RETURN TO UAO AR INDEX

6.4

New Bedford
6.4
214276

SDMS DocID 000214276

Total Environmental Restoration Contract

New England Division

USACE Contract No. DACW33-94-D-0002

FOSTER WHEELER ENVIRONMENTAL CORPORATION

USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

FINAL
BASIS OF DESIGN / DESIGN ANALYSIS REPORT (100%) DESANDING AND DEWATERING FACILITIES NEW BEDFORD HARBOR SUPERFUND SITE

New Bedford Harbor, Massachusetts

APPENDIX C

December 2002

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Appendix C

Design Calculations

List of Design Calculations
Desanding and Dewatering Facilities
New Bedford Harbor Superfund Site – OU#1

Civil
C-01 Stormwater Management Systems
C-02 Rail Area Subsurface Drainage
C-03 Pavement Design
C-04 Parking Design
C-05 Handicapped Accessibility
C-06 Roof Drainage System

Electrical
E-01 Electrical Power Requirements

Utilities
U-01 Potable Water Calculations for Personnel Area
U-02 Fire Suppression System Water Requirements
U-03 Sanitary Sewer Calculation for Personnel Area
U-04 Sanitary Sewer Calculation for Support Trailers
U-05 Potable Water Calculation for Support Trailers

Mechanical
M-01 Dewatering Facility Process Building Heating Load Calculation
M-02 Dewatering Facility Process Building Cooling Ventilation Calculation

Rail
R-01 Rail Design: Ballast Track/Top of Rail
R-02 Rail Design: Final Design Criteria
R-03 Rail Design: Rail Size/Rail Gauge/Tie Size and Material/Track Geometry
R-04 Rail Design: Rail Layout and Equipment
R-05 Rail Design: Rail Attachment in Dewatering Building
R-06 Rail Design: Weigh Scale

Structural
S-01 Dewatering Facility Foundation Design
S-02 Dewatering Facility Footing Design
S-03 Estimate of Settlement of Spread Footings

Process
P-01 Dredging, Dewatering, and Water Treatment Mass Balance
P-02 Desanding Operation Sizing
P-03 +3/8 inch and +200 mesh Material Storage Bin Sizing
P-04 Desanded Dredged Slurry Storage Capacity
P-05 Slurry Transfer Pump Sizing (Area C to Area D)
P-06 Dewatering Building Sump Sizing
P-07 Filtrate Transfer Pump Sizing (Area D to Area C)
P-08 Filtrate Transfer Pipeline Sizing (Area D to Area C)
P-09 Polymer Usage
P-10 Process Area Secondary Containment Volume
P-11 Filter Cake Loading

CALCULATION COVER SHEET

Sheet 0 of 44

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Stormwater Management Systems

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. C-01 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES X NO

PREPARER DANIEL R. MANER

REVIEWED BY [signature] DATE 10/25/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES X NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DANIEL A. MAHER DATE 03/29/02 SHEET i OF AA

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR

SUBJECT STORMWATER MANAGEMENT

STORMWATER MANAGEMENT SYSTEMS

PURPOSE: THE FOLLOWING CALCULATIONS ARE PROVIDED FOR THE DESIGN OF STORMWATER COLLECTION SYSTEMS FOR POST-DEVELOPMENT CONDITIONS AT THE MECHANICAL DEWATERING BUILDING SITE

DESIGN REQUIREMENTS:

- STORMWATER MANAGEMENT SYSTEMS SHALL BE DESIGNED TO MEET THE APPLICABLE STORMWATER MANAGEMENT STANDARDS AS OUTLINED IN THE MASSACHUSETTS STORMWATER MANAGEMENT POLICY TO SATISFY REGULATORY REQUIREMENTS
- SYSTEMS SHALL BE DESIGNED TO DIVERT STORMWATER RUN-ON AWAY FROM THE DEVELOPED BUILDING SITE
- ON-SITE STORMWATER RUN-OFF SHALL BE COLLECTED OR DIVERTED TO DISCHARGE TO THE ACUSHNET RIVER. (TIDAL)
- SYSTEMS SHALL BE DESIGNED TO ACCOMODATE A 2-YEAR AND 10-YEAR STORM EVENT.
- ROOF DRAIN SYSTEM SHALL BE DESIGNED BY OTHERS. A JUNCTION SHALL BE PROVIDED SO THAT THE ROOF DRAIN SYSTEM MAY BE DISCHARGED TO THE ACUSHNET RIVER VIA AN OUTFALL PIPE.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DRM DATE 03/29/02 SHEET 2 OF 44

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR

SUBJECT STORMWATER MANAGEMENT

▶ FIND DRAINAGE CATCHMENT AREAS:

- SEE DRAINAGE AREA MAP (SHEET D-1; ATTACHED)
- STORMWATER DESIGN SHALL BE EVALUATED USING THE RATIONAL METHOD.

Summary of Drainage Areas

Project: New Bedford Harbor
Mechanical Dewatering Building

Catchment Area	A (SF)	A (Acres)	C ---	Description (*)
1	11142	0.26	0.95	(2)
2	9247	0.21	0.95	(2)
3	7510	0.17	0.95	(1)
4	13347	0.31	0.95	(1)
5	6180	0.14	0.95	(1)
6	8411	0.19	0.95	(1)
7	9907	0.23	0.95	(2)
8	6888	0.16	0.95	(2)
9	6888	0.16	0.95	(2)
10	12625	0.29	0.95	(2)
11	49157	1.13	0.04	(3)
12	1968	0.05	0.95	(1)
13	26145	0.60	0.95	(4)
14	19305	0.44	0.95	(4)
15	8100	0.19	0.95	(4)
16	25565	0.59	0.70	(5)
Total Drainage Area	222385	5.11	---	---

Notes:
(*) Runoff coefficients for Rational Method are based on the following cover types. (See runoff coefficient table attached)
(1) Cover types within these areas are primarily asphalt, concrete and roof with very little pervious coverage.
(2) Asphalt and Concrete
(3) Primarily gravel w/ some asphalt and concrete
(4) Roof
(5) Off-site gravel, roof and asphalt

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DRM DATE 03/29/02 SHEET 3 OF 44

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR

SUBJECT STORMWATER MANAGEMENT

▶ DEFINE STORMWATER MANAGEMENT SYSTEMS

- STORMWATER FOR POST-DEVELOPMENT CONDITIONS WILL BE HANDLED BY TWO SEPARATE STORM SEWER NETWORKS FOR MOST IMPERVIOUS AREAS OF THE SITE THAT WILL COLLECT STORMWATER RUN-OFF AND CONVEY IT TO THE ACUSHNET RIVER.
- STORMWATER FOR THE REMAINING, MOSTLY PERVIOUS AREAS OF THE SITE WILL BE HANDLED BY INFILTRATION.
- STORMWATER RUN-ON FROM UNDEVELOPED (EXISTING CONDITIONS) AREAS WILL DRAIN NORMALLY WITH THE EXCEPTION OF THE NORTH PERIMETER WHERE THE NORMAL DRAINAGE PATH TO THE ACUSHNET RIVER WILL BE BACKFILLED. A TREATMENT SWALE WILL DIVERT THIS RUN-ON BACK TO THE ACUSHNET RIVER.

SYSTEM 1

SYSTEM 1 INCLUDES CATCHMENT AREAS 1 THRU 10.

SYSTEM 2

SYSTEM 2 INCLUDES ROOF DRAINAGE ONLY FROM CATCHMENT AREAS 13 THRU 15. (TO BE DESIGNED BY OTHERS)

SYSTEM 3

SYSTEM 3 INCLUDES THE RAIL CORRIDER; CATCHMENT AREA 11.

SYSTEM 4

SYSTEM 4 INCLUDES OFF-SITE RUN-ON FROM CATCHMENT AREA 1

SYSTEM 1

THE FOLLOWING CALCULATIONS ARE FOR THE SYSTEM 1 NETWORK.

WATER QUALITY CALCULATIONS

- FIND TSS REMOVAL

1) STORMWATER SYSTEM 1 DESIGN CALLS FOR ROUTING ALL DRAINAGE COLLECTED THROUGH A VORTECHNICS MODEL 7000 STORMWATER TREATMENT SYSTEM. THIS INNOVATIVE TECHNOLOGY BMP PROVIDES AN 80% NET TSS REMOVAL RATE FOR A 10-YR DESIGN STORM.

- ASSUME AVERAGE ANNUAL TSS LOAD = 100%

AVERAGE ANNUAL LOAD (1.00) * BMP REMOVAL (0.80) = 0.8

80% TSS REMOVAL SHALL BE ACHIEVED WITH A REGULAR MAINTENANCE SCHEDULE. (UP TO 82% TSS REMOVAL MAY BE ACHIEVED WITH A REGULAR PARKING LOT SWEEPING PLAN IN PLACE.

NOTE: DEEP SUMPS (4 FT) ARE USED FOR DESIGN, BUT ARE NOT INCLUDED IN TSS REMOVAL CALCULATION.

2) SYSTEM 2 (TO BE DESIGNED BY OTHERS) IS INTENDED TO BE CONNECTED TO A MANHOLE JUNCTION PROVIDED BY SYSTEM 1. PIPE REACH FROM THIS JUNCTION IS CONNECTED TO THE SYSTEM 1 DISCHARGE, BYPASSING TREATMENT. ROOF DRAINAGE IS EXPECTED TO BE UNCONTAMINATED, AND IS DISCHARGED WITHOUT TREATMENT FOR TSS IN ACCORDANCE WITH STANDARD 1 OF THE MADEP POLICY.

SYSTEM 1 NETWORK MODEL

SYSTEM 1 WAS EVALUATED USING THE RATIONAL METHOD WITH EAGLE POINT 2001 VERSION 01 1.4.1

ATTACHMENTS:

EAGLE POINT SOFTWARE OUTPUT
- SUMMARY REPORT
- DETAILED REPORT
- RAINFALL REPORT

REFERENCES
- RUNOFF COEFFICIENTS (C)
- ROUGHNESS COEFFICIENTS - MANNINGS "n" VALUE
- JUNCTION LOSS COEFFICIENTS (K_J)
- SOFTWARE MODELING METHODOLOGY

ASSUMPTIONS:

- DISCHARGE IS PROVIDED TO THE ACUSHNET RIVER. THE ACUSHNET (LOWER HARBOR) PROVIDES UNIMPEDED TIDAL FLUSHING AND THEREFORE CONTROL OF PEAK DISCHARGE FOR SYSTEM DESIGN WAS CONSIDERED UNNECESSARY.

- VELOCITY DISSIPATION OR EROSION PROTECTION AT DISCHARGE POINT WAS CONSIDERED UNNECESSARY SINCE THE OUTFALL WAS LOCATED AT THE FACE OF A VERTICAL SHEET-PILE WALL AT SUFFICIENT ELEVATION TO AVOID SCOUR EFFECTS;

SYSTEM 1 NETWORK MODEL (CONT'D)

ASSUMPTIONS (CONT'D):

- SYSTEM 1 WAS DESIGNED TO EXPERIENCE SURCHARGING EFFECTS IN JUNCTIONS, BUT NOT TO OVERTOP FRAMES AND GRATES. DESIGN CASE WAS ASSUMED TO BE A 10-YEAR STORM AT A HIGH-TIDE CONDITION OF MHW = 2.5 FT NGVD29.

7/AA

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 1

Storm Sewers Summary Report

Pipe Name	Total Flow (cfs)	Pipe Dia. (in)	HGL Down (ft)	HGL Up (ft)	Inv. Down (ft)	Inv. Up (ft)	Downstream Junction
DMH1 to OUTFALL	15.18	24.00	2.50	2.64	0.89	1.03	Outfall
WQU1 to DMH1	9.67	18.00	2.78	2.79	1.53	1.58	DMH1
DMH2 to WQU1	9.67	18.00	3.07*	3.09*	1.58	1.60	WQU1
DMH3 to DMH2	5.90	18.00	3.77*	3.79*	1.70	1.73	DMH2
CB1 to DMH3	5.96	18.00	3.94*	4.05*	1.83	1.97	DMH3
CB2 to CB1	5.18	18.00	4.22*	4.36*	2.07	2.25	CB1
CB3 to CB2	3.24	15.00	4.49*	4.81*	2.50	2.96	CB2
CB4 to CB3	2.51	12.00	4.95*	5.51*	3.21	3.86	CB3
CB5 to CB4	1.47	10.00	5.70*	5.95*	4.02	4.25	CB4
CB2A to CB2	1.58	10.00	4.36*	4.58*	2.81	3.35	CB2
CB6 to DMH2	4.15	15.00	3.96	4.03	3.13	3.15	DMH2
CB7 to CB6	3.04	12.00	4.22*	4.36	3.15	3.37	CB6
CB8 to CB7	2.26	12.00	4.64*	4.75*	3.37	3.50	CB7
CB9 to CB8	1.47	10.00	4.90*	5.11*	3.66	3.83	CB8
DMH4 to DMH1 (1)	6.25	12.00	2.64	6.30*	2.03	4.50	DMH1

*Surcharged Condition

Note:

(1) TOTAL FLOW TO DMH4 (6.25 CFS) IS THE ESTIMATED RATIONAL FLOW INPUT TO SYSTEM 1 FROM THE ROOF DRAIN SYSTEM (SYSTEM 2) TO BE DESIGNED BY OTHERS.

8/AA

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 1

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: DMH1 to OUTFALL

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= DMH1 to OUTFALL
Downstream Pipe	= Outfall
Pipe Material	= PVC
Pipe Length	= 30.42 ft
Plan Length	= 32.42 ft
Pipe Type	= Circular
Pipe Dimensions	= 24.00 in
Pipe Manning's "n"	= 0.013
Pipe Capacity at Invert Slope	= 15.34 cfs
Invert Elevation Downstream	= 0.89 ft
Invert Elevation Upstream	= 1.03 ft
Invert Slope	= 0.46%
Invert Slope (Plan Length)	= 0.43%
Rim Elevation Downstream	= 11.50 ft
Rim Elevation Upstream	= 8.45 ft
Crown Elevation Downstream	= 2.89 ft
Crown Elevation Upstream	= 3.03 ft

----FLOW INFORMATION----

Catchment Area	= 0.00 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.00 cfs
Total Area	= 3.38 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.93 min
Total Intensity	= 4.69 in/hr
Total Rational Flow	= 15.18 cfs
Uniform Capacity	= 15.34 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 2.50 ft
HGL Elevation Upstream	= 2.64 ft
HGL Slope	= 0.46 %
EGL Elevation Downstream	= 2.99 ft
EGL Elevation Upstream	= 3.13 ft
EGL Slope	= 0.46 %
Critical Depth	= 16.86 in
Depth Downstream	= 19.32 in
Depth Upstream	= 19.33 in
Velocity Downstream	= 5.60 ft/s
Velocity Upstream	= 5.60 ft/s
Uniform Velocity Downstream	= 0.00 ft/s
Uniform Velocity Upstream	= 5.57 ft/s
Area Downstream	= 2.71 ft^2
Area Upstream	= 2.71 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.135 ft

9/AA

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: WQU1 to DMH1

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= WQU1 to DMH1
Downstream Pipe	= DMH1 to OUTFALL
Pipe Material	= PVC
Pipe Length	= 8.62 ft
Plan Length	= 17.62 ft
Pipe Type	= Circular
Pipe Dimensions	= 18.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 10.40 cfs
Invert Elevation Downstream	= 1.53 ft
Invert Elevation Upstream	= 1.58 ft
Invert Slope	= 0.58%
Invert Slope (Plan Length)	= 0.28%
Rim Elevation Downstream	= 8.45 ft
Rim Elevation Upstream	= 7.66 ft
Crown Elevation Downstream	= 3.03 ft
Crown Elevation Upstream	= 3.08 ft

----FLOW INFORMATION----

Catchment Area	= 0.00 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.00 cfs
Total Area	= 2.15 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.90 min
Total Intensity	= 4.69 in/hr
Total Rational Flow	= 9.67 cfs
Uniform Capacity	= 10.40 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 2.78 ft
HGL Elevation Upstream	= 2.79 ft
HGL Slope	= 0.20 %
EGL Elevation Downstream	= 3.37 ft
EGL Elevation Upstream	= 3.41 ft
EGL Slope	= 0.54 %
Critical Depth	= 14.41 in
Depth Downstream	= 14.94 in
Depth Upstream	= 14.55 in
Velocity Downstream	= 6.16 ft/s
Velocity Upstream	= 6.32 ft/s
Uniform Velocity Downstream	= 6.69 ft/s
Uniform Velocity Upstream	= 6.69 ft/s
Area Downstream	= 1.57 ft^2
Area Upstream	= 1.53 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.279 ft

