J	**[4.5J]**	0.94U	0.94U	0.87U			
Calcium	NA	63800	62000	71900	53300	55700	57600					51700	68800	69900	42600	46200	58800			
Chromium	70	2.0U	2.0U	2.2U	3.0U	3.0U	3.0U					1.8J	1.1U	1.1U	2.0U	2.0U	2.2U			
Cobalt	NA	1.7J	1.7U	1.6U	2.1U	2.1U	2.1U					0.62U	0.62U	0.66U	9.6J	10J	11.6			
Copper	1300	2.6U	2.6U	2.6J	3.0J	2.7U	2.7U					1.2J	3.0J	2.1U	2.6U	2.6U	2.1U			
IRON	300	**[553]**	40J	173J	**[1090]**	52.2U	52.2U					**[314]**	32.2J	182J	**[5000]**	**[3700]**	**[7260]**			
Lead	5	8.9U	8.9U	9.3U	6.9U	**[21.2]**	**[19.2]**	6.9U	6.9U	6.9U	2.2U	2.2U	2.2U	5.1U	8.9U	8.9U	9.3U	10.0U	10.0U	8.4U
Magnesium	NA	14000	14000	16600	12300	13500	13300					10700	15400	15300	34100	35500	41300			
Manganese	50	**[2270]**	**[2800]**	**[1050]**	**[777]**	**[52.6]**	**[109]**					**[81.7]**	9.8	**[411]**	**[3630]**	**[3600]**	**[3660]**			
Mercury	2	0.079U	0.080U	0.16U	0.056U	0.056U	0.056U					0.026U	0.026U	0.065J	0.079U	0.080U	0.16U			
Nickel	100	5.2J	4.4J	7.4J	5.6U	5.6U	5.6U					3.9J	3.8J	5.7J	2.2J	3.6J	3.8U			
Potassium	NA	2190	3000	2570	2710	2880	2820					2110	2400	2290	3220	3000	3220			
Selenium	40	4.8U	4.8U	4.7U	10.7U	10.7U	10.7U					6.9U	6.9U	7.5U	4.8U	4.8U	4.7U			
Silver	40	1.4U	1.4U	1.8U	2.2U	2.2U	2.2U					0.91U	0.91U	1.2U	1.4U	1.4U	1.8U			
Sodium	50000	**[70900]**	**[66500]**	**[76800]**	**[66000]**	**[68700]**	**[66700]**					**[57900]**	**[104000]**	**[94700]**	48800	46200	48700			
Thallium	2	9.5U	9.5U	8.9U	14.0U	14.0U	14.0U					4.2U	4.2U	5.7U	**[13.8J]**	9.5U	8.9U			
Vanadium	NA	1.7U	1.7U	1.7U	2.5U	2.5U	2.5U					0.96U	0.96U	1.3U	1.7U	1.7U	1.7U			
Zinc	2000	6.1J	19J	4.2J	33.5	10.8J	11.7J					9.8J	8.2J	30.4	4.9U	4.9U	6.9J			

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-120**											**MW-210**								
Sample Date		11/03/2005	05/31/2006	12/04/2006	06/04/2007	08/12/2008	06/30/2009	06/07/2010	06/15/2011	03/13/2012	05/29/2012	07/31/2012	01/31/2005	05/31/2005	10/27/2005	05/30/2006	11/06/2006	05/23/2007	12/17/2007	08/11/2008	11/05/2008
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200									80.1U	80.1U	74.3U								80.2U	80.2U
Antimony	6									5.8U	5.8U	3.5U								9.7U	9.7U
Arsenic	3									5.1U	5.1U	6.8U								10.2U	10.0U
Barium	2000									267	244	234								279	250
Beryllium	1									0.24U	0.24U	0.67U								0.90U	0.90U
Cadmium	4									0.77J	0.27U	0.36U								2.0U	2.0U
Calcium	NA									110000	104000	103000								166000	161000
Chromium	70									1.1U	2J	1.1U								3.0U	3.0U
Cobalt	NA					14.2	13.1	14.7	14.5	14.4	14.6	14.4								2.1U	2.1U
Copper	1300									0.94U	1.3J	2.1U								2.7U	2.7U
IRON	300									**[18300]**	**[3120]**	**[2160]**	**[24700]**	**[21300]**	**[6310]**	**[2580]**	**[501]**	**[26500]**	**[8260]**	**[27900]**	**[19800]**
Lead	5	8.4U	6.9U	6.9U	6.9U	6.9U	6.9U	6.9U	2.2U	3.0J	2.2U	5.1U								6.9U	**[35.0]**
Magnesium	NA									54600	54400	52000								172000	173000
Manganese	50									**[5190]**	**[5220]**	**[5020]**								**[548]**	**[501]**
Mercury	2									0.026U	0.026U	0.0081U								0.056U	0.056U
Nickel	100									6.1J	4.4J	5.5J								5.6U	5.6U
Potassium	NA									2970	3260	3490								88400	93400
Selenium	40									6.9U	6.9U	7.5U								10.7U	10.7U
Silver	40									0.91U	0.91U	1.2U								2.2U	2.2U
Sodium	50000									**[78700]**	**[74200]**	**[73400]**								**[1290000]**	**[1380000]**
Thallium	2					14.0U	**[14.2J]**	14.0U	**[4.7J]**	4.2U	4.2U	5.7U								14.0U	14.0U
Vanadium	NA									1.3J	0.96U	1.3U								4.0J	4.7J
Zinc	2000									4.6J	4.9J	5.7J								8.1U	8.1U

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

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Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**MW-210**						**MW-211**													**MW-233**
Sample Date		07/23/2009	11/23/2009	06/07/2010	09/22/2010	06/15/2011	03/13/2012	01/31/2005	05/31/2005	10/26/2005	05/24/2006	11/06/2006	05/23/2007	12/17/2007	06/23/2008	10/29/2008	05/19/2009	11/23/2009	06/07/2010	09/22/2010	06/01/2006
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200	80.2U	80.2U	80.2U	83.4U	87.8J	80.1U														
Antimony	6	9.7U	9.7U	9.7U	10.0U	5.8U	5.8U														
Arsenic	3	7.2U	7.2U	7.2U	9.8U	5.1U	5.1U														
Barium	2000	374	443	312	238	323	212														
Beryllium	1	1.4U	1.4U	1.4U	1.4U	0.24U	0.24U														
Cadmium	4	2.0U	2.0U	2.0U	2.0U	0.74J	0.39J														
Calcium	NA	174000	181000	157000	163000	161000	147000														
Chromium	70	3.4U	4.4J	3.4U	3.4U	1.1U	1.6J														
Cobalt	NA	2.1U	2.1U	2.1U	2.3U	0.62U	1.7J														
Copper	1300	2.7U	4.8J	13.9	2.7U	1.3J	0.94U														
IRON	300	**[41900]**	**[35100]**	**[27600]**	**[6400]**	**[22300]**	**[11400]**	**[9470]**	**[18600]**	**[46900]**	**[22900]**	**[42100]**	**[42000]**	**[27100]**	**[9630]**	216	**[29200]**	**[3880]**	**[9540]**	**[798]**	**[17000]**
Lead	5	6.9U	6.9U	6.9U	6.9U	2.2U	2.2U														
Magnesium	NA	172000	175000	131000	157000	109000	135000														
Manganese	50	**[617]**	**[567]**	**[1000]**	**[570]**	**[1220]**	**[592]**														
Mercury	2	0.084J	0.056U	0.056U	0.056U	0.026U	0.026U														
Nickel	100	2.7J	1.8U	1.8U	3.0U	0.95U	1.1J														
Potassium	NA	58000	71200	49700	63300	34500	49900														
Selenium	40	8.9U	8.9U	8.9U	8.9U	6.9U	6.9U														
Silver	40	2.3U	2.3U	2.3U	2.3U	0.91U	0.91U														
Sodium	50000	**[1310000]**	**[1410000]**	**[1030000]**	**[1270000]**	**[800000]**	**[1190000]**														
Thallium	2	14.0U	14.0U	14.0U	14.0U	4.2U	4.2U														
Vanadium	NA	2.5U	5.5	2.5U	2.5U	0.96U	0.96U														
Zinc	2000	8.1U	8.1U	8.1U	8.1U	3.2U	3.2U														

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

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NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS	MW-233												MW-240						
Sample Date		12/11/2006	05/23/2007	12/18/2007	06/23/2008	11/10/2008	05/28/2009	11/19/2009	05/13/2010	09/23/2010	03/20/2012	05/24/2012	07/25/2012	11/30/2006	05/10/2007	12/05/2007	07/28/2008	10/29/2008	05/26/2009	10/26/2009
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200										80.1U	80.1U	74.3U	121J	92.3J	80.2U	**[341]**	**[437]**		
Antimony	6										5.8U	5.8U	3.5U	9.7U	9.7U	9.7U	9.7U	9.7U		
Arsenic	3										**[6.9J]**	**[6.1J]**	**[14.4J]**	10U	**[11.7J]**	10.0U	10.2U	10.0U	7.2U	7.2U
Barium	2000										151	175	203	2.3J	46.6	63.9	60.4	4.0J		
Beryllium	1										0.24U	0.24U	0.67U	0.94U	0.94U	0.90U	0.90U	0.90U		
Cadmium	4										0.27U	1.7J	0.36U	0.91U	0.91U	0.90U	2.0U	2.0U		
Calcium	NA										59700	63400	78600	136000	144000	154000	150000	8430		
Chromium	70										1.3J	1.1U	1.6J	2.3U	4.9J	2.3U	3.0U	3.0U		
Cobalt	NA										0.62U	0.62U	0.66U	2.1U	2.1U	2.1U	2.1U	2.1U		
Copper	1300										2.3J	0.94U	2.1U	4.6J	2.2U	3.9J	6.3J	10.7		
IRON	300	**[3520]**	**[15500]**	**[5740]**	**[13400]**	**[17700]**	**[12400]**	**[12600]**	**[15800]**	**[17800]**	**[21000]**	**[17100]**	**[25000]**	**[4160]**	**[7960]**	**[642]**	**[2480]**	86.2J	**[2180]**	**[378]**
Lead	5										2.2U	2.2U	5.1U	6.9U	6.9U	6.9U	6.9U	6.9U		
Magnesium	NA										18200	18600	24900	35600	39400	41800	39800	672		
Manganese	50										**[1420]**	**[1630]**	**[1910]**	**[4510]**	**[5530]**	**[5200]**	**[5560]**	29.1		
Mercury	2										0.037J	0.026U	0.012J	0.061J	0.056U	0.056U	0.056U	0.056U		
Nickel	100										0.95U	0.95U	1.4J	5.6U	5.6U	5.6U	5.6U	5.6U		
Potassium	NA										6170	7270	8340	3600	7070	10200	3080	19000		
Selenium	40										6.9U	6.9U	7.5U	9.4U	9.4U	9.4U	10.7U	10.7U		
Silver	40										0.91U	0.91U	1.2U	1.6U	2.0J	1.6U	2.2U	2.2U		
Sodium	50000										**[113000]**	**[107000]**	**[161000]**	**[81300]**	**[79700]**	**[96000]**	**[84200]**	**[88600]**		
Thallium	2										**[5.4J]**	4.2U	5.7U	13.5U	13.5U	10.5U	14.0U	14.0U		
Vanadium	NA										1.4J	1.1J	3.5J	1.5U	1.5U	1.9J	2.5U	2.5U		
Zinc	2000										3.2U	3.2U	2.0U	17.2J	21	43.4	11.8J	260		

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	NJDEP GWQS		MW-240	MW-322			MW-323			MW-324			MW-325				MW-326			MW
Sample Date		06/22/2011	03/14/2012	03/14/2012	05/16/2012	07/30/2012	03/14/2012	05/16/2012	07/30/2012	03/12/2012	05/17/2012	07/30/2012	3/12/2012	03/12/2012	05/17/2012	07/26/2012	03/12/2012	05/23/2012	07/26/2012	03/13/2012
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200			**[388]**	99.8J	74.3U	148J	98.4J	**[296]**	**[946]**	**[3340]**	**[1490]**	100J	145J	80.1U	74.3U	**[2170]**	**[835J]**	167J	**[451]**
Antimony	6			5.8U	5.8U	3.5U	5.8U	5.8U	3.5U	5.8U	5.8U	5.9J	5.8U	5.8U	5.8U	3.5U	5.8U	5.8U	4.7J	5.8U
Arsenic	3	5.1U	5.1U	**[23.1]**	**[16.8J]**	**[14.2J]**	**[6.2J]**	5.1U	6.8U	**[36.8]**	5.1U	**[11.8J]**	**[7.6J]**	5.1U	5.1U	6.8U	**[36.1J]**	**[44.8J]**	34.0U	5.1U
Barium	2000			54.4	75.5	115	135	138	116	667	404	367	737	733	733	714	310	227	181	112
Beryllium	1			0.24U	0.24U	0.67U	0.24U	0.24U	0.67U	0.24U	0.24U	0.67U	0.24U	0.24U	0.24U	0.67U	0.24U	0.24U	0.67U	0.24U
Cadmium	4			1.4J	0.27U	0.36U	0.65J	0.53J	0.36U	3.1J	3.9J	0.36U	0.27U	0.27U	0.27U	0.36U	**[6.5]**	**[19.8]**	**[5.9]**	0.27U
Calcium	NA			83000	84600	140000	213000	216000	217000	185000	175000	166000	61500	62700	58100	58900	216000	191000	166000	129000
Chromium	70			5.2J	5.1J	4.2J	1.1J	1.6J	2.6J	4.9J	9.6J	8.2J	1.4J	1.5J	1.1U	1.1U	6.8J	4.9J	3.8J	1.2J
Cobalt	NA			1.7J	0.62U	0.66U	1.9J	1.4J	2.7J	99.9	238	306	0.62U	0.62U	0.62U	0.66U	66.1	74.9	70.4	1.3J
Copper	1300			3.1J	0.94U	8.4J	0.97J	0.94U	6.5J	3.4J	9.8J	39.5	1.2J	1.3J	0.94U	2.1U	3.6J	0.94U	2.1U	2.0J
IRON	300			**[55700]**	**[67300]**	**[91900]**	**[29500]**	**[29400]**	**[28600]**	**[144000]**	**[292000]**	**[391000]**	**[3100]**	**[3160]**	**[3260]**	**[3600]**	**[288000]**	**[367000]**	**[343000]**	**[765]**
Lead	5			3.2J	11.0U	**[8.9J]**	2.2U	2.2U	5.1U	**[6.4J]**	**[8.4J]**	**[16.4]**	2.2U	2.2U	4.3J	5.1U	**[14.0J]**	2.2U	**[5.2J]**	2.2U
Magnesium	NA			78600	87500	100000	48300	49000	49400	155000	133000	129000	65400	66000	63800	64500	156000	146000	127000	28900
Manganese	50			**[886]**	**[784]**	**[1520]**	**[2160]**	**[2200]**	**[2160]**	**[5110]**	**[12600]**	**[18600]**	**[367]**	**[373]**	**[344]**	**[335]**	**[46000]**	**[50500]**	**[44900]**	**[1880]**
Mercury	2			0.026U	0.026U	0.0081U	0.026U	0.026U	0.0081U	0.026U	0.026U	0.0081U	0.026U	0.026U	0.026U	0.0081U	0.026U	0.026U	0.0081U	0.026U
Nickel	100			16.7	11.4	1.1U	5.3J	6.8J	5.8J	38.4	71.8	91.6	1.3J	0.95U	0.95U	1.1U	19.7	11.9	12.4	3.0J
Potassium	NA			36200	36400	32100	4370	3960	5070	29000	21600	17900	25100	25400	27000	24800	14300	7860	6110	2450
Selenium	40			6.9U	6.9U	7.5U	6.9U	6.9U	7.5U	21.9	**[51.5]**	7.5U	6.9U	6.9U	32.9	7.5U	**[50.5]**	16.7J	24	6.9U
Silver	40			0.91U	0.95J	1.2U	0.91U	1.0J	1.2U	1.3J	2.3J	1.2U	0.91U	0.91U	0.91U	1.2U	5.8	5.9	10.1	0.91U
Sodium	50000			**[455000]**	**[470000]**	**[549000]**	**[131000]**	**[119000]**	**[141000]**	**[1280000]**	**[802000]**	**[764000]**	**[260000]**	**[269000]**	**[252000]**	**[270000]**	**[846000]**	**[545000]**	**[464000]**	32800
Thallium	2			**[5.1J]**	**[8.7J]**	**[12.2J]**	4.2U	**[6.4J]**	5.7U	4.2U	4.2U	**[46.5]**	4.2U	4.2U	4.2U	5.7U	4.2U	21.0U	28.5U	4.2U
Vanadium	NA			11.5	9.3	7.5	0.96U	0.96U	5.5	7.3	14.6	3.1J	0.96U	0.96U	0.96U	1.3U	15.7	12.3	8.6	2.0J
Zinc	2000			11.2J	8.3J	4.2J	7.3J	6.9J	8.1J	134	281	324	3.2U	3.2U	3.2U	2.0U	74.5	27.5	2.0U	7.5J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-3
HISTORICAL ANALYTICAL GROUND WATER SAMPLING RESULTS FOR METALS – CAMU AREA
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

