MILLER CONSTRUCTION, INC.

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TRANSMITTAL

TO: Jennifer Fitch, PE Project Manager Vermont Agency of Transportation	DATE	PROJECT NO.
	5/9/2014	Brookfield BRF FLBR (2)

XX WE ENCLOSE THE FOLLOWING: _____ UNDER SEPARATE COVER WE ARE SENDING THE FOLLOWING

COPIES	NUMBER	DESCRIPTION	CODE
1		Cofferdam Plan Submittal - Rev 1	H

CODE:

A FOR INITIAL APPROVAL
B FOR FINAL APPROVAL
C APPROVED AS NOTED-RESUBMISSION REQUIRED
D APPROVED AS NOTED-RESUBMISSION NOT REQUIRED
E DISAPPROVED-RESUBMIT
F QUOTATION REQUESTED
G APPROVED
H FOR APPROVAL
I AS REQUESTED OR REQUIRED
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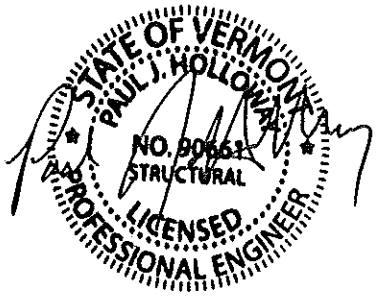
K LETTER FOLLOWS
L FOR FIELD CHECK
M FOR YOUR USE

BY: Paul J. Miller

COFFERDAM PLAN
for
State of Vermont Project: Brookfield BRF FLBR (2)

Town of: Brookfield, Vermont
County of: Orange



5/9/14

Prepared By:

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May 1, 2014
Revised May 9, 2014

COFFERDAM PLAN
FOR
State of Vermont Project: Brookfield BRF FLBR (2)

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Attachment 4: Design Calculations

General Project Description and Timetable

Brookfield BRF FLBR (2) includes the replacement of Bridge No. 2 on VT RT. 65 spanning 321 feet over the body of water known as Sunset Lake in the Town of Brookfield. The project begins at a point approximately 0.13 miles west of the VT RT. 65 / Stone Road Intersection and extends southeasterly for 0.08 miles along VT RT. 65. Work will involve complete replacement of Bridge No. 2 along with related roadway and removal of the existing floating bridge superstructure, abutments, and incidental items.

Sheet pile cofferdams are required at both abutments. The cofferdam at Abutment No. 1 (Cofferdam No. 1) is designed as a Cantilever Sheet Pile Wall. The cofferdam at Abutment No. 2 (Cofferdam No. 2) is designed as a Braced Sheet Pile Wall driven to ledge.

Anticipated installation of cofferdams shall occur during May and June of 2014.

Cofferdam No. 1

Cofferdam No. 1 is designed as a Cantilevered Sheet Pile Wall in Granular Soil. Reference Material includes the USS Steel Sheet Piling Design Manual, Dated July 1984. Soil Properties are assumed. Active and Passive Earth Pressure Coefficients were determined using Log-Spiral Theory and the Simplified Method was used to develop the pressure diagram.

Required embedment depth of the sheets below the dredge line is **D = 10.92 feet**. At this depth, a minimum distance of 4 feet between the centerline of battered H-Pile at Elev. 1269.5 (or 2.5 feet from the face of footing) and the line of sheeting shall be maintained to eliminate conflicts with H-Pile. Required Section Modulus is very low. All sheet sections on hand meet the requirement.

Cofferdam No. 1 shall be vented at O.H.W. (Elev. 1275.3).

Although internal bracing is not required, the driving frame may be left in place for convenience.

Cofferdam No. 1 is subject to field revisions based on actual conditions. Any changes shall be documented and this plan shall be amended.

Cofferdam No. 2

Cofferdam No. 2 is designed as a Braced Sheet Pile Wall in Loose Sand. Reference Material includes the USS Steel Sheet Piling Design Manual, Dated July 1984. Soil Properties are assumed. Active Earth Pressure Coefficient was determined using Log-Spiral Theory, and the pressure diagram was developed using the Modified Method for Braced Cuts in Sand, After Teng.

Cofferdam No. 2 shall be installed in 3 separate phases.

Phase 1:
Phase 1 includes the driving of sheets to ledge, the cofferdam excavation, and the internal bracing. ***The distance between the dredge line and the centerline of the bottom waler shall not exceed 3 feet. Meeting this requirement may require multiple elevation changes of the bottom waler as excavation progresses.*** The distance between the top of ledge and the centerline of the bottom waler shall not exceed 3 feet.

The distance between additional internal bracing shall not exceed 20 feet and shall be oriented with the web horizontal.

Phase 2:
Phase 2 includes the pinning of sheets to the ledge where the distance between the top of ledge and the centerline of the bottom waler needs to exceed 3 feet. After pinning, the bottom waler and subsequent bracing shall be adjusted.

Where required, each individual sheet shall be pinned to the ledge using a piece of #8 Rebar with a minimum embedment depth of 10 inches. Rebar shall be grouted into the ledge (product to be determined based on actual conditions). Total pin length shall be a minimum of 16 inches.

After pinning of the sheets is complete, the bottom waler and subsequent internal bracing shall be adjusted to a higher elevation to maintain a horizontal orientation. The distance between the pins and the centerline of the bottom waler shall not exceed 5 feet.

Phase 3:
Phase 3 includes the placement of the bottom lift of Class C Concrete for Subfooting and the removal of the bottom waler where conditions allow.

The lift of Class C Concrete shall be placed to an elevation below the bottom waler and shall receive a raked finish. An additional lift of Class C Concrete will be required to reach the required elevation per contract.

