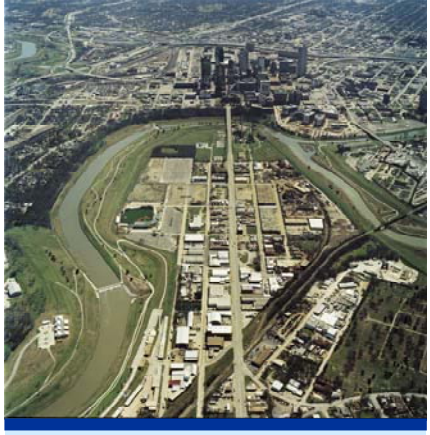

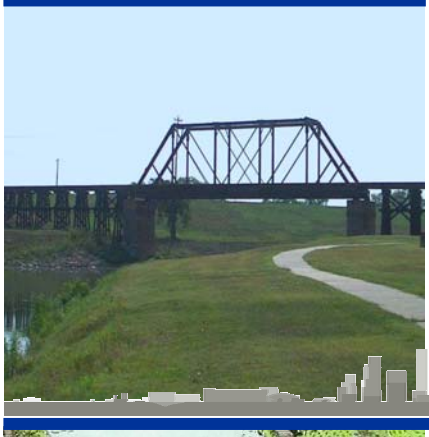

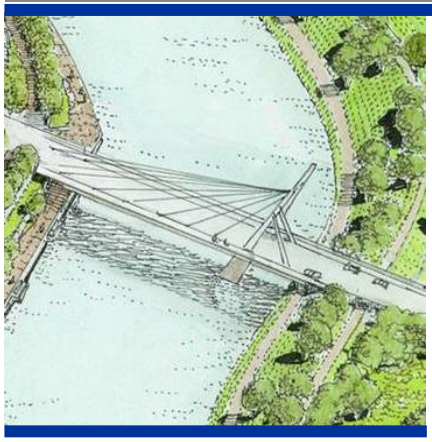

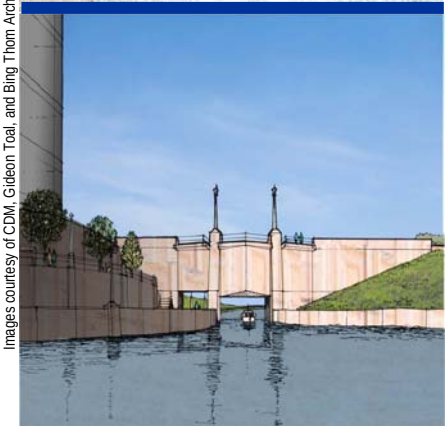

Fort Worth Central City Preliminary Design

Civil/Structural Preliminary Design

Draft Environmental Impact Statement

Appendix C

May 2005

Volume V – Stability Analysis Storm Water Pump Station

Images courtesy of CDM, Gideon Toal, and Bing Thom Architects

STABILITY ANALYSES FOR STORM WATER PUMP STATION

Contents: Stability Analyses for Storm Water Pump Station

Volume V

Section 1 **Index of Excel Spreadsheets**

Section 2 **Center of Gravity (CG) Spreadsheet for Various Components**

Section 3 **Counterfort**

Section 4 **Storm Water Pump Station Stability Analyses**
- Load Case 1 – During Construction
- Load Case 2 – During Construction Maintenance
- Load Case 3 - Normal
- Load Case 4 - Normal

Section 5 **Bearing Pressure**

Section 6 **Cell Formulas for Excel Spreadsheets**
- Counterfort
- Stability
- Bearing Pressure Analysis

Section 7 **Design of Steel H – Piles (Manual Calculations)**

Section 8 **Seismic Load Case Check**

CDM

Section 1
Index of Excel Spreadsheets

STABILITY ANALYSES
STORM WATER PUMP STATION

Index of Excel Spreadsheets:

Center of Gravity of various structure components:
File name: CG of building side walls
File name: CG of conc Upper side wall
File name: CG of conc Lower side wall
File name: CG of conc Upper counterfort
File name: CG of conc Lower counterfort

Counterfort:
File name: Counterfort.xls

Stability:
File name: PS Stability.xls
Tab name: Load Case 1
(Construction Case - Unusual)
Tab name: Load Case 2
(Maintenance or Construction Case - Unusual)
Tab name: Load Case 3
(Normal (drained soil) - Usual)
Tab name: Load Case 4
(Normal (undrained soil) - Usual)

Bearing Pressure:
File name: PS Bearing Pressure.xls

Section 2
Center of Gravity (CG)
Spreadsheets for Various Components

CDM

Storm Water Pump Station

Center of Gravity (CG) spreadsheets for various components:

1. Building Side Walls (File: CG of building side walls.xls)

2. Upper Concrete Side Wall (File: CG of conc Upper side wall.xls)

3. Lower Concrete Side Wall (File: CG of conc Lower side wall.xls)

4. Upper Counterfort for Lateral Force (File: CG of conc Upper counterfort.xls)

5. Lower Counterfort for Lateral Force (File: CG of conc Lower counterfort.xls)

CDM 8140 Walnut Hill Lane Dallas, TX 75231 tel. (214) 346-2800	Project: TRWD-FWCC Storm Water P.S.	Engineer:	EJB	Project # 42275
		Date:	18-Jan	
	Subject: Building side walls	Checker:		Page:
		Date:		

PROPERTIES OF SECTION DESCRIBED BY NODES COORDINATES

Units: **ft**

Nodes Coordinates		
	X	Y
1	0.000	0.000
2	0.000	20.000
3	20.000	20.000
4	20.000	8.500
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000
15	0.000	0.000
16	0.000	0.000
17	0.000	0.000
18	0.000	0.000
19	0.000	0.000
20	0.000	0.000
21	0.000	0.000
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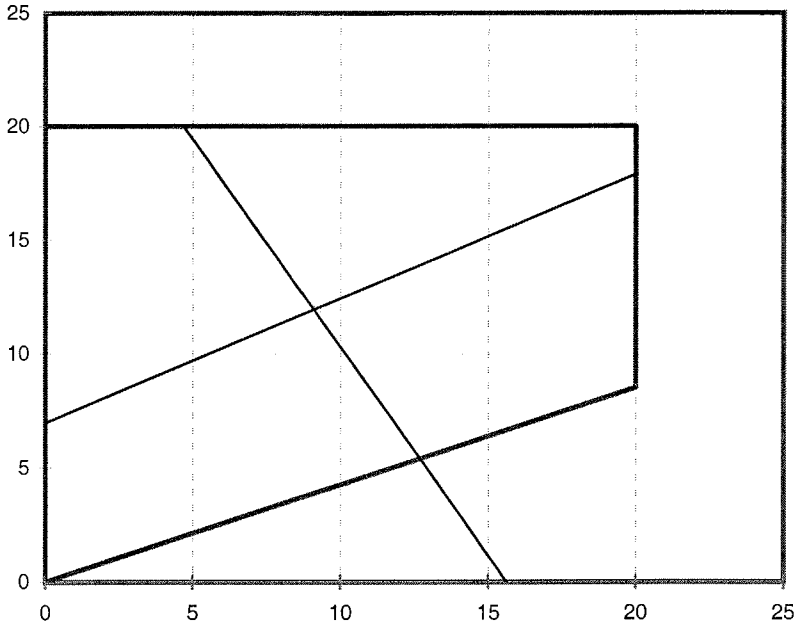
32		
33		

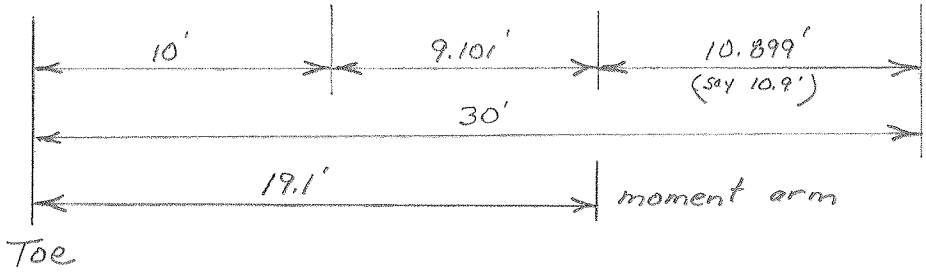
Section Properties
About Centroidal Axis Parallel to Original Axis