Location	**NJDEP GWQS**	**-327**	**MW-327**	**MW-328**			**MW-333**		**MW-334**		**RW-02**										
Sample Date		05/18/2012	07/31/2012	03/20/2012	05/23/2012	07/25/2012	05/16/2012	07/24/2012	05/17/2012	07/31/2012	09/21/2004	05/26/2005	10/25/2005	05/24/2006	11/30/2006	05/14/2007	08/12/2008	05/26/2009	06/22/2011	03/14/2012	09/16/2003
Parameter Name		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Aluminum	200	80.1U	74.3U	**[415]**	80.1U	74.3U	178J	98.3J	128J	74.3U							**[200]**				135J
Antimony	6	29.0U	3.5U	5.8U	5.8U	3.5U	5.8U	3.5U	5.8U	3.5U							9.7U				8.5U
Arsenic	3	5.1U	6.8U	**[8.1J]**	5.1U	6.8U	**[18.2J]**	**[33.9]**	5.1U	**[12.6J]**							10.2U	7.2U	5.1U	5.1U	4.9U
Barium	2000	155	124	136	113	108	193	396	207	233							380				567
Beryllium	1	0.24U	0.67U	0.24U	0.24U	0.67U	0.24U	0.67U	0.24U	0.67U							0.90U				0.34U
Cadmium	4	0.27U	0.36U	0.27U	0.80J	0.36U	0.36J	0.36U	0.41J	0.36U							2.0U				0.87U
Calcium	NA	150000	150000	124000	146000	156000	146000	123000	106000	167000							75700				104000
Chromium	70	1.1U	1.1U	2.2J	1.9J	1.3J	2.0J	2.0J	2.3J	4.0J							3.0U				2.2U
Cobalt	NA	1.8J	1.9J	1.9J	2.1J	1.7J	1.3J	2.0J	0.95J	1.8J							2.1U				1.6U
Copper	1300	3.4J	2.1U	7.2J	0.94U	2.1U	1.7J	2.1U	1.5J	2.1U							2.7U				2.1U
IRON	300	**[1280]**	**[952]**	**[13300]**	**[10700]**	**[12900]**	**[41600]**	**[27600]**	**[103000]**	**[71900]**	**[17500]**	**[13400]**	**[15300]**	**[15900]**	**[9340]**	**[16200]**	**[11600]**	**[14000]**			**[19500]**
Lead	5	3.5J	5.1U	2.5J	2.2U	5.1U	2.2U	5.1U	2.2U	5.1U							6.9U	6.9U	**[6.0J]**	2.2U	9.3U
Magnesium	NA	33100	32200	32600	37600	39500	90700	76500	182000	313000							14700				25000
Manganese	50	**[2230]**	**[2120]**	**[2670]**	**[2950]**	**[2950]**	**[517]**	**[352]**	**[586]**	**[1860]**							**[2270]**				**[3370]**
Mercury	2	0.026U	0.0081U	0.038J	0.026U	0.0081U	0.026U	0.070J	0.026U	0.0081U							0.056U				0.16U
Nickel	100	1.8J	2.9J	2.4J	0.95U	1.1U	6.3J	1.3J	0.95U	1.1U							5.6U				3.8U
Potassium	NA	2490	3050	6020	5370	4550	27200	30000	40900	104000							5580				6070
Selenium	40	38.6	7.5U	6.9U	6.9U	7.5U	6.9U	7.5U	6.9U	7.5U							10.7U				4.7U
Silver	40	0.91U	1.2U	0.91U	0.91U	1.2U	1.0J	1.2U	0.91U	1.2U							2.2U				1.8U
Sodium	50000	38900	38900	**[74100]**	**[69100]**	**[76200]**	**[481000]**	**[477000]**	**[2080000]**	**[2600000]**							**[147000]**				**[141000]**
Thallium	2	4.2U	5.7U	**[4.3J]**	4.2U	5.7U	**[6.1J]**	5.7U	4.2U	5.7U							14.0U				8.9U
Vanadium	NA	0.96U	1.3U	1.7J	1.2J	1.3U	1.8J	1.5J	2.4J	2.4J							2.6J				1.7U
Zinc	2000	12.8J	5.8J	4.5J	3.2U	2.0U	7.4J	3.0J	7.1J	7.5J							14.9J				8.3J

Notes:
NJDEP GWQS - NJ GW Higher of PQL & GW Quality Criterion

Bold, Shaded and Brackets indicates exceedance to NJDEP GWQS
NA - No Criteria Available for the Analyte

Table I-4
MONITORING WELL CONSTRUCTION DETAIL - CAMU AREA
Final Design Report - CAMU
Chevron Perth Amboy Refinery, NJ

Monitoring Well	Well Cluster # in CAMU Application	Zone	Installation Date	Monitoring Well Diameter (inch)	Monitoring Well Type - Flushmount or Stick-up	Monitoring Well Casing and Screen Material	Top of PVC Screen (Ft bgs)	Bottom of PVC Screen (Ft bgs)	Monitoring Well Depth (Ft bgs)
MW-114	Cluster 1	Shallow	7/17/2002	4	Flushmount	PVC	1.5	12	13
MW-115	Cluster 1	Deep	7/18/2002	4	Flushmount	PVC	17	22	23
MW-324	Cluster 2	Shallow	12/6/2011	4	Flushmount	PVC	9	19	20
MW-325	Cluster 2	Deep	12/6/2011	4	Flushmount	PVC	36	41	42
MW-0057	Cluster 3	Shallow	2/22/2000	2	Flushmount	PVC	1	16	17
MW-326	Cluster 3	Deep	11/28/2011	4	Flushmount	PVC	20	25	26
MW-120	Cluster 4	Shallow	7/16/2002	4	Flushmount	PVC	1	11	12
MW-327	Cluster 4	Deep	11/30/2011	4	Flushmount	PVC	18	23	24
MW-322	Cluster 5	Shallow	1/6/2012	4	Flushmount	PVC	8.5	18.5	19.5
MW-323	Cluster 5	Deep	1/6/2012	4	Flushmount	PVC	37	42	43
MW-233	Cluster 6	Shallow	4/7/2006	4	Flushmount	PVC	1	6	7
MW-328	Cluster 6	Deep	11/28/2011	4	Flushmount	PVC	23	28	29
MW-211	Not Proposed	Shallow	12/17/2004	4	Stick-up	PVC	1	8	9
MW-333	Not Proposed	Shallow	3/14/2012	4	Stick-up	PVC	2	10.5	11
MW-334	Not Proposed	Shallow	3/14/2012	4	Stick-up	PVC	5	15	16

Note:
PVC - Poly vinyl chloride
in - inch
Ft bgs - Feet Below grade surface

Table I-5
PROPOSED LEACHATE MONITORING PROGRAM
CAMU Final Design Report
Chevron Perth Amboy Refinery, NJ

Sump #	CAMU Cell #	Proposed Analytical Parameter	Frequency
1 and 2	Cell 1	TCL VOCs, TCL SVOCs, TAL Metals, Ammonia-Nitrogen pH and DO	Quarterly (after construction of CAMU)
3 and 4	Cell 2	TCL VOCs, TCL SVOCs, TAL Metals, Ammonia-Nitrogen pH and DO	Quarterly (after construction of CAMU)
5 and 6	Cell 3	TCL VOCs, TCL SVOCs, TAL Metals, Ammonia-Nitrogen pH and DO	Quarterly (after construction of CAMU)

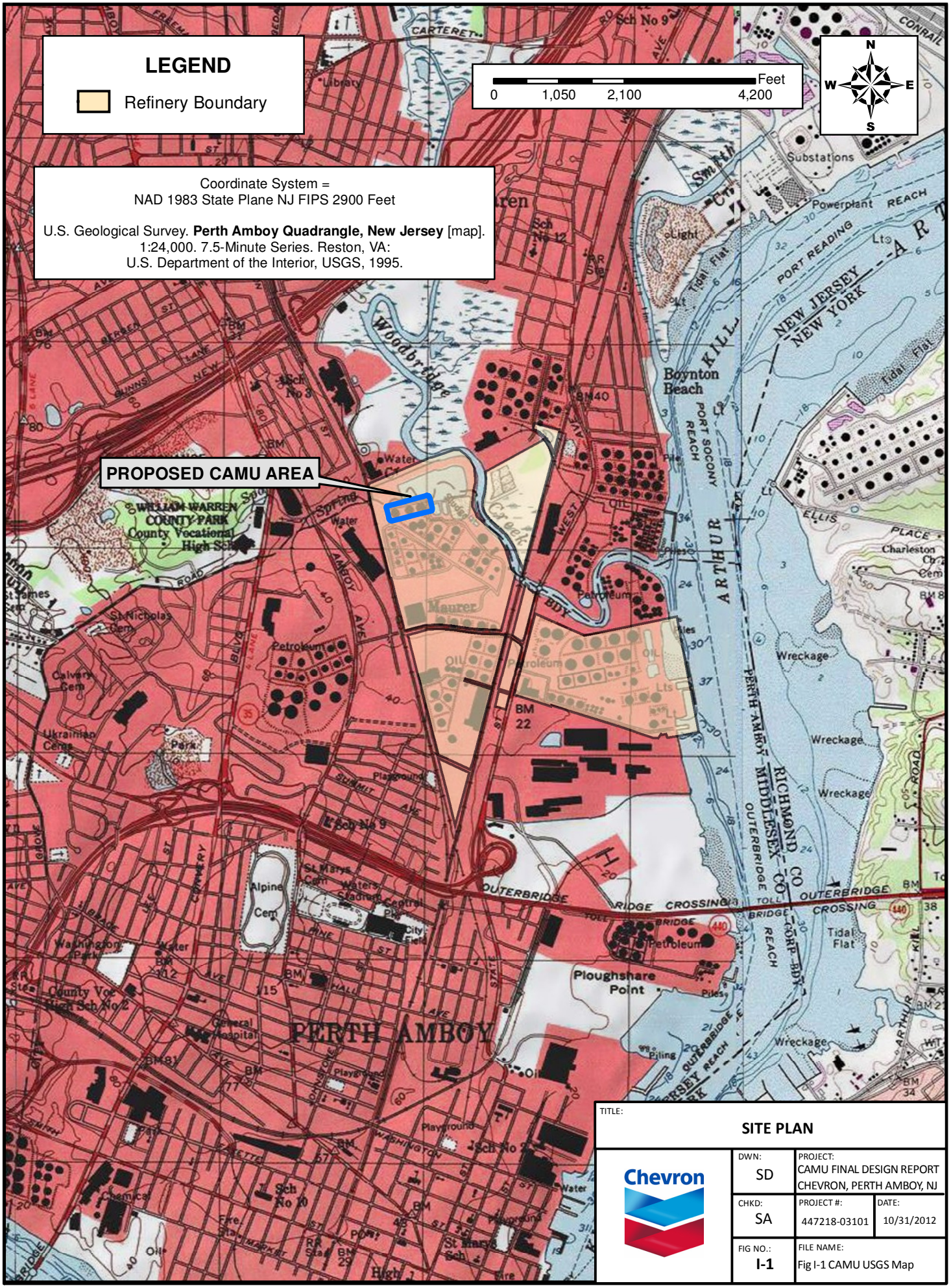
Table I-6
PROPOSED GROUND WATER MONITORING PROGRAM
CAMU Final Design Report
Chevron Perth Amboy Refinery, NJ

Monitoring Well	Well Cluster # in CAMU Application	Shallow/Deep Zone	Monitoring Well Screen Interval (ft TPVC)	Proposed Pump Intake Depth (ft TPVC)	Frequency	Proposed Analytical Parameters	Rationale
MW-114	Cluster 1	Shallow	1.5-12	8	Quarterly (*)	Target Compound List (TCL) VOCs+ Tentatively Identified Compounds (TICs), TCL SVOCs +TICs, Target Analyte List Metals (**) Ammonia- Nitorgen DO, pH, and ORP	To monitor shallow zone groundwater quality upgradient of CAMU area.
MW-115	Cluster 1	Deep	17-22	20			To monitor deep zone groundwater quality upgradient of CAMU area.
MW-324	Cluster 2	Shallow	9-19	13			Compliance well to monitor shallow zone groundwater quality downgradient of CAMU area.
MW-325	Cluster 2	Deep	36-41	38			Compliance well to monitor deep zone groundwater quality downgradient of CAMU area.
MW-0057	Cluster 3	Shallow	1-16	8			Compliance well to monitor shallow zone groundwater quality downgradient of CAMU area.
MW-326	Cluster 3	Deep	20-25	22			Compliance well to monitor deep zone groundwater quality downgradient of CAMU area.
MW-120	Cluster 4	Shallow	1-11	5			To monitor shallow zone groundwater quality crossgradient of CAMU area.
MW-327	Cluster 4	Deep	18-23	21			To monitor shallow zone groundwater quality crossgradient of CAMU area.
MW-322	Cluster 5	Shallow	8.5-18.5	13			To monitor shallow zone groundwater quality upgradient of CAMU area.
MW-323	Cluster 5	Deep	37-42	40			To monitor deep zone groundwater quality upgradient of CAMU area.
MW-233	Cluster 6	Shallow	1-6	5.5			To monitor shallow zone groundwater quality upgradient of CAMU area.
MW-328	Cluster 6	Deep	23-28	25			To monitor deep zone groundwater quality upgradient of CAMU area.
MW-211	--	Shallow	1-8	5			To monitor shallow zone groundwater quality downgradient of CAMU Cell 1 until Cell 2 is constructed.
MW-333	--	Shallow	2-10.5	8			To monitor shallow zone groundwater quality downgradient of CAMU Cell 1 until Cell 2 is constructed.
MW-334	--	Shallow	5-15	8			To monitor shallow zone groundwater quality downgradient of CAMU Cell 2 until Cell 3 is constructed.

Notes:
* - The six monitoring well clusters identified in the 2011 CAMU Application and listed above will be sampled on a quarterly basis for at least two years after initiation of waste disposal in Cell 1. The frequency of monitoring will be be revisited after analyzing two years of monitoring data. It is expected that MW-211 and MW-333 will be removed during Cell 2 construction and MW-334 will be removed during Cell 3 construction.
** - Trip blank will be collected only for TCL VOCs at a rate of 1 per sampling cooler.
** - Matrix spike (MS), MS duplicate (MSD), field duplicate, equipment blanks will be collected for TCL VOCs, TCL SVOCs and TAL Metals at a rate of 1 per 20 samples.
-- Not Applicable.

APPENDIX I

FIGURES



TITLE:

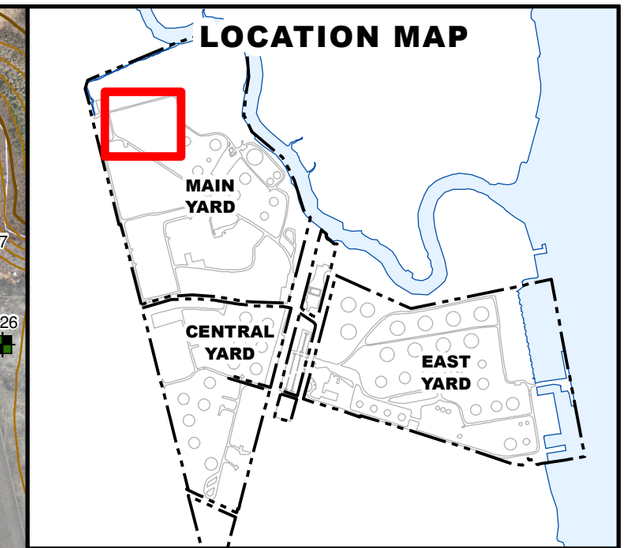
SITE PLAN

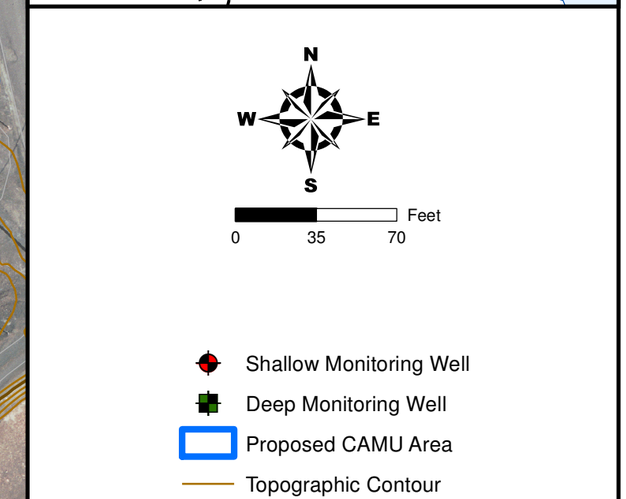
Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: I-1	FILE NAME: Fig I-1 CAMU USGS Map	

TITLE: AERIAL PHOTO OF SITE

Chevron	DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
	CHKD: SA	PROJECT #: 447218-03101 / DATE: 10/31/2012
	FIG NO.: I-2	FILE NAME: Fig I-2 CAMU Site Aerial





TITLE:

EXISITING CONDITIONS IN CAMU AREA

Chevron

DWN: MTK	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: JS	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: I-3	FILE NAME: Fig I-3 CAMU Current Conditions	

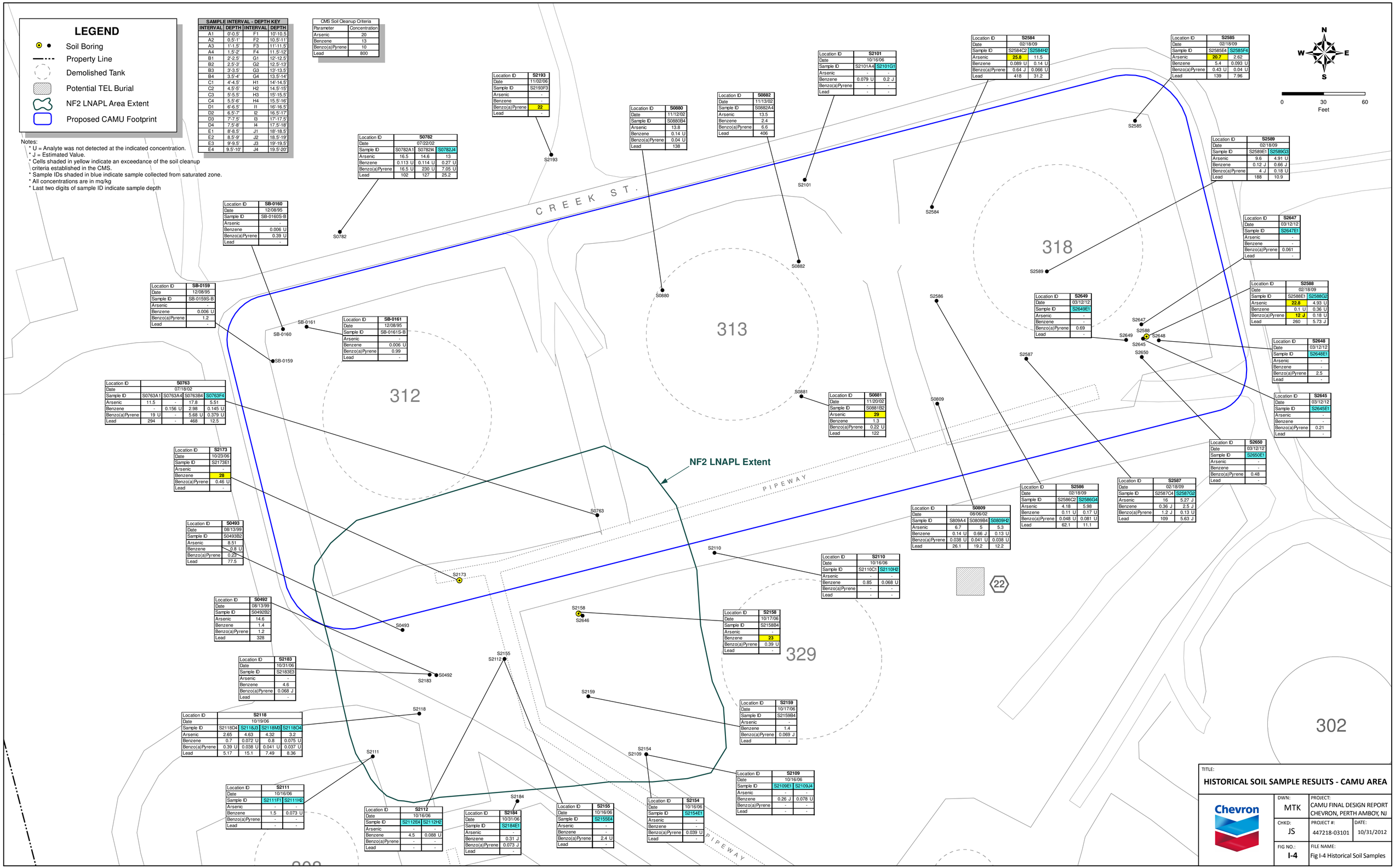
LEGEND

- Soil Boring
- Property Line
- Demolished Tank
- Potential TEL Burial
- NF2 LNAPL Area Extent
- Proposed CAMU Footprint

Notes:
* U = Analyte was not detected at the indicated concentration.
* J = Estimated Value.
* Cells shaded in yellow indicate an exceedance of the soil cleanup criteria established in the CMS.
* Sample IDs shaded in blue indicate sample collected from saturated zone.
* All concentrations are in mg/kg
* Last two digits of sample ID indicate sample depth

SAMPLE INTERVAL - DEPTH KEY			
INTERVAL	DEPTH	INTERVAL	DEPTH
A1	0'-0.5'	F1	10'-10.5
A2	0.5'-1'	F2	10.5'-11'
A3	1'-1.5'	F3	11'-11.5'
A4	1.5'-2'	F4	11.5'-12'
B1	2'-2.5'	G1	12'-12.5'
B2	2.5'-3'	G2	12.5'-13'
B3	3'-3.5'	G3	13'-13.5'
B4	3.5'-4'	G4	13.5'-14'
C1	4'-4.5'	H1	14'-14.5'
C2	4.5'-5'	H2	14.5'-15'
C3	5'-5.5'	H3	15'-15.5'
C4	5.5'-6'	H4	15.5'-16'
D1	6'-6.5'	I1	16'-16.5'
D2	6.5'-7'	I2	16.5'-17'
D3	7'-7.5'	I3	17'-17.5'
D4	7.5'-8'	I4	17.5'-18'
E1	8'-8.5'	J1	18'-18.5'
E2	8.5'-9'	J2	18.5'-19'
E3	9'-9.5'	J3	19'-19.5'
E4	9.5'-10'	J4	19.5'-20'

CMS Soil Cleanup Criteria	
Parameter	Concentration
Arsenic	20
Benzene	13
Benzo(a)Pyrene	10
Lead	800



Location ID	S2193
Date	11/02/06
Sample ID	S2193F3
Arsenic	-
Benzene	
Benzo(a)Pyrene	22
Lead	-

Location ID	S0880
Date	11/12/02
Sample ID	S0880B4
Arsenic	13.8
Benzene	0.14 U
Benzo(a)Pyrene	0.04 U
Lead	138

Location ID	S0882	
Date	11/13/02	
Sample ID	S0882A4	
Arsenic	13.5	
Benzene	2.4	
Benzo(a)Pyrene	6.6	
Lead	406	

Location ID	S2101	
Date	10/16/06	
Sample ID	S2101A4	S2101G1
Arsenic	-	-
Benzene	0.079 U	0.2 J
Benzo(a)Pyrene	-	-
Lead	-	-

Location ID	S2584	
Date	02/18/09	
Sample ID	S2584C2	S2584H2
Arsenic	25.8	11.5
Benzene	0.089 U	0.14 U
Benzo(a)Pyrene	0.64 J	0.066 U
Lead	418	31.2

Location ID	S2585	
Date	02/18/09	
Sample ID	S2585E4	S2585F4
Arsenic	20.7	2.62
Benzene	5.4	0.093 U
Benzo(a)Pyrene	0.43 U	0.04 U
Lead	139	7.96

Location ID	S2589	
Date	02/18/09	
Sample ID	S2589E1	S2589G3
Arsenic	9.6	4.91 U
Benzene	0.12 J	0.66 J
Benzo(a)Pyrene	4 J	0.18 U
Lead	188	10.9

Location ID	S2647
Date	03/12/12
Sample ID	S2647E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	0.061
Lead	-

Location ID	S2588	
Date	02/18/09	
Sample ID	S2588E1	S2588G2
Arsenic	22.8	4.93 U
Benzene	0.1 U	0.36 U
Benzo(a)Pyrene	12 J	0.18 U
Lead	260	5.73 J

Location ID	S2649
Date	03/12/12
Sample ID	S2649E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	0.69
Lead	-

Location ID	S2648
Date	03/12/12
Sample ID	S2648E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	2.5
Lead	-

Location ID	S2645
Date	03/12/12
Sample ID	S2645E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	0.21
Lead	-

Location ID	S2650
Date	03/12/12
Sample ID	S2650E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	0.48
Lead	-

Location ID	S2587	
Date	02/18/09	
Sample ID	S2587C4	S2587G2
Arsenic	16	5.27 J
Benzene	0.36 J	2.5 J
Benzo(a)Pyrene	1.2 J	0.13 U
Lead	109	5.63 J

Location ID	S2586	
Date	02/18/09	
Sample ID	S2586C2	S2586G4
Arsenic	4.18	5.98
Benzene	0.11 U	0.17 U
Benzo(a)Pyrene	0.048 U	0.081 U
Lead	62.1	11.1

Location ID	S0809		
Date	08/06/02		
Sample ID	S809A4	S0809B4	S0809H2
Arsenic	6.7	5	5.3
Benzene	0.14 U	0.66 J	0.13 U
Benzo(a)Pyrene	0.038 U	0.041 U	0.038 U
Lead	26.1	19.2	12.2

Location ID	S0881
Date	11/20/02
Sample ID	S0881B2
Arsenic	29
Benzene	1.3
Benzo(a)Pyrene	0.22 U
Lead	122

Location ID	S0782		
Date	07/22/02		
Sample ID	S0782A1	S0782I4	S0782J4
Arsenic	16.5	14.6	13
Benzene	0.113 U	0.114 U	0.27 U
Benzo(a)Pyrene	16.5 U	230 U	7.05 U
Lead	102	127	25.2

Location ID	SB-0160
Date	12/08/95
Sample ID	SB-0160S-B
Arsenic	
Benzene	0.006 U
Benzo(a)Pyrene	0.39 U
Lead	-

Location ID	SB-0159
Date	12/08/95
Sample ID	SB-0159S-B
Arsenic	-
Benzene	0.006 U
Benzo(a)Pyrene	1.2
Lead	-

Location ID	SB-0161
Date	12/08/95
Sample ID	SB-0161S-B
Arsenic	
Benzene	0.006 U
Benzo(a)Pyrene	0.99
Lead	-

Location ID	S0763			
Date	07/18/02			
Sample ID	S0763A1	S0763A4	S0763B4	S0763F4
Arsenic	11.5	-	17.8	5.51
Benzene		0.156 U	2.98	0.145 U
Benzo(a)Pyrene	19 U	-	5.68 U	0.379 U
Lead	294	-	468	12.5

Location ID	S2173
Date	10/23/06
Sample ID	S2173E1
Arsenic	-
Benzene	28
Benzo(a)Pyrene	0.46 U
Lead	-

Location ID	S0493
Date	08/13/99
Sample ID	S0493B2
Arsenic	8.51
Benzene	0.8 U
Benzo(a)Pyrene	0.23
Lead	77.5

Location ID	S0492
Date	08/13/99
Sample ID	S0492B2
Arsenic	14.6
Benzene	1.4
Benzo(a)Pyrene	1.2
Lead	328

Location ID	S2183
Date	10/31/06
Sample ID	S2183E3
Arsenic	-
Benzene	4.6
Benzo(a)Pyrene	0.068 J
Lead	-

Location ID	S2118			
Date	10/19/06			
Sample ID	S2118D4	S2118J3	S2118M3	S2118O4
Arsenic	2.65	4.63	4.32	3.2
Benzene	0.7	0.072 U	0.8	0.075 U
Benzo(a)Pyrene	0.39 U	0.038 U	0.041 U	0.037 U
Lead	5.17	15.1	7.49	8.36

Location ID	S2111	
Date	10/16/06	
Sample ID	S2111F1	S2111H2
Arsenic	-	-
Benzene	1.5	0.073 U
Benzo(a)Pyrene	-	-
Lead	-	-

Location ID	S2112	
Date	10/16/06	
Sample ID	S2112E4	S2112H2
Arsenic	-	-
Benzene	4.5	0.088 U
Benzo(a)Pyrene	-	-
Lead	-	-

Location ID	S2184
Date	10/31/06
Sample ID	S2184E1
Arsenic	-
Benzene	0.31 J
Benzo(a)Pyrene	0.073 J
Lead	-

Location ID	S2155
Date	10/16/06
Sample ID	S2155E4
Arsenic	-
Benzene	-
Benzo(a)Pyrene	2.4 U
Lead	-

Location ID	S2154
Date	10/16/06
Sample ID	S2154E1
Arsenic	-
Benzene	-
Benzo(a)Pyrene	0.039 U
Lead	-

Location ID	S2110	
Date	10/16/06	
Sample ID	S2110C1	S2110H2
Arsenic	-	-
Benzene	0.85	0.068 U
Benzo(a)Pyrene		
Lead	-	-

Location ID	S2158
Date	10/17/06
Sample ID	S2158B4
Arsenic	-
Benzene	23
Benzo(a)Pyrene	0.39 U
Lead	-

Location ID	S2159
Date	10/17/06
Sample ID	S2159B4
Arsenic	-
Benzene	1.4
Benzo(a)Pyrene	0.069 J
Lead	-

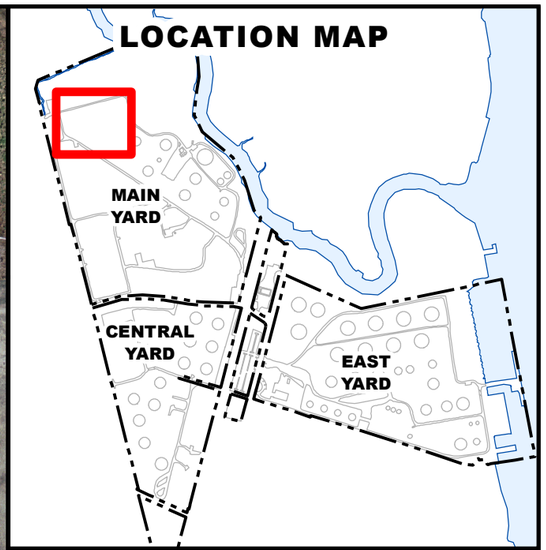
Location ID	S2109	
Date	10/16/06	
Sample ID	S2109E1	S2109J4
Arsenic	-	-
Benzene	0.26 J	0.078 U
Benzo(a)Pyrene	-	-
Lead	-	-

TITLE:
HISTORICAL SOIL SAMPLE RESULTS - CAMU AREA

Chevron

DWN:	PROJECT:
MTK	CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ
CHKD: JS	PROJECT #: 447218-03101 / DATE: 10/31/2012
FIG NO.: I-4	FILE NAME: Fig I-4 Historical Soil Samples

LOCATION MAP



N
W E
S

0 35 70 Feet

- Shallow Monitoring Well
- Deep Monitoring Well
- OWSS (See Note)
- Proposed CAMU Area
- Excavation Extent

NOTE:
OWSS LINE WITHIN CAMU FOOTPRINT WAS REMOVED IN 2012.