If conditions allow the bottom of all sheeting to bear laterally on a minimum thickness of 6 inches of concrete, then the bottom waler and subsequent bracing shall be removed. If conditions do not allow 6 inches of bearing on concrete, then the bottom waler and subsequent bracing shall be adjusted to a higher elevation. The distance between the top of concrete and the centerline of the bottom waler shall not exceed 5 feet.

Minimum thickness of the bottom lift of Class C Concrete on ledge shall be 6 inches. Any location where 6 inches of thickness cannot be achieved shall require a bulkhead to avoid "feathering" of concrete into the ledge.

Required Section Modulus is very low. All sheet sections on hand meet the requirement.

Cofferdam No. 2 shall be vented at O.H.W. (Elev. 1275.3).

Waler and bracing connections are shown in Attachment 3.

Cofferdam No. 2 is subject to field revisions based on actual conditions and ledge elevations. Any changes shall be documented and this plan shall be amended.

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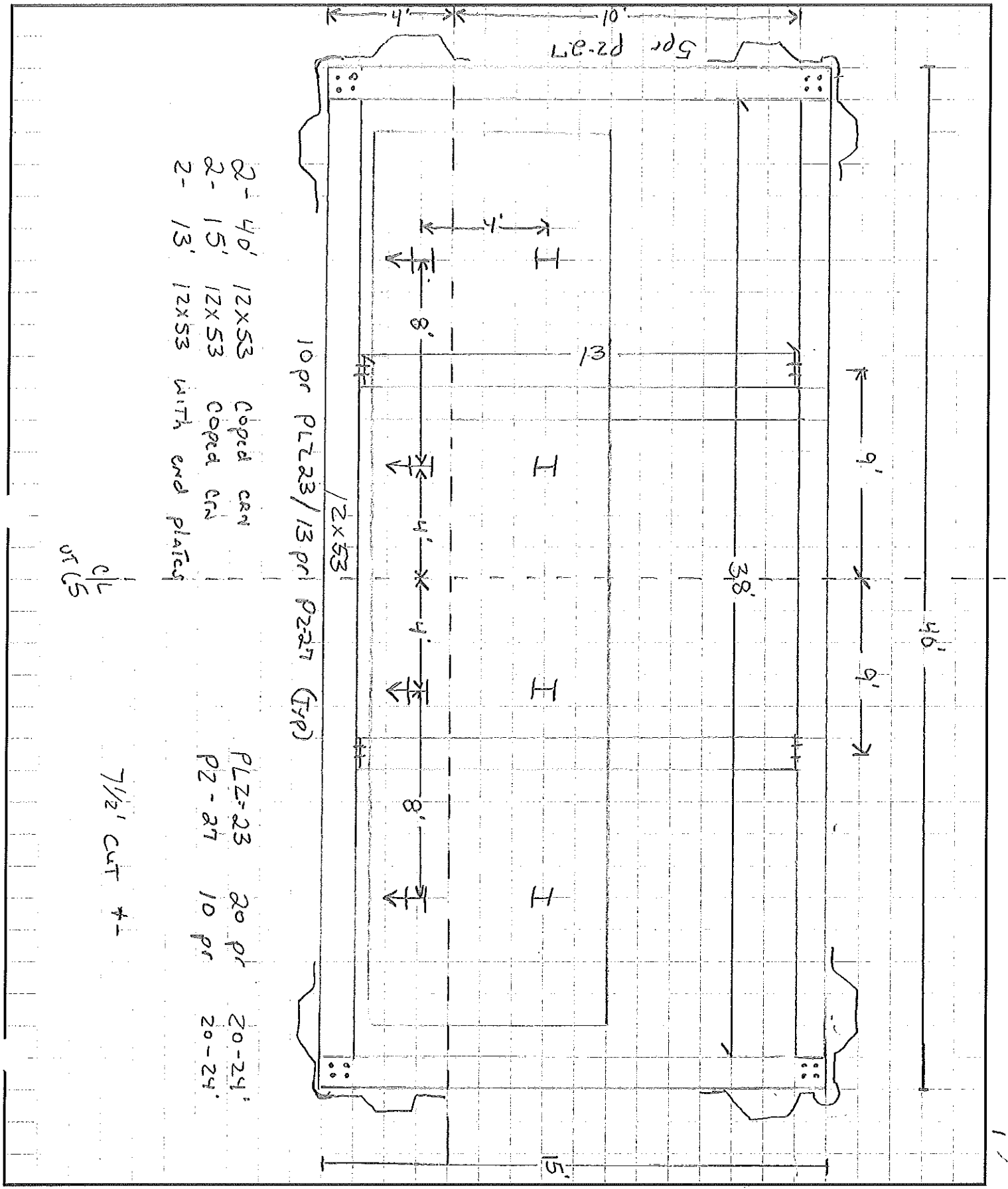
C/L Brg

JOB Brookfield Abut 1 Coffer dam
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____