ϕ =	28.643 deg	X-dim =	20 ft
A =	315.00 ft^2	Y-dim =	20 ft
Xcg =	9.101 ft	Sx(top) =	923.4 ft^3
Ycg =	11.934 ft	Sx(bot) =	624.1 ft^3
Ixo =	7448.4 ft^4	Sy(left) =	1125.8 ft^3
Iyo =	10245.1 ft^4	Sy(right)=	940.0 ft^3
Ixyo =	2177.1 ft^4		

Section Properties About Principal Axis

ϕ =	28.643 deg	Sxp(top) =	547.1 ft^3
Ixp =	6259.3 ft^4	Sxp(bot) =	759.8 ft^3
Iyp =	11434.3 ft^4	Syp(left) =	834.2 ft^3
Ixyp =	0.0 ft^4	Syp(right)=	851.3 ft^3
J =	17693.6 ft^4		





CDM 8140 Walnut Hill Lane Dallas, TX 75231 tel. (214) 346-2800	Project: TRWD-FWCC Storm Water P.S.	Engineer:	EJB	Project # 42275
		Date:	18-Jan	
	Subject: Upper Conc Side Wall	Checker:		Page:
		Date:		

PROPERTIES OF SECTION DESCRIBED BY NODES COORDINATES

Units: **ft**

Nodes Coordinates		
	X	Y
1	0.000	0.000
2	0.000	26.000
3	30.000	33.500
4	30.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000
15	0.000	0.000
16	0.000	0.000
17	0.000	0.000
18	0.000	0.000
19	0.000	0.000
20	0.000	0.000
21	0.000	0.000
22		
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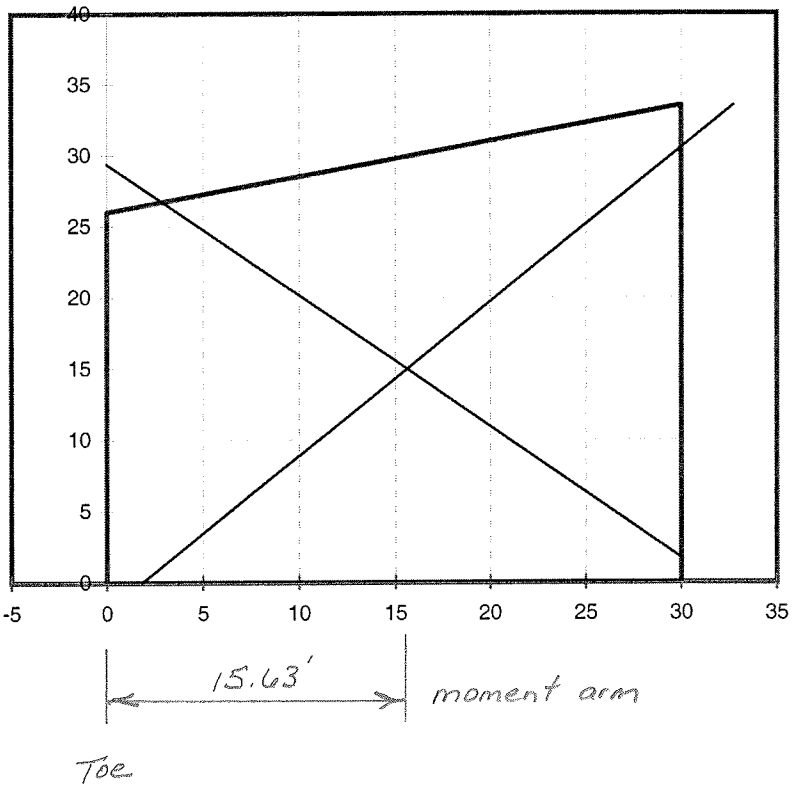
33		

Section Properties About Centroidal Axis Parallel to Original Axis			
ϕ =	-42.716 deg	X-dim =	30 ft
A =	892.50 ft^2	Y-dim =	33.5 ft
Xcg =	15.630 ft	Sx(top) =	3661.8 ft^3
Ycg =	14.954 ft	Sx(bot) =	4541.5 ft^3
Ixo =	67912.8 ft^4	Sy(left) =	4259.9 ft^3
Iyo =	66583.0 ft^4	Sy(right)=	4633.6 ft^3
Ixyo =	8322.9 ft^4		

Section Properties About Principal Axis			
ϕ =	-42.716 deg	Sxp(top) =	3234.2 ft^3
Ixp =	75597.3 ft^4	Sxp(bot) =	3501.5 ft^3
Iyp =	58898.5 ft^4	Syp(left) =	3103.6 ft^3
Ixyp =	0.0 ft^4	Syp(right)=	2845.1 ft^3
J =	134495.8 ft^4		



CDM 8140 Walnut Hill Lane Dallas, TX 75231 tel. (214) 346-2800	Project: TRWD-FWCC Storm Water P.S.	Engineer: EJB Date: 18-Jan	Project # 42275
	Subject: Lower Conc Side Wall	Checker: Date:	Page:

PROPERTIES OF SECTION DESCRIBED BY NODES COORDINATES

Units: **ft**

Nodes Coordinates		
	X	Y
1	0.000	0.000
2	0.000	32.500
3	30.000	41.000
4	30.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000
15	0.000	0.000
16	0.000	0.000
17	0.000	0.000
18	0.000	0.000
19	0.000	0.000
20	0.000	0.000
21	0.000	0.000
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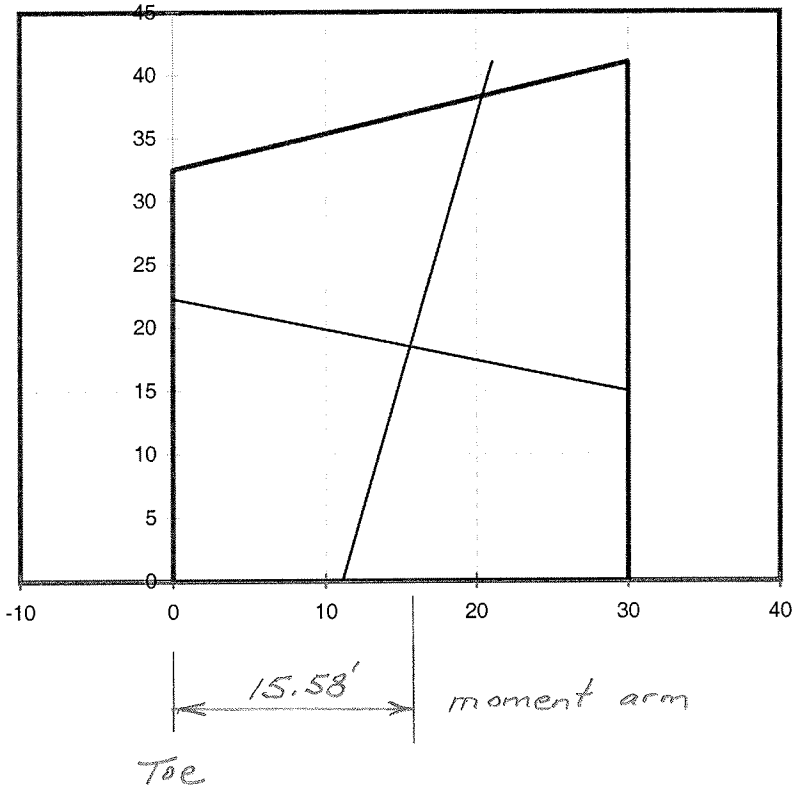
33		

Section Properties About Centroidal Axis Parallel to Original Axis			
ϕ =	-13.679 deg	X-dim =	30 ft
A =	1102.50 ft^2	Y-dim =	41 ft
Xcg =	15.578 ft	Sx(top) =	5651.2 ft^3
Ycg =	18.457 ft	Sx(bot) =	6902.3 ft^3
Ixo =	127394.5 ft^4	Sy(left) =	5284.2 ft^3
Iyo =	82318.9 ft^4	Sy(right)=	5708.0 ft^3
Ixyo =	11661.8 ft^4		