10/AA

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 3

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: DMH2 to WQU1

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= DMH2 to WQU1
Downstream Pipe	= WQU1 to DMH1
Pipe Material	= PVC
Pipe Length	= 3.00 ft
Plan Length	= 12.00 ft
Pipe Type	= Circular
Pipe Dimensions	= 18.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 11.53 cfs
Invert Elevation Downstream	= 1.58 ft
Invert Elevation Upstream	= 1.60 ft
Invert Slope	= 0.71%
Invert Slope (Plan Length)	= 0.18%
Rim Elevation Downstream	= 7.66 ft
Rim Elevation Upstream	= 7.75 ft
Crown Elevation Downstream	= 3.08 ft
Crown Elevation Upstream	= 3.10 ft

----FLOW INFORMATION----

Catchment Area	= 0.00 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.00 cfs
Total Area	= 2.15 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.89 min
Total Intensity	= 4.70 in/hr
Total Rational Flow	= 9.67 cfs
Uniform Capacity	= 11.53 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 3.07 ft
HGL Elevation Upstream	= 3.09 ft
HGL Slope	= 0.60 %
EGL Elevation Downstream	= 3.54 ft
EGL Elevation Upstream	= 3.55 ft
EGL Slope	= 0.49 %
Critical Depth	= 14.41 in
Depth Downstream	= 17.90 in
Depth Upstream	= 17.81 in
Velocity Downstream	= 5.48 ft/s
Velocity Upstream	= 5.48 ft/s
Uniform Velocity Downstream	= 7.31 ft/s
Uniform Velocity Upstream	= 7.31 ft/s
Area Downstream	= 1.77 ft^2
Area Upstream	= 1.77 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.687 ft

11/44

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 4

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: DMH3 to DMH2

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= DMH3 to DMH2
Downstream Pipe	= DMH2 to WQU1
Pipe Material	= PVC
Pipe Length	= 11.69 ft
Plan Length	= 15.69 ft
Pipe Type	= Circular
Pipe Dimensions	= 18.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 6.75 cfs
Invert Elevation Downstream	= 1.70 ft
Invert Elevation Upstream	= 1.73 ft
Invert Slope	= 0.24%
Invert Slope (Plan Length)	= 0.18%
Rim Elevation Downstream	= 7.75 ft
Rim Elevation Upstream	= 7.96 ft
Crown Elevation Downstream	= 3.20 ft
Crown Elevation Upstream	= 3.23 ft

----FLOW INFORMATION----

Catchment Area	= 0.00 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.00 cfs
Total Area	= 1.31 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.84 min
Total Intensity	= 4.70 in/hr
Total Rational Flow	= 5.90 cfs
Uniform Capacity	= 6.75 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 3.77 ft
HGL Elevation Upstream	= 3.79 ft
HGL Slope	= 0.19 %
EGL Elevation Downstream	= 3.95 ft
EGL Elevation Upstream	= 3.97 ft
EGL Slope	= 0.19 %
Critical Depth	= 11.26 in
Depth Downstream	= 18.00 in
Depth Upstream	= 18.00 in
Velocity Downstream	= 3.34 ft/s
Velocity Upstream	= 3.34 ft/s
Uniform Velocity Downstream	= 4.31 ft/s
Uniform Velocity Upstream	= 4.31 ft/s
Area Downstream	= 1.77 ft^2
Area Upstream	= 1.77 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.147 ft

12/44

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 5

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB1 to DMH3

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB1 to DMH3
Downstream Pipe	= DMH3 to DMH2
Pipe Material	= PVC
Pipe Length	= 57.55 ft
Plan Length	= 61.55 ft
Pipe Type	= Circular
Pipe Dimensions	= 18.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 6.67 cfs
Invert Elevation Downstream	= 1.83 ft
Invert Elevation Upstream	= 1.97 ft
Invert Slope	= 0.24%
Invert Slope (Plan Length)	= 0.22%
Rim Elevation Downstream	= 7.96 ft
Rim Elevation Upstream	= 7.48 ft
Crown Elevation Downstream	= 3.33 ft
Crown Elevation Upstream	= 3.47 ft

----FLOW INFORMATION----

Catchment Area	= 0.19 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.97 cfs
Total Area	= 1.31 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.61 min
Total Intensity	= 4.75 in/hr
Total Rational Flow	= 5.96 cfs
Uniform Capacity	= 6.67 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 3.94 ft
HGL Elevation Upstream	= 4.05 ft
HGL Slope	= 0.19 %
EGL Elevation Downstream	= 4.12 ft
EGL Elevation Upstream	= 4.23 ft
EGL Slope	= 0.19 %
Critical Depth	= 11.31 in
Depth Downstream	= 18.00 in
Depth Upstream	= 18.00 in
Velocity Downstream	= 3.37 ft/s
Velocity Upstream	= 3.37 ft/s
Uniform Velocity Downstream	= 4.27 ft/s
Uniform Velocity Upstream	= 4.27 ft/s
Area Downstream	= 1.77 ft^2
Area Upstream	= 1.77 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.172 ft

13/AA

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB2 to CB1

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB2 to CB1
Downstream Pipe	= CB1 to DMH3
Pipe Material	= PVC
Pipe Length	= 96.06 ft
Plan Length	= 100.06 ft
Pipe Type	= Circular
Pipe Dimensions	= 18.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 5.95 cfs
Invert Elevation Downstream	= 2.07 ft
Invert Elevation Upstream	= 2.25 ft
Invert Slope	= 0.19%
Invert Slope (Plan Length)	= 0.18%
Rim Elevation Downstream	= 7.48 ft
Rim Elevation Upstream	= 7.50 ft
Crown Elevation Downstream	= 3.57 ft
Crown Elevation Upstream	= 3.75 ft

----FLOW INFORMATION----

Catchment Area	= 0.14 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.71 cfs
Total Area	= 1.12 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 7.18 min
Total Intensity	= 4.83 in/hr
Total Rational Flow	= 5.18 cfs
Uniform Capacity	= 5.95 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.22 ft
HGL Elevation Upstream	= 4.36 ft
HGL Slope	= 0.14 %
EGL Elevation Downstream	= 4.36 ft
EGL Elevation Upstream	= 4.49 ft
EGL Slope	= 0.14 %
Critical Depth	= 10.52 in
Depth Downstream	= 18.00 in
Depth Upstream	= 18.00 in
Velocity Downstream	= 2.93 ft/s
Velocity Upstream	= 2.93 ft/s
Uniform Velocity Downstream	= 3.79 ft/s
Uniform Velocity Upstream	= 3.79 ft/s
Area Downstream	= 1.77 ft^2
Area Upstream	= 1.77 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= 0.127 ft

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 7

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB3 to CB2

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB3 to CB2
Downstream Pipe	= CB2 to CB1
Pipe Material	= PVC
Pipe Length	= 217.71 ft
Plan Length	= 221.71 ft
Pipe Type	= Circular
Pipe Dimensions	= 15.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 3.87 cfs
Invert Elevation Downstream	= 2.50 ft
Invert Elevation Upstream	= 2.96 ft
Invert Slope	= 0.21%
Invert Slope (Plan Length)	= 0.21%
Rim Elevation Downstream	= 7.50 ft
Rim Elevation Upstream	= 7.45 ft
Crown Elevation Downstream	= 3.75 ft
Crown Elevation Upstream	= 4.21 ft

----FLOW INFORMATION----

Catchment Area	= 0.17 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.86 cfs
Total Area	= 0.67 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 6.14 min
Total Intensity	= 5.04 in/hr
Total Rational Flow	= 3.24 cfs
Uniform Capacity	= 3.87 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.49 ft
HGL Elevation Upstream	= 4.81 ft
HGL Slope	= 0.15 %
EGL Elevation Downstream	= 4.60 ft
EGL Elevation Upstream	= 4.92 ft
EGL Slope	= 0.15 %
Critical Depth	= 8.70 in
Depth Downstream	= 15.00 in
Depth Upstream	= 15.00 in
Velocity Downstream	= 2.64 ft/s
Velocity Upstream	= 2.64 ft/s
Uniform Velocity Downstream	= 3.53 ft/s
Uniform Velocity Upstream	= 3.53 ft/s
Area Downstream	= 1.23 ft^2
Area Upstream	= 1.23 ft^2
Kj (JLC)	= 0.25
Calculated Junction Loss	= 0.135 ft

15/AA

Storm Sewers Detail Report

PIPE DESCRIPTION: CB4 to CB3

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB4 to CB3
Downstream Pipe	= CB3 to CB2
Pipe Material	= PVC
Pipe Length	= 191.60 ft
Plan Length	= 195.60 ft
Pipe Type	= Circular
Pipe Dimensions	= 12.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 2.69 cfs
Invert Elevation Downstream	= 3.21 ft
Invert Elevation Upstream	= 3.86 ft
Invert Slope	= 0.34%
Invert Slope (Plan Length)	= 0.33%
Rim Elevation Downstream	= 7.45 ft
Rim Elevation Upstream	= 8.08 ft
Crown Elevation Downstream	= 4.21 ft
Crown Elevation Upstream	= 4.86 ft

----FLOW INFORMATION----

Catchment Area	= 0.21 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 1.07 cfs
Total Area	= 0.50 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.32 min
Total Intensity	= 5.23 in/hr
Total Rational Flow	= 2.51 cfs
Uniform Capacity	= 2.69 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.95 ft
HGL Elevation Upstream	= 5.51 ft
HGL Slope	= 0.29 %
EGL Elevation Downstream	= 5.10 ft
EGL Elevation Upstream	= 5.67 ft
EGL Slope	= 0.29 %
Critical Depth	= 8.14 in
Depth Downstream	= 12.00 in
Depth Upstream	= 12.00 in
Velocity Downstream	= 3.19 ft/s
Velocity Upstream	= 3.19 ft/s
Uniform Velocity Downstream	= 3.89 ft/s
Uniform Velocity Upstream	= 3.89 ft/s
Area Downstream	= 0.79 ft^2
Area Upstream	= 0.79 ft^2
Kj (JLC)	= 0.25
Calculated Junction Loss	= 0.188 ft

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 9

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB5 to CB4

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB5 to CB4
Downstream Pipe	= CB4 to CB3
Pipe Material	= PVC
Pipe Length	= 64.22 ft
Plan Length	= 68.22 ft
Pipe Type	= Circular
Pipe Dimensions	= 10.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 1.69 cfs
Invert Elevation Downstream	= 4.02 ft
Invert Elevation Upstream	= 4.25 ft
Invert Slope	= 0.35%
Invert Slope (Plan Length)	= 0.33%
Rim Elevation Downstream	= 8.08 ft
Rim Elevation Upstream	= 8.08 ft
Crown Elevation Downstream	= 4.86 ft
Crown Elevation Upstream	= 5.08 ft

----FLOW INFORMATION----

Catchment Area	= 0.29 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 1.47 cfs
Total Area	= 0.29 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.00 min
Total Intensity	= 5.31 in/hr
Total Rational Flow	= 1.47 cfs
Total Flow	= 1.47 cfs
Uniform Capacity	= 1.69 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 5.70 ft
HGL Elevation Upstream	= 5.95 ft
HGL Slope	= 0.40 %
EGL Elevation Downstream	= 5.81 ft
EGL Elevation Upstream	= 6.07 ft
EGL Slope	= 0.40 %
Critical Depth	= 6.53 in
Depth Downstream	= 10.00 in
Depth Upstream	= 10.00 in
Velocity Downstream	= 2.70 ft/s
Velocity Upstream	= 2.70 ft/s
Uniform Velocity Downstream	= 3.48 ft/s
Uniform Velocity Upstream	= 0.00 ft/s
Area Downstream	= 0.55 ft^2
Area Upstream	= 0.55 ft^2
Kj (JLC)	= 0.75
Calculated Junction Loss	= NA

17/A4

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB2A to CB2

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB2A to CB2
Downstream Pipe	= CB2 to CB1
Pipe Material	= PVC
Pipe Length	= 51.69 ft
Plan Length	= 55.69 ft
Pipe Type	= Circular
Pipe Dimensions	= 10.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 2.91 cfs
Invert Elevation Downstream	= 2.81 ft
Invert Elevation Upstream	= 3.35 ft
Invert Slope	= 1.05%
Invert Slope (Plan Length)	= 0.97%
Rim Elevation Downstream	= 7.50 ft
Rim Elevation Upstream	= 7.18 ft
Crown Elevation Downstream	= 3.64 ft
Crown Elevation Upstream	= 4.18 ft

----FLOW INFORMATION----

Catchment Area	= 0.31 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 1.58 cfs
Total Area	= 0.31 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.00 min
Total Intensity	= 5.31 in/hr
Total Rational Flow	= 1.58 cfs
Uniform Capacity	= 2.91 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.36 ft
HGL Elevation Upstream	= 4.58 ft
HGL Slope	= 0.43 %
EGL Elevation Downstream	= 4.49 ft
EGL Elevation Upstream	= 4.71 ft
EGL Slope	= 0.43 %
Critical Depth	= 6.75 in
Depth Downstream	= 10.00 in
Depth Upstream	= 10.00 in
Velocity Downstream	= 2.89 ft/s
Velocity Upstream	= 2.89 ft/s
Uniform Velocity Downstream	= 6.50 ft/s
Uniform Velocity Upstream	= 0.00 ft/s
Area Downstream	= 0.55 ft^2
Area Upstream	= 0.55 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= NA

16/AA

Storm Sewers Detail Report

PIPE DESCRIPTION: CB6 to DMH2

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB6 to DMH2
Downstream Pipe	= DMH2 to WQU1
Pipe Material	= PVC
Pipe Length	= 7.00 ft
Plan Length	= 11.00 ft
Pipe Type	= Circular
Pipe Dimensions	= 15.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 4.49 cfs
Invert Elevation Downstream	= 3.13 ft
Invert Elevation Upstream	= 3.15 ft
Invert Slope	= 0.29%
Invert Slope (Plan Length)	= 0.18%
Rim Elevation Downstream	= 7.75 ft
Rim Elevation Upstream	= 7.55 ft
Crown Elevation Downstream	= 4.38 ft
Crown Elevation Upstream	= 4.40 ft

----FLOW INFORMATION----

Catchment Area	= 0.23 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 1.17 cfs
Total Area	= 0.84 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.62 min
Total Intensity	= 5.16 in/hr
Total Rational Flow	= 4.15 cfs
Uniform Capacity	= 4.49 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 3.96 ft
HGL Elevation Upstream	= 4.03 ft
HGL Slope	= 1.12 %
EGL Elevation Downstream	= 4.32 ft
EGL Elevation Upstream	= 4.35 ft
EGL Slope	= 0.39 %
Critical Depth	= 9.90 in
Depth Downstream	= 9.90 in
Depth Upstream	= 10.60 in
Velocity Downstream	= 4.83 ft/s
Velocity Upstream	= 4.48 ft/s
Uniform Velocity Downstream	= 4.24 ft/s
Uniform Velocity Upstream	= 4.15 ft/s
Area Downstream	= 0.86 ft^2
Area Upstream	= 0.93 ft^2
Kj (JLC)	= 0.25
Calculated Junction Loss	= 0.186 ft

19/AA

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB7 to CB6

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB7 to CB6
Downstream Pipe	= CB6 to DMH2
Pipe Material	= PVC
Pipe Length	= 46.00 ft
Plan Length	= 50.00 ft
Pipe Type	= Circular
Pipe Dimensions	= 12.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 3.17 cfs
Invert Elevation Downstream	= 3.15 ft
Invert Elevation Upstream	= 3.37 ft
Invert Slope	= 0.47%
Invert Slope (Plan Length)	= 0.43%
Rim Elevation Downstream	= 7.55 ft
Rim Elevation Upstream	= 7.66 ft
Crown Elevation Downstream	= 4.15 ft
Crown Elevation Upstream	= 4.37 ft

----FLOW INFORMATION----

Catchment Area	= 0.16 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.81 cfs
Total Area	= 0.61 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.45 min
Total Intensity	= 5.20 in/hr
Total Rational Flow	= 3.04 cfs
Uniform Capacity	= 3.17 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.22 ft
HGL Elevation Upstream	= 4.36 ft
HGL Slope	= 0.31 %
EGL Elevation Downstream	= 4.45 ft
EGL Elevation Upstream	= 4.60 ft
EGL Slope	= 0.31 %
Critical Depth	= 8.97 in
Depth Downstream	= 12.00 in
Depth Upstream	= 11.97 in
Velocity Downstream	= 3.87 ft/s
Velocity Upstream	= 3.87 ft/s
Uniform Velocity Downstream	= 4.60 ft/s
Uniform Velocity Upstream	= 4.60 ft/s
Area Downstream	= 0.79 ft^2
Area Upstream	= 0.79 ft^2
Kj (JLC)	= 0.25
Calculated Junction Loss	= 0.280 ft

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: CB8 to CB7

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB8 to CB7
Downstream Pipe	= CB7 to CB6
Pipe Material	= PVC
Pipe Length	= 46.00 ft
Plan Length	= 50.00 ft
Pipe Type	= Circular
Pipe Dimensions	= 12.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 2.45 cfs
Invert Elevation Downstream	= 3.37 ft
Invert Elevation Upstream	= 3.50 ft
Invert Slope	= 0.28%
Invert Slope (Plan Length)	= 0.26%
Rim Elevation Downstream	= 7.66 ft
Rim Elevation Upstream	= 7.66 ft
Crown Elevation Downstream	= 4.37 ft
Crown Elevation Upstream	= 4.50 ft