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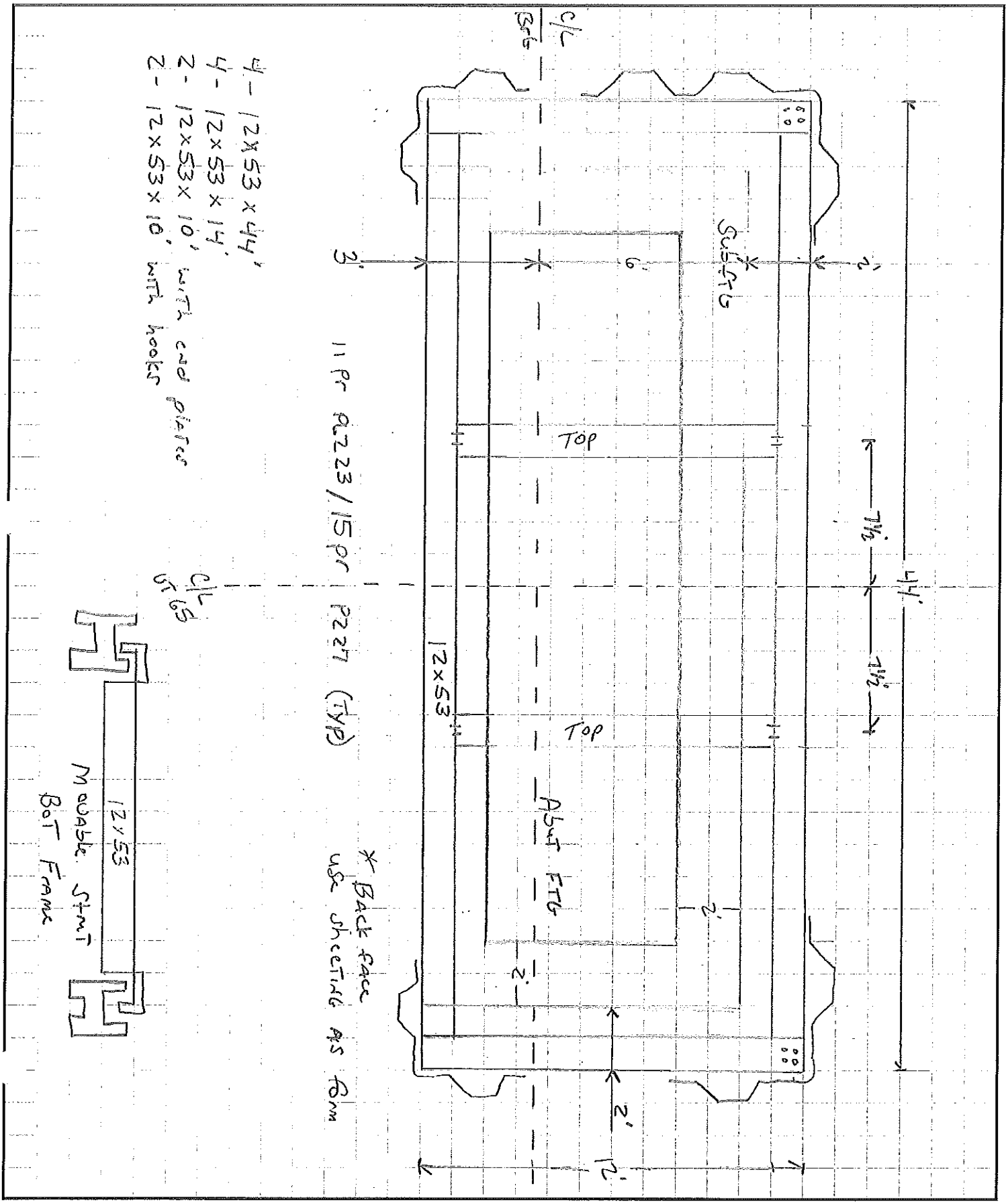
JOB Brok field Abut 2 cofferdam