TITLE:

LNAPL EXCAVATION AREAS

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: I-5	FILE NAME: Fig I-5 LNAPL Exc Area	

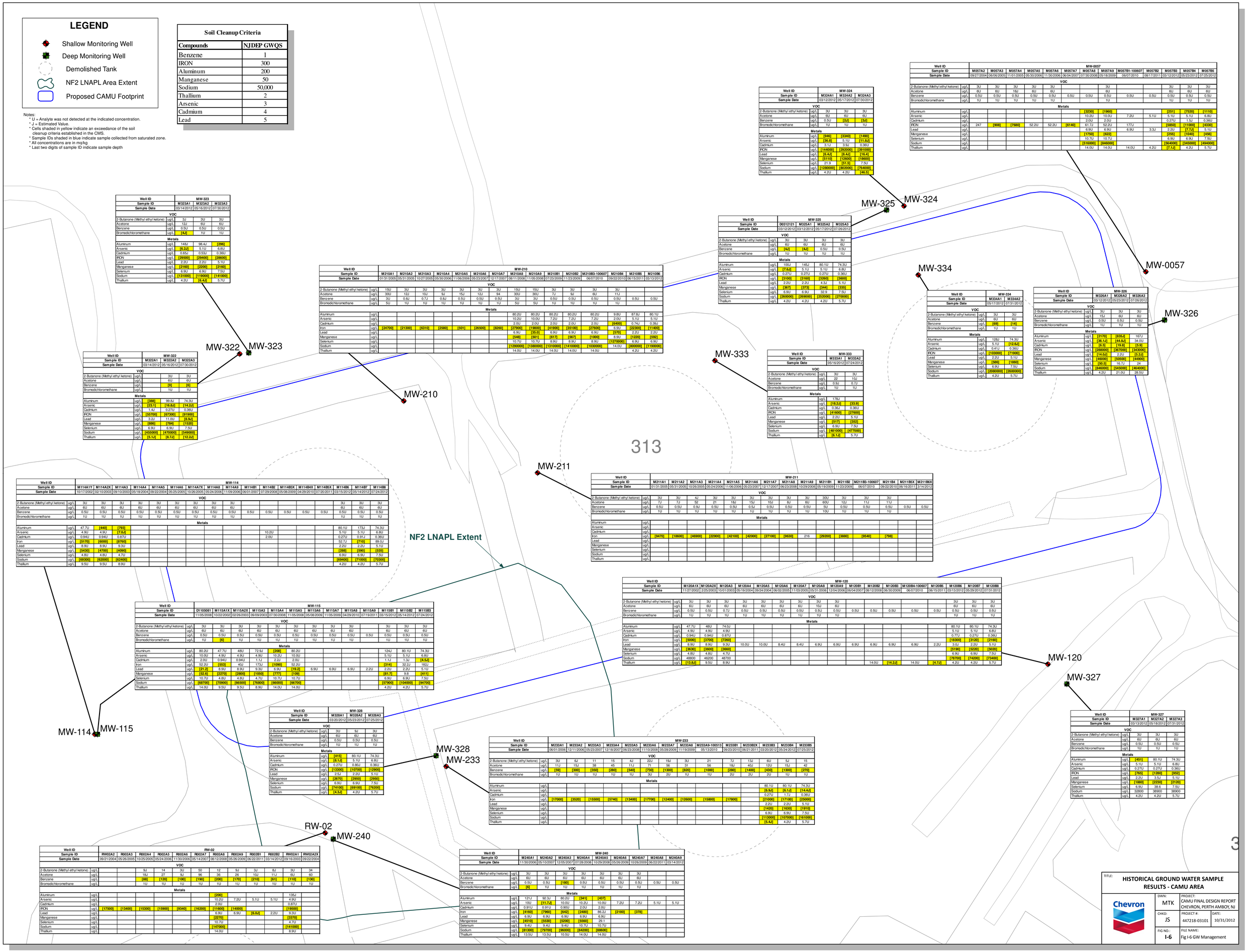
LEGEND

- Shallow Monitoring Well
- Deep Monitoring Well
- Demolished Tank
- NF2 LNAPL Area Extent
- Proposed CAMU Footprint

Notes:
* U = Analyte was not detected at the indicated concentration.
* J = Estimated Value.
* Cells shaded in yellow indicate an exceedance of the soil cleanup criteria established in the CMS.
* Sample IDs shaded in blue indicate sample collected from saturated zone.
* All concentrations are in mg/kg
* Last two digits of sample ID indicate sample depth

Soil Cleanup Criteria

Compounds	NJDEP GWQS
Benzene	1
IRON	300
Aluminum	200
Manganese	50
Sodium	50,000
Thallium	2
Arsenic	3
Cadmium	4
Lead	5



Well ID	MW-323		
Sample ID	M323A1	M323A2	M323A3
Sample Date	03/14/2012	05/16/2012	07/30/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L	3J	3U	3U
Acetone ug/L	12J	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	[4J]	1U	1U
Metals			
Aluminum ug/L	148J	98.4J	[296]
Arsenic ug/L	[6.2J]	5.1U	6.8U
Cadmium ug/L	0.65J	0.53J	0.36U
IRON ug/L	[29300]	[29400]	[28600]
Lead ug/L	2.2U	2.2U	5.1U
Manganese ug/L	[2160]	[2200]	[2160]
Selenium ug/L	6.9U	6.9U	7.5U
Sodium ug/L	[131000]	[119000]	[141000]
Thallium ug/L	4.2U	[5.4J]	5.7U

Well ID	MW-322		
Sample ID	M322A1	M322A2	M322A3
Sample Date	03/14/2012	05/16/2012	07/30/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L		3U	3U
Acetone ug/L		6U	6U
Benzene ug/L		[9]	[6]
Bromodichloromethane ug/L		1U	1U
Metals			
Aluminum ug/L	[388]	99.8J	74.3U
Arsenic ug/L	[23.1]	[16.8J]	[14.2J]
Cadmium ug/L	1.4J	0.27U	0.36U
IRON ug/L	[55700]	[67300]	[91900]
Lead ug/L	3.2J	11.0U	[8.9J]
Manganese ug/L	[886]	[784]	[1320]
Selenium ug/L	6.9U	6.9U	7.5U
Sodium ug/L	[455000]	[470000]	[549000]
Thallium ug/L	[5.1J]	[8.7J]	[12.2J]

Well ID	MW-210													
Sample ID	M210A1	M210A2	M210A3	M210A4	M210A5	M210A6	M210A7	M210A8	M210A9	M210B1	M210B2	M210B3-100607	M210B4	M210B5	M210B6
Sample Date	01/31/2005	05/31/2005	10/27/2005	05/30/2006	11/06/2006	05/23/2007	12/17/2007	08/11/2008	11/05/2008	07/23/2009	11/23/2009	06/07/2010	09/22/2010	06/15/2011	03/13/2012
VOC															
2-Butanone (Methyl ethyl ketone) ug/L	15U	3U	3U	3U	3U	3U	3U	15U	15U	3U	3U	3U	3U		
Acetone ug/L	30U	12J	10J	9J	15J	12J	94	30U	30U	7J	9J	6U	11J		
Benzene ug/L	3U	0.8J	0.7J	0.8J	0.5U	0.5U	0.5U	3U	3U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	5U	1U	1U	1U	1U	1U	1U	5U	5U	1U	1U	1U	1U		
Metals															
Aluminum ug/L								80.2U	80.2U	80.2U	80.2U	80.2U	9.8U	87.8J	80.1U
Arsenic ug/L								10.2U	10.0U	7.2U	7.2U	7.2U	2.0U	5.1U	5.1U
Cadmium ug/L								2.0U	2.0U	2.0U	2.0U	2.0U	[6400]	0.74J	0.36U
Iron ug/L	[24700]	[21300]	[6310]	[2580]	[501]	[26500]	[8260]	[27900]	[19800]	[41900]	[33100]	[27600]	6.9U	[22300]	[11400]
Lead ug/L								6.9U	[35.0]	6.9U	6.9U	6.9U	[570]	2.2U	2.2U
Manganese ug/L								[548]	[501]	[617]	[567]	[1000]	8.5U	[1220]	[592]
Selenium ug/L								10.7U	10.7U	8.9U	8.9U	8.9U	[1270000]	6.9U	6.9U
Sodium ug/L								[1290000]	[1380000]	[1310000]	[1410000]	[1030000]	14.0U	[800000]	[1190000]
Thallium ug/L								14.0U	14.0U	14.0U	14.0U	14.0U		4.2U	4.2U

Well ID	MW-114																	
Sample ID	M114A1Y	M114A2X	M114A3	M114A4	M114A5	M114A6	M114A7X	M114A8	M114A9	M114B1	M114B2	M114B3X	M114B4X	M114B5X	M114B6	M114B7	M114B8
Sample Date	10/17/2002	02/10/2003	09/10/2003	05/18/2004	09/22/2004	05/25/2005	10/26/2005	05/24/2006	11/09/2006	06/01/2007	07/29/2008	05/08/2009	04/29/2010	07/20/2011	03/15/2012	05/14/2012	07/24/2012
VOC																	
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U	3U	3U	3U	3U	3U						3U	3U	3U
Acetone ug/L	6U	6U	6U	6U	6U	6U	6U	6U	6U						6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U
Metals																	
Aluminum ug/L	47.7U	[440]	[793]												80.1U	173J	74.3U
Arsenic ug/L	4.9U	4.9U	[7.0J]								10.2U				5.1U	5.1U	6.8U
Cadmium ug/L	0.94U	0.94U	0.87U								2.0U				0.27U	0.91J	0.36U
Iron ug/L	[5170]	[6000]	[8750]												52.7J	[710]	89.0J
Lead ug/L	8.9U	8.9U	9.3U												3.2U	2.2U	5.1U
Manganese ug/L	[5430]	[4700]	[4090]												[288]	[590]	[535]
Selenium ug/L	4.6U	4.8U	4.7U												6.9U	6.9U	7.5U
Sodium ug/L	[69300]	[62000]	[62400]												[69400]	[71000]	[70300]
Thallium ug/L	9.5U	9.5U	8.9U												4.2U	4.2U	5.7U

Well ID	MW-115												
Sample ID	D1050B1	M115A1X	M115A2X	M115A3	M115A4	M115A5	M115A6	M115A7	M115A8	M115A9	M115B1	M115B2	M115B3
Sample Date	11/05/2008	10/22/2002	02/26/2003	09/09/2003	07/30/2008	11/05/2008	05/08/2009	11/05/2009	04/29/2010	07/19/2011	03/15/2012	05/14/2012	07/24/2012
VOC													
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U	3U	3U	3U	3U	3U		3U	3U	3U
Acetone ug/L	6U	6U	6U	6U	6U	6U	6U	6U	6U		6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	[6]	1U	1U	1U	1U	1U	1U	1U		1U	1U	1U
Metals													
Aluminum ug/L	80.2U	47.7U	48U	72.9J	[208]	80.2U					124J	80.1U	74.3U
Arsenic ug/L	10.0U	4.9U	4.9U	4.9U	10.2U	10.0U					5.1U	5.1U	6.8U
Cadmium ug/L	2.0U	0.94U	0.94U	1.1J	2.2J	2.0U					1.1J	1.3J	[4.5J]
Iron ug/L	52.2U	[553]	40J	173J	[1090]	52.2U					[314]	32.2J	182J
Lead ug/L	[21.2]	6.9U	8.9U	9.3U	6.9U	[19.2]	6.9U	6.9U	6.9U	2.2U	2.2U	2.2U	5.1U
Manganese ug/L	[52.6]	[2270]	[2800]	[1050]	[777]	[109]					[81.7]	9.8	[411]
Selenium ug/L	10.7U	4.8U	4.8U	4.7U	10.7U	10.7U					6.9U	6.9U	7.5U
Sodium ug/L	[68700]	[70900]	[66500]	[76800]	[66000]	[66700]					[57900]	[104000]	[94700]
Thallium ug/L	14.0U	9.5U	9.5U	8.9U	14.0U	14.0U					4.2U	4.2U	5.7U

Well ID	MW-328		
Sample ID	M328A1	M328A2	M328A3
Sample Date	03/20/2012	05/23/2012	07/25/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L	3U	9J	3U
Acetone ug/L	6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U
Metals			
Aluminum ug/L	[415]	80.1U	74.3U
Arsenic ug/L	[6.1J]	5.1U	6.8U
Cadmium ug/L	0.27U	0.80J	0.36U
IRON ug/L	[13300]	[10700]	[12900]
Lead ug/L	2.5J	2.2U	5.1U
Manganese ug/L	[2670]	[2950]	[2950]
Selenium ug/L	6.9U	6.9U	7.5U
Sodium ug/L	[74100]	[69100]	[76200]
Thallium ug/L	[4.3J]	4.2U	5.7U

Well ID	RW-02												
Sample ID	RW02A2	R002A3	R002A4	R002A5	R002A6	R002A7	R002A8	R002A9	R002B1	R002B2	RW02A1	RW02A2X	
Sample Date	09/21/2004	05/26/2005	10/25/2005	05/24/2006	11/30/2006	05/14/2007	08/12/2008	05/26/2009	06/22/2011	03/14/2012	05/16/2003	09/22/2004	
VOC													
2-Butanone (Methyl ethyl ketone) ug/L			9J	14	3U	50	12	9J	3J	8J	3U	34	
Acetone ug/L			18J	27	9J	96	36	26	15U	11J	6U	60	
Benzene ug/L			[68]	[120]	[100]	[190]	[200]	[170]	[210]	[61]	[110]	[130]	
Bromodichloromethane ug/L			1U	1U	1U	1U	1U	1U	1U	1U	1U	1U	
Metals													
Aluminum ug/L							[200]				135J		
Arsenic ug/L							10.2U	7.2U	5.1U	5.1U	4.9U		
Cadmium ug/L							2.0U				0.87U		
IRON ug/L	[17500]	[13400]	[15300]	[15900]	[9340]	[16200]	[11600]	[14000]			[19500]		
Lead ug/L							6.9U	6.9U	[6.0J]	2.2U	9.3U		
Manganese ug/L							[2270]				[3370]		
Selenium ug/L							10.7U				4.7U		
Sodium ug/L							[147000]				[141000]		
Thallium ug/L							14.0U				8.9U		

Well ID	MW-240									
Sample ID	M240A1	M240A2	M240A3	M240A4	M240A5	M240A6	M240A7	M240A8	M240A9	
Sample Date	11/30/2006	05/10/2007	12/05/2007	07/28/2008	10/29/2008	05/26/2009	10/26/2009	06/22/2011	03/14/2012	
VOC										
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U	3U	3U	3U			
Acetone ug/L	6U	6U	6U	6U	6U	6U	6U			
Benzene ug/L	0.5U	0.5U	[160]	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	
Bromodichloromethane ug/L	[6]	1U	1U	1U	1U	1U	1U			
Metals										
Aluminum ug/L	121J	92.3J	80.2U	[341]	[437]					
Arsenic ug/L	10U	[11.7J]	10.0U	10.2U	10.0U	7.2U	7.2U	5.1U	5.1U	
Cadmium ug/L	0.91U	0.91U	0.90U	2.0U	2.0U					
Iron ug/L	[4160]	[7960]	[542]	[2480]	86.2J	[2180]	[378]			
Lead ug/L	6.9U	6.9U	6.9U	6.9U	6.9U					
Manganese ug/L	[4510]	[5530]	[5200]	[5560]	29.1					
Selenium ug/L	9.4U	9.4U	9.4U	10.7U	10.7U					
Sodium ug/L	[81300]	[70700]	[96000]	[54200]	[69600]					
Thallium ug/L	13.5U	13.5U	10.5U	14.0U	14.0U					

Well ID	MW-324		
Sample ID	M324A1	M324A2	M324A3
Sample Date	03/12/2012	05/17/2012	07/30/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U
Acetone ug/L	6U	6U	6U
Benzene ug/L	0.5U	[2J]	[3J]
Bromodichloromethane ug/L	1U	1U	1U
Metals			
Aluminum ug/L	[946]	[3340]	[1490]
Arsenic ug/L	[36.8]	5.1U	[11.8J]
Cadmium ug/L	3.1J	3.9J	0.36U
IRON ug/L	[144000]	[292000]	[391000]
Lead ug/L	[6.4J]	[8.4J]	[16.4]
Manganese ug/L	[5110]	[12600]	[18600]
Selenium ug/L	21.9	[51.5]	7.5U
Sodium ug/L	[1280000]	[820000]	[764000]
Thallium ug/L	4.2U	4.2U	[46.5]

Well ID	MW-325			
Sample ID	D0312121	M325A1	M325A2	M325A3
Sample Date	03/12/2012	03/12/2012	05/17/2012	07/26/2012
VOC				
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U
Acetone ug/L	6U	6U	6U	6U
Benzene ug/L	[4J]	[4J]	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U	1U
Metals				
Aluminum ug/L	100J	145J	80.1U	74.3U
Arsenic ug/L	[7.6J]	5.1U	5.1U	6.8J
Cadmium ug/L	0.27U	0.27U	0.27U	0.36U
IRON ug/L	[3100]	[3160]	[3260]	[3600]
Lead ug/L	2.2U	2.2U	4.3J	5.1U
Manganese ug/L	[927]	[373]	[344]	[335]
Selenium ug/L	6.9U	6.9U	32.9	7.5U
Sodium ug/L	[260000]	[269000]	[252000]	[270000]
Thallium ug/L	4.2U	4.2U	4.2U	5.7U

Well ID	MW-333	
Sample ID	M333A1	M333A2
Sample Date	05/16/2012	07/24/2012
VOC		
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U
Acetone ug/L	22	10J
Benzene ug/L	0.9J	0.7J
Bromodichloromethane ug/L	1U	1U
Metals		
Aluminum ug/L	178J	
Arsenic ug/L	[18.2J]	[33.9]
Cadmium ug/L	0.36J	0.36U
IRON ug/L	[41600]	[27600]
Lead ug/L	2.2U	5.1U
Manganese ug/L	[517]	[352]
Selenium ug/L	6.9U	7.5U
Sodium ug/L	[481000]	[477000]
Thallium ug/L	[6.1J]	5.7U

Well ID	MW-0057													
Sample ID	M057A2	M057A3	M057A4	M057A5	M057A6	M057A7	M057A8	M057A9	M057B1-100607	M057B2	M057B3	M057B4	M057B5
Sample Date	09/27/2004	06/06/2005	11/01/2005	05/30/2006	11/30/2006	06/04/2007	07/30/2008	05/18/2009	06/07/2010	08/17/2011	03/12/2012	05/23/2012	07/25/2012
VOC													
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U	3U			3U			3U	3U	3U
Acetone ug/L	6U	6U	18J	6U	6U			6U			6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U	1U	1U			1U			1U	1U	1U
Metals													
Aluminum ug/L							[3230]	[1960]			[251]	[7520]	[1110]
Arsenic ug/L							10.2U	10.0U	7.2U	5.1U	5.1U	5.1U	6.8U
Cadmium ug/L							2.0U	2.0U			0.27U	1.5J	0.36U
IRON ug/L	247	[908]	[7680]	52.2U	52.2U	[6140]	61.7J	52.2U	177J		[5850]	[11000]	[4330]
Lead ug/L							6.9U	6.9U	6.9U	3.3J	2.2U	[7.7J]	5.1U
Manganese ug/L							[1750]	[622]			[255]	[1040]	[459]
Selenium ug/L							10.7U	10.7U			6.9U	6.9U	7.5U
Sodium ug/L							[516000]	[846000]			[564000]	[345000]	[494000]
Thallium ug/L							14.0U	14.0U	14.0U	4.2U	[7.1J]	4.2U	5.7U