Section Properties About Principal Axis			
ϕ =	-13.679 deg	Sxp(top) =	5144.7 ft^3
Ixp =	130232.9 ft^4	Sxp(bot) =	6024.4 ft^3
Iyp =	79480.5 ft^4	Syp(left) =	4306.2 ft^3
Ixyp =	0.0 ft^4	Syp(right)=	4324.9 ft^3
J =	209713.4 ft^4		



CDM 8140 Walnut Hill Lane Dallas, TX 75231 tel. (214) 346-2800	Project: TRWD-FWCC Storm Water P.S.	Engineer: EJB Date: 18-Jan	Project # 42275
	Subject: Upper Counterfort for lateral force	Checker: Date:	Page:

PROPERTIES OF SECTION DESCRIBED BY NODES COORDINATES

Units: **ft**

Nodes Coordinates		
	X	Y
1	0.000	0.000
2	0.000	19.000
3	10.000	3.000
4	10.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000
15	0.000	0.000
16	0.000	0.000
17	0.000	0.000
18	0.000	0.000
19	0.000	0.000
20	0.000	0.000
21	0.000	0.000
22		
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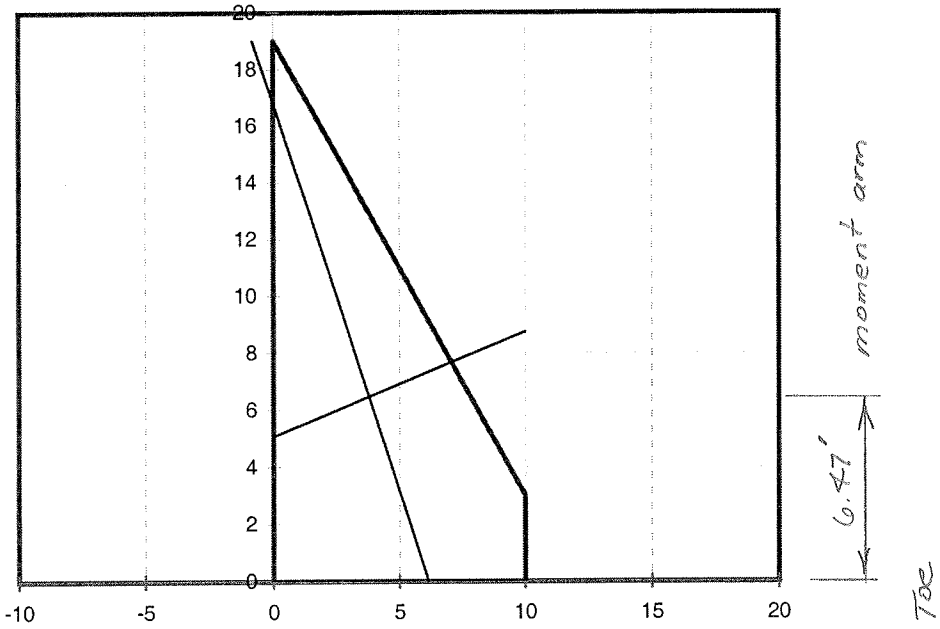
Section Properties About Centroidal Axis Parallel to Original Axis			
ϕ =	20.155 deg	X-dim =	10 ft
A =	110.00 ft^2	Y-dim =	19 ft
Xcg =	3.788 ft	Sx(top) =	173.9 ft^3
Ycg =	6.470 ft	Sx(bot) =	336.8 ft^3
Ixo =	2179.1 ft^4	Sy(left) =	199.3 ft^3
Iyo =	755.1 ft^4	Sy(right)=	121.5 ft^3
Ixyo =	-604.0 ft^4		

Section Properties About Principal Axis			
ϕ =	20.155 deg	Sxp(top) =	183.7 ft^3
Ixp =	2400.8 ft^4	Sxp(bot) =	292.3 ft^3
Iyp =	533.3 ft^4	Syp(left) =	92.2 ft^3
Ixyp =	0.0 ft^4	Syp(right)=	115.0 ft^3
J =	2934.1 ft^4		



Use Area (110 ft²) for lateral force

CDM 8140 Walnut Hill Lane Dallas, TX 75231 tel. (214) 346-2800	Project: TRWD-FWCC Storm Water P.S.	Engineer: EJB Date: 18-Jan	Project # 42275
	Subject: Lower Counterfort for lateral force	Checker: Date:	Page:

PROPERTIES OF SECTION DESCRIBED BY NODES COORDINATES

Units: **ft**

Nodes Coordinates		
	X	Y
1	0.000	0.000
2	-9.500	0.000
3	-9.500	3.000
4	0.000	29.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000
15	0.000	0.000
16	0.000	0.000
17	0.000	0.000
18	0.000	0.000
19	0.000	0.000
20	0.000	0.000
21	0.000	0.000
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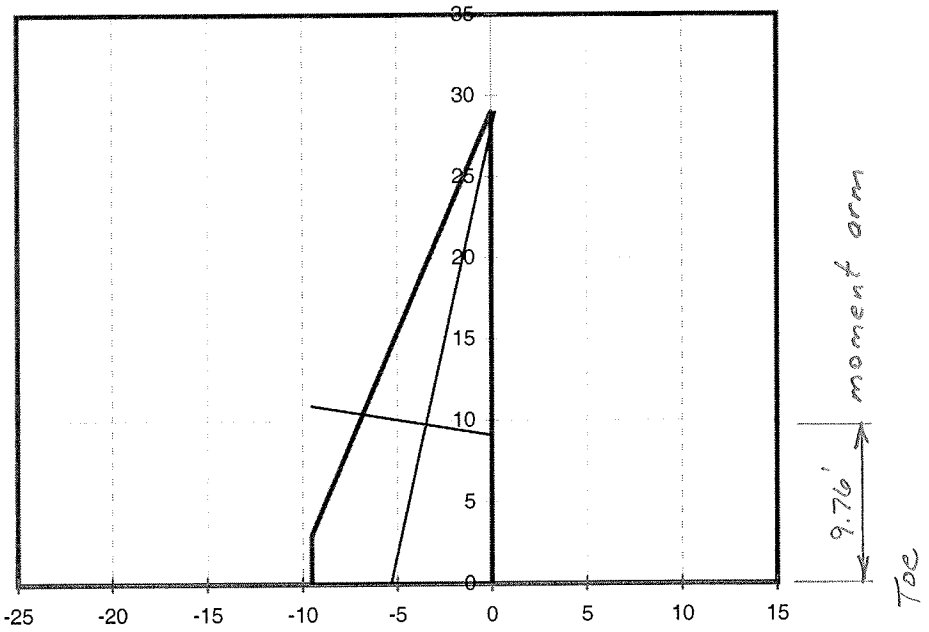
Section Properties
About Centroidal Axis Parallel to Original Axis

ϕ =	-10.803 deg	X-dim =	9.5 ft
A =	152.00 ft^2	Y-dim =	29 ft
Xcg =	-3.464 ft	Sx(top) =	366.6 ft^3
Ycg =	9.760 ft	Sx(bot) =	722.6 ft^3
Ixo =	7052.9 ft^4	Sy(left) =	147.7 ft^3
Iyo =	891.6 ft^4	Sy(right)=	257.4 ft^3
Ixyo =	1220.1 ft^4		

Section Properties About Principal Axis

ϕ =	-10.803 deg	Sxp(top) =	372.7 ft^3
Ixp =	7285.8 ft^4	Sxp(bot) =	679.7 ft^3
Iyp =	658.8 ft^4	Syp(left) =	141.3 ft^3
Ixyp =	0.0 ft^4	Syp(right)=	125.9 ft^3
J =	7944.6 ft^4		



Use Area (152 ft²) for lateral force

Section 3
Counterfort

Storm Water Pump Station
Counterfort

(File: Counterfort.xls)