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____



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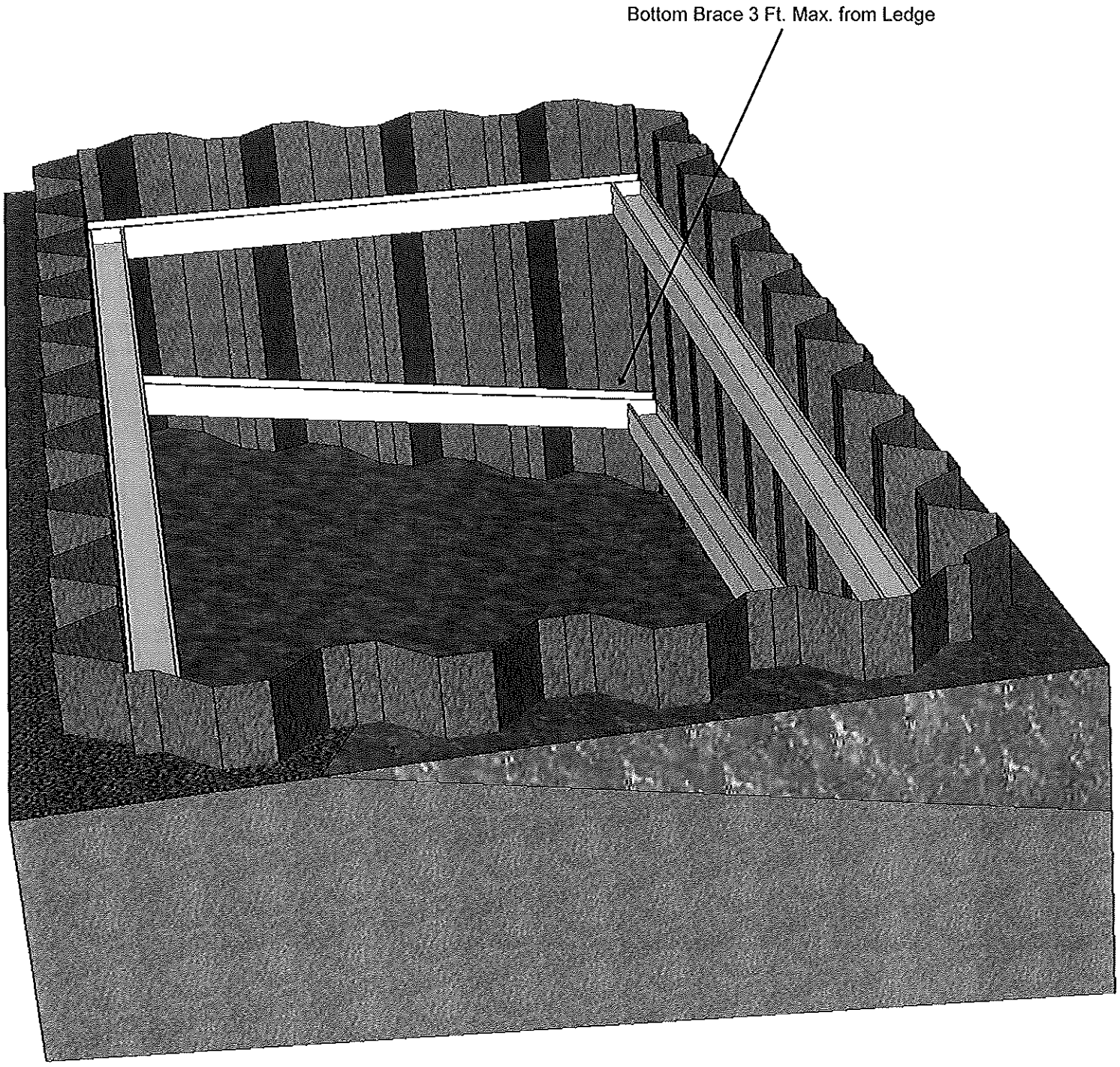
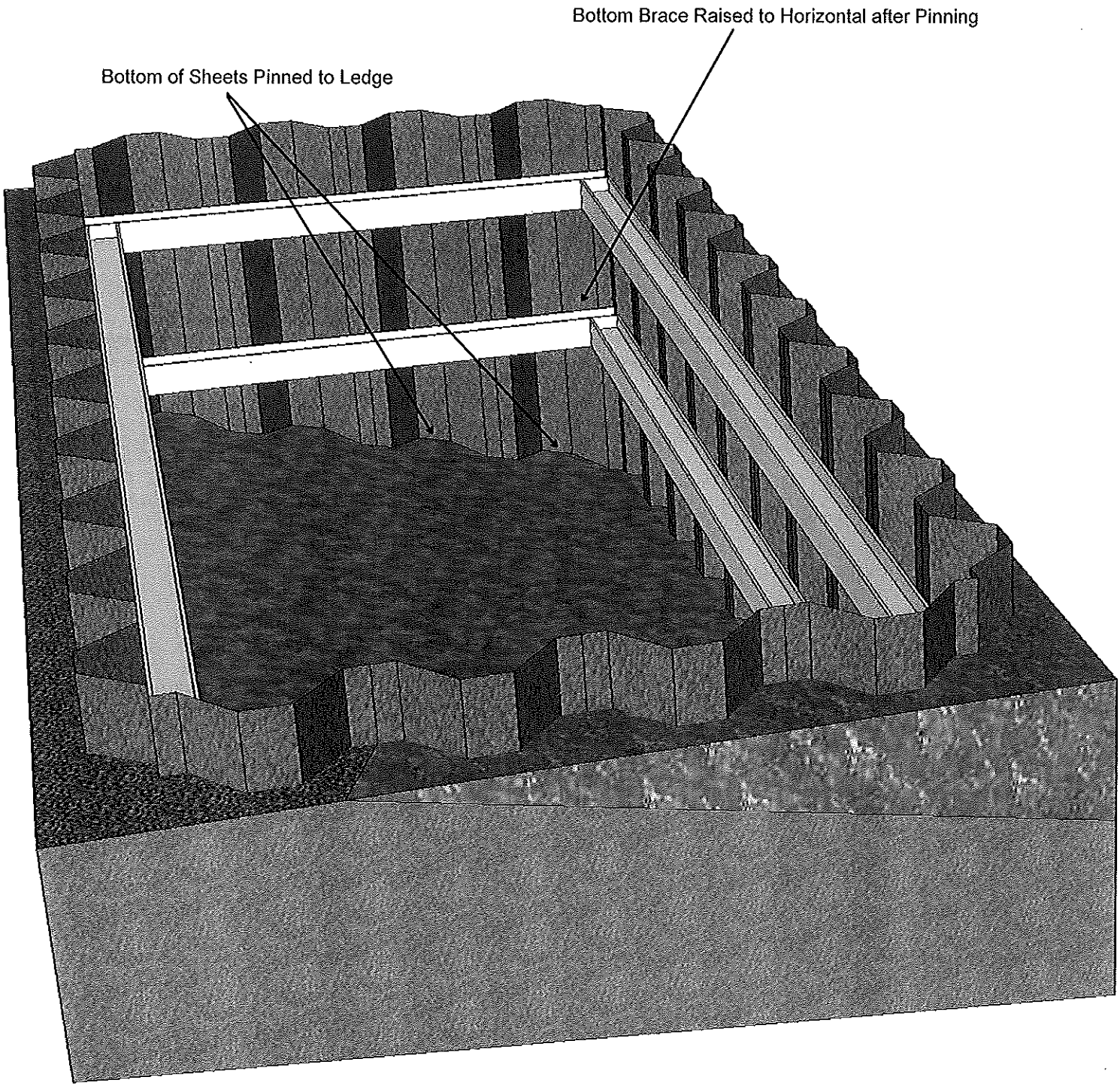
Brookfield BRF FLBR (2) - Cofferdam 2 - Phase 1