Well ID	MW-334	
Sample ID	M334A1	M334A2
Sample Date	05/17/2012	07/31/2012
VOC		
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U
Acetone ug/L	6U	6U
Benzene ug/L	[66]	[14]
Bromodichloromethane ug/L	1U	1U
Metals		
Aluminum ug/L	128J	74.3U
Arsenic ug/L	5.1U	[12.5J]
Cadmium ug/L	0.41J	0.36U
IRON ug/L	[103000]	[71900]
Lead ug/L	2.2U	5.1U
Manganese ug/L	[586]	[1860]
Selenium ug/L	6.9U	7.5U
Sodium ug/L	[2680000]	[2600000]
Thallium ug/L	4.2U	5.7U

Well ID	MW-326		
Sample ID	M326A1	M326A2	M326A3
Sample Date	03/12/2012	05/23/2012	07/26/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U
Acetone ug/L	15J	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U
Metals			
Aluminum ug/L	[2170]	[835J]	167J
Arsenic ug/L	[36.1J]	[44.8J]	34.0U
Cadmium ug/L	[6.5]	[19.8]	[5.9]
IRON ug/L	[268000]	[367000]	[343000]
Lead ug/L	[14.0J]	2.2U	[5.2J]
Manganese ug/L	[49000]	[50500]	[44900]
Selenium ug/L	[50.5]	16.7J	24
Sodium ug/L	[846000]	[545000]	[464000]
Thallium ug/L	4.2U	21.0U	28.5U

Well ID	MW-120																
Sample ID	M120A1X	M120A2X	M120A3	M120A4	M120A5	M120A6	M120A7	M120A8	M120A9	M120B1	M120B2	M120B3	M120BA-100607	M120B5	M120B6	M120B7	M120B8
Sample Date	11/27/2002	2/25/2003	10/01/2003	05/19/2004	09/24/2004	06/02/2005	11/03/2005	05/31/2006	12/04/2006	06/04/2007	08/12/2008	06/30/2009	06/07/2010	06/15/2011	03/13/2012	05/29/2012	07/31/2012
VOC																	
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U	3U	3U	3U	3U	3U	3U						3U	3U	3U
Acetone ug/L	6U	6U	6U	6U	6U	6U	6U	10J	6U						6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.7J	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U	1U	1U	1U	1U	1U	1U						1U	1U	1U
Metals																	
Aluminum ug/L	47.7U	48U	74.0J												80.1U	80.1U	74.3U
Arsenic ug/L	4.9U	4.9U	4.9U												5.1U	5.1U	6.8U
Cadmium ug/L	0.94U	0.94U	0.87U												0.77J	0.27U	0.36U
Iron ug/L	[3000]	[3700]	[7250]												[16300]	[3120]	[2160]
Lead ug/L	8.9U	8.9U	9.3U	10.0U	10.0U	8.4U	8.4U	6.9U	6.9U	6.9U	6.9U	6.9U	6.9U	2.2U	3.0J	2.2U	5.1U
Manganese ug/L	[3630]	[3600]	[3660]												[5190]	[5220]	[5020]
Selenium ug/L	4.6U	4.8U	4.7U												6.9U	6.9U	7.5U
Sodium ug/L	48800	46200	48700												[76700]	[74200]	[73400]
Thallium ug/L	[13.8J]	9.5U	8.9U								14.0U	[14.2J]	14.0U	[4.7J]	4.2U	4.2U	5.7U

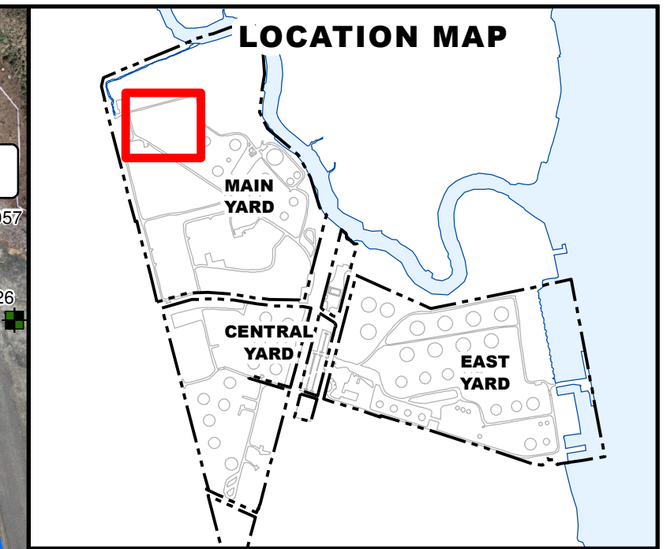
Well ID	MW-327		
Sample ID	M327A1	M327A2	M327A3
Sample Date	03/13/2012	05/18/2012	07/31/2012
VOC			
2-Butanone (Methyl ethyl ketone) ug/L	3U	3U	3U
Acetone ug/L	6U	6U	6U
Benzene ug/L	0.5U	0.5U	0.5U
Bromodichloromethane ug/L	1U	1U	1U
Metals			
Aluminum ug/L	[451]	80.1U	74.3U
Arsenic ug/L	5.1U	5.1U	6.8U
Cadmium ug/L	0.27U	0.27U	0.36U
IRON ug/L	[765]	[1280]	[952]
Lead ug/L	2.2U	3.5J	5.1U
Manganese ug/L	[1880]	[2230]	[2120]
Selenium ug/L	6.9U	38.6	7.5U
Sodium ug/L	32800	38900	38900
Thallium ug/L	4.2U	4.2U	5.7U

Well ID	MW-233														
Sample ID	M233A1	M233A2	M233A3	M233A4	M233A5	M233A6	M233A7	M233A8	M233A9-100513	M233B1	M233B2X	M233B3	M233B4	M233B5	
Sample Date	06/01/2006	12/11/2006	05/23/2007	12/18/2007	06/23/2008	11/10/2008	05/28/2009	11/19/2009	05/13/2010	09/23/2010	06/21/2011	03/20/2012	05/24/2012	07/25/2012	
VOC															
2-Butanone (Methyl ethyl ketone) ug/L	3U	6J	11	15	4J	22J	19J	3U	21	7J	13J	6U	5J	15	
Acetone ug/L	11J	15J	38	45	11J	71	56	31	56	18J	40J	12U	15J	42	
Benzene ug/L	[59]	[300]	[350]	[280]	[540]	[730]	[1300]	[820]	[1000]	[280]	[1400]	[430]	[1300]	[275]	
Bromodichloromethane ug/L	1U	1U	1U	1U	1U	3U	2U	1U	1U	2U	2U	2U	1U	1U	
Metals															
Aluminum ug/L												80.1U	80.1U	74.3U	
Arsenic ug/L												[6.9J]	[6.1J]	[14.4J]	
Cadmium ug/L												0.27U	1.7J	0.36U	
Iron ug/L	[17000]	[3520]	[15500]	[5740]	[13400]	[17700]	[12400]	[12600]	[15800]	[17800]		[21000]	[17100]	[25000]	
Lead ug/L												2.2U	2.2U	5.1U	
Manganese ug/L												[1420]	[1630]	[1910]	
Selenium ug/L												6.9U	6.9U	7.5U	
Sodium ug/L												[113000]	[107000]	[101000]	
Thallium ug/L												[5.4J]	4.2U	5.7U	

TITLE: **HISTORICAL GROUND WATER SAMPLE RESULTS - CAMU AREA**

Chevron

DWN:	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
MTK		
CHKD: JS	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: I-6	FILE NAME: Fig I-6 GW Management	



N
W E
S

Feet
0 30 60

Shallow Monitoring Well

Deep Monitoring Well

Proposed CAMU Area

TITLE:

PROPOSED GROUND WATER MONITORING PLAN

Chevron

DWN: SD	PROJECT: CAMU FINAL DESIGN REPORT CHEVRON, PERTH AMBOY, NJ	
CHKD: SA	PROJECT #: 447218-03101	DATE: 10/31/2012
FIG NO.: I-7	FILE NAME: Fig I-7 Prop GW Monitoring Plan	

ATTACHMENT I-1

MONITORING WELL INSPECTION FORM

Attachment I-1
Monitoring Well Inspection Form
CAMU Final Design Report
Chevron Perth Amboy Facility, NJ

WELL INFORMATION

MW #: _____ Location: _____

Casing Type: _____ Stainless Steel _____ PVC

Flush-mount/Above Ground Completion: _____

Monitoring Interval: _____ ft BGS to _____ ft bgs
Measured Monitoring Well Depth: _____ ft BTOC

INSPECTION ITEMS

	YES	NO	N/A	Observations
Well-head Completion				
Above-ground completion				
Number of guard posts at well: _____				
Are the posts positioned to prevent collision	[ ]	[ ]	[ ]	_____
damage to the well?	[ ]	[ ]	[ ]	_____
Are any of the posts damaged or degraded	[ ]	[ ]	[ ]	_____
Is a concrete pad installed?	[ ]	[ ]	[ ]	_____
Is the pad cracked or deteriorated?	[ ]	[ ]	[ ]	_____
Is steel protective casing installed?	[ ]	[ ]	[ ]	_____
Does the protective casing have a weep hole?	[ ]	[ ]	[ ]	_____
Flush-mount Completion:				
Is the traffic cover securely bolted to the flush-mount box?	[ ]	[ ]	[ ]	_____
Does the well have a flush-mount box cover?	[ ]	[ ]	[ ]	_____
Is the flush-mount cover cracked or broken?	[ ]	[ ]	[ ]	_____
Is the concrete apron cracked or deteriorated?	[ ]	[ ]	[ ]	_____
Identification				
Is the well labeled with the correct number	[ ]	[ ]	[ ]	_____
Describe labeling:	[ ]	[ ]	[ ]	_____
Security				
Does the well have a cap?	[ ]	[ ]	[ ]	_____
Does the well have a weather proof lock?	[ ]	[ ]	[ ]	_____
Does the lock secure the well?	[ ]	[ ]	[ ]	_____
Does the inner casing have a cap?	[ ]	[ ]	[ ]	_____
Down-hole Condition:				
Is the well casing bent, corroded, or broken (at the surface)	[ ]	[ ]	[ ]	_____
Is the well casing loose (at the surface)?	[ ]	[ ]	[ ]	_____
Is a measurement point marked at the top of the well casing?	[ ]	[ ]	[ ]	_____
Does vegetation around well need clearing?	[ ]	[ ]	[ ]	_____
Are there any obstructions in the well?	[ ]	[ ]	[ ]	_____
Measured depth of well from measurement point:				
Thickness of sediment accumulation				

Inspection Date: _____ **Inspected by:** _____

ATTACHMENT I-2

STATISTICAL EVALUATION OF BACKGROUND GROUND WATER QUALITY IN THE CAMU AREA

1.0 INTRODUCTION

This attachment I-2 presents the statistical evaluation of the baseline ground water condition in the proposed CAMU area of the Facility. This attachment presents:

- Proposed constituents for a leak detection monitoring program
- Proposed monitoring well networks for a leak detection monitoring program
- A statistical method used in establishing background ground water quality
- Determinations of background 99% Upper Prediction Limit (UPLs) for selected constituents in the CAMU area
- Results of the statistical evaluation
- Application of background UPLs in future monitoring
- Conclusions and recommendations

1.1 Constituents for Evaluation – Leak Detection Monitoring Program

The monitoring constituents of the leak detection program should provide a reliable indication of the presence of constituents in ground water (NJAC 7:14A-10.12) to evaluate potential leakage from the CAMU. They should be selected based on the types, quantities, and concentrations of constituents in wastes to be managed at the CAMU, as well as their mobility, stability and persistence in the environment. Based on existing information, the following four constituents were identified as PCOCs for the Facility, and were selected as target analytes for leak detection monitoring and statistical evaluation:

- benzene
- benzo(a)pyrene
- arsenic
- lead

These PCOCs include a metal (lead), an inorganic metalloid (arsenic), a volatile organic compound (benzene), and a semivolatile organic compound (benzo(a)pyrene). They are moderately to highly stable constituents, have a range of mobility in ground water, are detectable at concentrations of concern, and are expected to be present in wastes to be placed in the CAMU. Their presence in the shallow water-bearing zone at compliance point wells at concentrations that are statistically significantly higher than background levels will be interpreted as evidence of likely leakage from the CAMU. The list of constituents for statistical detection monitoring may be modified in the future if other waste constituents are identified that would be more reliable indicators of leaks from the CAMU.

In addition, the statistical evaluation was performed for the compounds that exceed NJDEP's Ground Water Quality Standards (GWQS), defined in N.J.A.C. 7:9C as they will represent the background ground water quality for the compounds prior to construction of CAMU. Pursuant to N.J.A.C. 7:14A-10.8(a)2i, higher concentration limits can be requested for background ground water quality for arsenic, silver,

barium, cadmium, chromium, lead, mercury and selenium if they are already present. A statistical evaluation of background concentrations of the following constituents were also performed that meet these two criteria:

- aluminum
- antimony
- barium
- bromodichloromethane
- cadmium
- chromium
- cobalt
- iron
- manganese
- mercury
- selenium
- silver
- sodium
- thallium

The use of a lengthier list of monitoring constituents has undesirable effects on statistical significance testing, due to an increase in the chance of a statistical false positive (wrongly determining that a statistically significant concentration increase has occurred). In order to limit the site-wide false positive rate (SWFPR) to 10% per year, in accordance with the USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (*Unified Guidance)*, the statistical power of tests to identify a significant concentration change for each individual constituent must be substantially reduced if a longer list of monitoring constituents is used.

1.2 Wells for Background and Leak Detection Monitoring

The statistical leak detection monitoring will be based on the following downgradient wells screened in the shallow water-bearing zone:

- MW-324
- MW-0057
- MW-120
- MW-211
- MW-333
- MW-334

Wells MW-324, MW-0057, and MW-120 are downgradient/compliance wells, while wells MW-211, MW-333, and MW-334 are downgradient of CAMU Cell 1 (see Figure I-5 of LGMP), but will be

abandoned when CAMU Cells 2 and 3 are opened for waste disposal. Monitoring will also be performed at upgradient and cross-gradient wells, and in the deep water-bearing zone, but statistical significance testing will not be performed on monitoring results for these wells.

Background wells are intended to represent the quality of background ground water that has not been affected by leakage from the CAMU, and may include wells that are not hydraulically upgradient of the unit (NJAC 7:14A-10.11). Few of the background wells, and none of the downgradient wells, have a sufficient number of historical water quality measurements to permit reliable calculation of well-specific background concentrations. Thus, a sitewide background concentration was estimated for each constituent in each water-bearing zone from wells in the vicinity of the CAMU. For the shallow water-bearing zone, these wells included (see Figure I-5 of LGMP):

MW-0057	MW-233	MW-324
MW-114	MW-234	MW-333
MW-116R	MW-262	MW-334
MW-120	MW-269	NF-11
MW-210	MW-315	RW-02
MW-211	MW-322	

In the deep water-bearing zone, the wells included (Figure I-5 of LGMP):

MW-115	MW-325	MW-328
MW-240	MW-326	
MW-323	MW-327	

The pooling of data from multiple wells and times is valid only if it can be assumed that spatial variability, seasonality, and temporal autocorrelation are insignificant. The spatial variability assumption does not appear to be met. However, all of the wells represent background concentrations in the CAMU area, with their inherent spatial variability. Because there is no acceptable option that meets all statistical assumptions, the pooling of data was required. However, in some cases, not meeting the spatial variability assumption may lead to an elevated frequency of Type I (false positive) and Type II (false negative) errors. As additional data are collected, site background concentration limits will be re-calculated for each individual downgradient well after eight to ten measurements of each constituent are available.

1.3 Statistical Test Method and Applicable Performance Standards

The NJAC 7:14A-10 rule specifies statistical methods that may be used in evaluating ground water monitoring data for each constituent. The accepted methods include: 1) parametric analysis of variance (ANOVA) followed by multiple comparisons procedures; 2) ANOVA based on ranks followed by multiple comparisons procedures; 3) a tolerance or prediction interval procedure; 4) a control chart approach; and 5) another statistical test method approved by NJDEP.

The prediction interval procedure was selected as a statistical method for ground water monitoring data evaluation. Prediction intervals offer a convenient, easy to interpret, and statistically valid way to test for significant differences in constituent concentrations between background and compliance point wells. Prediction intervals are recommended by the *Unified Guidance* due to their flexibility, which can accommodate a wide range of monitoring strategies and statistical tests. Also, limited data will be available during each future reporting period, which will preclude the use of some other statistical methods, such as ANOVA. The 99% upper prediction limit (UPL) represents the upper end of the prediction interval, such that a specified number of future observations from the range of background concentrations will be less than or equal to the UPL with 99% confidence.