----FLOW INFORMATION----

Catchment Area	= 0.16 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 0.81 cfs
Total Area	= 0.45 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.23 min
Total Intensity	= 5.25 in/hr
Total Rational Flow	= 2.26 cfs
Uniform Capacity	= 2.45 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.64 ft
HGL Elevation Upstream	= 4.75 ft
HGL Slope	= 0.24 %
EGL Elevation Downstream	= 4.77 ft
EGL Elevation Upstream	= 4.88 ft
EGL Slope	= 0.24 %
Critical Depth	= 7.72 in
Depth Downstream	= 12.00 in
Depth Upstream	= 12.00 in
Velocity Downstream	= 2.88 ft/s
Velocity Upstream	= 2.88 ft/s
Uniform Velocity Downstream	= 3.55 ft/s
Uniform Velocity Upstream	= 3.55 ft/s
Area Downstream	= 0.79 ft^2
Area Upstream	= 0.79 ft^2
Kj (JLC)	= 0.25
Calculated Junction Loss	= 0.148 ft

21/44

Storm Sewers Detail Report

PIPE DESCRIPTION: CB9 to CB8

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= CB9 to CB8
Downstream Pipe	= CB8 to CB7
Pipe Material	= PVC
Pipe Length	= 46.00 ft
Plan Length	= 50.00 ft
Pipe Type	= Circular
Pipe Dimensions	= 10.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 1.70 cfs
Invert Elevation Downstream	= 3.66 ft
Invert Elevation Upstream	= 3.83 ft
Invert Slope	= 0.36%
Invert Slope (Plan Length)	= 0.33%
Rim Elevation Downstream	= 7.66 ft
Rim Elevation Upstream	= 7.66 ft
Natural Ground Slope	= 0.00%
Crown Elevation Downstream	= 4.50 ft
Crown Elevation Upstream	= 4.66 ft

----FLOW INFORMATION----

Catchment Area	= 0.29 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 1.47 cfs
Total Area	= 0.29 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.00 min
Total Intensity	= 5.31 in/hr
Total Rational Flow	= 1.47 cfs
Uniform Capacity	= 1.70 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 4.90 ft
HGL Elevation Upstream	= 5.11 ft
HGL Slope	= 0.45 %
EGL Elevation Downstream	= 5.01 ft
EGL Elevation Upstream	= 5.22 ft
EGL Slope	= 0.45 %
Critical Depth	= 6.53 in
Depth Downstream	= 10.00 in
Depth Upstream	= 10.00 in
Velocity Downstream	= 2.70 ft/s
Velocity Upstream	= 2.70 ft/s
Uniform Velocity Downstream	= 3.52 ft/s
Uniform Velocity Upstream	= 0.00 ft/s
Area Downstream	= 0.55 ft^2
Area Upstream	= 0.55 ft^2
Kj (JLC)	= 0.75
Calculated Junction Loss	= NA

22/AA

User Name: maherd
Project: NBHDEWAT
Network: 01 - System 1

Date: 03-29-02
Time: 15:42:23
Page: 15

Storm Sewers Detail Report

==========

PIPE DESCRIPTION: DMH4 to DMH1

----RAINFALL INFORMATION----

Return Period	= 10 Year
Rainfall File	= New Bedford Rainfall

----PIPE INFORMATION----

Current Pipe	= DMH4 to DMH1
Downstream Pipe	= DMH1 to OUTFALL
Pipe Material	= PVC
Pipe Length	= 65.70 ft
Plan Length	= 69.65 ft
Pipe Type	= Circular
Pipe Dimensions	= 12.00 in
Pipe Manning's "n"	= 0.010
Pipe Capacity at Invert Slope	= 8.98 cfs
Invert Elevation Downstream	= 2.03 ft
Invert Elevation Upstream	= 4.50 ft
Invert Slope	= 3.76%
Invert Slope (Plan Length)	= 3.55%
Rim Elevation Downstream	= 8.45 ft
Rim Elevation Upstream	= 9.10 ft
Crown Elevation Downstream	= 3.03 ft
Crown Elevation Upstream	= 5.50 ft

----FLOW INFORMATION----

Catchment Area	= 1.23 ac
Runoff Coefficient	= 0.950
Inlet Time	= 5.00 min
Inlet Intensity	= 5.31 in/hr
Inlet Rational Flow	= 6.25 cfs
Total Area	= 1.23 ac
Weighted Coefficient	= 0.950
Total Time of Concentration	= 5.00 min
Total Intensity	= 5.31 in/hr
Total Rational Flow	= 6.25 cfs
Uniform Capacity	= 8.98 cfs

----HYDRAULIC INFORMATION----

HGL Elevation Downstream	= 2.64 ft
HGL Elevation Upstream	= 6.30 ft
HGL Slope	= 5.57 %
EGL Elevation Downstream	= 5.02 ft
EGL Elevation Upstream	= 8.68 ft
EGL Slope	= 5.57 %
Critical Depth	= 11.54 in
Depth Downstream	= 7.37 in
Depth Upstream	= 7.37 in
Velocity Downstream	= 12.36 ft/s
Velocity Upstream	= 12.36 ft/s
Uniform Velocity Downstream	= 13.80 ft/s
Uniform Velocity Upstream	= 0.00 ft/s
Area Downstream	= 0.51 ft^2
Area Upstream	= 0.51 ft^2
Kj (JLC)	= 0.50
Calculated Junction Loss	= NA

23/49

User Name: maherd
Date: 03-29-02
Project: New Bedford Harbor
Network: Mechanical Dewatering Building

Rainfall Report

==========

Rainfall Type Eastern/Central
Rainfall Library New Bedford Rainfall

Eastern/Central Precipitation

2yr/5min	0.34 in
2yr/15min	0.69 in
2yr/60min	1.21 in
100yr/5min	0.61 in
100yr/15min	1.29 in
100yr/60min	2.57 in

Rainfall Intensity (in/hr)

	5 min	15 min	30 min	60 min	2 hr	24 hr
2 yr	4.08	2.75	1.90	1.21	0.73	0.10
5 yr	~~4.78~~	3.30	2.33	1.53	0.96	0.15
10 yr	5.30	3.71	2.64	1.76	1.11	0.19
25 yr	~~6.08~~	4.29	3.09	2.08	1.33	0.23
50 yr	6.69	4.75	3.44	2.33	1.51	0.27
100 yr	7.30	5.21	3.79	2.58	1.68	0.31

BDE Values Intensity = B/(Tc + D)^E

	B	D	E	X	Y
2 yr	40.70	11.27	0.82	0.00	0.00
5 yr	40.73	11.21	0.77	0.00	0.00
10 yr	42.48	11.23	0.75	0.00	0.00
25 yr	46.19	11.29	0.73	0.00	0.00
50 yr	49.41	11.34	0.72	0.00	0.00
100 yr	52.71	11.39	0.71	0.00	0.00

Runoff Coefficients

Description of Area		Coefficient
Business	Central Business	0.70 - 0.95
	District and Local	0.50 - 0.70 × USE FOR OFF-SITE RUN-ON
Residential	Single Family	0.30 - 0.50
	Multi-units	0.40 - 0.75
	1/2 acre lots or larger	0.25 - 0.40
Industrial	Light	0.50 - 0.80
	Heavy	0.60 - 0.90
	Parks, cemeteries	0.10 - 0.25
	Playgrounds	0.20 - 0.35
	Railroad yards	0.20 - 0.35
	Unimproved	0.10 - 0.30

Langworthy, V.W. et al., *Design and Construction of Sanitary and Storm Sewers (ASCE Manuals and Reports on Engineering Practice No. 37).* Fourth Edition. Water Pollution Control Federation,1970.

For Impervious Surfaces

Description of Surface	Coefficient
Asphalt	0.70 - 0.95
Concrete	0.70 - 0.95
Roofs	0.75 - 0.95

25/44

Langworthy, V.W. et al., *Design and Construction of Sanitary and Storm Sewers (ASCE Manuals and Reports on Engineering Practice No. 37)*. Fourth Edition. Water Pollution Control Federation, 1970.

For Pervious Surfaces

Slope	***SCS Soils***			
	A	B	C	D
Flat (0 - 2%)	0.04 *	0.07	0.11	0.15
Average (2 - 6%)	0.09	0.12	0.16	0.20
Steep (Over 6%)	0.13	0.18	0.23	0.28

Texas Highway Department, *Hydraulic Manual*. Third Edition. December, 1985.

* USE FOR RAIL CORRIDOR.

26/44

Roughness Coefficients – Manning's "n" Value

Surface	Manning's "n" Value
Reinforced concrete pipe	0.013 - FOR CONCRETE LINED D.I.P.
Reinforced concrete box	0.013
Vitrified clay	0.013
Coated cast iron	0.011
Uncoated cast iron	0.012
Commercial wrought-iron, black	0.012
Commercial wrought-iron, galvanized	0.013
Smooth lockbar and welded OD pipe	0.010
Riveted and spiral steel	0.013
Corrugated metal pipe	0.0225
Corrugated aluminum pipe	0.0225
Corrugated metal pipe (paved invert)	0.020
Corrugated metal multi-plate	0.035
Polyvinyl chloride (PVC)	0.010 - FOR SMOOTH WALL PVC

Langworthy, V.W. et al., *Design and Construction of Sanitary and Storm Sewers (ASCE Manuals and Reports on Engineering Practice No. 37)*, Fourth Edition. Water Pollution Control Federation,1970.

Tchobanoglous, George, *Wastewater Engineering: Collection and Pumping of Wastewater.* 6th Edition. McGraw-Hill, New York, 1981.

27/AA

Junction Loss Coefficients (K_j)

Description of Condition	Dynamic Method Coefficient	Approximate Method Coefficient
Manhole on main line	.50 - 1.50	* .25 - 1.25
Manhole on main line with 45 degree branch	.75 - 1.50	.50 - 1.25
Manhole on main line with 90 degree branch	.75 - 1.25	.25 - 1.00
Inlet or manhole at beginning	1.00 - 1.50	0.75 - 1.25
Orifice (see explanation following)	1.75 - 2.75	1.25 - 2.50

*USE MINIMUM VALUES LOSSES ARE EXPECTED TO BE MINIMAL

Storm Drain Design, Bureau of Engineering Manual, Part G. City of Los Angeles Department of Public Works, 1973.

The above ranges are typical values for the junction loss coefficient. However, you may need a value other than the ones listed due to varying designs. Check your design standards or hydraulics textbook for the correct K_j to use.

Using a Line as an Orifice

In certain cases you may wish to model a line as a restriction in order to limit the final outflow to a "target" outflow. In these conditions the line would have a very short length and relatively small diameter making the line act as an orifice and causing a backwater effect upstream. To model this type of configuration you can modify the junction loss coefficient as follows.

The general orifice equation is

$$Q = C_o A(2gh)^{0.5} \qquad \textbf{A.1}$$

where:

Q = outflow in cfs

C_o = orifice coefficient (usually 0.63)

A = area of flow in sq. ft

g = gravity

h = head in feet

The orifice equation can be rewritten as

25/AA

General Modeling Guidelines

Storm Sewers allows you to model and/or design storm sewer networks much in the same fashion as traditional methods except that non-uniform flow is analyzed. In brief, ***Storm Sewers*** can design and model a network of up to 2000 pipes at once. The network is basically made up of pipes. Junctions can be manholes, junction boxes or other structures where losses occur. There may be more than one pipe entering a junction, but only one can exit. ***Storm Sewers*** allows you to enter required data one pipe at a time starting at the most downstream point or multiple pipes at a time using the Global Editor feature. The data you need to enter includes subcatchment drainage areas and drainage times, runoff coefficients, return periods and other pipe and inlet parameters.

When you enter a pipe in the system, ***Storm Sewers*** numbers it for you by default according to the order the line was input. You can also assign some other unique description for the line rather than using numbers. Pipe 1 is the first pipe you enter in the system (the most downstream line), Pipe 2 is the second pipe input, etc. The order you input the pipes doesn't mean that they flow into each other. Specify which pipes flow into each other by entering the downstream pipe number. This indicates to ***Storm Sewers*** how the sewer network is arranged. For example, if you enter pipe 3 into the system, you can specify Pipe 1 as the downstream pipe number to indicate that pipe 3 flows into pipe 1. Once you enter the required data, you can compute and view the results which include the hydraulic grade line and the full flow capacity of the system along with other pertinent data.

Existing Systems

Use ***Storm Sewers*** to model existing systems by describing each individual pipe's invert elevations, length, size, etc. ***Storm Sewers*** allows you to input anticipated flows for each pipe by direct entry and/or by using the Rational Method. Automatic capacity calculations allow you to compare the actual conditions with the system's full flow capacity, thereby determining any undersized pipes and to correct any deficiencies in the existing system.

Determining Sewer and Catchment Flow Rates

In performing storm sewer designs, there are two types of flows:

- **Catchment Flow:** the flow rate that drains to the inlet point of each catchment.
- **Sewer Flow:** the flow rate that occurs in the sewer.

Catchment flow is used to design the size of the inlet device that collects this amount of flow. If given an existing inlet, it is also used to determine how much of the catchment flow

29/AA

is captured in this inlet (captured flow) and how much is bypassed to the next downstream inlet (bypassed flow). This bypassed flow (by default) then becomes an input to the downstream inlet. You also have the option to direct the bypassed flow to a specified inlet.

The sewer flow is used to perform the hydraulic computations required to establish the hydraulic grade line. To evaluate the total sewer flow, ***Storm Sewers*** uses the Rational formula to calculate the cumulative rational flow, to which are added known flow and infiltration flows.

Rational Flow Rate

The Rational Flow Rate (below) is used by ***Storm Sewers*** to determine the flow rate that emanates from a single catchment (the most upstream catchment) or from multiple catchments.

$$Q = CAi$$

1.1 Rational Flow Rate

where:

Q = flow rate, cubic feet per second (cfs)
C = runoff coefficient
A = drainage areas, acres
i = rainfall intensity, inches per hour

For metric units, the equation is

$$Q = 2.77 \times 10^{-3} CAi$$

1.2

where:

Q = flow rate, cubic meters per second (m^3/s)
C = runoff coefficient
A = drainage areas, hectares
i = rainfall intensity, millimeters per hour

Inlet Flows

The Rational formula is used to find the flow from each individual catchment in order to perform analysis and design calculations for all inlets. The rainfall intensity (i) used in the formula is computed using the individual catchment drainage time in the IDF equation (see *Intensity-Duration-Frequency Curves* on page 6). Additional information on how inlets are sized and how carry-over flow from upstream inlets is handled, is presented in *Inlets* on page 12.

The program uses the Rational formula for an:

- Individual catchment to determine the flow rate within that catchment for the purpose of sizing an inlet for any user-defined capture efficiency of the runoff.
- Existing inlet to evaluate the amount of flow that enters the sewer at that point versus the amount that bypasses the inlet and proceeds to the next inlet.

Network Flows

The Rational formula is also used to find the flow in all of the sewers in the network from all upstream catchments (Q_{sewer}). The intensity (i) used in this case is computed from the IDF equation using the maximum time of concentration along any hydraulic path to the node where the flow is being computed, including both overland and pipe flow times.

Only in the most upstream subcatchments is this flow rate directly used for the pipe flow rate. The flow in any downstream pipe is calculated using the protocol explained below.

When the watershed consists of multiple catchments in a series, ***Storm Sewers*** uses the most common approach in engineering practice to determine the sewer flow rate. For a pipe under consideration, the time of concentration (t_c) is determined as the maximum of the hydraulic flow times of the pipe's catchment time and the longest upstream catchment time plus pipe travel time to the pipe under consideration (see Figure 1-1 on page 5). This t_c is then used in the IDF equation to determine the rainfall intensity to use in the Rational formula. Information on the time of concentration calculations is given in chapter 4 of the HEC-22 documentation (reprinted as *Appendix D: HEC-22 Chapter 4 –Pavement Drainage*, which begins on page 205 of this manual).