PROJECT:		TRWD - STORM WATER PUMP STATION					
PROJECT NO:		2521-42275-PRSTR.PS					
DESIGNED BY:		E. BJORKLUND			DATE:	1/17/2005	
CHECKED BY:					DATE:		
UPPER COUNTERFORT							
E.F.P.=	**70**	psf / ft of depth					
Depth =	38	ft from grade to upper counterfort base					
Centroid =	6.47	ft from centroid to upper counterfort base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about upper slab	Moment
Trapezoid	31.53	2207	110	242781	6.47	6.47	1570793
LOWER COUNTERFORT							
E.F.P.=	**70**	psf / ft of depth					
Depth =	45.5	ft from grade to base					
Centroid =	9.76	ft from centroid to base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about lower slab	Moment
Trapezoid	35.74	2502	152	380273.6	9.76	9.76	3711470
UPPER COUNTERFORT							
E.F.P.=	**105**	psf / ft of depth					
Depth =	38	ft from grade to upper counterfort base					
Centroid =	6.47	ft from centroid to upper counterfort base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about upper slab	Moment
Trapezoid	31.53	3311	110	364171.5	6.47	6.47	2356190
LOWER COUNTERFORT							
E.F.P.=	**105**	psf / ft of depth					
Depth =	45.5	ft from grade to base					
Centroid =	9.76	ft from centroid to base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about lower slab	Moment
Trapezoid	35.74	3753	152	570410.4	9.76	9.76	5567206

Section 4
Storm Water Pump Station Stability Analysis

CDM

Storm Water Pump Station

Stability

(File: PS Stability.xls with Tabs for Load Cases)

Load Case 1 – During Construction

1. Dead loads + equipment.

2. No live loads, no soil, no water.

PROJECT:	TRWD - STORM WATER PUMP STATION													
PROJECT NO:	2521-42275-PRSTR.PS													
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005											
CHECKED BY:		DATE:												
STABILITY														
Load Condition 1 - During Construction														
(dead loads + equipment loads, no live loads no soil, no water)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL														
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	53,750	20	1,075,000		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	64,320	9.25	594,960		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	40,000	19.1	764,000		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	38,520	30.75	1,184,490		
Top Floor Slab	18" thick	225	psf		21.5	50				241,875	19.25	4,656,094		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					56,300	16	900,800		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			412,125	31.17	12,845,936		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			263,250	15.63	4,114,598		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			216,624	31.17	6,752,176		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			372,645	15.58	5,805,809		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			506,250	15	7,593,750		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			50,625	15	759,375		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			24,000	1	24,000		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			24,000	16	384,000		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			24,000	31	744,000		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			32,775	1	32,775		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			32,775	16	524,400		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			32,775	31	1,016,025		
Base Slab	36" thick	450	psf		75	51				1,721,250	25.5	43,891,875		
Pumps	Upper vertical pumps	30500	lbs	3						91,500	25.5	2,333,250		
	Lower vertical pump	34500	lbs	1						34,500	25.5	879,750		
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165						52,635	4.25	223,699		
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55						29,975	4.25	127,394		
										4,416,469	22.01	97,228,155		

Storm Water Pump Station

Stability

(File: PS Stability.xls with Tabs for Load Cases)

Load Case 2 – During Construction or Maintanence

1. Dead loads.

2. No equipment, no live loads, low water (empty inlet).

3. Undrained (saturated) backfill.

4. Uplift

PROJECT:	TRWD - STORM WATER PUMP STATION															
PROJECT NO:	2521-42275-PRSTR.PS															
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 2 - During Construction/Maintenance																
(dead loads, no equipment, no live loads saturated backfill + low water/empty + uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	53,750		20	1,075,000		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	64,320		9.25	594,960		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	40,000		19.1	764,000		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	38,520		30.75	1,184,490		
Top Floor Slab	18" thick	225	psf		21.5	50				241,875		19.25	4,656,094		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					56,300		16	900,800		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			412,125		31.17	12,845,936		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			263,250		15.63	4,114,598		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			216,624		31.17	6,752,176		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			372,645		15.58	5,805,809		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			506,250		15	7,593,750		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			50,625		15	759,375		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			24,000		1	24,000		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			24,000		16	384,000		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			24,000		31	744,000		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			32,775		1	32,775		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			32,775		16	524,400		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			32,775		31	1,016,025		
Base Slab	36" thick	450	psf		75	51				1,721,250		25.5	43,891,875		
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	130	pcf		51.17	18.5	35			4,307,235		41.75	179,827,051		
	on Lower Heel Footing (vertical volume, no cone action)	130	pcf		23.83	18	42.5			2,369,894		42	99,535,527		
	on Upper Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	10	29.25			1,140,750		15	17,111,250		
	on Lower Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	9.5	36.75			1,361,588		15	20,423,813		
										13,387,325		30.67	410,561,703		
LATERAL															
Saturated soil forces	on Upper end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	pcf		51.17		38				3,879,198	12.65		49,087,368	Assumes moment-arm rotation about bottom of UPPER foundation
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3311	pcf			10	11				364,210	6.47		2,356,439	Assumes moment-arm rotation about bottom of UPPER foundation
	on Lower end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	pcf		23.83		45.5				2,590,038	15.15		39,242,961	Assumes moment-arm rotation about bottom of LOWER foundation
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3753	pcf			9.5	16				570456	9.76		5,567,651	Assumes moment-arm rotation about bottom of LOWER foundation
											7,403,902	13.00		96,254,418	
UPLIFT															
Uplift	at Upper channel at inlet/bar screen (UPPER TOE): High Groundwater/Saturated soil up to Elev. 513.0, bottom of base at 510.0 = 3.0 ft head (uniform load)	62.4	pcf		49.5	51	3			-472,586		25.5		12,050,953	
	at Upper channel at end wall (UPPER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 513.0 = 35.0 ft head (triangular load)	62.4	pcf		49.5	51	35			-2,756,754		34.02		93,784,771	
	at Lower channel at inlet/bar screen (LOWER TOE): High Groundwater/Saturated soil up to Elev. 505.5, bottom of base at 502.5 = 3.0 ft head (uniform load)	62.4	pcf		25.33	51	3			-241,831		25.5		6,166,680	
	at Lower channel at end wall (LOWER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 505.5 = 42.5 ft head (triangular load)	62.4	pcf		25.33	51	42.5			-1,712,967		34.02		58,275,123	
										-5,184,138		32.85		170,277,527	
										8,203,187	7,403,902		410,561,703	266,531,945	

Storm Water Pump Station

Stability

(File: PS Stability.xls with Tabs for Load Cases)

Load Case 3 – Normal

1. Dead loads + equipment + live loads.

2. Maximum design water surface (full inlet) at Elevation 527.3.

3. Drained (dry) backfill.

4. No uplift.

PROJECT:	TRWD - STORM WATER PUMP STATION															
PROJECT NO:	2521-42275-PRSTR.PS															
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 3 - Normal																
(dead loads + equipment + live loads, unsaturated backfill + max. water surface, no uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions			Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof L.L.		55	psf		23	53					67,045		20	1,340,900		
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =		144	53,750		20	1,075,000		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =		256	64,320		9.25	594,960		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =		80	40,000		19.1	764,000		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =		128	38,520		30.75	1,184,490		
Top Floor Slab L.L.		200	psf		20	50					200,000		20	4,000,000		
Top Floor Slab	18" thick	225	psf		21.5	50					241,875		19.25	4,656,094		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50						56,300		16	900,800		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35				412,125		31.17	12,845,936		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25				263,250		15.63	4,114,598		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5				216,624		31.17	6,752,176		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75				372,645		15.58	5,805,809		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25				506,250		15	7,593,750		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5				50,625		15	759,375		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16				24,000		1	24,000		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16				24,000		16	384,000		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16				24,000		31	744,000		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23				32,775		1	32,775		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23				32,775		16	524,400		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23				32,775		31	1,016,025		
Base Slab	36" thick	450	psf		75	51					1,721,250		25.5	43,891,875		
Pumps	Upper vertical pumps	30500	lbs	3							91,500		25.5	2,333,250		
	Lower vertical pump	34500	lbs	1							34,500		25.5	879,750		
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165							52,635		4.25	223,699		
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55							29,975		4.25	127,394		
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	100	pcf		51.17	18.5	35				3,313,258		41.75	138,328,501		
	on Lower Heel Footing (vertical volume, no cone action)	100	pcf		23.83	18	42.5				1,822,995		42	76,565,790		
	on Upper Counterfort Footing (vertical volume, no cone action)	100	pcf	1	30	10	29.25				877,500		15	13,162,500		
	on Lower Counterfort Footing (vertical volume, no cone action)	100	pcf	1	30	9.5	36.75				1,047,375		15	15,710,625		
Water weight	Upper channels w/ Max Design Flow WS Elev. Elev. 527.3 to 513.0 base = 14.3' water height	62.4	pcf	3	30	11.33	14.3				909,899		15	13,648,481		
	Lower channels w/ Max Design Flow WS Elev. Elev. 527.3 to 505.5 base = 21.8' water height	62.4	pcf	1	30	11.33	21.8				462,373		15	6,935,592		
											12,996,118		28.23	366,920,543		
LATERAL																
Unsaturated soil forces	on Upper end wall area. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge	70	pcf		51.17		38					2,586,132	12.65		32,724,912	Assumes moment-arm rotation about bottom of UPPER foundation
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	2207	pcf			10	11					242,770	6.47		1,570,722	Assumes moment-arm rotation about bottom of UPPER foundation
	on Lower end wall area. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge	70	pcf		23.83		45.5					1,726,692	15.15		26,161,974	Assumes moment-arm rotation about bottom of LOWER foundation
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	2502	pcf			9.5	16					380,304	9.76		3,711,767	Assumes moment-arm rotation about bottom of LOWER foundation
												4,935,898	13.00		64,169,375	
											12,996,118	4,935,898		366,920,543	64,169,375	