*Internal Bracing not Shown for Clarity

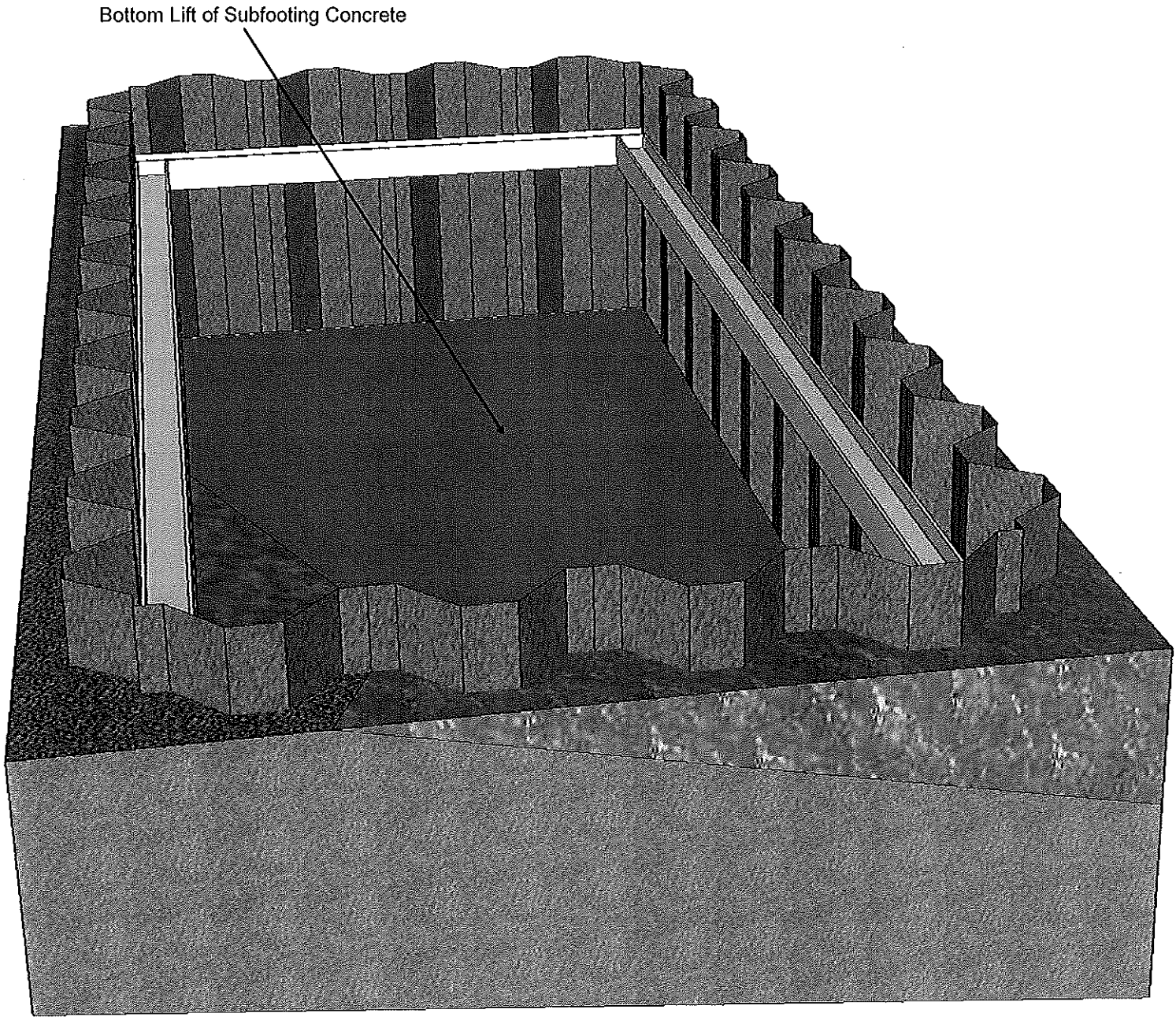
Brookfield BRF FLBR (2) - Cofferdam 2 - Phase 2



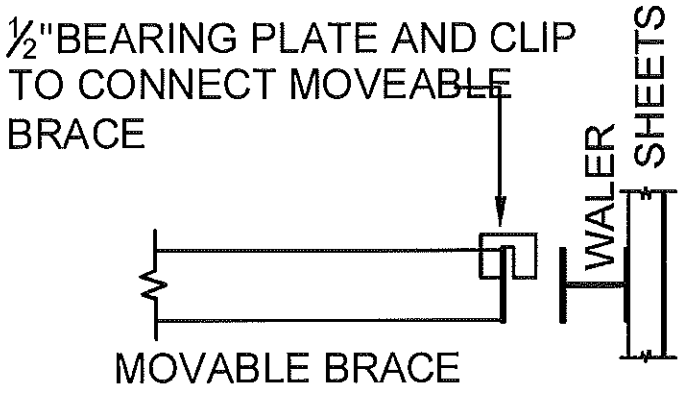
*Internal Bracing not Shown for Clarity

Brookfield BRF FLBR (2) - Cofferdam 2 - Phase 3

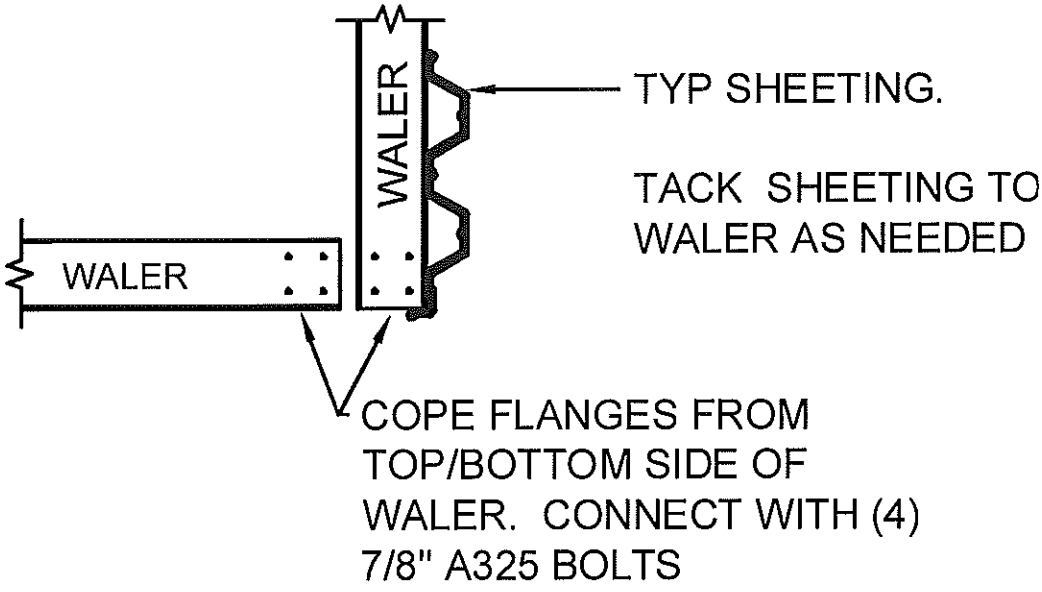
Remove Bottom Brace after Concrete Placement