31/44

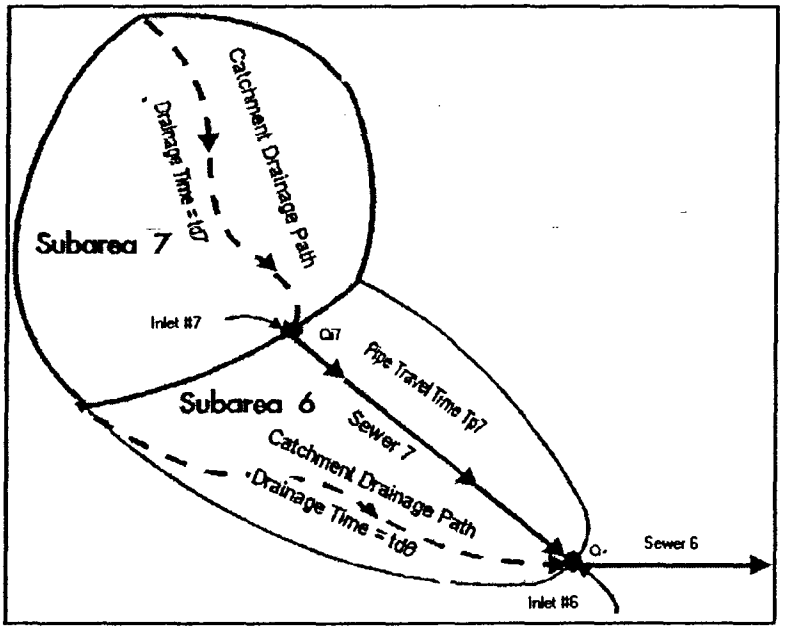


Figure 1-1 Network Flows Example

Time of Concentration for drainage area:

Subarea 7 $t_{c7} = t_{d7}$

Subarea 6 $t_{c6} = maximum\ t_{d6}\ or(t_{d7} + t_{p7})$

Flow Rates

Sewer #7 $Qs_7 = Qi_7 = C_7 A_7 i(t_{c7})$

Sewer #6 $Qs_6 = [\sum(CA) \cdot i(t_{c6})]$

$= (C\ A\ + C\ A\ ) \cdot i(t\ \ )$

Inlet #6 $Qi_6 = C_6 A_6 i(t_{d6})$

1.3

where:

$Q_i = Q_{inlet}$

$Q_s = Q_{sewer}$

i(tc) = rainfall intensity as a function of the time of concentration

SYSTEM 2

SYSTEM 2 SHALL BE A ROOF DRAIN SYSTEM TO BE DESIGNED BY OTHERS WHEN THE BUILDING IS DEVELOPED. A MANHOLE JUNCTION SHALL BE PROVIDED AS PART OF SYSTEM 1 TO COLLECT THIS FLOW AND CARRY IT TO THE OUTFALL. THIS FLOW WAS ESTIMATED BY THE RATIONAL METHOD AS PART OF SYSTEM 1 DESIGN.

SYSTEM 3

THE FOLLOWING CALCULATIONS ARE PROVIDED FOR HANDLING RUN-OFF FROM SYSTEM 3.

SYSTEM 3 CONSISTS OF A NEARLY FLAT AREA WITH A FREE DRAINING GRAVEL COVER TYPE. RUN-OFF IS EXPECTED TO INFILTRATE.

SYSTEM 4

THE FOLLOWING CALCULATIONS ARE PROVIDED FOR DESIGN OF A GRASSED TREATMENT SWALE TO COLLECT SYSTEM 4 RUN-OFF, AND CONVEY IT TO THE ACUSHNET RIVER.

DETEMINE SWALE SECTION

A TRIAL AND ERROR METHOD IS USED TO FIND DIMENSIONS OF SWALE SECTION USING HYDROCAD v5.11 TO MODEL CONDITIONS BY THE RATIONAL METHOD.

DESIGN CRITERIA

- SWALE SHALL BE GRASS LINED FOR IMPROVED TSS REMOVAL AND VELOCITY CONTROL
- DESIGN STORM SHALL BE A 10-YR 24-HR EVENT
- INITIAL FLOW VELOCITY (FPS) SHALL BE < 3.0
- LONG TERM FLOW VELOCITY (FPS) SHALL BE < 1.5
- SWALE SHALL CAPTURE ENTIRE STORMWATER RUNOFF WATER QUALITY VOLUME (WQV)
- BOTTOM WIDTH SHALL BE 1 FT. W/SIDESLOPES 2:1 OR FLATTER.

INITIAL CONDITIONS:

- PEAK FLOW FOR DESIGN = 1.75 CFS (FROM HYDROCAD)
- $n = 0.02$ (STRAIGHT CHANNEL, RECENTLY COMPLETED)
- $L = 390$ FT
- SLOPE = 0.005 FT/FT

PEAK DEPTH = 0.29 FT
PEAK VELOCITY = 1.8 FPS ∴ OK

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DRM DATE _____ SHEET 34 OF 44

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR

SUBJECT STORMWATER MANAGEMENT

DETERMINE SWALE SECTION (CONT'D)

LONG TERM CONDITIONS:

n = 0.12 (CHANNEL WITH DENSE GROWTH, HIGH AS FLOW DEPTH)

PEAK DEPTH = 0.51 FT
PEAK VELOCITY = 0.7 FPS ∴ OK

- FIND SWALE DEPTH

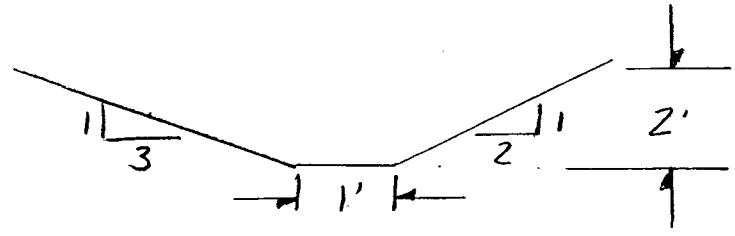
SWALE CHANNEL SHALL BE LARGE ENOUGH TO HANDLE 1.5 TIMES THE DESIGN FLOW (2.63 CFS)

DEPTH ≈ 2 FT (SEE OPEN CHANNEL FLOW WORKSHEET ATTACHED.)

SUMMARY:

A LIMITED DRAINAGE EASEMENT WAS PROVIDED FOR DURING PROJECT PLANNING, AND SWALE SIDESLOPES WERE CHOSEN TO ENSURE COMPLIANCE WITH THE AREA GIVEN FOR DESIGN. THE FOLLOWING MINIMUM SWALE GEOMETRY SHALL BE PROVIDED.

L = 390 FT
S = 0.005 FT/FT
D = 2.0 FT
W = 1.0 FT



WATER QUALITY CALCULATIONS

THE FOLLOWING CALCULATIONS ARE TO CHECK SYSTEM 4 TSS REMOVAL AND WATER QUALITY VOLUME IS MET IN ACCORDANCE WITH MADEP STORMWATER POLICY

▶ FIND TSS REMOVAL

1) STORMWATER INFLOW TO SYSTEM 4 IS BY LATERAL FLOW TO SWALE FROM OFFSITE, UNDISTURBED AREAS. A GRASSED "BIOFILTER" SWALE IS PROPOSED FOR TREATMENT, WITH PRETREATMENT ACCOMPLISHED BY GRASSED SIDESLOPES, AND A 200 FT DRAINAGE CHANNEL. MOST RUN-OFF FROM IMPERVIOUS AREAS SHALL BE CAPTURED IN THE CHANNEL (FOREBAY) BEFORE BEING CONVEYED TO RIVER.

- ASSUME AVERAGE ANNUAL TSS LOAD = 100%
- BMP 1 - PRETREATMENT (CHANNEL AND SIDESLOPES) = 25%
- BMP 2 - GRASSED TREATMENT SWALE = 80%

AVE ANNUAL LOAD (1.00) × BMP 1 REMOVAL (0.25) = 0.25 REMOVAL
▶ 1.0 - 0.25 = 0.75 REMAINING

TSS LOAD REMAINING (0.75) × BMP 2 REMOVAL (0.80) = 0.525
▶ (0.75 - 0.60) = 0.15 REMAINING

▶ TSS REMOVAL = 1.00 - 0.15 = 0.85 = **85% TSS REMOVAL ∴ OK**

SYSTEM 4 (CONT'D)

WATER QUALITY CALCULATIONS (CONT'D)

- FIND WATER QUALITY VOLUME (WQV)

NOTE: THE RUNOFF VOLUME TO BE TREATED IS CALCULATED AS 0.5 in. OF RUNOFF TIMES THE TOTAL IMPERVIOUS AREA OF THE POST-DEVELOPMENT SITE.
THE RUNOFF TO THE BMP'S SELECTED FOR SYSTEM 4 ARE FROM AREAS REPRESENTING EXISTING CONDITIONS. BY DEFINITION, TREATMENT SHOULD NOT BE REQUIRED. HOWEVER, SOME LEVEL OF TREATMENT WAS EXISTING AS OVERLAND FLOW THROUGH A VEGETATED BUFFER, WHICH IS PROPOSED TO BE REMOVED AS PART OF THIS PROJECT.

BMP'S SELECTED FOR SYSTEM 4 PROVIDE A GREATER LEVEL OF TREATMENT THAN IS EXISTING.

$WQV = 0.5\ in \times A_{impervious} = 0.5\ in \times 0.19\ Ac. = 0.095/12in.$
$WQV = 0.007$ Acre-ft (AF)

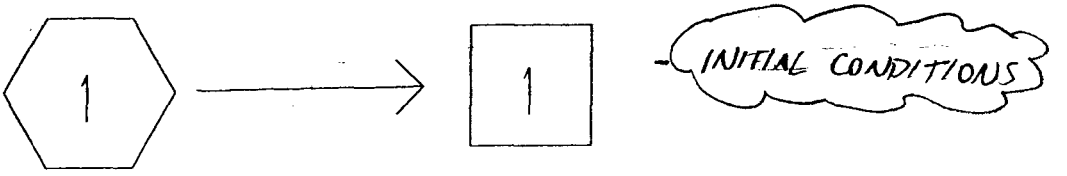
FROM HYDROCAD, V @ PEAK FLOW = 0.01 AF.
76% OF PEAK FLOW IS RETAINED AT LONG-TERM FLOW CONDITIONS, OR V = 0.0076 AF TREATED. ∴ ENTIRE PRESCRIBED WQV IS RETAINED.

ATTACHMENTS:

- HYDROCAD OUTPUT FOR 10 YR STORM EVENT W/ APPENDICES (INITIAL AND LONG-TERM CONDITIONS)
- OPEN CHANNEL FLOW ANALYSIS (FLOWMASTER v 3.12)

Data for **NBH System 4**
DURATION= 5 MIN INTEN= 5.30 IN/HR
Prepared by FOSTER WHEELER ENVIRONMENTAL 22 Apr 02
HydroCAD 5.11 001411 (c) 1986-1999 Applied Microcomputer Systems

WATERSHED ROUTING ==========



SUBCATCHMENT 1 = Catchment 16 -> REACH 1

REACH 1 = Perimeter Swale -> RIVER
GRASSED SWALE

SUBCATCHMENT 1 **Catchment 16**

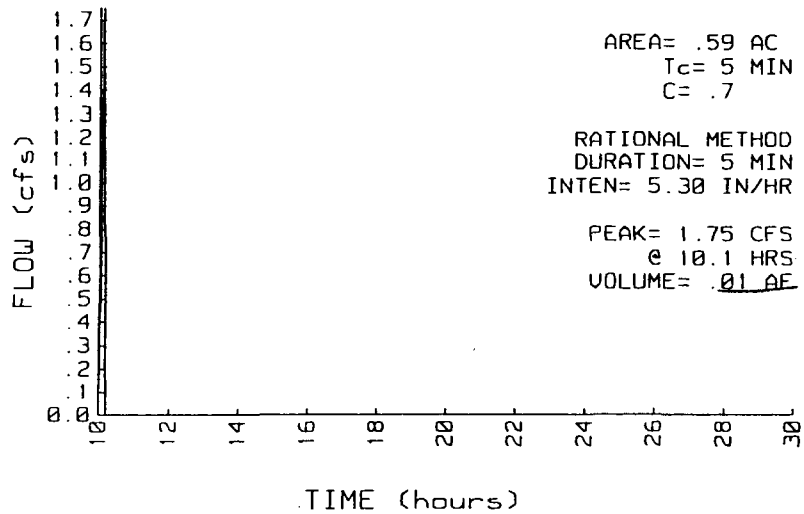
PEAK= 1.75 CFS @ 10.10 HRS, VOLUME= .01 AF

ACRES	CN	C= .70
.59	0	Off-Site

RATIONAL METHOD
DURATION= 5 MIN
INTEN= 5.30 IN/HR
SPAN= 10-30 HRS, dt=.1 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**Marine Hydraulics Run-off**	5.0

SUBCATCHMENT 1 RUNOFF
Catchment 16



REACH 1 **Perimeter Swale**

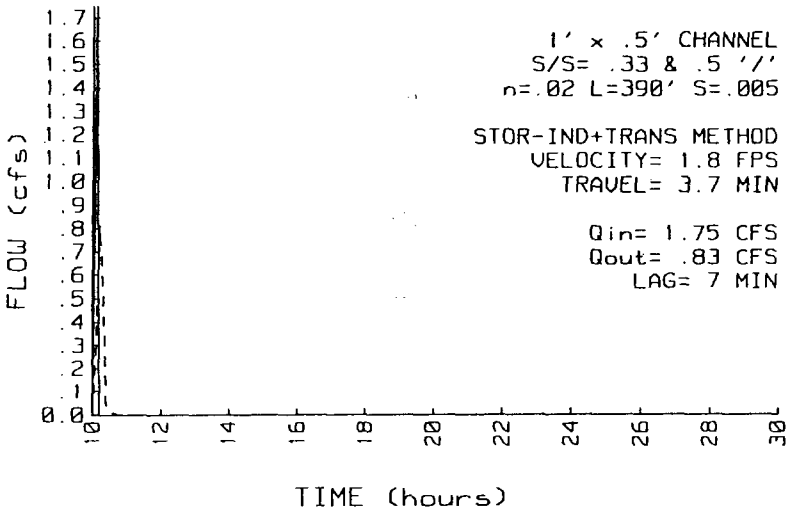
Qin = 1.75 CFS @ 10.10 HRS, VOLUME= .01 AF
Qout= .83 CFS @ 10.22 HRS, VOLUME= .01 AF, ATTEN= 53%, LAG= 7.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.05	.06	.04
.10	.13	.12
.15	.21	.26
.22	.33	.50
.30	.53	.95
.40	.80	1.69
.50	1.13	2.68

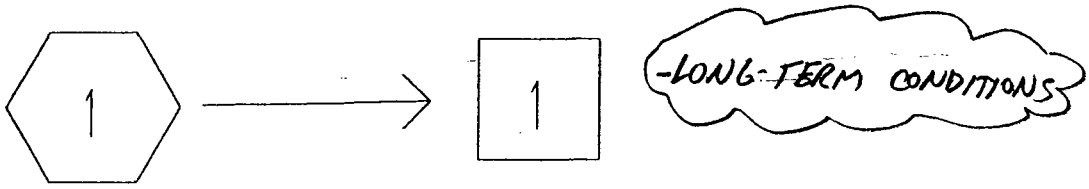
1' x .5' CHANNEL
S/S= .33 & .5 '/'
n= .02
LENGTH= 390 FT
SLOPE= .005 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .29 FT
PEAK VELOCITY= 1.8 FPS
TRAVEL TIME = 3.7 MIN
SPAN= 10-30 HRS, dt=.1 HRS

REACH 1 INFLOW & OUTFLOW
Perimeter Swale



WATERSHED ROUTING ==========



SUBCATCHMENT 1 = Catchment 16 -> REACH 1

REACH 1 = Perimeter Swale -> RIVER

GRASSED SWALE

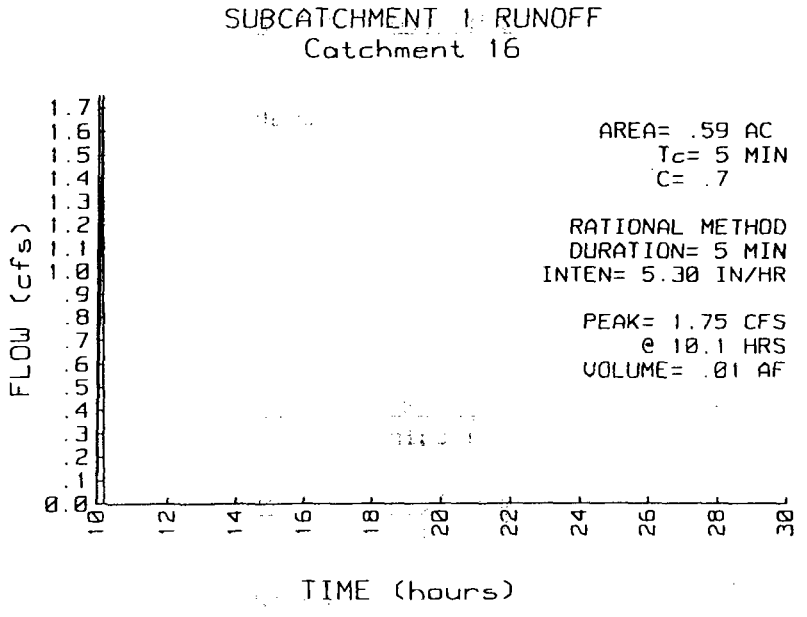
SUBCATCHMENT 1 **Catchment 16**

PEAK= 1.75 CFS @ 10.10 HRS, VOLUME= .01 AF

ACRES	CN	C= .70
.59	0	Off-Site

RATIONAL METHOD
DURATION= 5 MIN
INTEN= 5.30 IN/HR
SPAN= 10-30 HRS, dt=.1 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**Marine Hydraulics Run-off**	5.0