Storm Water Pump Station

Stability

(File: PS Stability.xls with Tabs for Load Cases)

Load Case 4 – Normal

1. Dead loads + equipment.

2. No live loads, low water (empty inlet).

3. Undrained (saturated) backfill.

4. Uplift

PROJECT:	TRWD - STORM WATER PUMP STATION															
PROJECT NO:	2521-42275-PRSTR.PS															
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 4 - Normal																
(dead loads + equipment loads, no live loads saturated backfill + low water/empty + uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	53,750		20	1,075,000		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	64,320		9.25	594,960		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	40,000		19.1	764,000		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	38,520		30.75	1,184,490		
Top Floor Slab	18" thick	225	psf		21.5	50				241,875		19.25	4,656,094		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					56,300		16	900,800		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			412,125		31.17	12,845,936		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			263,250		15.63	4,114,598		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			216,624		31.17	6,752,176		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			372,645		15.58	5,805,809		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			506,250		15	7,593,750		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			50,625		15	759,375		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			24,000		1	24,000		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			24,000		16	384,000		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			24,000		31	744,000		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			32,775		1	32,775		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			32,775		16	524,400		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			32,775		31	1,016,025		
Base Slab	36" thick	450	psf		75	51				1,721,250		25.5	43,891,875		
Pumps	upper vertical pumps	30500	lbs	3						91,500		25.5	2,333,250		
	lower vertical pump	34500	lbs	1						34,500		25.5	879,750		
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165						52,635		4.25	223,699		
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55						29,975		4.25	127,394		
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	130	pcf		51.17	18.5	35			4,307,235		41.75	179,827,051		
	on Lower Heel Footing (vertical volume, no cone action)	130	pcf		23.83	18	42.5			2,369,894		42	99,535,527		
	on Upper Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	10	29.25			1,140,750		15	17,111,250		
	on Lower Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	9.5	36.75			1,361,588		15	20,423,813		
										13,595,935		30.46	414,125,796		
LATERAL																
Saturated soil forces	on Upper end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	psf		51.17		38				3,879,198	12.65		49,087,368	Assumes moment-arm rotation about bottom of UPPER foundation	
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3311	psf			10	11				364,210	6.47		2,356,439	Assumes moment-arm rotation about bottom of UPPER foundation	
	on Lower end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	psf		23.83		45.5				2,590,038	15.15		39,242,961	Assumes moment-arm rotation about bottom of LOWER foundation	
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3753	psf			9.5	16				570,456	9.76		5,567,651	Assumes moment-arm rotation about bottom of LOWER foundation	
											7,403,902	13.00		96,254,418		
UPLIFT																
Uplift	at Upper channel at inlet/bar screen (UPPER TOE): High Groundwater/Saturated soil up to Elev. 513.0, bottom of base at 510.0 = 3.0 ft head (uniform load)	62.4	pcf		49.5	51	3			-472,586		25.5		12,050,953		
	at Upper channel at end wall (UPPER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 513.0 = 35.0 ft head (triangular load)	62.4	pcf		49.5	51	35			-2,756,754		34.02		93,784,771		
	at Lower channel at inlet/bar screen (LOWER TOE): High Groundwater/Saturated soil up to Elev. 505.5, bottom of base at 502.5 = 3.0 ft head (uniform load)	62.4	pcf		25.33	51	3			-241,831		25.5		6,166,680		
	at Lower channel at end wall (LOWER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 505.5 = 42.5 ft head (triangular load)	62.4	pcf		25.33	51	42.5			-1,712,967		34.02		58,275,123		
										-5,184,138		32.85		170,277,527		
										8,411,797	7,403,902		414,125,796	266,531,945		

Section 5
Bearing Pressure

CDM

Storm Water Pump Station

Bearing Pressure

(File: PS Bearing Pressure.xls)

PROJECT:	TRWD - STORM WATER PUMP STATION								
PROJECT NO:	2521-42275-PRSTR.PS								
DESIGNED BY:	E. BJORKLUND				DATE:	1/18/2005			
CHECKED BY:					DATE:				
	Values from STABILITY spreadsheet								
	Fdn Length	Fdn Width	Weight	Lateral force	Mom. Resist	Mom. Overturn			
	ft	ft	lbs	lbs	lb-ft	lb-ft			
Case 1	51	75	4,416,469	0	97,228,155	0			
Case 2	51	75	8,203,187	7,403,902	410,561,703	266,531,945			
Case 3	51	75	12,996,118	4,935,898	366,920,543	64,169,375			
Case 4	51	75	8,411,797	7,403,902	414,125,796	266,531,945			
friction coefficient =	0.4								
						Case 1	Case 2	Case 3	Case 4
sliding ratio =	(weight x friction coeff) / lateral force =					n/a	0.44	1.05	0.45
overturning ratio =	moment resist / moment overturn =					n/a	1.54	5.72	1.55
eccentricity (from CL) (ft) =	1/2 Fdn length - (moment resist - moment overturn) / weight =					3.49	7.94	2.20	7.95
bearing pressure (psf) =	((weight / Fdn length) x (1 +\- (6 x (eccen / Fdn length)))) / Fdn width =								
max bearing pressure (psf) =	((weight / Fdn length) x (1 + (6 x (eccen / Fdn length)))) / Fdn width =					1628	4149	4279	4257
min bearing pressure (psf) =	((weight / Fdn length) x (1 - (6 x (eccen / Fdn length)))) / Fdn width =					681	141	2516	141

Section 6
Cell Formulas for Excel Spreadsheets

CDM

CELL FORMULAS FOR EXCEL SPREADSHEETS

(Exception is the Center of Gravity (CG) spreadsheets, which were produced using a freeware spreadsheet with the sheet protected by the author)

PROJECT:		TRWD - STORM WATER PUMP STATION					
PROJECT NO:		2521-42275-PRSTR.PS					
DESIGNED BY:		E. BJORKLUND			DATE:	1/17/2005	
CHECKED BY:					DATE:		
UPPER COUNTERFORT							
E.F.P.=	**70**	psf / ft of depth					
Depth =	38	ft from grade to upper counterfort base					
Centroid =	6.47	ft from centroid to upper counterfort base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about upper slab	Moment
Trapezoid	=B9-B10	=B13*B8	110	=C13*D13	=B10	=F13	=E13*G13
LOWER COUNTERFORT							
E.F.P.=	**70**	psf / ft of depth					
Depth =	45.5	ft from grade to base					
Centroid =	9.76	ft from centroid to base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about lower slab	Moment
Trapezoid	=B18-B19	=B22*B17	152	=C22*D22	=B19	=F22	=E22*G22
UPPER COUNTERFORT							
E.F.P.=	**105**	psf / ft of depth					
Depth =	38	ft from grade to upper counterfort base					
Centroid =	6.47	ft from centroid to upper counterfort base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about upper slab	Moment
Trapezoid	=B30-B31	=B34*B29	110	=C34*D34	=B31	=F34	=E34*G34
LOWER COUNTERFORT							
E.F.P.=	**105**	psf / ft of depth					
Depth =	45.5	ft from grade to base					
Centroid =	9.76	ft from centroid to base - SEE CG SPREADSHEET					
Section	ground to centroid	pressure at centroid	Section Area	Total Force on Area	Centroid Location	Moment Arm about lower slab	Moment
Trapezoid	=B39-B40	=B43*B38	152	=C43*D43	=B40	=F43	=E43*G43