*Internal Bracing not Shown for Clarity



SECTION SHOWING WALER BRACE



PLAN VIEW OF CORNER

WALER CONNECTION DETAILS

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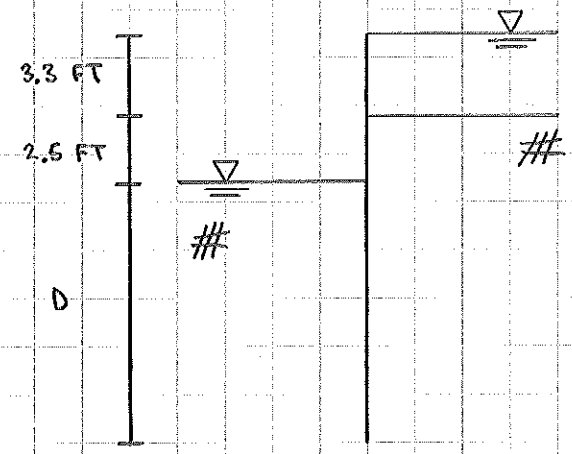
JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 1 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY DATE
SCALE N.T.S.

COFFERDAM NO. 1 CALCULATIONS:

O.H.W. = ELEV. 1275.3
BOTTOM OF FOOTING = ELEV. 1269.5
LAKE BED (ASSUMED) = ELEV. 1272.0
SAND WITH SOME GRAVEL AND SILT TO D = 11 FT



ASSUME:

γ_s = 65 PCF
γ_{WATER} = 62.5 PCF
ϕ = 30°
β = 0

LOG - SPIRAL THEORY:

K_a = 0.33

K_p = (6.6)(0.746) = 4.92

K'_p = 3.94 (1.25 F.O.S. FOR TEMP. SHEETING)

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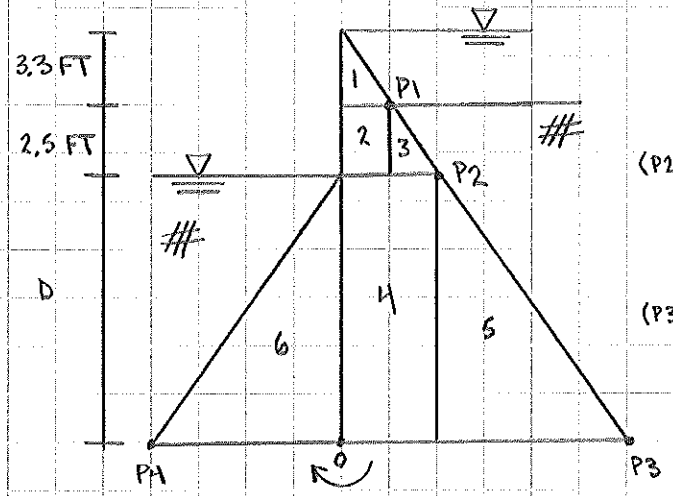
JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 2 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY _____ DATE _____
SCALE N.T.S.

* SIMPLIFIED METOD



$P1 = (3.3\ FT)(62.5\ PCF) = 206.25\ PSF$

$P2' = (2.5\ FT)(65\ PCF)(0.33) + (2.5\ FT)(62.5\ PCF) = 209.88\ PSF$
(P2 - P1)

$P3' = (65\ PCF)(D)(0.33) + (62.5\ PCF)(D) = 83.95\ D\ PSF$
(P3 - P2)

$PH = (65\ PCF)(D)(3.94) + (62.5\ PCF)(D) = 318.6\ D\ PSF$

FORCES:

$F_1 = (1/2)(206.25\ PSF)(3.3\ FT) = 340.3\ ^{LB}/_{FT}$
$F_2 = (206.25\ PSF)(2.5\ FT) = 515.6\ ^{LB}/_{FT}$
$F_3 = (1/2)(209.88\ PSF)(2.5\ FT) = 262.4\ ^{LB}/_{FT}$
$F_4 = (416.13\ PSF)(D) = 416.13\ D\ ^{LB}/_{FT}$
$F_5 = (1/2)(83.95\ D\ PSF)(D) = 42.0\ D^2\ ^{LB}/_{FT}$
$F_6 = (1/2)(318.6\ D\ PSF)(D) = 159.3\ D^2\ ^{LB}/_{FT}$

EMBEDMENT DEPTH:

$$\Sigma M_0 = 0 = -53.1\ D^3 + 14\ D^3 + 208\ D^2 + 262.4\ (D + 0.83) + 515.6\ (D + 1.25) + 340.3\ (D + 3.6)$$

$$\Rightarrow 39.1\ D^3 - 208\ D^2 - 1118.3\ D - 2087.4 = 0$$

$$\therefore D = 9.1\ FT$$

INCREASE D BY 20% SIMPLIFIED VS. CONVENTIONAL

$$\therefore D = 10.92\ FT$$

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JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 3 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY DATE
SCALE N.T.S.