REACH 1 **Perimeter Swale**

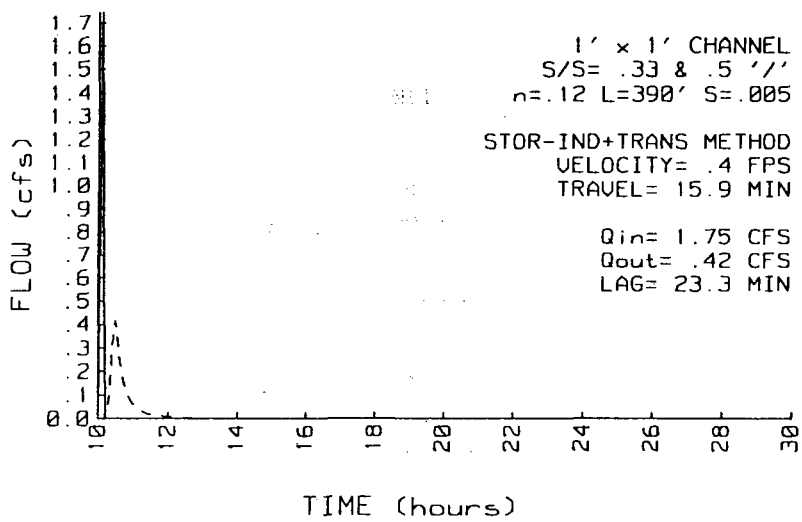
Qin = 1.75 CFS @ 10.10 HRS, VOLUME= .01 AF
Qout= .42 CFS @ 10.49 HRS, VOLUME= .01 AF, ATTEN= 76%, LAG= 23.3 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.13	.02
.20	.30	.07
.30	.53	.16
.43	.90	.33
.60	1.51	.66
.80	2.41	1.24
1.00	3.52	2.06

1' x 1' CHANNEL
S/S= .33 & .5 '/'
n= .12
LENGTH= 390 FT
SLOPE= .005 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .51 FT
PEAK VELOCITY= .4 FPS
TRAVEL TIME = 15.9 MIN
SPAN= 10-30 HRS, dt=.1 HRS

REACH 1 INFLOW & OUTFLOW
Perimeter Swale



A3/A4

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Grassed swale

Comment: rassed Swale

Solve For Depth

Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	0.33:1 (H:V)
Right Side Slope.	0.50:1 (H:V)
Manning's n.....	0.120
Channel Slope....	0.0050 ft/ft
Discharge.....	2.63 cfs

Computed Results:

Depth.....	2.06 ft
Velocity.....	0.69 fps
Flow Area.....	3.82 sf
Flow Top Width...	2.71 ft
Wetted Perimeter.	5.47 ft
Critical Depth...	0.55 ft
Critical Slope...	0.4685 ft/ft
Froude Number....	0.10 (flow is Subcritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 9/25 /02 SHEET 1 OF 2

CHKD. BY K. Bogatch DATE 10/8/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROPOSED SWALE CAPACITY (REVISED SEPTEMBER 2002 FOR NEW SWALE DIMENSIONS)

Estimated Drainage Flow:

- Using Rational Method[1]

  Q = CIA

  C = Rational method runoff coefficient
  I = Rainfall intensity (in/hr)
  A = Drainage area (acres)

- Estimated Drainage Area

  Total estimated drainage area = 95,220 ft^2 = 2.19 acres

  Estimated drainage area consisting of gravel = 19,370 ft^2 = 0.44 acres
  Estimated drainage area consisting of asphalt = 75,850 ft^2 = 1.74 acres

- Weighted "C" Value

  For asphalt[1], C = 0.85
  For gravel[1], C = 0.28

  Weighted C = (0.85)(1.74) + (0.28)(0.44) ÷ (0.44 + 1.74)
  = 0.73

- Rain Intensity

  I = 1.20 in/hr for 2 year storm[2]
  I = 2.00 in/hr for 10 year storm[2]
  I = 2.60 in/hr for 25 year storm[2]

- Estimated Drainage Flow

  Q = (0.73)(1.20)(2.18) = **1.92 ft^3/s** for 2 year storm

  Q = (0.73)(2.00)(2.18) = **3.20 ft^3/s** for 10 year storm

  Q = (0.73)(2.60)(2.18) = **4.16 ft^3/s** for 25 year storm

The proposed swale has side slopes that vary from 2H:1V, 3H:1V, and 4H:1V and the channel slope varies from 0.0050 ft/ft to 0.0070 ft/ft. The critical section of the proposed swale that has the least amount of hydraulic capacity is the section that has a side slope of 2H:1V and a channel slope of 0.0050 ft/ft. Using the Open Channel Flow Module, Version 3.12 © 1990, the hydraulic capacity of this critical swale section was calculated to be 7.04 ft^3/s, which is greater than the estimated flow rate generated by a 25 year storm event (4.16 ft^3/s). Therefore, it was calculated

that the dimensions of the proposed swale has enough hydraulic capacity to manage the estimated surface run-off flow rate generated during a storm 25-year storm event.

References:

1. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
2. National Oceanic and Atmospheric Administration (NOAA) Technical Paper No. 40

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: NBH-Revised Swale

Comment: Revised Swale

Solve For Discharge

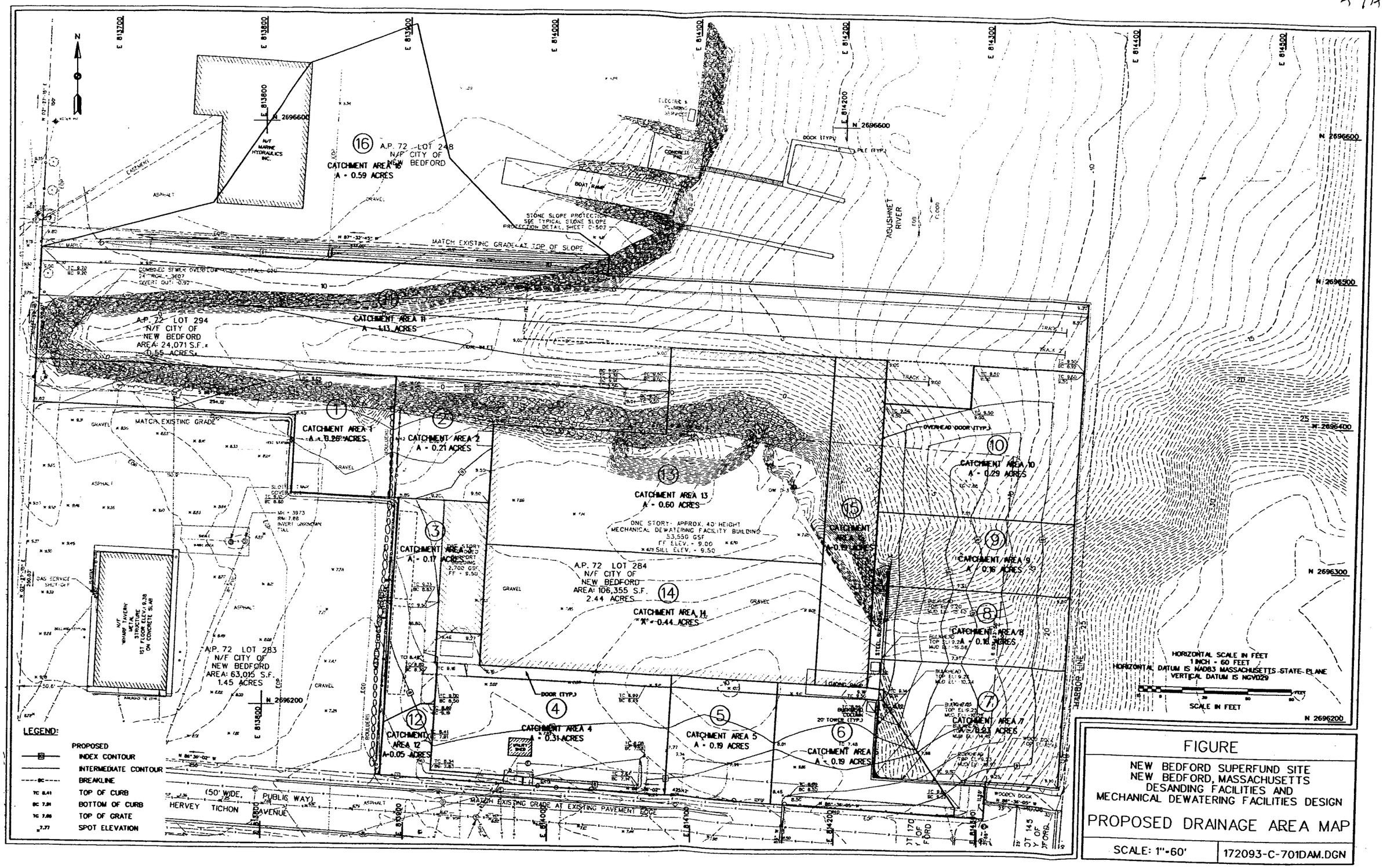
Given Input Data:

Bottom Width.....	1.00 ft
Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.030
Channel Slope....	0.0050 ft/ft
Depth.....	1.00 ft

Computed Results:

Discharge.....	7.04 cfs
Velocity.....	2.35 fps
Flow Area.....	3.00 sf
Flow Top Width...	5.00 ft
Wetted Perimeter.	5.47 ft
Critical Depth...	0.74 ft
Critical Slope...	0.0190 ft/ft
Froude Number....	0.53 (flow is Subcritical)

A9/A9



FIGURE

NEW BEDFORD SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS
DESANDING FACILITIES AND
MECHANICAL DEWATERING FACILITIES DESIGN

PROPOSED DRAINAGE AREA MAP

SCALE: 1"=60'	172093-C-701DAM.DGN

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Rail Area Subsuface Drainage

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. C-02 PROJECT NO. 5197.1720.9302

NO OF SHEETS 19 DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES X NO

PREPARER A. Toguvon

REVIEWED BY [signature] DATE 10-3-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION X YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

TABLE OF CONTENTS

GENERAL INFORMATION 2
- DESCRIPTION: NEW BEDFORD HARBOR RAIL AREA SUBSURFACE DRAINAGE DESIGN 2
- DRAINAGE CRITERIA 2
- EVALUATION 2
  - Capacity of Drainage Layer 2
  - Minimum Thickness of Drainage Layer 3
  - Time for Drainage 3
- MATERIAL PARAMETERS 4
- RESULTS 4
- RECOMMENDATIONS 4
- REFERENCES 5

LIST OF EXHIBITS

Exhibit 1 – Design Storm Index

Exhibit 2 – Time Factor

Exhibit 3 - Material Parameters for Rapid Draining Materials

Exhibit 3 - Results from the Subsurface Drainage Calculations

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA				PROJECT:	New Bedford Harbor	
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

GENERAL INFORMATION

DESCRIPTION: New Bedford Harbor Rail Area Subsurface Drainage Design

The following documents adequacy of subsurface drainage for the rail access area at the New Bedford Harbor Dewatering Facility.

DRAINAGE CRITERIA

Drainage criteria for the subsurface drainage is based on ETL 1110-3-435 Technical Guidance for Design of the Subsurface Drainage for Military Pavements.

For drainage beneath the rail area, the design of the drainage layer shall be based on the premise that the capacity of the drainage layer should be greater than the volume of water entering the area, and that the drainage layer, if saturated, should reach a degree of drainage of 0.85 within 1 day after the inflow of water stops. The degree of drainage for the drainage layer is defined as the volume of water that has drained from the layer over a specified time period divided by the total volume of water in the layer that can be drained by gravity.

The subsurface drainage for the rail area is to be designed to handle water infiltration through the rail area from a design storm index for a design storm of 1 hr duration at an expected return frequency of 2 years. For the continental United States, this can be determined from Exhibit 1 (taken from Th 5-820-l/AFM 88-5, Chap. 1). Rainfall intensity index values are based upon surface infiltration estimated using Hydrocad software for a 10 year design storm.

EVALUATION

Capacity of Drainage Layer

The capacity of the drainage layer (Q in cubic feet per foot width of rail area) is computed based on the effective porosity (n) and the volume of water draining from the drainage layer during the 1 hr of water inflow. Since the criterion is for a degree of drainage of 0.85 within 24 hr, it is to be assumed that only 85 percent of the voids will be available for storage of water. Thus, the capacity of the drainage layer may be computed by the equation.

$$Q = (0.85)(n)(H)(L) + (k/24)(t)(i)(H)/2$$

Where,

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA				PROJECT:	New Bedford Harbor	
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

Q = capacity of the drainage layer in cubic feet/feet
n = effective porosity
H = thickness of the drainage layer in feet
L = length of the drainage path in feet
k = permeability of the drainage layer in feet/day
t = 1 hr (length of design storm)
i = slope of the drainage path in feet/foot

Minimum Thickness of Drainage Layer

The minimum thickness in feet of the drainage layer required to provide the storage capacity for a 1 hour design storm is determined from the equation:

$$H = 4\ F\ R\ L/[40.8\ n\ L + ki)$$

n = effective porosity
k = permeability of the drainage layer in feet/day
i = slope of the drainage path in feet/foot
H = thickness of the drainage layer in feet
L = length of the drainage path in feet
F = infiltration coefficient
R = design rainfall index in inches per hour

If the term (ki) is small compared to the term (40.8n L) which would probably be the case for long drainage paths (> 20 ft), then the required thickness of the drainage layer can be estimated by deleting the term (ki) resulting in:

$$H = (F\ R)/(10.2\ n)$$

Time for Drainage

The time for drainage of the drainage layer is a function of effective porosity, length of the drainage path, thickness of the drainage layer, slope of the drainage path, and permeability of the drainage layer. This function has been solved in terms of time factor TF and a parameter m. The time factor is obtained from Exhibit 2 as a function of the parameter S which is determined by the equation

$$S = Li/(H)$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

After determining the time factor TF from Exhibit 2, the time required to obtain a degree of drainage of 0.85 is computed from:

$T = (TF)(m)$

Where,

T = time in days required to obtain a degree of drainage of 0.85
m = a parameter defined as
$m=(n\ L\ )/(k\ H)^2$

MATERIAL PARAMETERS

Exhibit 3, presents documentation of the parameters used in the evaluation for the drainage layer (subballast material). Rapid draining materials were assumed for the subballast layer, which represents a well graded gravel or a well graded sand (grain size distribution given in Exhibit 3). Permeability of the subballast layer was assumed to be 2500 ft/day or the median of the typically observed for a rapid draining material.

RESULTS

Results from the subsurface drainage estimates are contained in Exhibit 4. Capacity of Drainage Layer, Minimum Thickness of Drainage Layer, and Time for Drainage were calculated, using design rainfall estimates assumed for surface water evaluations conducted using HydroCADD software (output provided in Exhibit 4). Minimum thickness of the drainage layer was estimated to be 1.8 ft for the peak design rainfall index. Which is slightly thicker than the subballast layer (1.25 ft) which suggests some mounding (~6 inches) in the ballast layer at peak rainfall.

For the subballast material assumed, the 1 day required for drainage meets the drainage criteria; thus, the design would call for a 2 ft. drainage layer with a 85-ft drainage path.

RECOMMENDATIONS

Stabilized fill should be graded to a minimum of a 0.5% slope towards the northern swale drain.

The subballast layer between the stabilized fill and the ballast should be made up of a rapid draining material, classified as a well graded gravel or sand as indicated on the grain size distribution chart in Exhibit 3.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

The drainage layer must be protected from contamination of fines from the overlying and underlying layers by a separation layer to be placed directly above or beneath the drainage layer. Given that the ballast rail area will be subject to storm water infiltration, a filter fabric placed between the ballast and the subballast should minimize fines entering the subballast layer and maintain better drainage over time.