Storm Water Pump Station
Stability
Excel Spreadsheet with Cell Formulas Displayed

PROJECT:	TRWD - STORM WATER PUMP STATION													
PROJECT NO:	2521-42275-PRSTR.PS													
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005											
CHECKED BY:		DATE:												
STABILITY														
Load Condition 1 - During Construction														
(dead loads + equipment loads, no live loads no soil, no water)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL														
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	=C11*((F11*G11)-J11)	20	=K11*L11		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	=C12*((F12*H12)-J12)	9.25	=K12*L12		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	=C13*E13*((F13*H13)-J13)	19.1	=K13*L13		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	=C14*((F14*H14)-J14)	30.75	=K14*L14		
Top Floor Slab	18" thick	225	psf		21.5	50				=C15*F15*G15	19.25	=K15*L15		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					=C16*E16*F16	16	=K16*L16		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			=C17*F17*H17	31.17	=K17*L17		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			=C18*F18*H18	15.63	=K18*L18		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			=C19*F19*H19	31.17	=K19*L19		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			=C20*F20*H20	15.58	=K20*L20		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			=C21*E21*F21*H21	15	=K21*L21		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			=C22*F22*H22	15	=K22*L22		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			=C23*F23*H23	1	=K23*L23		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			=C24*F24*H24	16	=K24*L24		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			=C25*F25*H25	31	=K25*L25		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			=C26*F26*H26	1	=K26*L26		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			=C27*F27*H27	16	=K27*L27		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			=C28*F28*H28	31	=K28*L28		
Base Slab	36" thick	450	psf		75	51				=C29*F29*G29	25.5	=K29*L29		
Pumps	Upper vertical pumps	30500	lbs	3						=C30*E30	25.5	=K30*L30		
	Lower vertical pump	34500	lbs	1						=C31*E31	25.5	=K31*L31		
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165						=C32*E32	4.25	=K32*L32		
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55						=C33*E33	4.25	=K33*L33		
										=SUM(K11:K33)	=M34/K34	=SUM(M11:M33)		

PROJECT:	TRWD - STORM WATER PUMP STATION															
PROJECT NO:	2521-42275-PRSTR.PS															
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 2 - During Construction/Maintenance																
(dead loads, no equipment, no live loads saturated backfill + low water/empty + uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	=C11*((F11*G11)-J11)		20	=K11*M11			
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	=C12*((F12*H12)-J12)		9.25	=K12*M12			
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	=C13*E13*((F13*H13)-J13)		19.1	=K13*M13			
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	=C14*((F14*H14)-J14)		30.75	=K14*M14			
Top Floor Slab	18" thick	225	psf		21.5	50				=C15*F15*G15		19.25	=K15*M15			
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					=C16*E16*F16		16	=K16*M16			
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			=C17*F17*H17		31.17	=K17*M17			
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			=C18*F18*H18		15.63	=K18*M18			
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			=C19*F19*H19		31.17	=K19*M19			
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			=C20*F20*H20		15.58	=K20*M20			
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			=C21*E21*F21*H21		15	=K21*M21			
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			=C22*F22*H22		15	=K22*M22			
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			=C23*F23*H23		1	=K23*M23			
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			=C24*F24*H24		16	=K24*M24			
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			=C25*F25*H25		31	=K25*M25			
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			=C26*F26*H26		1	=K26*M26			
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			=C27*F27*H27		16	=K27*M27			
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			=C28*F28*H28		31	=K28*M28			
Base Slab	36" thick	450	psf		75	51				=C29*F29*G29		25.5	=K29*M29			
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	130	pcf		51.17	18.5	35			=C30*F30*G30*H30		41.75	=K30*M30			
	on Lower Heel Footing (vertical volume, no cone action)	130	pcf		23.83	18	42.5			=C31*F31*G31*H31		42	=K31*M31			
	on Upper Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	10	29.25			=C32*E32*F32*G32*H32		15	=K32*M32			
	on Lower Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	9.5	36.75			=C33*E33*F33*G33*H33		15	=K33*M33			
										=SUM(K11:K33)		=N34/K34	=SUM(N11:N33)			
LATERAL																
Saturated soil forces	on Upper end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	pcf		51.17		38				=C36*H36^2/2*F36	=H36*0.333		=L36*M36	Assumes moment-arm rotation about bottom of UPPER foundation	
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3311	pcf			10	11				=C37*G37*H37	6.47		=L37*M37	Assumes moment-arm rotation about bottom of UPPER foundation	
	on Lower end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	pcf		23.83		45.5				=C38*H38^2/2*F38	=H38*0.333		=L38*M38	Assumes moment-arm rotation about bottom of LOWER foundation	
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3753	pcf			9.5	16				=C39*G39*H39	9.76		=L39*M39	Assumes moment-arm rotation about bottom of LOWER foundation	
											=SUM(L36:L39)	=O40/L40		=SUM(O36:O39)		
UPLIFT																
Uplift	at Upper channel at inlet/bar screen (UPPER TOE): High Groundwater/Saturated soil up to Elev. 513.0, bottom of base at 510.0 = 3.0 ft head (uniform load)	62.4	pcf		49.5	51	3			=-C42*F42*G42*H42		25.5		=-K42*M42		
	at Upper channel at end wall (UPPER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 513.0 = 35.0 ft head (triangular load)	62.4	pcf		49.5	51	35			=-0.5*(C43*F43*G43*H43)		34.02		=-K43*M43		
	at Lower channel at inlet/bar screen (LOWER TOE): High Groundwater/Saturated soil up to Elev. 505.5, bottom of base at 502.5 = 3.0 ft head (uniform load)	62.4	pcf		25.33	51	3			=-C44*F44*G44*H44		25.5		=-K44*M44		
	at Lower channel at end wall (LOWER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 505.5 = 42.5 ft head (triangular load)	62.4	pcf		25.33	51	42.5			=-0.5*(C45*F45*G45*H45)		34.02		=-K45*M45		
										=SUM(K42:K45)		=O46/-K46		=SUM(O42:O45)		
										=K34+K46	=L40		=N34	=O40+O46		

PROJECT:	TRWD - STORM WATER PUMP STATION															
PROJECT NO:	2521-42275-PRSTR.PS															
DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 3 - Normal																
(dead loads + equipment + live loads, unsaturated backfill + low water/empty, no uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof L.L.		55	psf		23	53				=C11*F11*G11		20	=K11*M11			
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	=C12*((F12*G12)-J12)		20	=K12*M12			
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	=C13*((F13*H13)-J13)		9.25	=K13*M13			
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	=C14*E14*((F14*H14)-J14)		19.1	=K14*M14			
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	=C15*((F15*H15)-J15)		30.75	=K15*M15			
Top Floor Slab L.L.		200	psf		20	50				=C16*F16*G16		20	=K16*M16			
Top Floor Slab	18" thick	225	psf		21.5	50				=C17*F17*G17		19.25	=K17*M17			
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					=C18*E18*F18		16	=K18*M18			
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			=C19*F19*H19		31.17	=K19*M19			
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			=C20*F20*H20		15.63	=K20*M20			
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			=C21*F21*H21		31.17	=K21*M21			
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			=C22*F22*H22		15.58	=K22*M22			
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			=C23*E23*F23*H23		15	=K23*M23			
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			=C24*F24*H24		15	=K24*M24			
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			=C25*F25*H25		1	=K25*M25			
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			=C26*F26*H26		16	=K26*M26			
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			=C27*F27*H27		31	=K27*M27			
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			=C28*F28*H28		1	=K28*M28			
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			=C29*F29*H29		16	=K29*M29			
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			=C30*F30*H30		31	=K30*M30			
Base Slab	36" thick	450	psf		75	51				=C31*F31*G31		25.5	=K31*M31			
Pumps	Upper vertical pumps	30500	lbs	3						=C32*E32		25.5	=K32*M32			
	Lower vertical pump	34500	lbs	1						=C33*E33		25.5	=K33*M33			
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165						=C34*E34		4.25	=K34*M34			
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55						=C35*E35		4.25	=K35*M35			
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	100	pcf		51.17	18.5	35			=C36*F36*G36*H36		41.75	=K36*M36			
	on Lower Heel Footing (vertical volume, no cone action)	100	pcf		23.83	18	42.5			=C37*F37*G37*H37		42	=K37*M37			
	on Upper Counterfort Footing (vertical volume, no cone action)	100	pcf	1	30	10	29.25			=C38*E38*F38*G38*H38		15	=K38*M38			
	on Lower Counterfort Footing (vertical volume, no cone action)	100	pcf	1	30	9.5	36.75			=C39*E39*F39*G39*H39		15	=K39*M39			
Water weight	Upper channels w/ Max Design Flow WS Elev. Elev. 527.3 to 513.0 base = 14.3' water height	62.4	pcf	3	30	11.33	14.3			=C40*E40*F40*G40*H40		15	=K40*M40			
	Lower channels w/ Max Design Flow WS Elev. Elev. 527.3 to 505.5 base = 21.8' water height	62.4	pcf	1	30	11.33	21.8			=C41*E41*F41*G41*H41		15	=K41*M41			
										=SUM(K13:K41)		=N42/K42	=SUM(N11:N41)			
LATERAL																
Unsaturated soil forces	on Upper end wall area. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge	70	pcf		51.17		38				=C44*H44^2/2*F44	=H44*0.333		=L44*M44	Assumes moment-arm rotation about bottom of UPPER foundation	
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	2207	pcf			10	11				=C45*G45*H45	6.47		=L45*M45	Assumes moment-arm rotation about bottom of UPPER foundation	
	on Lower end wall area. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge	70	pcf		23.83		45.5				=C46*H46^2/2*F46	=H46*0.333		=L46*M46	Assumes moment-arm rotation about bottom of LOWER foundation	
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 70 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	2502	pcf			9.5	16				=C47*G47*H47	9.76		=L47*M47	Assumes moment-arm rotation about bottom of LOWER foundation	
											=SUM(L44:L47)	=O48/L48		=SUM(O44:O47)		
										=K42	=L48		=N42	=O48		