The NJAC 7:14A-10 rule also provides performance standards for each acceptable statistical method. The following performance standards are applicable to the chosen prediction limit method:

- The statistical method used to evaluate ground water monitoring data shall be appropriate for the distribution of chemical parameters or constituents.
- The levels of confidence shall be proposed by the owner or operator and approved by the Department.
- The statistical method shall account for data below the limit of detection with one or more statistical procedures that are protective of human health and the environment.
- If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

These performance standards are met in the present evaluation by conducting a series of preliminary evaluations to determine data distribution, detection limit treatment method, seasonal and spatial variability, and temporal trends. These preliminary evaluations and levels of confidence in each test are presented in detail in the following subsections.

1.4 Data Compilation and Preliminary Evaluation

All historical ground water monitoring data for the wells listed in Section 1.2, and for the 18 constituents listed in Section 1.1 were compiled. Following compilation, an exploratory data analysis was performed, followed by checks for outliers and identification of the data distribution.

In the exploratory data analysis, data were statistically summarized so that appropriate approaches and limitations in using the datasets could be identified. A table of basic summary statistics (mean, median, minimum, maximum, standard deviation, skewness, and kurtosis) was developed for each well and monitoring constituent (see Table IA2-1). For purposes of the data summaries, non-detect (ND) results were not used except for calculating the number of samples and detection rates. The summary statistics were used to make inferences concerning the population (for 18 constituents in the CAMU area) from which the sample data were drawn. The number of sampling periods and detection rates were also summarized.

To identify outliers in a constituent data set, Rosner's test for outliers was conducted when the sample size was greater than 25, and Dixon's test was conducted when the samples size was 25 or less. When conducting the outlier tests, ND results were removed from the dataset. According to the *Unified Guidance*, "outlier tests can provide supportive information, but generally a reasonable rationale needs to be identified for removal of suspect outlier values (usually limited to background data)." Therefore, additional examination of each dataset was conducted to decide whether the outlier would be removed from further analysis. In most cases, unless data appeared to be reported in the wrong units, or there was sufficient justification to believe that the outlier resulted from analytical or data reporting problems, outliers were not removed from a dataset.

Statistical tests were then performed to determine whether the constituent concentrations followed a normal distribution, which is an assumption used in some statistical methods for estimating background concentration limits. The Shapiro-Wilks test was used in this evaluation, using the USEPA's ProUCL version 4.1 software. If the data did not fit a normal distribution, at 95% confidence, the data were log-transformed and re-tested versus the normal distribution. If the data did not fit normal or log-normal distributions, non-parametric statistical methods were used to estimate background. The normality evaluation was based on detected values only. For constituents with more than 50% non-detects, only non-parametric statistical methods were applied.

1.5 Determination of Background 99% Upper Prediction Limits

Following the preliminary evaluation, 99% UPLs were calculated for each constituent to establish initial background conditions for application in ground water leak detection monitoring. As stated earlier, the 99% UPL represents the concentration such that a specified number of future observations from the range of background concentrations will be less than or equal to the UPL, with 99% confidence. Only background data are used to calculate UPLs.

99% background UPLs were calculated for the other 14 constituents listed in Section 1.1 and for the deeper water-bearing zone, although these are not intended to be used in statistical tests as part of the leak detection monitoring program. The 99% UPLs for the other 14 constituents in downgradient wells screened in the shallow water-bearing zone were calculated assuming there were five PCOCs in six downgradient wells. In other words, a single constituent was added to the existing four PCOCs. Adding a larger number of constituents would result in higher UPLs to achieve the target SWFPR. The UPLs of constituents in the deeper water-bearing zone were calculated assuming that statistical testing would be based on five PCOCs in nine downgradient wells — the three downgradient deep wells (MW-325, MW-326, and MW-327) plus the six downgradient shallow wells.

It is important to note that the UPL calculation depends on the number of wells to be tested, the number of constituents to be tested, the frequency of testing, and the number of re-samples to be collected if a constituent exceeds its UPL. These UPLs were calculated for the four PCOCs (Section 1.1), at the six downgradient wells in the shallow water-bearing zone (Section 1.2), on a quarterly basis (four samples

per year), with one re-sample to be collected if a constituent exceeds its 99% UPL in the future sampling events.

For constituents with normal or log-normal data distributions, background UPLs were calculated using parametric methods. For constituents that did not fit a normal or log-normal distribution, or with more than 50% NDs, non-parametric background UPLs were calculated.

1.5.1 *Parametric Background UPL Calculations*

Parametric background UPLs were calculated using the mean ($\bar{x}$) and standard deviation (s) of the background dataset, and a multiplier K.

$$\text{UPL} = \bar{x} + K * s$$

The multiplier K is derived from tables in the *Unified Guidance* based on the sampling scheme (one sample + one re-sample [if required]), the number of wells, the number of constituents, the number of background samples, and the number of tests per year. The tables are designed to meet an annual SWFPR of 10%. Parametric UPLs can be calculated for background datasets of eight or more values that follow a normal or log-normal distribution, with sufficient statistical power to detect a concentration increase above background. For background constituent datasets that follow a log-normal distribution, the background concentrations were first log-normalized prior to calculation of the mean and standard deviation, and the resulting UPL was back-transformed into typical units (micrograms per liter [µg/L]). For background constituent datasets with NDs, the mean and standard deviations were calculated using the Kaplan-Meier method in ProUCL, as recommended in the *Unified Guidance*.

1.5.2 Non-Parametric Background 99% UPL Calculations

Non-parametric UPLs do not rely on the distribution of the data, but are instead calculated based on the ranks (orders) of data in the background data set. The non-parametric 99% UPL was calculated using ProUCL software as the mth highest value in the background dataset of n values where:

$$m = (n+1) * (1 - 0.99)$$

For example, for a data set with 99 (or less values), m=1 and the 99% UPL will be the largest background concentration measurement. For a dataset with 199 values, m=2 and the 99% UPL is the second largest background concentration measurement. For intermediate ranks, 99% UPLs were linearly interpolated between the ranked values. The minimum number of samples to calculate a non-parametric UPL is controlled by the target annual SWFPR (α_{SWFP}) of 10%. The *Unified Guidance* recommends that the SWFPR be partitioned evenly among the constituents to derive a target false positive rate per constituent (α_c). With four PCOCs, the target α_c can be calculated:

$$\alpha_c = 1 - (1 - \alpha_{SWFP})^{1/(c)}$$

$$= 1 - 0.9^{1/4}$$

$$= 0.026$$

For four PCOCs in six shallow wells tested four times per year with one re-sample, the background data set needs 38 samples to achieve the target annual SWFPR. Otherwise the annual likelihood of a false-positive error exceeds 10%. The following table provides information on number of samples and associated ranking that were used to calculate 99% UPLs and further discussed in section 2.2.

Number of values in background dataset	Rank (order) of background dataset to use as 99% UPL	
<38	1*	SWFPR may exceed 10%
38 – 99	1	Highest
100 - 198	1 – 2	Linearly interpolated between highest and 2nd highest
199	2	2nd highest
200 - 298	2 – 3	Linearly interpolated between 2nd highest and 3rd highest
299	3	3rd highest

1.5.3 UPLs for Constituents Never Detected in Background Samples

For PCOCs that have not been detected in the background dataset, such as benzo(a)pyrene, neither parametric nor non-parametric statistical methods can be used to calculate a UPL. Therefore, a double detection quantification rule was used in evaluating leak detection monitoring data. The double quantification rule is described in the *Unified Guidance* as follows:

"*A confirmed exceedance is registered if any well-constituent pair in the 100% non-detect group exhibits quantified measurements (i.e., at or above the reporting limit [RL]) in two consecutive sample and resample events*."

Some flexibility and interpretation is required when applying the double quantification rule because laboratory data reporting limits are not fixed, but may vary from sample to sample based on the sample dilution required to minimize analytical interferences, the analytical method, and other factors. Quantification at a level lower than the typical reporting limits in the background dataset will not imply an exceedance of the UPL.

2.0 STATISTICAL EVALUATION RESULTS

2.1 Descriptive Statistics and Data Distributions

Table IA2-1 provides a summary of exploratory data analysis results for individual wells. The summary statistics include the number of samples, detection rate, minimum, maximum, mean, median, standard deviation, skewness, and kurtosis, which establish concentration ranges, means, and other descriptive statistics for all selected constituents.

Table IA2-2 provides a summary of exploratory data analysis results for the pooled datasets, with statistics provided for the shallow and deep water-bearing zones. Based on the analysis of outliers, the following adjustments were made to the data sets. Two unit errors were identified and corrected from milligrams to micrograms per liter. One barium measurement of 0.6 µg/L was deleted from the pooled data set. Benzene measurements from MW-233 were removed from the pooled dataset because there was known to be localized historical contamination of benzene near this well.

Table IA2-2 also provides the data distribution for each constituent and water-bearing zone. Most constituents do not exhibit a parametric distribution, or were assumed to not exhibit a parametric distribution because more than 50% of the values were NDs. Constituents that exhibit a log-normal distribution included barium, manganese, and iron (in the deep water-bearing zone only). Benzo(a)pyrene was not detected in the background dataset (shallow or deep water bearing zone), and bromodichloromethane was not detected in the shallow water-bearing zone.

2.2 PCOCs Background UPLs for the Leak Detection Monitoring Program

The PCOCs' background UPLs for the leak detection monitoring program are provided in Table IA2-3. For benzo(a)pyrene, because it was not detected in 104 background samples in the shallow water-bearing zone, the double quantification rule will be used in lieu of a statistics-based UPL. The 99% UPL for arsenic is 133 µg/L, the highest of 87 background measurements for the shallow water-bearing zone. The 99% UPL for benzene is 230 µg/L, between the 2nd and 3rd highest of 200 background measurements from the shallow water-bearing zone (excluding data from MW-233). The 99% UPL for lead is 33.1 µg/L, between the highest and 2nd highest of 119 background measurements for the shallow water-bearing zone.

2.3 Background UPLs for Other Constituents in the Shallow and Deep Water-bearing zones

Background UPLs were calculated for the 14 constituents in the shallow-water bearing zone and are included in Table IA2-4. The background UPLs for four PCOCs and 14 constituents identified in section 1.1 in the deep water-bearing zones are included in Table IA2-5. The 14 constituents identified in section 1.1 will not be used in statistical leak detection monitoring testing due to their impact on the SWFPR. Some of the UPLs may not be statistically valid because there are insufficient background samples. Most of the non-parametric UPLs are based on the highest measurement in the background data set. For the parametric UPLs, the log-normalized mean and standard deviation, and the K-multiplier used in the UPL calculations, are provided below.

Constituent	Water-bearing zone	Mean†	Standard deviation†	K-multiplier
Barium	Shallow	5.187	0.646	2.00
Barium	Deep	4.466	1.377	2.18
Iron	Deep	7.797	2.515	2.12
Manganese	Shallow	7.296	1.308	2.00
Manganese	Deep	7.252	2.018	2.16

† log-transformed data

3.0 APPLICATION OF BACKGROUND UPPER PREDICTION LIMITS IN FUTURE MONITORING

In the leak detection monitoring program, downgradient wells in the shallow water-bearing zone will be sampled on a frequency identified in Section 3.2.2 of the LGMP, and the measured concentrations of four PCOCs will be compared to the background 99% UPLs. The UPLs were calculated at 99% confidence for quarterly sampling (4x/year) of four PCOCs from the six downgradient wells screened in the shallow water-bearing zone Thus, there will be 24 comparisons (statistical tests) for each quarterly period. The analytical results for the four PCOCs from each of the six downgradient wells will individually be compared to their background UPLs on a semi-annual basis (i.e., after completion of two quarterly sampling events) to evaluate a leakage from the waste placed in CAMU. For benzo(a)pyrene, which has not been detected in background samples, the laboratory reporting limit or existing GWQS will serve as the UPL, provided that the reporting limit is not lower than typical reporting limits or GWQS for background samples.

If the concentration of any of the four PCOCs in any well exceeds its UPL, a single re-sample of that constituent in that well will be collected one to three months after the original sample (to minimize temporal autocorrelation) and analyzed. The re-sample would be a statistically independent sample from the same well analyzed for any monitoring constituent that exceeds the 99% UPL. The purpose of the re-sample is to reduce the impact of false positive errors (making a faulty determination that a leak has occurred). If the re-sample also exceeds the UPL, this provides statistically significant evidence of contamination that may be due to leakage from the CAMU, which will trigger further investigation and, potentially, compliance monitoring. In evaluating potential leakage from the CAMU for benzo(a)pyrene, the double quantification rule will be used in lieu of a statistically-based UPL, as recommended in the *Unified Guidance*. The spatial variability of the background concentrations of the exceeding constituent will also be examined; if historical concentrations in the well where the exceedance was observed have

been higher than other wells in the background dataset, the exceedance may not represent a statistically significant indication of leakage from the CAMU.

The annual SWFPR, which is the likelihood of making an erroneous decision that a leak has occurred from the CAMU, is expected to be 10%. This rate is in accordance with statistical guidance from the USEPA, and cannot be further reduced without a substantial reduction in statistical power to detect a significant increase in concentrations or a further reduction in the number of wells or constituents tested. If the number of wells, constituents, samples per year, and re-samples is changed, the UPLs must be re-calculated because it will impact the SWFPR, set at an annual rate of 10% based on USEPA's *Unified Guidance*.

The interpretation of detection monitoring data must also consider that the UPLs are calculated so that even in the absence of leakage from the CAMU, there is a 10% chance in any year that one of the four constituent's concentration will exceed a UPL at one of the six wells. Over many years such a false positive is more likely than not.

The list of constituents for statistical detection monitoring may be modified in the future as analytical results for waste leachate samples become available (i.e., if other waste constituents are identified that would be more reliable indicators of potential leaks from the CAMU).

As groundwater monitoring continues, the background data set will be augmented with new measurements. UPLs should be re-calculated periodically using the augmented background dataset, assuming that the additional data for the point of compliance wells do not indicate a release of contaminants from the CAMU. It is proposed that the data analyzed on semi-annual basis and UPLs are updated on annual basis, if required. New monitoring results are then compared to the revised UPLs.

4.0 REFERENCES

USEPA, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*. EPA 530-R-09-007. Office of Resource Conservation and Recovery.

Enclosure:

Table IA2-1. Summary of Exploratory Data Analysis Results - Individual Wells

Table IA2-2. Summary Statistics for Background Concentrations (µg/L) in Ground Water - Pooled Data

Table IA2-3. Proposed Background Upper Prediction Limits for PCOCs in Downgradient Wells Screened in the Shallow Water-Bearing Zone

Table IA2-4. Proposed Background Upper Prediction Limits for Additional Monitoring Constituents in Downgradient Wells Screened in the Shallow Water-Bearing Zone

Table IA2-5. Proposed Background Upper Prediction Limits for PCOCs and Additional Monitoring Constituents in Downgradient Wells Screened in the Deep Water-Bearing Zone

Table IA2-1
SUMMARY OF EXPLORATORY DATA ANALYSIS RESULTS - INDIVIDUAL WELLS
CAMU Final Design Report
Former Chevron Perth Amboy Facility, New Jersey

Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-0057	Aluminum	7	6	86%	75	7520	2358	1535	2785	1.6	2.6
MW-0057	Antimony	7	0	0%							
MW-0057	Arsenic	9	2	22%	0	2	1	1	1		
MW-0057	Barium	7	7	100%	92	283	169	149	71	0.9	-0.7
MW-0057	Benzene	16	0	0%							
MW-0057	Benzo(a)Pyrene	7	0	0%							
MW-0057	Bromodichloromethane	12	0	0%							
MW-0057	Cadmium	7	1	14%	2	2	2	2			
MW-0057	Chromium	7	5	71%	2	13	6	4	5	1.7	3.2
MW-0057	Cobalt	9	7	78%	1	10	4	3	3	2.1	4.6
MW-0057	Iron	14	11	79%	62	29800	6327	4330	8549	2.4	6.5
MW-0057	Lead	9	3	33%	0	8	4	3	4	0.5	
MW-0057	Manganese	7	7	100%	101	3690	1131	622	1257	1.7	3.0
MW-0057	Mercury	7	2	29%	0	0	0	0	0		
MW-0057	Selenium	7	0	0%							
MW-0057	Silver	7	0	0%							
MW-0057	Sodium	7	7	100%	345000	846000	521571	494000	160674	1.5	3.2
MW-0057	Thallium	9	1	11%	7	7	7	7			
MW-114	Aluminum	8	4	50%	140	793	387	307	302	1.0	-0.3
MW-114	Antimony	8	0	0%							
MW-114	Arsenic	9	1	11%	7	7	7	7			
MW-114	Barium	8	8	100%	44	191	105	64	69	0.6	-2.2
MW-114	Benzene	20	0	0%							
MW-114	Benzo(a)Pyrene	10	0	0%							
MW-114	Bromodichloromethane	15	0	0%							
MW-114	Cadmium	9	1	11%	1	1	1	1			
MW-114	Chromium	8	1	13%	2	2	2	2			
MW-114	Cobalt	8	4	50%	1	5	4	4	2	-1.6	2.8