REFERENCES

1. USACE (1992) "Technical Guidance for Design of the Subsurface Drainage for Military Pavements", ETL 1110-3-435, 1 May 92

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 1

DESIGN STORM INDEX

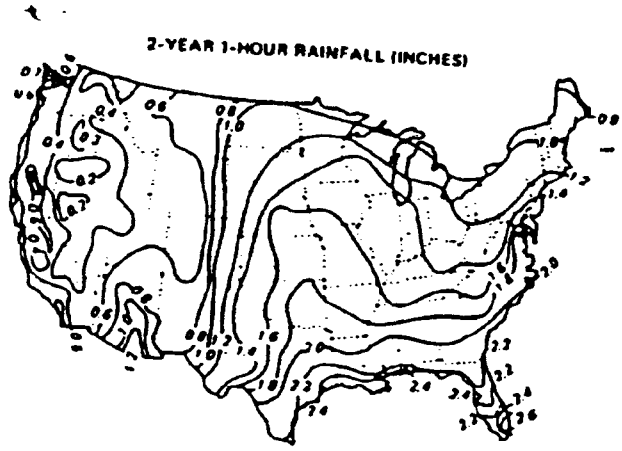


Figure 1. Design Storm Index, 1-hr Rainfall Intensity-Frequency Data for Continental United States Excluding Alaska (Chart reproduced from US Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of The United States, Washington, DC, May 1961.)

water to the drainage layer but such water would be minor and would not be a consideration in the design of the drainage layer. Should ground water be present in any substantial quantities, special provisions should be made to intercept and drain the water before it reaches the drainage layer. The drainage layer is expected to aid in draining of water in the subbase and subgrade caused by frost action, but this volume of water will not be considered in computing the design water inflow.

c. Length and Slope of Drainage Path. The length of drainage path is measured along the slope of the drainage layer from the crest of the slope to where the water will exit the drainage layer. In simple terms, the length of the drainage path is the maximum distance water will travel in the drainage layer. The length of drainage path (L) in feet may be computed by the equation

$$L = \frac{X\sqrt{i_t^2 + i_e^2}}{i_t} \qquad \text{(eq 2)}$$

where

X = the length in feet of the transverse slope of the drainage layer

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA				PROJECT:	New Bedford Harbor	
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 2

TIME FACTOR

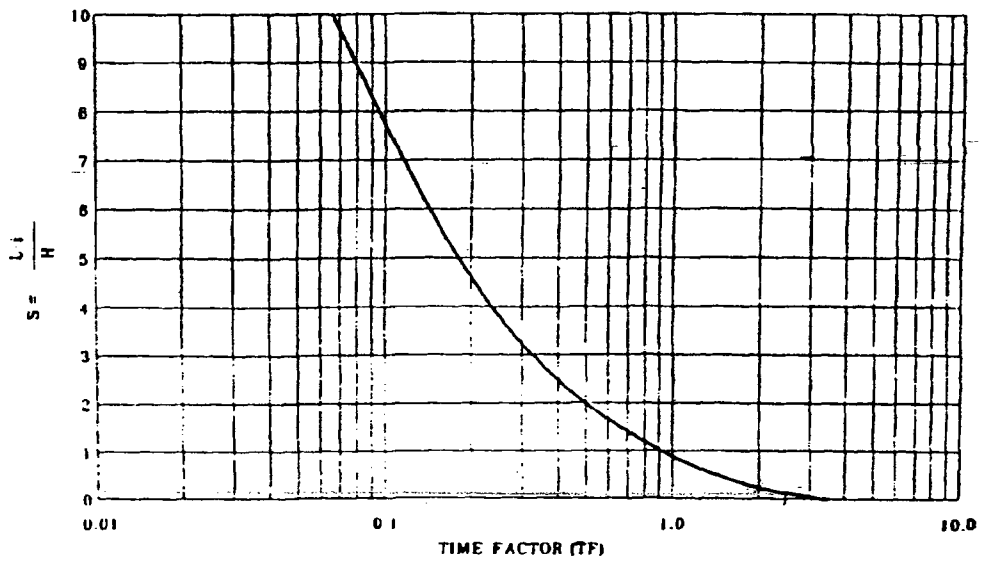


Figure 2. Time Factor for 85 Percent Drainage

The slope of the drainage path (i) = 0.01

The infiltration coefficient (F) = 0.5

First the thickness, H, of the drainage layer required to provide the necessary storage capacity is computed by substituting into equation 5 as follows

$$H = [4(0.5)(2.0)\ (150)]/[40.8(0.2)\ (150) + (0.01)\ (2,000))$$

$$H = 0.48 \text{ ft. or } 5.8 \text{ in.}$$

Rounding the computed thickness up to the next full inch gives a design thickness of 6 in. Equation 6 could have been used to estimate the thickness as follows

$$H = F\ R/10.2\ n_0 = [(0.5)\ (2)]/[(10.2)\ (0.2)] = 0.49 \text{ ft}$$

Again the thickness would round up to 6 in. The next step would be to use Figure 2 to determine the time to obtain a degree of drainage of 0.85. Using equation 7 the value of s is computed to be 3.0 and from equation 9 the value of m is computed to be 4.5. From Figure 2 the time factor, TF, is found to be 0.32. The time to obtain a degree of drainage of 0.85 is computed from equation 8.

$$T_{85} = (TF)(m) = (0.32)\ (4.5) = 1.44 \text{ days}$$

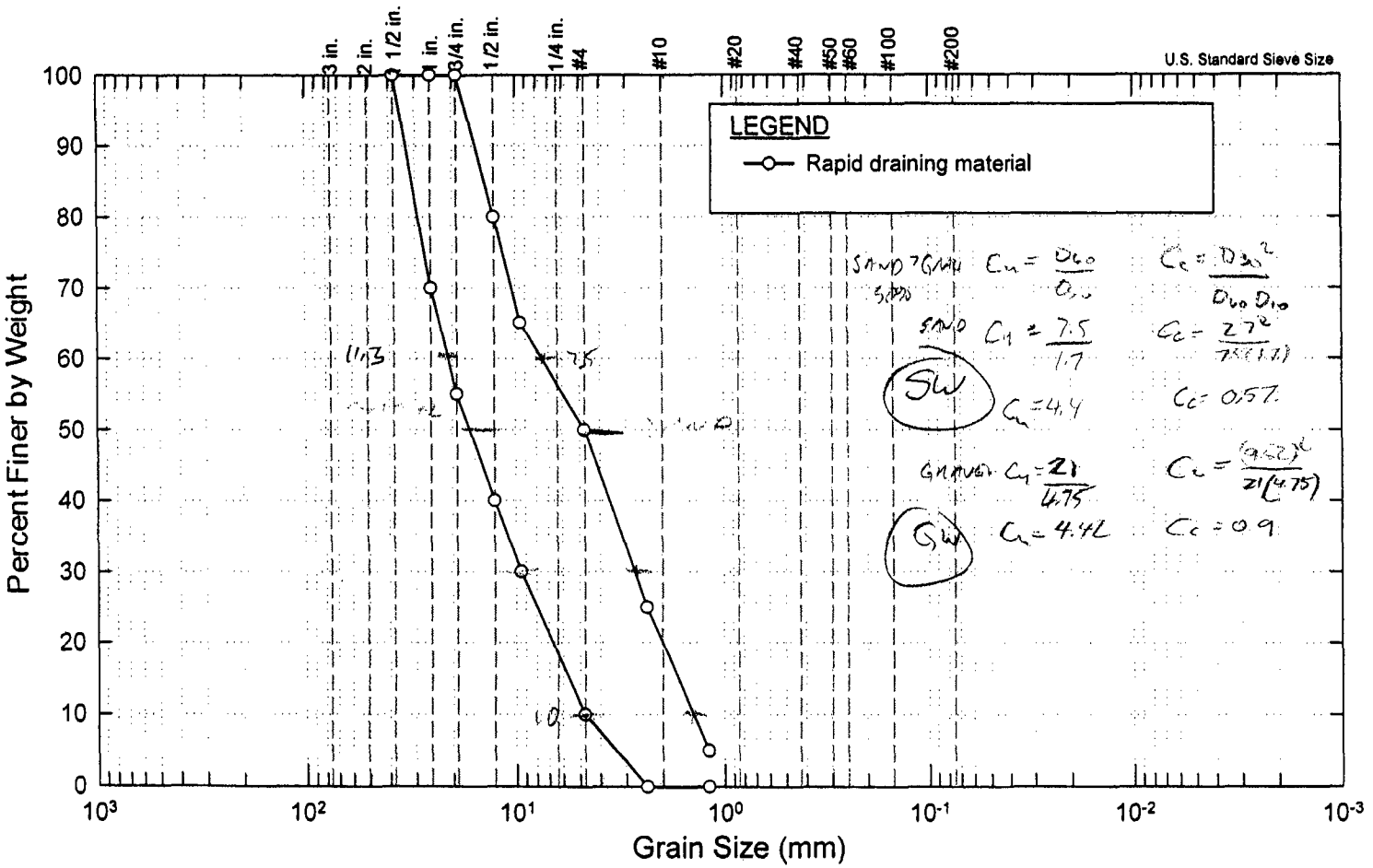
FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 3

MATERIAL PARAMETERS FOR RAPID DRAINING MATERIALS

Particle Size Distribution



COBBLES	GRAVEL		SAND			SILT	CLAY
	Coarse	Fine	Coarse	Medium	Fine		

Boring No.:		Soil Description:	Dk. Brown Organic Silt (OH)
Sample:		Liquid Limit % (LL):	
Depth:		Plastic Limit % (PL):	
File:		Specific Gravity (G_s):	
Laboratory:		Date:	
Technician:		Reviewer:	

Boring No.:		Soil Description:	Dk. Brown Organic Silt (OH)
Sample:		Liquid Limit % (LL):	
Depth:		Plastic Limit % (PL):	
File:		Specific Gravity (G_s):	
Laboratory:		Date:	
Technician:		Reviewer:	

GEOTECHNICAL ENGINEERING REMEDIATION PLANNING CONSULTING

FOSTER WHEELER ENVIRONMENTAL CORPORATION
133 FEDERAL STREET
BOSTON, MASSACHUSETTS 02110

TEL: (617) 8200 FAX: (617)457-8498/8499

RAIL AREA SUBSURFACE DRAIN
NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSSETTS

GRAIN SIZE ANALYSIS

DATE: Au t 2000

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 4

RESULTS FROM THE SUBSURFACE DRAINAGE CALCULATIONS

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Rail Area Subsurface Drainage						
BY/DATE:	ARMT	05/18/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

Table 1

Gradations of Materials for Drainage Layers and Choke Stone

Sieve Designation	Drainage Layer Material: Rapid Draining Material	Drainage Layer Material: Open Graded Material	Choke Stone
1-1/2 in.	100	100	100
1 in.	70-100	95-100	100
3/4 in.	55-100	--	100
1/2 in.	40-80	25-80	100
3/8 in.	30-65	--	80-100
No. 4	10-50	0-10	10-100
No. 8	0-25	0-5	5-40
No. 16	0-5	--	0-10

Table 2

Properties of Materials for Drainage Layers

Property	Rapid Draining Material	Open Graded Material
Permeability ft/day	1,000-5,000	>5,000
Effective Porosity	0.25	0.32
Percent Fractured	90% for 80 CBR	90% for 80 CBR
Faces (COE method)	75% for 50 CBR	75% for 50 CBR
C_u	>3.5	--
LA Abrasion	<40	<40

Note: C_u is the uniformity coefficient = D_{60}/D_{10}.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY AAMT DATE MAY 16/02 SHEET 15 OF 19

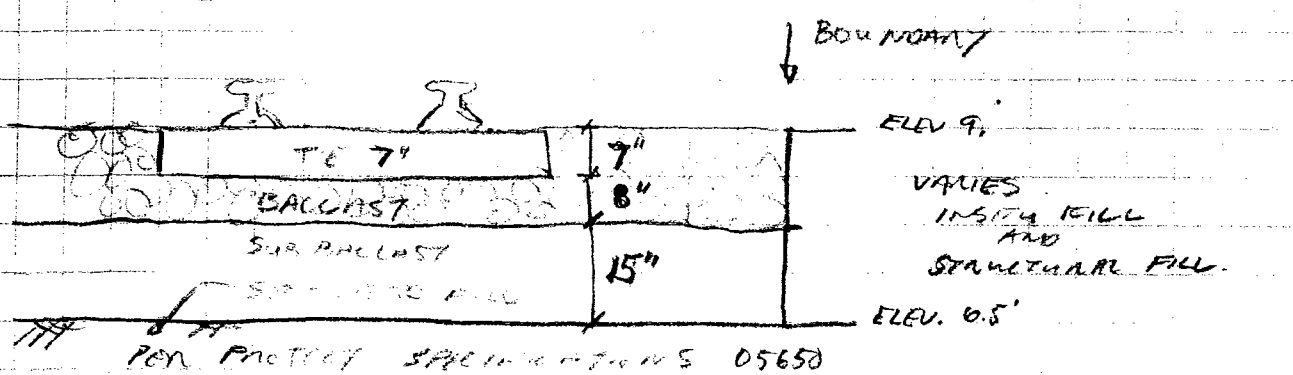
CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / NE EPA

PROJECT NBIY

SUBJECT RAIL AREA SUBSURFACE DRAINAGE

DRAINAGE ESTIMATE FOR RAIL



PER PROJECT SPECIFICATIONS 05650

BALLAST SIZE NO. 5 (SIEVE SIZE / PASSING)

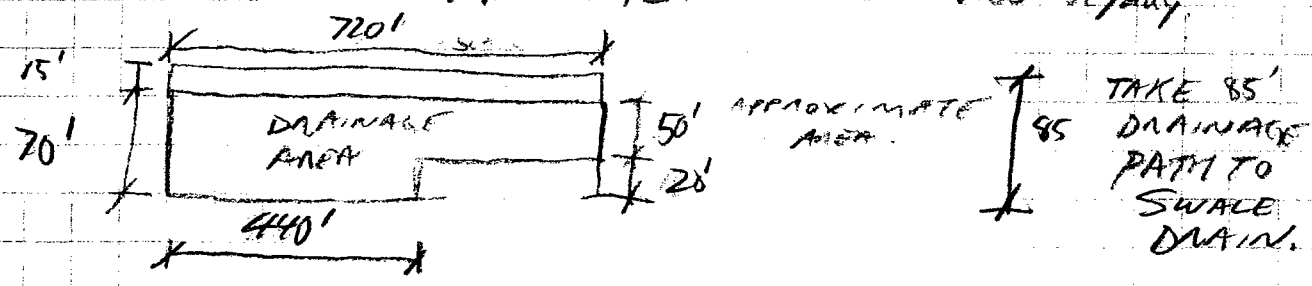
1.5"	100% PASSING
1"	90-100% PASSING
3/4"	40-75% PASS
1/2"	15-35

ASSUME SUB BALLAST BELOW BALLAST AND ABOVE ELEVATION. 6.5 (NO SPEC IN 05650)

USE THE STRUCTURAL FILL OR ADD NEW SPEC. FOR SUB BALLAST

↳ STRUCTURAL FILL.

↳ GRANULAR MATERIAL $k = 1000 - 5000$ ft/day



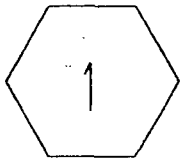
FROM HYDROCAD CALC - INFILTRATION RATE INTO DRAINAGE AREA IS ESTIMATED TO BE 0.19 cfs (REPRESENTS PEAK FLOW).