PROJECT:	TRWD - STORM WATER PUMP STATION															
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DESIGNED BY:	E. BJORKLUND	DATE:	1/18/2005													
CHECKED BY:		DATE:														
STABILITY																
Load Condition 4 - Normal																
(dead loads + equipment loads, no live loads saturated backfill + low water/empty + uplift)		Unit force		Quantity	Total or Avg Length (ft)	Total or Avg Width (ft)	Total or Avg Height (ft)	Removed portions		Weight/force (lbs)	Lateral Force (lbs)	Moment Arm to Toe (ft)	Resisting Moment (lbs-ft)	Overturning Moment (lbs-ft)	
VERTICAL																
Roof D.L.	lt wt conc on metal deck/bar joists at 6' spacing/ lighting/etc. minus roof openings	50	psf		23	53		4 x 36sf =	144	=C11*((F11*G11)-J11)		20	=K11*M11		
Building Walls	12" CMU at 20' height minus vent openings	80	psf		53		20	16 x 16 sf =	256	=C12*((F12*H12)-J12)		9.25	=K12*M12		
	12" CMU at 16.5' avg height minus vent openings	80	psf	2	20		16.5	5 x 16 sf =	80	=C13*E13*((F13*H13)-J13)		19.1	=K13*M13		
	12" CMU at 11.5' height minus vent openings	80	psf		53		11.5	8 x 16 sf =	128	=C14*((F14*H14)-J14)		30.75	=K14*M14		
Top Floor Slab	18" thick	225	psf		21.5	50				=C15*F15*G15		19.25	=K15*M15		
Top Floor Beams	2 beams at 2.5' x 1.5' each (beneath slab)	563	pLF	2	50					=C16*E16*F16		16	=K16*M16		
C.I.P. Walls	Upper exterior end wall - 24" avg thickness El 548.0 to 513.0 =35' height	300	psf		39.25		35			=C17*F17*H17		31.17	=K17*M17		
	Upper exterior side wall - 24" avg thickness El (546.5-538.0) to 513.0 =29.25' avg height	300	psf		30		29.25			=C18*F18*H18		15.63	=K18*M18		
	Lower (deep) exterior end wall - 27" avg thickness El 548.0 to 505.5 =42.5' height	338	psf		15.08		42.5			=C19*F19*H19		31.17	=K19*M19		
	Lower (deep) exterior side wall - 27" avg thickness El (546.5-538.0) to 505.5 =36.75' avg height	338	psf		30		36.75			=C20*F20*H20		15.58	=K20*M20		
	channel divider wall 18" thick El 538.0 to 513.0 =25' height	225	psf	3	30		25			=C21*E21*F21*H21		15	=K21*M21		
	Lower channel divider (side) wall 18" thick	225	psf		30		7.5			=C22*F22*H22		15	=K22*M22		
	Upper counterfort (SOUTH) 24" thick	300	psf	1	5		16			=C23*F23*H23		1	=K23*M23		
	Upper counterfort (MID) 24" thick	300	psf	1	5		16			=C24*F24*H24		16	=K24*M24		
	Upper counterfort (NORTH) 24" thick	300	psf	1	5		16			=C25*F25*H25		31	=K25*M25		
	Lower counterfort (SOUTH) 24" thick	300	psf	1	4.75		23			=C26*F26*H26		1	=K26*M26		
	Lower counterfort (MID) 24" thick	300	psf	1	4.75		23			=C27*F27*H27		16	=K27*M27		
	Lower counterfort (NORTH) 24" thick	300	psf	1	4.75		23			=C28*F28*H28		31	=K28*M28		
Base Slab	36" thick	450	psf		75	51				=C29*F29*G29		25.5	=K29*M29		
Pumps	upper vertical pumps	30500	lbs	3						=C30*E30		25.5	=K30*M30		
	lower vertical pump	34500	lbs	1						=C31*E31		25.5	=K31*M31		
Trash Racks	at Upper channels w/ 11.33' width each using 55 ~ 5/8"x6" steel bars x 25' long @ 2.5"c/c	319	lbs	165						=C32*E32		4.25	=K32*M32		
	at Lower channel w/ 11.33' width using 55 ~ 5/8"x8" steel bars x 32' long @ 2.5"c/c	545	lbs	55						=C33*E33		4.25	=K33*M33		
Soil weight	on Upper Heel Footing (vertical volume, no cone action)	130	pcf		51.17	18.5	35			=C34*F34*G34*H34		41.75	=K34*M34		
	on Lower Heel Footing (vertical volume, no cone action)	130	pcf		23.83	18	42.5			=C35*F35*G35*H35		42	=K35*M35		
	on Upper Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	10	29.25			=C36*E36*F36*G36*H36		15	=K36*M36		
	on Lower Counterfort Footing (vertical volume, no cone action)	130	pcf	1	30	9.5	36.75			=C37*E37*F37*G37*H37		15	=K37*M37		
										=SUM(K11:K37)		=N38/K38	=SUM(N11:N37)		
LATERAL															
Saturated soil forces	on Upper end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	psf		51.17		38				=C40*H40^2/2*F40	=H40*0.333		=L40*M40	Assumes moment-arm rotation about bottom of UPPER foundation
(see COUNTERFORT spreadsheet)	on Upper end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3311	psf			10	11				=C41*G41*H41	6.47		=L41*M41	Assumes moment-arm rotation about bottom of UPPER foundation
	on Lower end wall area. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge	105	psf		23.83		45.5				=C42*H42^2/2*F42	=H42*0.333		=L42*M42	Assumes moment-arm rotation about bottom of LOWER foundation
(see COUNTERFORT spreadsheet)	on Lower end wall counterfort area only. Pressure of 105 psf is per CTWALL results, includes effects from 260 psf surface surcharge. Unit force shown is at centroid of counterfort area.	3753	psf			9.5	16				=C43*G43*H43	9.76		=L43*M43	Assumes moment-arm rotation about bottom of LOWER foundation
											=SUM(L40:L43)	=O44/L44		=SUM(O40:O43)	
UPLIFT															
Uplift	at Upper channel at inlet/bar screen (UPPER TOE): High Groundwater/Saturated soil up to Elev. 513.0, bottom of base at 510.0 = 3.0 ft head (uniform load)	62.4	pcf		49.5	51	3			=-C46*F46*G46*H46		25.5		=-K46*M46	
	at Upper channel at end wall (UPPER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 513.0 = 35.0 ft head (triangular load)	62.4	pcf		49.5	51	35			=-0.5*(C47*F47*G47*H47)		34.02		=-K47*M47	
	at Lower channel at inlet/bar screen (LOWER TOE): High Groundwater/Saturated soil up to Elev. 505.5, bottom of base at 502.5 = 3.0 ft head (uniform load)	62.4	pcf		25.33	51	3			=-C48*F48*G48*H48		25.5		=-K48*M48	
	at Lower channel at end wall (LOWER HEEL): High Groundwater/Saturated soil up to Elev. 548.0, bottom of base at 505.5 = 42.5 ft head (triangular load)	62.4	pcf		25.33	51	42.5			=-0.5*(C49*F49*G49*H49)		34.02		=-K49*M49	
										=SUM(K46:K49)		=O50/-K50		=SUM(O46:O49)	
										=K38+K50	=L44		=N38	=O44+O50	