POINT OF ZERO SHEAR:

$$\Sigma F_H = 0 = 340.3 + 615.6 + 262.4 + 416.13y + 42y^2 - 159.3y^2$$

$$\Rightarrow 117.3y^2 - 416.13y - 1118.3 = 0$$

$$\Rightarrow y^2 - 3.55y - 9.53 = 0$$

$$\therefore y = 5.34 \text{ FT}$$

$$M_{MAX} = 39.1(5.34)^3 - 208(5.34)^2 - 1118.3(5.34) - 2087.4$$

$$\therefore M_{MAX} = 8.04 \text{ KIP-FT}$$

SECTION MODULUS:

$$S_{REQUIRED} = \frac{8.04 \text{ KIP.FT}}{25 \text{ KSI}} = 0.32 \text{ IN}^3$$

VERY SMALL SECTION MODULUS REQUIRED, CHECK ACTUAL SHEET USED FOR CONFORMANCE.

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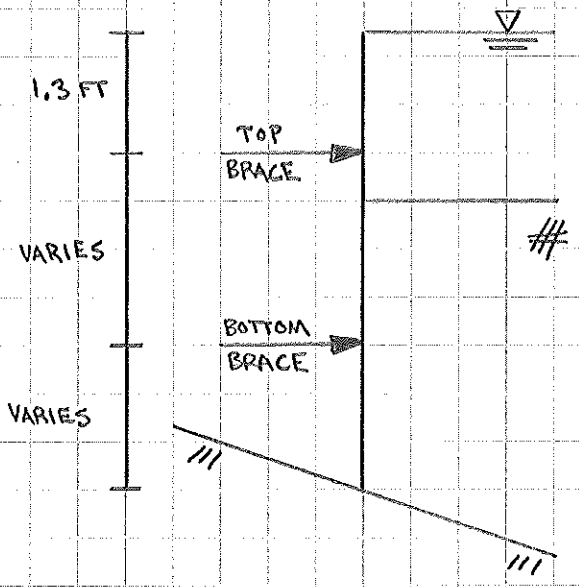
JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 4 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY DATE
SCALE

COFFERDAM NO. 2 CALCULATIONS :

O.H.W. = ELEV. 1276.3
LAKE BED (ASSUMED) = ELEV. 1272.0
LEDGE = ELEV. 1264.0 - 1268.0
LOOSE SAND WITH SILT TO LEDGE



ASSUME:

γ_s = 65 PCF
γ_{WATER} = 62.5 PCF
ϕ = 27.5°
β = 0
K_a = 0.37
δ = 14°

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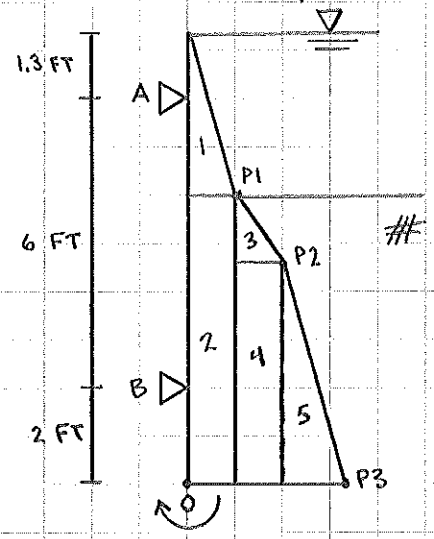
JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 5 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY DATE
SCALE N.T.S.

LEDGE ELEV. = 1266.0 (℄ OF COFFERDAM)

* MODIFIED METHOD BRACED CUTS IN LOOSE SAND, AFTER TENG



$P1 = (3.3\ FT)(62.5\ PCF) = 206.25\ PSF$

$P2' = 0.8(0.37)(65\ PCF)(6\ FT)\cos 14$ (P2-P1)
$+ (1.2\ FT)(62.5\ PCF) = 187.01\ PSF$

$P3' = (4.8\ FT)(62.5\ PCF) = 300.00\ PSF$ (P3-P2)

FORCES:

$F_1 = (1/2)(206.25\ PSF)(3.3\ FT) = 340.3\ ^{LB}/_{FT}$
$F_2 = (206.25\ PSF)(6\ FT) = 1237.5\ ^{LB}/_{FT}$
$F_3 = (1/2)(187.01\ PSF)(1.2\ FT) = 112.2\ ^{LB}/_{FT}$
$F_4 = (187.01\ PSF)(4.8\ FT) = 897.6\ ^{LB}/_{FT}$
$F_5 = (1/2)(300.00\ PSF)(4.8\ FT) = 720.0\ ^{LB}/_{FT}$

$\Sigma F_x = 0 = A + B - 3307.6 \Rightarrow A = 3307.6 - B$

$\Sigma M_0 = 0 = 8A + 2B - 7.1(340.3) - 3(1237.5) - 5.2(112.2)$
$- 2.4(897.6) - 1.6(720.0)$

$\Rightarrow 8A + 2B = 10,018.3$

$\therefore\ 8(3307.6 - B) + 2B = 10,018.3$

$\therefore$ **$A = 568\ ^{LB}/_{FT}$**
$B = 2740\ ^{LB}/_{FT}$

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JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 6 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
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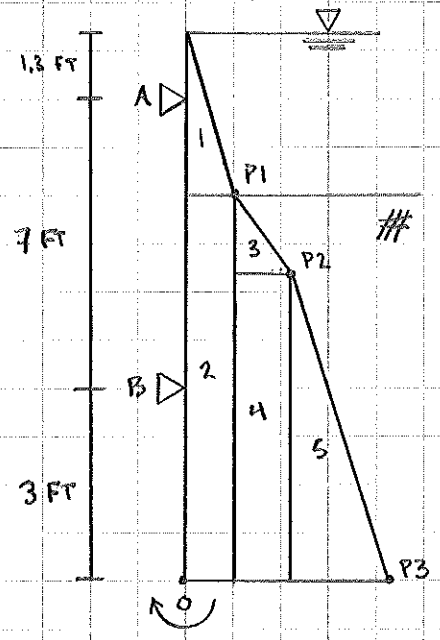
SCALE N.T.S.