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MW-114	Iron	8	8	100%	51	8760	2624	435	3483	1.0	-0.8
MW-114	Lead	8	1	13%	0	0	0	0			
MW-114	Manganese	8	8	100%	48	5430	1979	563	2321	0.7	-1.9
MW-114	Mercury	8	2	25%	0	0	0	0	0		
MW-114	Selenium	8	0	0%							
MW-114	Silver	8	1	13%	2	2	2	2			
MW-114	Sodium	8	8	100%	59400	71100	66863	69350	4759	-0.7	-1.6
MW-114	Thallium	8	0	0%							
MW-115	Aluminum	11	4	36%	73	208	125	110	59	1.3	1.7
MW-115	Antimony	10	0	0%							
MW-115	Arsenic	11	0	0%							
MW-115	Barium	10	10	100%	19	39	28	27	7	0.7	-0.4
MW-115	Benzene	14	0	0%							
MW-115	Benzo(a)Pyrene	10	0	0%							
MW-115	Bromodichloromethane	11	1	9%	6	6	6	6			
MW-115	Cadmium	10	7	70%	1	5	2	1	1	1.6	2.8
MW-115	Chromium	11	1	9%	2	2	2	2			
MW-115	Cobalt	10	1	10%	2	2	2	2			
MW-115	Iron	17	14	82%	32	3360	1240	807	1244	0.6	-1.5
MW-115	Lead	15	3	20%	0	21	14	19	12	-1.7	
MW-115	Manganese	11	11	100%	10	2800	818	411	953	1.3	0.6
MW-115	Mercury	11	1	9%	0	0	0	0			
MW-115	Selenium	10	0	0%							
MW-115	Silver	11	0	0%							
MW-115	Sodium	11	11	100%	57900	120000	81200	70900	20203	0.8	-0.6
MW-115	Thallium	11	0	0%							
MW-116R	Aluminum	0	0								
MW-116R	Antimony	0	0								

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MW-116R	Arsenic	0	0								
MW-116R	Barium	0	0								
MW-116R	Benzene	16	13	81%	1	230	79	59	69	1.3	1.0
MW-116R	Benzo(a)Pyrene	0	0								
MW-116R	Bromodichloromethane	16	0	0%							
MW-116R	Cadmium	0	0								
MW-116R	Chromium	0	0								
MW-116R	Cobalt	0	0								
MW-116R	Iron	10	10	100%	878	5300	2836	2675	1457	0.5	-0.1
MW-116R	Lead	0	0								
MW-116R	Manganese	0	0								
MW-116R	Mercury	0	0								
MW-116R	Selenium	0	0								
MW-116R	Silver	0	0								
MW-116R	Sodium	0	0								
MW-116R	Thallium	0	0								
MW-120	Aluminum	6	1	17%	74	74	74	74			
MW-120	Antimony	6	0	0%							
MW-120	Arsenic	6	0	0%							
MW-120	Barium	6	6	100%	130	267	195	197	60	0.0	-2.7
MW-120	Benzene	14	0	0%							
MW-120	Benzo(a)Pyrene	18	0	0%							
MW-120	Bromodichloromethane	9	0	0%							
MW-120	Cadmium	6	1	17%	1	1	1	1			
MW-120	Chromium	6	1	17%	2	2	2	2			
MW-120	Cobalt	10	10	100%	10	15	13	14	2	-1.1	-0.5
MW-120	Iron	6	6	100%	2160	18300	6590	4350	6002	2.0	4.2
MW-120	Lead	17	1	6%	3	3	3	3			

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MW-120	Manganese	6	6	100%	3600	5220	4387	4340	832	0.0	-3.3
MW-120	Mercury	6	0	0%							
MW-120	Selenium	6	0	0%							
MW-120	Silver	6	0	0%							
MW-120	Sodium	6	6	100%	46200	78700	61667	61100	15217	0.0	-3.1
MW-120	Thallium	10	3	30%	5	14	11	14	5	-1.7	
MW-210	Aluminum	8	1	13%	88	88	88	88			
MW-210	Antimony	8	0	0%							
MW-210	Arsenic	8	0	0%							
MW-210	Barium	8	8	100%	212	443	304	296	77	0.8	0.1
MW-210	Benzene	15	3	20%	1	1	1	1	0	-1.7	
MW-210	Benzo(a)Pyrene	0	0								
MW-210	Bromodichloromethane	13	0	0%							
MW-210	Cadmium	8	2	25%	0	1	1	1	0		
MW-210	Chromium	8	2	25%	2	4	3	3	2		
MW-210	Cobalt	8	1	13%	2	2	2	2			
MW-210	Iron	15	15	100%	501	41900	18837	21300	12383	0.1	-0.9
MW-210	Lead	8	1	13%	35	35	35	35			
MW-210	Manganese	8	8	100%	501	1220	702	581	261	1.6	1.2
MW-210	Mercury	8	1	13%	0	0	0	0			
MW-210	Selenium	8	0	0%							
MW-210	Silver	8	0	0%							
MW-210	Sodium	8	8	100%	800000	1410000	1210000	1280000	203470	-1.4	1.5
MW-210	Thallium	8	0	0%							
MW-211	Aluminum	0	0								
MW-211	Antimony	0	0								
MW-211	Arsenic	0	0								
MW-211	Barium	0	0								

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-211	Benzene	15	2	13%	1	1	1	1	0		
MW-211	Benzo(a)Pyrene	0	0								
MW-211	Bromodichloromethane	13	0	0%							
MW-211	Cadmium	0	0								
MW-211	Chromium	0	0								
MW-211	Cobalt	0	0								
MW-211	Iron	13	13	100%	216	46900	20180	18600	16301	0.4	-1.2
MW-211	Lead	0	0								
MW-211	Manganese	0	0								
MW-211	Mercury	0	0								
MW-211	Selenium	0	0								
MW-211	Silver	0	0								
MW-211	Sodium	0	0								
MW-211	Thallium	0	0								
MW-233	Aluminum	3	0	0%							
MW-233	Antimony	3	0	0%							
MW-233	Arsenic	3	3	100%	6	14	9	7	5	1.7	
MW-233	Barium	3	3	100%	151	203	176	175	26	0.2	
MW-233	Benzene	14	14	100%	59	1400	647	485	448	0.6	-1.1
MW-233	Benzo(a)Pyrene	5	0	0%							
MW-233	Bromodichloromethane	14	0	0%							
MW-233	Cadmium	3	1	33%	2	2	2	2			
MW-233	Chromium	3	2	67%	1	2	1	1	0		
MW-233	Cobalt	3	0	0%							
MW-233	Iron	14	14	100%	3520	25000	14983	15650	5499	-0.6	1.0
MW-233	Lead	3	0	0%							
MW-233	Manganese	4	4	100%	1420	1910	1683	1700	209	-0.4	-0.4
MW-233	Mercury	3	2	67%	0	0	0	0	0		

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-233	Selenium	3	0	0%							
MW-233	Silver	3	0	0%							
MW-233	Sodium	3	3	100%	107000	161000	127000	113000	29597	1.7	
MW-233	Thallium	3	1	33%	5	5	5	5			
MW-234	Aluminum	1	0	0%							
MW-234	Antimony	1	0	0%							
MW-234	Arsenic	1	0	0%							
MW-234	Barium	1	0	0%							
MW-234	Benzene	12	12	100%	8	120	58	58	42	0.3	-1.6
MW-234	Benzo(a)Pyrene	0	0								
MW-234	Bromodichloromethane	12	0	0%							
MW-234	Cadmium	1	0	0%							
MW-234	Chromium	1	0	0%							
MW-234	Cobalt	1	0	0%							
MW-234	Iron	10	9	90%	325	1930	977	810	507	0.7	0.0
MW-234	Lead	1	0	0%							
MW-234	Manganese	1	1	100%	6770	6770	6770	6770			
MW-234	Mercury	1	0	0%							
MW-234	Selenium	1	0	0%							
MW-234	Silver	1	0	0%							
MW-234	Sodium	1	0	0%							
MW-234	Thallium	1	0	0%							
MW-240	Aluminum	6	5	83%	92	437	236	187	148	0.6	-1.8
MW-240	Antimony	6	0	0%							
MW-240	Arsenic	10	2	20%	1	12	6	6	7		
MW-240	Barium	6	6	100%	2	64	37	47	27	-0.7	-1.9
MW-240	Benzene	10	1	10%	180	180	180	180			
MW-240	Benzo(a)Pyrene	7	0	0%							

Table IA2-1
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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-240	Bromodichloromethane	7	1	14%	6	6	6	6			
MW-240	Cadmium	6	0	0%							
MW-240	Chromium	6	2	33%	1	5	3	3	2		
MW-240	Cobalt	6	1	17%	1	1	1	1			
MW-240	Iron	8	8	100%	86	7960	2393	1720	2616	1.6	2.6
MW-240	Lead	6	1	17%	1	1	1	1			
MW-240	Manganese	6	6	100%	29	5560	4188	4855	2103	-2.1	4.7
MW-240	Mercury	6	1	17%	0	0	0	0			
MW-240	Selenium	6	0	0%							
MW-240	Silver	6	1	17%	2	2	2	2			
MW-240	Sodium	6	6	100%	75100	96000	84150	82750	7349	0.7	0.3
MW-240	Thallium	6	0	0%							
MW-262	Aluminum	0	0								
MW-262	Antimony	0	0								
MW-262	Arsenic	2	0	0%							
MW-262	Barium	0	0								
MW-262	Benzene	11	8	73%	1	11	2	1	4	2.7	7.6
MW-262	Benzo(a)Pyrene	9	0	0%							
MW-262	Bromodichloromethane	9	0	0%							
MW-262	Cadmium	0	0								
MW-262	Chromium	0	0								
MW-262	Cobalt	0	0								
MW-262	Iron	9	9	100%	1030	10900	7876	8610	2932	-1.8	3.9
MW-262	Lead	2	0	0%							
MW-262	Manganese	0	0								
MW-262	Mercury	0	0								
MW-262	Selenium	0	0								
MW-262	Silver	0	0								

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-262	Sodium	0	0								
MW-262	Thallium	0	0								
MW-269	Aluminum	4	3	75%	87	336	181	121	135	1.6	
MW-269	Antimony	4	0	0%							
MW-269	Arsenic	8	4	50%	7	133	48	25	58	1.8	3.4
MW-269	Barium	4	4	100%	169	233	186	172	31	2.0	4.0
MW-269	Benzene	11	6	55%	1	9	2	1	3	2.3	5.4
MW-269	Benzo(a)Pyrene	9	0	0%							
MW-269	Bromodichloromethane	9	0	0%							
MW-269	Cadmium	4	1	25%	3	3	3	3			
MW-269	Chromium	4	1	25%	5	5	5	5			
MW-269	Cobalt	8	8	100%	3	4	3	3	1	1.1	1.4
MW-269	Iron	9	9	100%	8960	52400	16288	10900	13796	2.8	8.1
MW-269	Lead	8	1	13%	19	19	19	19			
MW-269	Manganese	4	4	100%	3360	4700	4048	4065	562	-0.2	0.1
MW-269	Mercury	4	1	25%	0	0	0	0			
MW-269	Selenium	4	0	0%							
MW-269	Silver	4	0	0%							
MW-269	Sodium	4	4	100%	40300	58600	51050	52650	7714	-1.2	2.2
MW-269	Thallium	4	0	0%							
MW-315	Aluminum	1	0	0%							
MW-315	Antimony	1	0	0%							
MW-315	Arsenic	1	1	100%	6	6	6	6			
MW-315	Barium	1	1	100%	153	153	153	153			
MW-315	Benzene	3	3	100%	2	120	69	84	60	-1.1	
MW-315	Benzo(a)Pyrene	0	0								
MW-315	Bromodichloromethane	3	0	0%							
MW-315	Cadmium	1	1	100%	0	0	0	0			

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-315	Chromium	1	1	100%	2	2	2	2			
MW-315	Cobalt	1	1	100%	1	1	1	1			
MW-315	Iron	1	1	100%	4060	4060	4060	4060			
MW-315	Lead	1	0	0%							
MW-315	Manganese	1	1	100%	341	341	341	341			
MW-315	Mercury	1	1	100%	0	0	0	0			
MW-315	Selenium	1	0	0%							
MW-315	Silver	1	0	0%							
MW-315	Sodium	1	1	100%	626000	626000	626000	626000			
MW-315	Thallium	1	1	100%	6	6	6	6			
MW-322	Aluminum	5	4	80%	100	1050	538	502	401	0.5	0.2
MW-322	Antimony	5	1	20%	1	1	1	1			
MW-322	Arsenic	5	5	100%	12	23	16	14	4	1.3	2.1
MW-322	Barium	5	5	100%	54	116	88	79	27	0.0	-2.1
MW-322	Benzene	5	4	80%	2	9	6	6	3	0.0	0.9
MW-322	Benzo(a)Pyrene	7	0	0%							
MW-322	Bromodichloromethane	5	0	0%							
MW-322	Cadmium	5	2	40%	1	1	1	1	0		
MW-322	Chromium	5	5	100%	4	5	5	5	1	-0.5	-3.1
MW-322	Cobalt	5	3	60%	1	2	2	2	1	-0.7	
MW-322	Iron	5	5	100%	45100	91900	68040	67300	18683	0.1	-1.4
MW-322	Lead	5	3	60%	3	9	5	4	3	1.7	
MW-322	Manganese	5	5	100%	559	1520	862	784	394	1.6	2.6
MW-322	Mercury	5	0	0%							
MW-322	Selenium	5	0	0%							
MW-322	Silver	5	1	20%	1	1	1	1			
MW-322	Sodium	5	5	100%	432000	549000	486600	470000	49450	0.4	-2.2
MW-322	Thallium	5	3	60%	5	12	9	9	4	0.0	

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-323	Aluminum	5	4	80%	98	296	198	199	91	0.0	-3.5
MW-323	Antimony	5	0	0%							
MW-323	Arsenic	5	3	60%	1	6	3	2	3	1.5	
MW-323	Barium	5	5	100%	116	150	133	135	13	0.0	-0.6
MW-323	Benzene	5	0	0%							
MW-323	Benzo(a)Pyrene	6	0	0%							
MW-323	Bromodichloromethane	5	1	20%	4	4	4	4			
MW-323	Cadmium	5	2	40%	1	1	1	1	0		
MW-323	Chromium	5	4	80%	1	3	2	1	1	1.5	1.8
MW-323	Cobalt	5	5	100%	1	11	4	3	4	2.1	4.5
MW-323	Iron	5	5	100%	7800	29500	23100	28600	9399	-1.5	1.5
MW-323	Lead	5	1	20%	0	0	0	0			
MW-323	Manganese	5	5	100%	1820	2200	2073	2160	156	-1.4	1.3
MW-323	Mercury	5	0	0%							
MW-323	Selenium	5	0	0%							
MW-323	Silver	5	1	20%	1	1	1	1			
MW-323	Sodium	5	5	100%	106000	141000	123200	119000	13312	0.2	-0.3
MW-323	Thallium	5	1	20%	6	6	6	6			
MW-324	Aluminum	5	4	80%	946	3340	1974	1805	1029	0.8	0.3
MW-324	Antimony	5	2	40%	6	10	8	8	3		
MW-324	Arsenic	5	4	80%	12	37	24	23	12	0.1	-4.2
MW-324	Barium	5	5	100%	62	667	356	367	219	0.2	1.2
MW-324	Benzene	5	4	80%	1	3	2	2	1	0.0	1.5
MW-324	Benzo(a)Pyrene	7	0	0%							
MW-324	Bromodichloromethane	5	0	0%							
MW-324	Cadmium	5	2	40%	3	4	4	4	1		
MW-324	Chromium	5	4	80%	5	10	7	7	2	0.2	-3.1
MW-324	Cobalt	5	5	100%	100	369	248	238	101	-0.5	0.7

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-324	Iron	5	5	100%	144000	592000	358800	375000	163005	0.2	1.0
MW-324	Lead	5	5	100%	0	16	9	8	6	-0.3	-0.2
MW-324	Manganese	5	5	100%	5110	23600	14882	14500	6904	-0.3	0.3
MW-324	Mercury	5	1	20%	0	0	0	0			
MW-324	Selenium	5	4	80%	22	55	38	38	18	0.0	-5.7
MW-324	Silver	5	3	60%	1	3	2	2	1	0.0	
MW-324	Sodium	5	5	100%	554000	1280000	836800	784000	267255	1.4	3.0
MW-324	Thallium	5	1	20%	47	47	47	47			
MW-325	Aluminum	6	4	67%	100	203	138	124	48	1.1	-0.1
MW-325	Antimony	6	0	0%							
MW-325	Arsenic	6	3	50%	2	8	4	2	3	1.7	
MW-325	Barium	5	5	100%	714	817	748	733	40	1.9	3.9
MW-325	Benzene	5	1	20%	4	4	4	4			
MW-325	Benzo(a)Pyrene	7	0	0%							
MW-325	Bromodichloromethane	5	0	0%							
MW-325	Cadmium	5	0	0%							
MW-325	Chromium	6	2	33%	1	2	1	1	0		
MW-325	Cobalt	5	0	0%							
MW-325	Iron	6	6	100%	3100	4440	3592	3430	532	0.9	-0.6
MW-325	Lead	6	3	50%	1	8	4	4	4	0.0	
MW-325	Manganese	6	6	100%	335	373	351	346	15	0.7	-1.4
MW-325	Mercury	6	0	0%							
MW-325	Selenium	5	1	20%	33	33	33	33			
MW-325	Silver	6	0	0%							
MW-325	Sodium	6	6	100%	252000	271000	263000	264500	8099	-0.4	-2.2
MW-325	Thallium	6	0	0%							
MW-326	Aluminum	5	5	100%	167	2170	1219	992	824	0.0	-1.7
MW-326	Antimony	5	3	60%	0	10	5	5	5	0.2	