AND DESIGN RAINFALL R=5.3 in/hr

(SEE FOLLOWING PGS)

Data for **NBH - System 3**
DURATION= 5 MIN INTEN= 5.30 IN/HR
Prepared by FOSTER WHEELER ENVIRONMENTAL 15 May 02
HydroCAD 5.11 001411 (c) 1986-1999 Applied Microcomputer Systems

WATERSHED ROUTING ==========



SUBCATCHMENT 1 = Subcatchment 11 ->

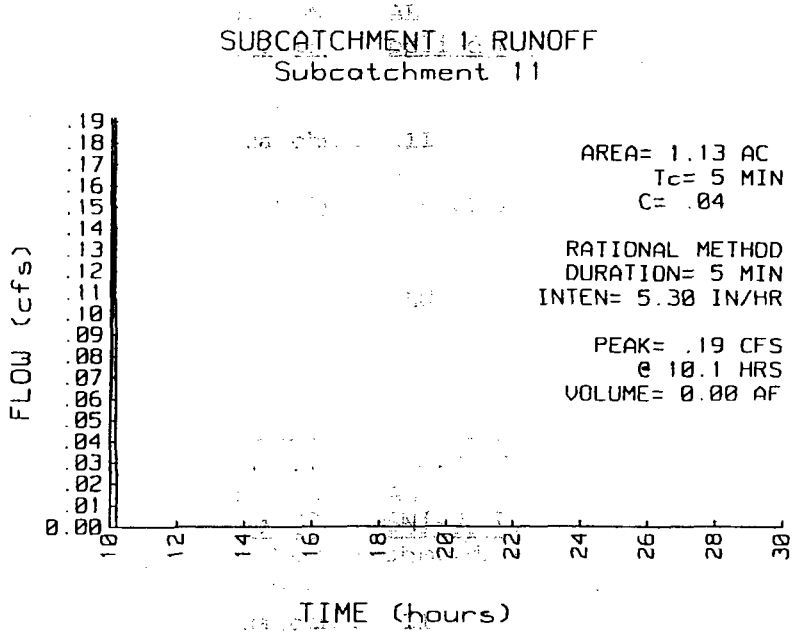
SUBCATCHMENT 1 **Subcatchment 11**

PEAK= .19 CFS @ 10.10 HRS, VOLUME= 0.00 AF

C= .04
TOTAL AREA = 1.13 AC

RATIONAL METHOD
DURATION= 5 MIN
INTEN= 5.30 IN/HR
SPAN= 10-30 HRS, dt=.1 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**Minimum Tc**	5.0



FOSTER WHEELER ENVIRONMENTAL CORPORATION

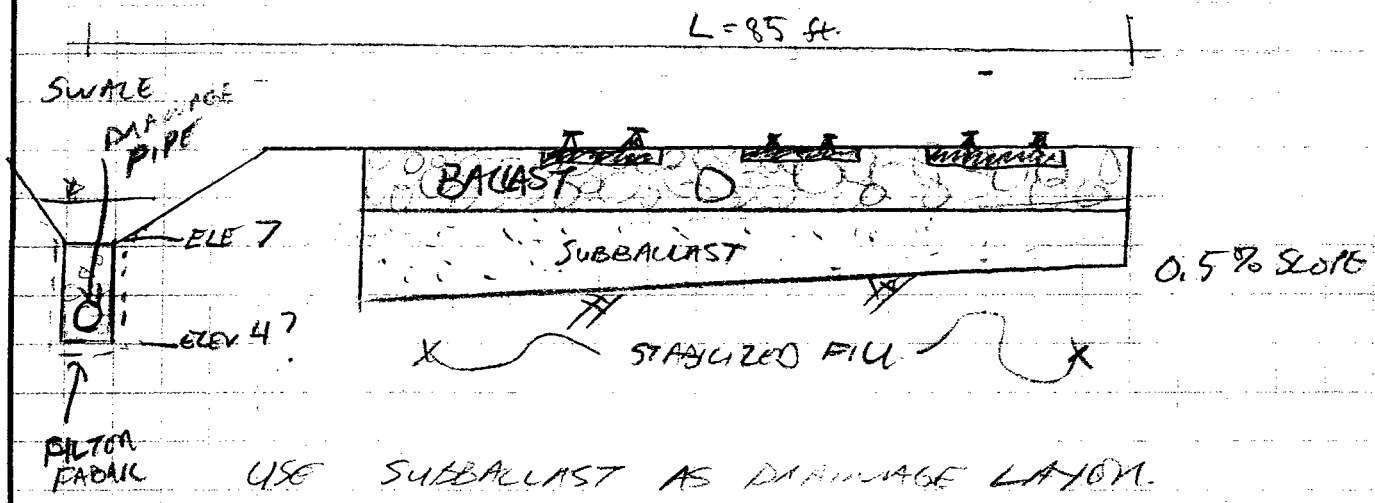
BY _____ DATE _____ SHEET 18 OF 19

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT _____



USE SUBBALLAST AS DRAINAGE LAYER.

CAPACITY OF SUBBALLAST

$$Q = 0.85\, n_e H L + \frac{K}{24}\, t\, i\, \frac{H}{2}$$

Q - CAPACITY OF DRAINAGE LAYER ft^3/ft

n_e - EFFECTIVE POROSITY → 0.35

H - THICKNESS OF DRAINAGE LAYER. (ft) → 1.25'

L - LENGTH OF DRAINAGE PATH. (ft) → 85'

K - PERMEABILITY OF DRAIN LAYER ft/day → 2500 ft/day

t - 1 hr. LENGTH OF DESIGN STORM. → 1 hr

i - SLOPE OF DRAINAGE PATH ft/ft. → 0.5%

$$Q = 0.85(0.35)(1.25')(85') + \frac{2500\ ft/day}{24}(1)(0.005)\frac{1.25'}{2}$$

$$Q = 31.9\ ft^3/ft$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 19 OF 19

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT _____

MIN THICKNESS OF DRAINAGE LAYER

$$H = \frac{4FRL}{40.8\, n_o L + Ki} \quad \text{FOR } L < 20'$$

$$H = \frac{FR}{10.2\, n_o} \quad \text{FOR } L > 20'$$

H = MIN THICKNESS TO PROVIDE STORAGE (ft) FOR 1HR STORM.

F - INFILTRATION COEFFICIENT FIG 1 → 1.2

R - DESIGN RAINFALL INDEX (HYDRO CAD OUTPUT) → 5.3 in/hr

n_o = POROSITY (EFFECTIVE) → 0.35

$$H = \frac{1.2\left(5.3 \frac{in}{hr}\right)}{10.2\,(0.35)}$$

$H = 1.78\,ft \sim 21''$

TIME FOR DRAINAGE

DRAINAGE FACTOR → $S = \frac{Li}{H}$

$$S = \frac{85'(0.005)}{1.78'}$$

$S = 0.238$

USE FIGURE 2 → TF = 2.0

$T_{85} = TF\, m$

TF - TIME FACTOR FIGURE 2 → 2.0

$$m = \frac{nL^2}{KH} = \frac{0.35(85')^2}{2500\,ft/d\ \ 2.37'}$$

$m = 0.43$

$T_{85} = 2.0\,(0.43) = 0.86$ DAYS. OK.

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT: New Bedford Harbor Superfund Site: Pavement Design

CLIENT : New England US Army Corps of Engineers/US Environmental Protection Agency

CALCULATION NO.: 1C-03 PROJECT NO.:519.1720.9302

NO OF SHEETS: 19 DESIGN LEVEL: 2

CALCULATION BY OTHERS_____YES X NO PREPARER: A.Tognon

REVIEWED BY [signature] DATE 4/8/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION: X YES___NO

ASSUMPTIONS CONFIRMED BY [signature] DATE 4/8/02

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	all	April 2, 2002	[signature]	4/8/02

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Asphalt Pavement Design						
BY/DATE:	ARMT	04/01/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

GENERAL INFORMATION

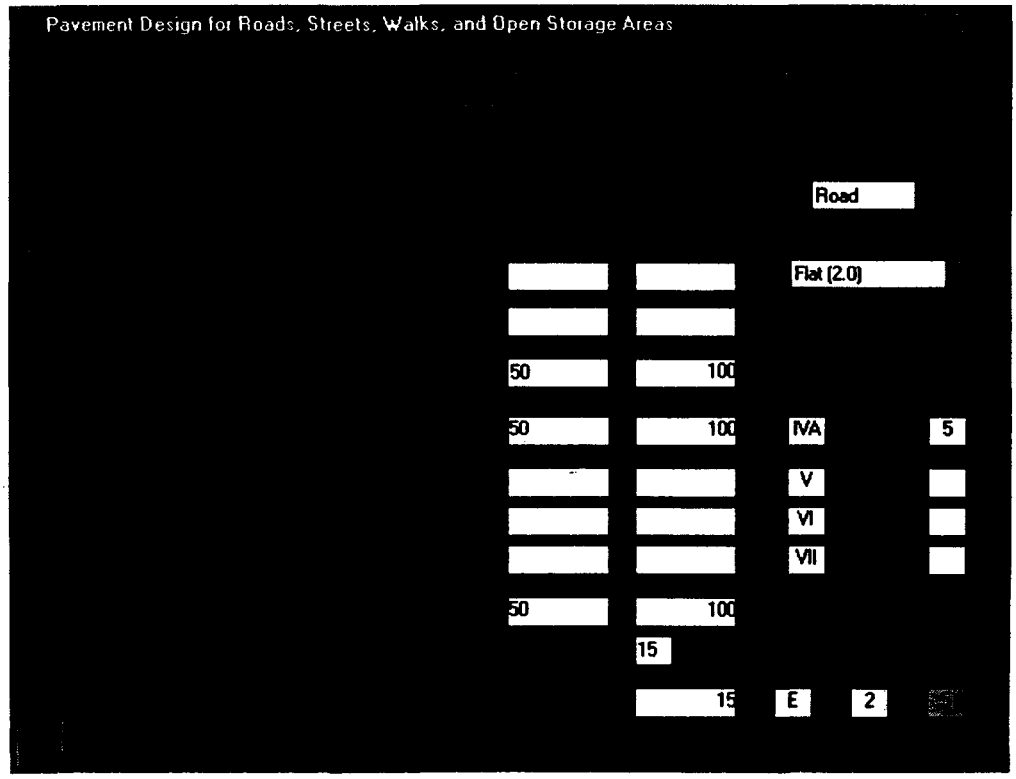
DESCRIPTION: New Bedford Harbor Pavement Design

The following documents pavement designs for the dewatering building at the New Bedford Harbor Dewatering Facility.

EVALUATION

Exhibit 1 and Exhibit 2 contain hand calculations and PCASE software output for the pavement section. The pavement design for the dewatering facility assumes that traffic use will consist of HS20 truck loading at a frequency of approximately 50 trips per day.

Design methods are based on Traffic Load Design Indexes commonly used for pavement design. Design indexes of 5 through 7 were evaluated in the pavement design, provided in figure below and in more detail in Exhibit 1.



FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA				PROJECT:	New Bedford Harbor	
SUBJECT:	Asphalt Pavement Design						
BY/DATE:	ARMT	04/01/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

TABLE OF CONTENTS

GENERAL INFORMATION 2
DESCRIPTION: NEW BEDFORD HARBOR PAVEMENT DESIGN 2
EVALUATION 2
RECOMMENDATIONS 3
REFERENCES 4

LIST OF EXHIBITS

Exhibit 1 – Pavement Design Hand Calculations

Exhibit 2 – PCASE Pavement Design Software Output

Design indexes are empirically correlated to provide appropriate to for asphalt, base and subbase courses. A summary of the results from the Exhibits 1 and 2 are given in Table 2.

Table 2 - Results from pavement evaluations

	Hand Calc. DI=7 [a]	PCASE DI=5 [a]	PCASE DI=6 [a]	PCASE DI=7 [a]	PCASE DI=8 [a]	PCASE DI=5 Sub-base CBR=10
Asphalt	3"	2.5"	3"	3"	3.5"	2.5"
Base Course (CBR-80)[b]	4"	5.5"	6"	7"	7.5"	9"
Subbase	3"	---	---	---	---	---

a - assumes a subgrade CBR of 15

b - base course assumed to achieve a CBR of 80

RECOMMENDATIONS

California bearing ratio assumed for the subgrade was 15 which is typical of a medium dense silty or clayey sand, which represents the midrange of silty/clayey sand material (where CBR ranges from 10 to 20). Reduction of the subgrade CBR to 10 (for a DI of 5) resulted in a 2 fold increase in required base course, demonstrating the need to properly prepare the subgrade for subsequent pavement courses. Proper preparation should include proof rolling before placement of the base material.

Site preparations indicate that when sub-grades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to 95% Proctor. Where additional fill is required to achieve final grades, compacted common fill will be used beneath the pavements. Given the proposed subgrade preparation, the PCASE (DI=6) case is even more conservative than the hand calculation, which recommmended a 3" sub-base. Therefore the PCASE (DI=6) was selected for final design, which consists of a 3" asphalt layer with a 6" base course, along with proper proof rolling of the subgrade. The design course thickness selected reflect a balance between design indexes and sufficient flexibility for larger vehicle equipment and inherent payloads potential for the operation of the dewatering facility.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Asphalt Pavement Design						
BY/DATE:	ARMT	04/01/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

REFERENCES

1. AASHTO (1993) "Guide for the Design of Pavement Structures" American Association of State Highway and Transportation Officials,

2. USACE (1992) "Pavement Design for Roads,Streets, Walks, and Open Storage Areas", TM 5-822-5, June

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Asphalt Pavement Design						
BY/DATE:	ARMT	04/01/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 1

PAVEMENT DESIGN HAND CALCULATIONS

7/24

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY ARMT DATE MARCH 23/2002 SJ SHEET 1 OF 8

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT NE-USACE/EPA

PROJECT NBH

SUBJECT PAVEMENT DESIGN

PAVEMENT DESIGN.

TRAFFIC USE ASSUMPTIONS

REF: FIGURE 1 → GVW ~ 72 kips.

FROM USACE TM 5-822-5

→ DESIGN INDEX = 7

- FOR TRAFFIC CONTAINING MORE THAN 25% TRUCKS
- FOR GVW < 90 000 lbs. or 90 kips FORKLIFTS OF 25 kips.

SUBGRADE CBR

(A) ONSHORE EXISTING FILL.

SUBGRADE WILL CONSIST OF INSITU MATERIAL REPRESENTED BY 0-8' OF MATERIALS CLASSIFIED ON BORINGS FD-19, FD-201, FD-202, FD-205 AS:

SP-SM, SM, SC } CBR 12-18

SP, GP } CBR >18

TAKE AVE CBR 15 FOR DESIGN.

CBR RANGES FROM NAVFAC DM5.4

(B) OFFSHORE STABILIZED FILL.

PLANS FOR RE USE OF STABILIZED NON-TSCA DREDGED MATERIAL MAY BE CONSIDERED FOR USE AS SUBGRADE MATERIAL BENEATH PAVEMENT SECTIONS. PENDING ADDITIONAL EVALUATION.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY AMT DATE MARCH 13/02 G7 SHEET 2 OF 8

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

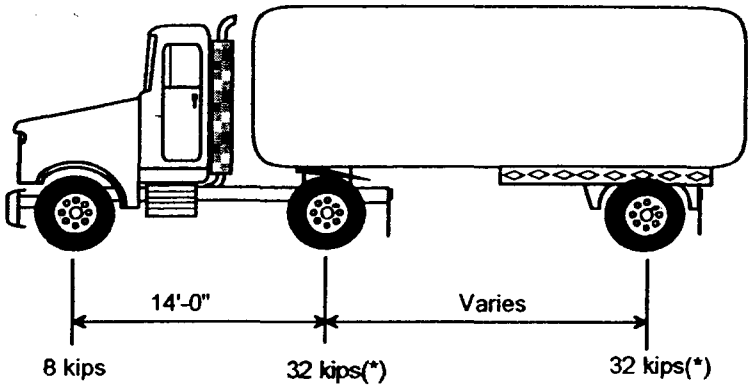
CLIENT NE-USACE / EPA

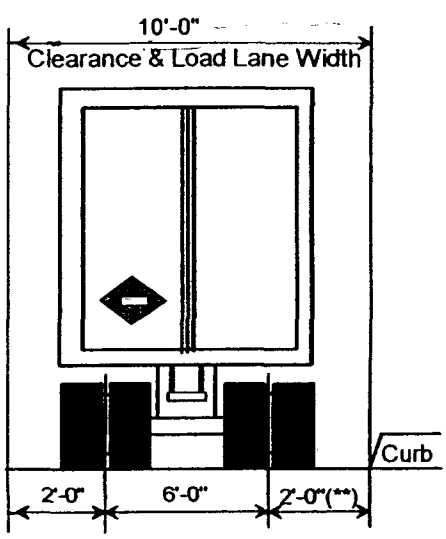
PROJECT NBH

SUBJECT PAVEMENT DESIGN

HS20-44 Truck Loading

- The HS20-44 truck is defined below as one 8 kip axle load and two 32 kip axle loads spaced as shown.

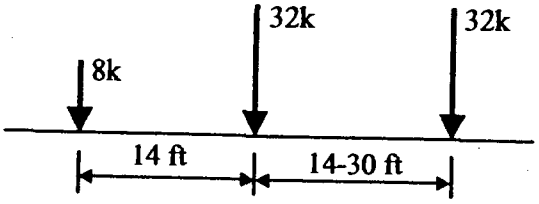




Varies = Variable spacing 14' to 30' inclusive. Spacing to be used is that which produces the maximum stresses.

AASHTO - STAND SPEC. FOR HIGH. BRIDGES.

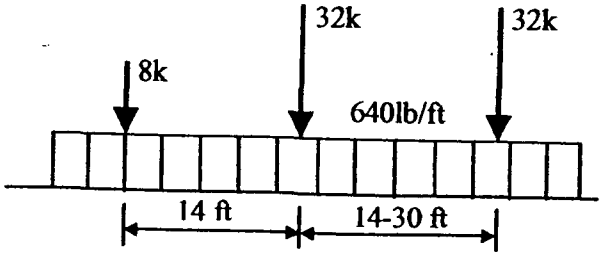
FIGURE 1.



(a) *Standard* HS20-44 Loading

GVW - GROSS VEHICLE WEIGH

GVW = 8k + 32k + 32k
= 72 000 lb
= 72 kip



(b) *LRFD* HL-93 Loading

BDDA
ESTIMATED TRAFFIC
50 LOAD TRIPS

~ 50 TRAFFIC ~~PASSED~~ / DAY.

CHAPTER 3

VEHICULAR TRAFFIC

3-1. Effect on Pavement Design.