LEDGE ELEV. = 1264.0 (CORNER)

* MODIFIED METHOD BRACED CUTS IN LOOSE SAND, AFTER TENG



$P_1 = (3.3\,FT)(62.5\,PCF) = 206.25\,PSF$

$P_2' = 0.8(0.37)(65\,PCF)(8\,FT)\cos 14$
$(P_2 - P_1) \quad + (1.6\,FT)(62.5\,PCF) = 249.35\,PSF$

$P_3' = (6.4\,FT)(62.5\,PCF) = 400\,PSF$
$(P_3 - P_2)$

FORCES:

$F_1 = (1/2)(206.25\,PSF)(3.3\,FT) = 340.3\,^{LB}/_{FT}$
$F_2 = (206.25\,PSF)(8\,FT) = 1650.0\,^{LB}/_{FT}$
$F_3 = (1/2)(249.35\,PSF)(1.6\,FT) = 199.5\,^{LB}/_{FT}$
$F_4 = (249.35\,PSF)(6.4\,FT) = 1595.8\,^{LB}/_{FT}$
$F_5 = (1/2)(400\,PSF)(6.4\,FT) = 1280.0\,^{LB}/_{FT}$

$\Sigma F_x = 0 = A + B - 5065.6 \Rightarrow A = 5065.6 - B$

$\Sigma M_0 = 0 = 10A + 3B - 9.1(340.3) - 4(1650.0) - 6.9(199.5)$
$- 3.2(1595.8) - 2.1(1280.0)$

$\Rightarrow 10A + 3B = 18,867.8$

$\therefore 10(5065.6 - B) + 3B = 18,867.8$

$\therefore$ **$A = 525\,^{LB}/_{FT} \quad B = 4541\,^{LB}/_{FT}$**

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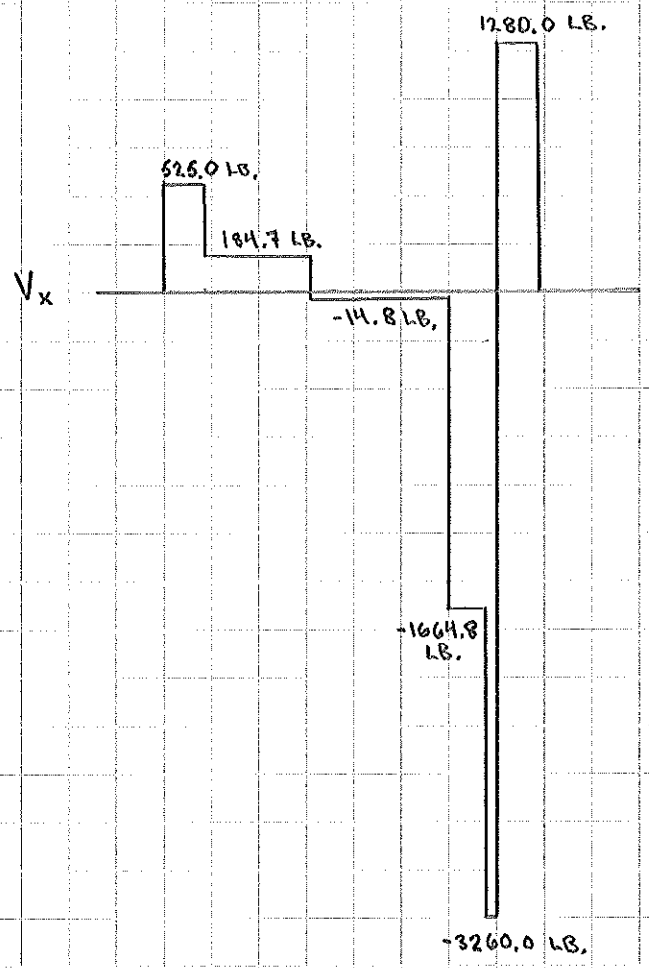
JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 7 OF 8
CALCULATED BY PJH DATE 1 MAY 2014
CHECKED BY _____ DATE _____
SCALE N.T.S.



M_{MAX} = 3.3 KIP.FT

SECTION MODULUS:

$$S = \frac{3.3 \text{ KIP-FT}}{25 \text{ KSI}} = 0.132 \text{ IN}^3$$

VERY SMALL SECTION MODULUS REQUIRED, CHECK ACTUAL SHEET USED FOR CONFORMANCE

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JOB BROOKFIELD BRF FLBR (2)
SHEET NO. 8 OF 8
CALCULATED BY PSH DATE 1 MAY 2014
CHECKED BY DATE
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BECAUSE RELATIVELY LOW PRESSURE AND WALER LOADS:

HP 12 x 53 ADEQUATE FOR WALERS AND INTERNAL BRACING.
7 FT. MAX SPACING BETWEEN TOP & BOTTOM WALER
20 FT. MAX SPACING BETWEEN BRACING. WEB ORIENTED HORIZONTAL TO ELIMINATE LATERAL BUCKLING.

IF 1 PIN PER SHEET, TAKE 10,000 LBS PER PIN IN SHEAR
∴ #4 BAR ADEQUATE IN SHEAR, BUT USE #8 BAR

ALL CALCULATIONS BASED ON ASSUMED SOIL PROPERTIES

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