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-326	Arsenic	5	4	80%	4	45	23	22	20	0.1	-5.0
MW-326	Barium	5	5	100%	181	326	256	235	61	0.1	-2.0
MW-326	Benzene	5	0	0%							
MW-326	Benzo(a)Pyrene	6	0	0%							
MW-326	Bromodichloromethane	5	0	0%							
MW-326	Cadmium	5	3	60%	6	20	11	7	8	1.7	
MW-326	Chromium	5	5	100%	4	11	6	5	3	1.5	2.3
MW-326	Cobalt	5	5	100%	65	84	72	70	8	1.0	0.4
MW-326	Iron	5	5	100%	288000	367000	335200	343000	29397	-1.2	2.1
MW-326	Lead	5	3	60%	2	14	7	5	6	1.1	
MW-326	Manganese	5	5	100%	39000	50700	46220	46000	4804	-0.8	0.1
MW-326	Mercury	5	0	0%							
MW-326	Selenium	5	5	100%	17	73	39	31	23	0.9	-0.3
MW-326	Silver	5	4	80%	6	10	7	6	2	2.0	4.0
MW-326	Sodium	5	5	100%	446000	846000	613600	545000	182152	0.5	-2.6
MW-326	Thallium	5	0	0%							
MW-327	Aluminum	3	1	33%	451	451	451	451			
MW-327	Antimony	3	0	0%							
MW-327	Arsenic	3	0	0%							
MW-327	Barium	3	3	100%	112	155	130	124	22	1.2	
MW-327	Benzene	3	0	0%							
MW-327	Benzo(a)Pyrene	5	0	0%							
MW-327	Bromodichloromethane	3	0	0%							
MW-327	Cadmium	3	0	0%							
MW-327	Chromium	3	1	33%	1	1	1	1			
MW-327	Cobalt	3	3	100%	1	2	2	2	0	-1.5	
MW-327	Iron	3	3	100%	765	1280	999	952	261	0.8	
MW-327	Lead	3	1	33%	4	4	4	4			

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-327	Manganese	3	3	100%	1880	2230	2077	2120	179	-1.0	
MW-327	Mercury	3	0	0%							
MW-327	Selenium	3	1	33%	39	39	39	39			
MW-327	Silver	3	0	0%							
MW-327	Sodium	3	3	100%	32800	38900	36867	38900	3522	-1.7	
MW-327	Thallium	3	0	0%							
MW-328	Aluminum	3	1	33%	415	415	415	415			
MW-328	Antimony	3	0	0%							
MW-328	Arsenic	3	1	33%	8	8	8	8			
MW-328	Barium	3	3	100%	108	136	119	113	15	1.5	
MW-328	Benzene	3	0	0%							
MW-328	Benzo(a)Pyrene	5	0	0%							
MW-328	Bromodichloromethane	3	0	0%							
MW-328	Cadmium	3	1	33%	1	1	1	1			
MW-328	Chromium	3	3	100%	1	2	2	2	0	-0.9	
MW-328	Cobalt	3	3	100%	2	2	2	2	0	0.0	
MW-328	Iron	3	3	100%	10700	13300	12300	12900	1400	-1.6	
MW-328	Lead	3	1	33%	3	3	3	3			
MW-328	Manganese	3	3	100%	2670	2950	2857	2950	162	-1.7	
MW-328	Mercury	3	1	33%	0	0	0	0			
MW-328	Selenium	3	0	0%							
MW-328	Silver	3	0	0%							
MW-328	Sodium	3	3	100%	69100	76200	73133	74100	3647	-1.1	
MW-328	Thallium	3	1	33%	4	4	4	4			
MW-333	Aluminum	2	2	100%	98	178	138	138	56		
MW-333	Antimony	2	0	0%							
MW-333	Arsenic	2	2	100%	18	34	26	26	11		
MW-333	Barium	2	2	100%	193	396	295	295	144		

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MW-333	Benzene	2	2	100%	1	1	1	1	0		
MW-333	Benzo(a)Pyrene	4	0	0%							
MW-333	Bromodichloromethane	2	0	0%							
MW-333	Cadmium	2	1	50%	0	0	0	0			
MW-333	Chromium	2	2	100%	2	2	2	2	0		
MW-333	Cobalt	2	2	100%	1	2	2	2	0		
MW-333	Iron	2	2	100%	27600	41600	34600	34600	9899		
MW-333	Lead	2	0	0%							
MW-333	Manganese	2	2	100%	352	517	435	435	117		
MW-333	Mercury	2	1	50%	0	0	0	0			
MW-333	Selenium	2	0	0%							
MW-333	Silver	2	1	50%	1	1	1	1			
MW-333	Sodium	2	2	100%	477000	481000	479000	479000	2828		
MW-333	Thallium	2	1	50%	6	6	6	6			
MW-334	Aluminum	3	2	67%	128	135	132	132	5		
MW-334	Antimony	3	0	0%							
MW-334	Arsenic	3	1	33%	13	13	13	13			
MW-334	Barium	3	3	100%	207	567	336	233	201	1.7	
MW-334	Benzene	2	2	100%	14	69	42	42	39		
MW-334	Benzo(a)Pyrene	4	0	0%							
MW-334	Bromodichloromethane	2	0	0%							
MW-334	Cadmium	3	1	33%	0	0	0	0			
MW-334	Chromium	3	2	67%	2	4	3	3	1		
MW-334	Cobalt	3	2	67%	1	2	1	1	1		
MW-334	Iron	3	3	100%	19500	103000	64800	71900	42200	-0.7	
MW-334	Lead	3	0	0%							
MW-334	Manganese	3	3	100%	586	3370	1939	1860	1394	0.3	
MW-334	Mercury	3	0	0%							

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
MW-334	Selenium	3	0	0%							
MW-334	Silver	3	0	0%							
MW-334	Sodium	3	3	100%	141000	2600000	1607000	2080000	1295943	-1.4	
MW-334	Thallium	3	0	0%							
NF-11	Aluminum	0	0								
NF-11	Antimony	0	0								
NF-11	Arsenic	20	6	30%	6	11	7	6	2	1.2	0.2
NF-11	Barium	0	0								
NF-11	Benzene	42	39	93%	1	190	67	60	51	0.6	-0.2
NF-11	Benzo(a)Pyrene	0	0								
NF-11	Bromodichloromethane	15	0	0%							
NF-11	Cadmium	43	7	16%	1	2	1	1	0	0.2	-0.1
NF-11	Chromium	42	3	7%	2	7	5	5	3	-0.6	
NF-11	Cobalt	0	0								
NF-11	Iron	16	16	100%	2110	50500	37823	42350	14511	-2.0	3.3
NF-11	Lead	42	3	7%	2	9	5	5	3	0.6	
NF-11	Manganese	0	0								
NF-11	Mercury	20	3	15%	0	0	0	0	0	-1.7	
NF-11	Selenium	20	1	5%	6	6	6	6			
NF-11	Silver	20	3	15%	3	7	5	5	2	-0.5	
NF-11	Sodium	20	20	100%	131000	317000	170950	149500	52919	2.0	3.6
NF-11	Thallium	0	0								
RW-02	Aluminum	2	1	50%	200	200	200	200			
RW-02	Antimony	2	0	0%							
RW-02	Arsenic	5	1	20%	0.54	0.54	0.54	0.54			
RW-02	Barium	2	2	100%	380	401	390.5	390.5	14.849242		
RW-02	Benzene	11	11	100%	61	210	134.45455	120	50.106614	0.32344203	-1.283423
RW-02	Benzo(a)Pyrene	2	0	0%							

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Well ID	Constituent	Sample Number	Number of Detections	Detection Rate	Min	Max	Mean	Median	Standard Deviation	Skewness	Kurtosis
RW-02	Bromodichloromethane	11	0	0%							
RW-02	Cadmium	2	0	0%							
RW-02	Chromium	2	0	0%							
RW-02	Cobalt	2	0	0%							
RW-02	Iron	8	8	100%	9340	17500	14155	14650	2673.5049	-0.7570618	0.026725
RW-02	Lead	5	2	40%	0.41	6	3.205	3.205	3.9527269		
RW-02	Manganese	2	2	100%	2270	3360	2815	2815	770.74639		
RW-02	Mercury	2	0	0%							
RW-02	Selenium	2	0	0%							
RW-02	Silver	2	0	0%							
RW-02	Sodium	2	2	100%	147000	320000	233500	233500	122329.47		
RW-02	Thallium	2	0	0%							

Table IA2-2

SUMMARY OF STATISTICS FOR BACKGROUN CONCENTRATIONS (µg/L) in GROUND WATER – POOLED DATA

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						Statistics for Detected Data				
Constituent	Aquifer	N	Detects	ND	% NDs	Min	Max	Mean	Median	Distribution
aluminum	deep	39	24	15	38%	72.9	2,170	416	195	non-parametric
aluminum	shallow	55	28	27	49%	74.0	7,520	971	294	non-parametric
antimony	deep	38	3	35	92%	0.47	29.0	4.89	4.7	non-parametric
antimony	shallow	55	3	52	95%	0.69	10.4	5.66	5.9	non-parametric
arsenic	deep	43	13	30	70%	1.10	44.8	10.3	6.2	non-parametric
arsenic	shallow	87	30	57	66%	0.44	133	17.3	11.8	non-parametric
barium	deep	37	37	0	0%	2.30	817	187	113	lognormal
barium	shallow	55	54	1	2%	44.3	667	216	191	lognormal
benzene	deep	45	2	43	96%	4.0	180	92	92	non-parametric
benzene	shallow	200	109	91	46%	0.50	230	57	38	non-parametric
benzo(a)pyrene	deep	46	0	46	100%	--	--	--	--	--
benzo(a)pyrene	shallow	104	0	104	100%	--	--	--	--	--
bromodichloromethane	deep	39	3	36	92%	4.00	6.00	5.33	6.00	non-parametric
bromodichloromethane	shallow	165	0	165	100%	--	--	--	--	--
cadmium	deep	37	13	24	65%	0.53	19.8	3.63	1.3	non-parametric
cadmium	shallow	99	21	78	79%	0.36	3.90	1.27	1.0	non-parametric
chromium	deep	39	18	21	54%	1.10	11.1	3.08	1.9	non-parametric
chromium	shallow	97	29	68	70%	1.30	13.2	4.27	4.2	non-parametric
cobalt	deep	37	18	19	51%	1.10	83.8	21.9	2.0	non-parametric
cobalt	shallow	65	43	22	34%	0.64	369	33.8	3.8	non-parametric
iron	deep	47	44	3	6%	32.2	367,000	42,942	2,970	lognormal
iron	shallow	148	144	4	3%	51.3	592,000	29,581	10,950	non-parametric
lead	deep	43	13	30	70%	0.082	21.2	6.26	3.50	non-parametric
lead	shallow	119	20	99	83%	0.079	35.0	7.57	5.50	non-parametric
manganese	deep	39	39	0	0%	9.80	50,700	7,500	2,120	lognormal
manganese	shallow	56	56	0	0%	47.7	23,600	3,156	1,575	lognormal
mercury	deep	39	3	36	92%	0.038	0.065	0.055	0.061	non-parametric
mercury	shallow	75	14	61	81%	0.012	0.084	0.055	0.065	non-parametric
selenium	deep	37	7	30	81%	16.7	73.0	38.1	32.9	non-parametric
selenium	shallow	75	5	70	93%	5.90	55.4	31.7	24.0	non-parametric
silver	deep	39	6	33	85%	1.00	10.1	5.12	5.85	non-parametric
silver	shallow	75	9	66	88%	0.95	6.60	2.77	2.30	non-parametric
sodium	deep	39	39	0	0%	32,800	846,000	179,233	96,000	non-parametric
sodium	shallow	75	74	1	1%	40,300	2,600,000	428,772	170,500	non-parametric
thallium	deep	39	2	37	95%	4.30	6.40	5.35	5.35	non-parametric
thallium	shallow	61	11	50	82%	4.70	46.5	11.8	7.10	non-parametric

Table IA2-3

PROPOSED BACKGROUND UPPER PREDICTION LIMITS FOR PCOCs IN DOWNFRADIENT WELLS SCREENED IN SHALLOW WATER-BEARING ZONE

CAMU FINAL DESIGN REPORT
Former Chevron Perth Amboy Facility, NJ

Constituent	Upper Prediction Limit (µg/L)	Basis
Arsenic	133	Non-Parametric
Benzene	230	Non-Parametric
Benzo(a)pyrene	Reporting Limit	Double Quantification Rule
Lead	33.1	Non-Parametric

Table IA2-4

PROPOSDED BACKGROUND UPPER PREDICTION LIMITS FOR ADDITIONAL MONITORING CONSTITUENTS IN DOWNGRADIENT WELLS SCREENED IN THE SHALLOW WATER-BEARING ZONE

CAMU Final Design Report

Former Chevron Perth Amboy Facility, NJ

Constituent	Upper Prediction Limit (µg/L except as noted)	Basis
aluminum	7.5 mg/L	Non-Parametric
antimony	10.4	Non-Parametric
barium	651	Parametric
bromodichloromethane	Reporting Limit	Double Quantification Rule
cadmium	3.9	Non-Parametric
chromium	13.2	Non-Parametric
cobalt	369	Non-Parametric
iron	494 mg/L	Non-Parametric
manganese	20.2 mg/L	Parametric
mercury	0.70	Non-Parametric
selenium	55.4	Non-Parametric
silver	6.6	Non-Parametric
sodium	2,600 mg/L	Non-Parametric
thallium	46.5	Non-Parametric

Table IA2-5

PROPOSDED BACKGROUND UPPER PREDICTION LIMITS FOR PCOCs AND ADDITIONAL MONITORING CONSTITUENTS IN DOWNGRADIENT WELLS SCREENED IN THE DEEP WATER-BEARING ZONE

CAMU Final Design Report

Former Chevron Perth Amboy Facility, NJ

Constituent	Upper Prediction Limit (µg/L except as noted)	Basis
aluminum	2.2 mg/L	Non-Parametric
antimony	29	Non-Parametric
arsenic	44.8	Non-Parametric
barium	1,739	Parametric
benzene	180	Non-Parametric
benzo(a)pyrene	Reporting Limit	Double Quantification Rule
bromodichloromethane	6	Non-Parametric
cadmium	19.8*	Non-Parametric
chromium	11.1	Non-Parametric
cobalt	83.8*	Non-Parametric
iron	510 mg/L	Parametric
lead	25.5	Non-Parametric
manganese	109 mg/L	Parametric
mercury	0.16	Non-Parametric
selenium	73*	Non-Parametric
silver	10.1	Non-Parametric
sodium	846 mg/L	Non-Parametric
thallium	28.5	Non-Parametric

* UPLs do not meet criteria for statistical significance based on the number of background samples. Calculated for illustrative purposes only

PERMIT DRAWINGS

The Permit Drawings is a 27-sheet drawing set that presents detailed information for the final design of the CAMU. The Permit Drawings present the configuration proposed for the CAMU, which includes the CAMU layout, base grading, waste grading, final cover grading and the sequence for the phased development of the CAMU. The drawings also present detailed information regarding the various systems that will be constructed as part of the CAMU development and closure, which include the bottom liner system, leachate collection system, final cover system, storm water management system, and the passive gas venting system.

A listing of the Permit Drawings is included below. The drawing set is issued under a separate cover.

G-001	Title Sheet
C-001	Existing Site Conditions – Aerial Photo
C-002	Existing Site Conditions – Topographic Map
C-003	Base Grading Plan
C-004	Leachate Collection System Layout Plan
C-005	Top of Waste Grading Plan - Cell 1
C-006	Top of Waste Grading Plan - Cells 1 & 2
C-007	Top of Waste Grading Plan - Cells 1, 2 & 3
C-008	Final Cover Grading Plan
C-009	CAMU East-West Cross Section
C-010	CAMU North-South Cross Sections
C-011	Perimeter Berm Cross Sections Near High Points
C-012	Perimeter Berm Cross Sections Near Low Points
C-013	Additional Berm Cross Sections
C-014	Liner and Leachate Collection System Details
C-015	Perimeter Leachate Sump Plan and Cross Sections
C-016	Perimeter Leachate Sump Cross Sections
C-017	Intercell Leachate Sump Grading Plans
C-018	Intercell Leachate Sump Cross Sections 1
C-019	Intercell Leachate Sump Cross Sections 2

C-020	Final Cover System Details 1
C-021	Final Cover System Details 2
C-022	Storm Water System During Operations
C-023	Post-Closure Storm Water System - North Side Outlet
C-024	Post-Closure Storm Water System - South Side Outlet
C-025	Post-Closure Storm Water System Details
C-026	Passive Gas Venting System