Storm Water Pump Station
Bearing Pressure Analysis
Excel Spreadsheet with Cell Formulas Displayed

PROJECT:	TRWD - STORM WATER PUMP STATION								
PROJECT NO:	2521-42275-PRSTR.PS								
DESIGNED BY:	E. BJORKLUND				DATE:	1/18/2005			
CHECKED BY:					DATE:				
	Values from STABILITY spreadsheet								
	Fdn Length	Fdn Width	Weight	Lateral force	Mom. Resist	Mom. Overturn			
	ft	ft	lbs	lbs	lb-ft	lb-ft			
Case 1	51	75	4416469	0	97228155	0			
Case 2	51	75	8203187	7403902	410561703	266531945			
Case 3	51	75	12996118	4935898	366920543	64169375			
Case 4	51	75	8411797	7403902	414125796	266531945			
friction coefficient =	0.4								
						Case 1	Case 2	Case 3	Case 4
sliding ratio =	(weight x friction coeff) / lateral force =					n/a	=(D10*B16)/E10	=(D11*B16)/E11	=(D12*B16)/E12
overturning ratio =	moment resist / moment overturn =					n/a	=F10/G10	=F11/G11	=F12/G12
eccentricity (from CL) (ft) =	1/2 Fdn length - (moment resist - moment overturn) / weight =					=(0.5*B9)-((F9-G9)/D9)	=(0.5*B10)-((F10-G10)/D10)	=(0.5*B11)-((F11-G11)/D11)	=(0.5*B12)-((F12-G12)/D12)
bearing pressure (psf) =	((weight / Fdn length) x (1 +\- (6 x (eccen / Fdn length)))) / Fdn width =								
max bearing pressure (psf) =	((weight / Fdn length) x (1 + (6 x (eccen / Fdn length)))) / Fdn width =					=((D9/B9)*(1+(6*(G20/B9))))/C9	=((D10/B10)*(1+(6*(H20/B10))))/C10	=((D11/B11)*(1+(6*(I20/B11))))/C11	=((D12/B12)*(1+(6*(J20/B12))))/C12
min bearing pressure (psf) =	((weight / Fdn length) x (1 - (6 x (eccen / Fdn length)))) / Fdn width =					=((D9/B9)*(1-(6*(G20/B9))))/C9	=((D10/B10)*(1-(6*(H20/B10))))/C10	=((D11/B11)*(1-(6*(I20/B11))))/C11	=((D12/B12)*(1-(6*(J20/B12))))/C12

Section 7
Design of H-Piles
(Manual Calculations)

CDM

Design of Steel H-Piles
(Manual Calculations)

CDM

CLIENT TRWD-FWCC | JOB NO. 2521-42275 | COMPUTER BY E. Bjorklund
PROJECT Storm Water P.S. | DATE CHECKED | DATE
DETAIL Foundation Design | CHECKED BY | PAGE NO.

From results of stability spreadsheets:

CASE 1
Vertical Summary = 4146 K
Horiz. (Lateral) Summary = N/A

CASE 2
Vertical Summary = 5714 K
Horiz. (Lateral) Summary = 7404 K

CASE 3
Vertical Summary = 12996 K ← controls
Horiz. (Lateral) Summary = 4936 K

CASE 4
Vertical Summary = 5923 K
Horiz. (Lateral) Summary = 7404 K ← controls

Need to determine number of piles required.

CDM

CLIENT TRWD - FWCC
PROJECT Storm water PS
DETAIL Foundation Design
JOB NO. 2521-42275
DATE CHECKED
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COMPUTER BY E. Bjorklund
DATE
PAGE NO.

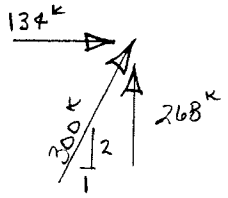
Number of H-piles

Assume: HP14 x 102 piles for analysis

: Max stress = 10 ksi

: Area = 30 in²

∴ P_{max} = 300 k each



Number of piles = $\frac{12996^{k} \text{ vert}}{268^{k} \text{ per pile vert.}} = 48.5$, say 50 piles

$\frac{7404^{k} \text{ lateral}}{134^{k} \text{ per pile lat.}} = 55.3$, say 60 piles ← controls

Piles per Row

$\frac{75' \text{ foundation width}}{5' \text{ pile spacing}} = 15$ piles

Number of Rows

$\frac{60 \text{ piles needed}}{15 \text{ piles/row}} = 4$ rows to resist controlling lateral load

Suggest adding same number of piles symmetrically to provide for balanced distribution

Section 8
Seismic Load Case Check

CDM

Stability Analysis
Seismic Load Case Check
(Manual Calculations)

CDM

CLIENT
PROJECT FWCC
DETAIL PUMP STATION SEISMIC
JOB NO.
DATE CHECKED
CHECKED BY
COMPUTED BY
DATE 1-19-05
PAGE NO.

SEISMIC ANALYSIS AT PUMP STATION:

HORIZ. GROUND ACCELERATION = 0.05 g

NEGLECT K_v

$\psi = \tan^{-1}(K_h) = 2.86$

$\phi_d = 24.85°$

$K_{AE} = 0.442$

STATIC $K_A = 0.408$

$\Delta K_{AE} = K_{AE} - K_A = 0.034$

REFER TO SEISMIC ANALYSIS AT FLOODWALLS

FROM LOAD CONDITION 4

INERTIA OF MASS (CONC, EQUIP, & SOIL) = 0.05(13,595,935) = 679,797. lbs ≈ 680.^{k}

SOIL PRESSURES W/ F.S. = 1.10:

$P_{AE} = P_A + P_{WS} + \Delta P_{AE}$

NOTE: CONSIDER SOIL FORCES ABOVE EL. 510.0 AND FOR 75' WIDTH ONLY FOR PRELIMINARY STUDY.

$= \frac{1}{2} K_A \gamma_b h^2 + \frac{1}{2} \gamma_w h^2 + \frac{1}{2} \Delta K_{AE} \gamma h^2$

$= \frac{1}{2}(0.408)\left(\frac{130-62.5}{1000}\right)(38)^2 + \frac{1}{2}(0.0625)(38)^2 + \frac{1}{2}(0.034)(0.130)(38)^2$

$= 19.9 + 45.1 + 3.2 = 68.2^{k/'}$ × 75' WIDTH = 5,115.^{k}

TOTAL SEISMIC LATERAL FORCE = 680. + 5115. = 5795.^{k}

EQUIVALENT STATIC LATERAL FORCE USED IN LOAD CONDITION 4

$= \frac{1}{2}(0.105)(38)^2 = 75.8^{k/'}$ × 75' = 5686.^{k}

$\frac{5795}{5686} = 1.02$ → 2% ADDL SEISMIC LOADS OKAY IF ALLOW STRESS INCREASE IN PILES

NOTE: ABOVE ANALYSIS IS APPROXIMATE — IT IGNORES SOIL FORCES AT COUNTERFORTS & AT DEEPER PORTION OF THE PUMP STATION BUT INCLUDES THE FULL INERTIA FORCE. RATIO OF SEISMIC TO STATIC FORCE IS CONSIDERED TO BE CONSERVATIVE.

CONCLUSION: SEISMIC LOAD CASE IS NOT CRITICAL.