Pavement thickness must be designed to withstand the anticipated traffic, categorized by type and weight of vehicles, and measured by average daily volume (ADV) of each type for the design life of the pavement. For most pavements, the magnitude of the axle load is of greater importance than the gross weight of pneumatic-tired vehicles because axle spacings are generally so large that there is little interaction between the wheel loads of one axle and the wheel loads of the other axles. Thus, for the case of pneumatic-tired vehicles having equal axle loads, the increased severity of loading imposed by conventional four- or five-axle trucks as compared with that imposed by two- or three-axle trucks is largely a fatigue effect resulting from an increased number of load repetitions per vehicle operation. For forklift trucks where the loading is concentrated largely on a single axle and for tracked vehicles where the loading is evenly divided between the two tracks, the severity of the vehicle loading is a function of the gross weight of the vehicle and the frequency of loading. Relations between load repetition and required rigid pavement thickness developed from accelerated traffic tests of full-scale pavements have shown that, for any given vehicle, increasing the gross weight by as little as 10 percent can be equivalent to increasing the volume of traffic by as much as 300 to 400 percent. On this basis, the magnitude of the vehicle loading must be considered as a more significant factor in the design of pavements than the number of load repetitions.

3-2. Traffic Evaluation.

Procedures for the evaluation of traffic and selection of design index are as follows.

a. Pneumatic-tired vehicles. To aid in evaluating vehicular traffic for the purpose of pavement design, pneumatic-tired vehicles have been divided into the following three groups —

Group 1. Passenger cars, panel trucks, and pickup trucks

Group 2. Two-axle trucks

Group 3. Three-, four-, and five-axle trucks

The design weights for various pneumatic-tired vehicles have been based on average weights, as determined from Federal Highway Administration traffic surveys made on public highways, plus one-fourth of the difference between these average weights and the maximum allowable weights. For group 2 and group 3 vehicles, maximum allowable weights are based on single-axle and tandem-axle loadings not exceeding 18,000 and 32,000 pounds, respectively. Since traffic rarely will be composed of vehicles from a single group, pneumatic-tired vehicular traffic has been classified into five general categories based on the distribution of vehicles from each of the three groups listed above. These traffic categories are defined as follows —

Category I. Traffic composed primarily of passenger cars, panel and pickup trucks (group 1 vehicles), but containing not more than 1 percent two-axle trucks (group 2 vehicles).

Category II. Traffic composed primarily of passenger cars, panel and pickup trucks (group 1 vehicles), but may contain as much as 10 percent two-axle trucks (group 2 vehicles). No trucks having three or more axles (group 3 vehicles) are permitted in this category.

Category III. Traffic containing as much as 15 percent trucks, but with not more than 1 percent of the total traffic composed of trucks having three or more axles (group 3 vehicles).

Category IV. Traffic containing as much as 25 percent trucks, but with not more than 10 percent of the total traffic composed of trucks having three or more axles group 3 vehicles).

Category IVA. Traffic containing more than 25 percent trucks.

b. Tracked vehicles and forklift trucks. Tracked vehicles having gross weights not exceeding 15,000 pounds and forklift trucks having gross weights not exceeding 6,000 pounds may be treated as two-axle trucks (group 2 vehicles) and substituted for trucks of this type in the traffic categories defined above on a one-for-one basis. Tracked vehicles having gross weights exceeding 15,000 pounds but not 40,000 pounds and forklift trucks having gross weights exceeding 6,000 pounds but not 10,000 pounds may be treated as group 3 vehicles and substituted for trucks having three or more axles in the appropriate traffic categories on a on-for-one basis. Traffic composed of tracked vehicles exceeding 40,000 pounds gross weight and forklift trucks exceeding 10,000 pounds gross weight has been divided into the following three categories —

Maximum Vehicle Gross Weight, Pounds

Category	Tracked Vehicles	Forklift Trucks
V	60,000	15,000
VI	90,000	25,000
VII	120,000	(*)

* Forklift trucks exceeding 25,000-pounds gross weight are treated in TM 5-809-12/AFM 88-3, Chap. 15.

c. Selection of design index. The design of pavements for Army and Air Force roads, streets, and similar areas is based on a "design index," which represents the combined effect of the loads defined by the traffic categories just described and the traffic volumes associated with each of the lettered classifications of roads or streets. This index extends from one through ten with an increase in numerical value indicative of an increase in pavement design requirements. Table 3-1 gives the appropriate design index for combinations of the eight traffic categories based on distribution of traffic, vehicle type, and the six-letter classifications based on the volume of traffic. For example, suppose an average daily traffic (ADT) of 2,000 vehicles composed primarily of passenger cars, panel trucks, and pickup trucks (group 1), but including 100 two-axle trucks (group 2) is anticipated for a road in flat terrain. First, the road class is determined from TM 5-822-2/AFM 88-7, Chap. 5 to be a class D road. Second, the group 2 vehicles are 100/2,000 or 5 percent of the total of groups 1 and 2, making this category II traffic. Therefore, the appropriate design index from table 3-1 is 2.

Table 3-1. Pavement Design Index

Traffic Category	Pavement Design Index for Road or Street Classification					
	A	B	C	D	E	F
I	2	2	2	1	1	1
II	3	2	2	2	2	1
III	4	4	4	3	3	2
IV	5	5	5	4	4	3
IVA	6	6	6	5	5	4
V (60-kilopound (kip) track-laying vehicles or 15 kip forklifts)	7	7	7	7	7	(*)
500/day	6	6	6	6	6	(*)
200/day	6	6	6	6	6	(*)
100/day	6	6	6	6	6	6
40/day	6	6	6	5	5	5
10/day	5	5	5	5	5	5
4/day	5	5	5	5	4	4
1/day	5	5	5	4	4	4
VI (90-kip track-laying vehicles or 25 kip forklifts)						
200/day	9	9	9	9	9	(*)
100/day	8	8	8	8	8	8
40/day	7	7	7	7	7	7
10/day	6	6	6	6	6	6
4/day	6	6	6	6	6	6
1/day	5	5	5	5	5	5
1/week	5	5	5	4	4	4
VII (120-kip track laying vehicles):						
100/day	10	10	10	10	10	10
40/day	9	9	9	9	9	9
10/day	8	8	8	8	8	8
4/day	7	7	7	7	7	7
1/day	6	6	6	6	6	6
1/week	5	5	5	5	5	5

* Traffic limited to 100 vehicles per day.

(1) *Tracked vehicles and forklift trucks.* Provision is made whereby the designer may determine pavement design requirements for tracked vehicles or forklifts in combination with traffic by pneumatic-tired vehicles or for traffic by tracked vehicles or forklifts only. Where pneumatic-tired vehicles, forklifts, and tracked vehicles are to be considered, the proper letter classification of the road or street is determined from TM 5-822-2/AFM 88-7, Chapter 5 according to the total volume of traffic from all types of vehicles. In table 3-1 the traffic for categories V, VI, and VII has been

fore the reduction Will be affected in the subbase course immediately above the subgrade. when only limited rainfall records are available, or the annual precipitation is close to the 15-inch criterion, careful consideration will be given to the sensitivity of the subgrade to small increases in moisture content before any reduction in thickness is made.

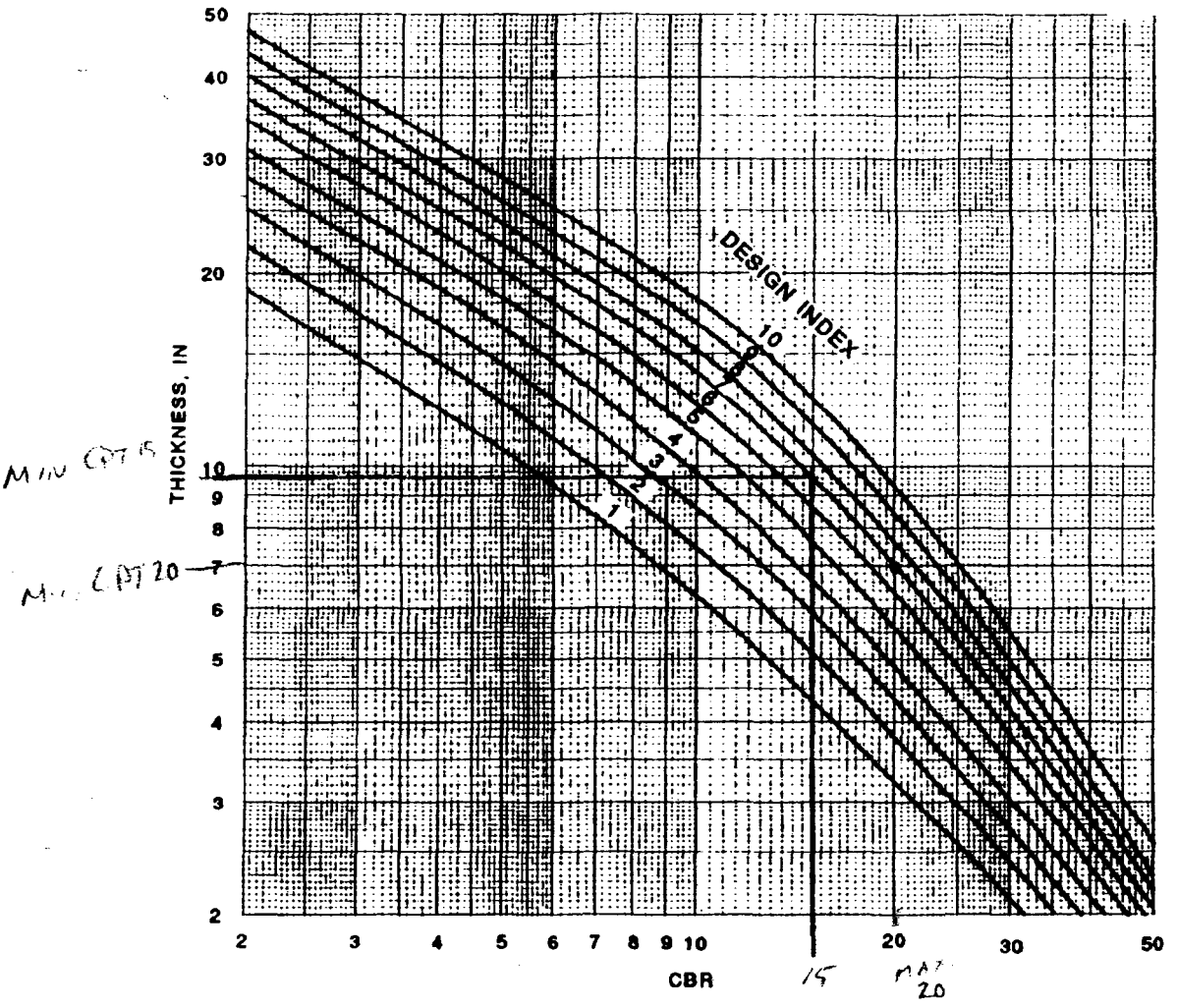


Figure 8-1. Flexible Pavement Design Curve for Roads and Streets.

8-5. Example Thickness Design-Conventional Flexible Pavements.

This example illustrates design by the CBR method when the subgrade, subbase, or base course materials are not affected by frost. Assume that a design is to be prepared for a road that will require a design index of 5. Further assume that compaction requirements will necessitate an increase in subgrade density to a depth of 9 inches below the subgrade surface and that a soft layer occurs within the subgrade 24 inches below the subgrade surface. The CBR design values of the various subgrade layers and the materials available for subbase and base course construction are as follows:

Table 6-1. Minimum Thickness of Pavement and Base Course.

	Minimum Base Course CBR								
	100			80			50*		
Design index	Pavement in.	Base in.	Total in.	Pavement in.	Base in.	Total in.	Pavement in.	Base in.	Total in.
1	ST**	4	4-1/2†	MST††	4	4-1/2†	2	4	6
2	MST††	4	5†	1-1/2	4	5-1/2†	2-1/2	4	6-1/2
3	1-1/2	4	5-1/2†	1-1/2	4	5-1/2†	2-1/2	4	6-1/2
4	1-1/2	4	5-1/2†	2	4	6	3	4	7
5	2	4	6	2-1/2	4	6-1/2	3-1/2	4	7-1/2
6	2-1/2	4	6-1/2	3	4	7	4	4	8
7	2-1/2	4	6-1/2	3	4	7	4	4	8
8	3	4	7	3-1/2	4	7-1/2	4-1/2	4	8-1/2
9	3	4	7	3-1/2	4	7-1/2	4-1/2	4	8-1/2
10	3-1/2	4	7	4	4	8	5	4	9

* In general 50-CBR base course will only be used for classes E and F roads and streets.

** Bituminous surface treatment (spray application).

† Minimum total thickness of pavement plus base for classes A through D roads and streets will be 6 inches.

†† Multiple bituminous surface treatment (spray application).

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY GMT DATE MARCH 23/2002 GT SHEET 7 OF 8

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT NE-USACE/EPA

PROJECT NBH

SUBJECT PAVEMENT DESIGN

(B) OFFSHORE STABILIZED FILL

PREVIOUS TESTING INDICATED AN UNCONFINED COMPRESSIVE STRENGTH OF APPROXIMATELY 200 psi LIKELY > CBR 15.
ASSUME CBR ≥ 15

THICKNESS DESIGN. USACE S-822-5

(C) FOR CBR 15 AND DESIGN INDEX 7.

FIGURE 2. GIVES. TOTAL THICKNESS OF 10"

(D) TABLE 1 GIVES MIN THICKNESS OF PAVEMENT & BASE COURSE.

FOR CBR 80 FOR BASE COURSE. DESIGN INDEX 7

PT PAVEMENT THICKNESS = 3"

BT BASE THICKNESS = 4"

SUBBASE 3"

CBR 100.
PT = 2½"
BT = 4" → 6½" + 3½" SUBBASE.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY ARMY DATE MARCH 25/02 97 SHEET 8 OF 8

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT NE-USACE/EPA

PROJECT NBH

SUBJECT PAVEMENT DESIGN

HAND CALC SUMMARY.
PAVEMENT X-SECTION :-

AC.	3"	ASPHALT CONCRETE.
BASE	6"	BASE COURSE. SP, SW,

OR

AC	3"	
BASE CBR=80	4"	SANDY
SUBGRADE.	3"	SUBBASE MATERIAL

OR

AC	2½"	
BASE CBR=100	4"	GRAVEL
SUBGRADE.	3½"	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	NE-USACE/EPA					PROJECT:	New Bedford Harbor
SUBJECT:	Asphalt Pavement Design						
BY/DATE:	ARMT	04/01/02					PROJECT NO.: 5197.1720.9302.00010
CHKD/DATE:							CALC NO.:

EXHIBIT 2

PCASE DESIGN SOFTWARE OUTPUT

17/24

FLEXIBLE/RIGID PAVEMENT DESIGN PROGRAM
(ROADS FOR WINDOWS VERSION 1.0a)
(ENGLISH UNITS - Thickness = in)

PROJECT INFORMATION

PROJECT NAME : NBH Pavement
PROJECT INSTALLATION: New Bedford Harbor
PROJECT COMMENTS : Flexible Pavement Design for Dewatering Facility

DESIGN INFORMATION

DESIGN ID : Design A
DESIGN DESCRIPTION : Pavement layers over prepared subgrade
DESIGN TYPE : Flexible
TYPE OF SUBGRADE MATERIAL: COHESIONLESS FILL PI <= 5 AND LL <= 25
FROST PENETRATION, in. : 0.0

TRAFFIC INFORMATION

	Avg Daily Traffic	Effective ADT	Terrain: Flat (2.0)	
Group 1	0			
Group 2	0			
Group 3	50	100	Category	Design Index
Subtotal	50	100	IVA	5
Tracked (40k-60k)	0		V	
Tracked (60k-90k)	0		VI	
Tracked (90k-120k)			VII	
Total	50	100		
		X 12 %		
Design Hourly Vehicles (DHV) =		12	Class: E Lanes: 2 DI: 5	

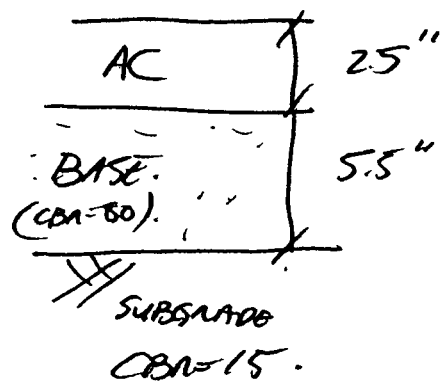
Non-Frost

Layer No.	Layer Type	Thick	CBR	Frost Code	Frost CBR	Eqv Subb	Cumul Subb	Thk Mins	Calc Thick
1	PA-AC	2.50				2.50		2.50	0.50
2	BA-CRST	5.50	80.0	F0		5.50	2.50	4.00	5.50
3	SB-GRAN		15.0	F1	9.0		8.00		

Compaction Requirement

Layer Type	Compaction	From	To	Thickness

PCASE DESIGN SOFTWARE
DI = 5



16/29

FLEXIBLE/RIGID PAVEMENT DESIGN PROGRAM
(ROADS FOR WINDOWS VERSION 1.0a)
(ENGLISH UNITS - Thickness = in)

PROJECT INFORMATION

PROJECT NAME : NBH Pavement
PROJECT INSTALLATION: New Bedford Harbor
PROJECT COMMENTS : Flexible Pavement Design for Dewatering Facility

DESIGN INFORMATION

DESIGN ID : Design A
DESIGN DESCRIPTION : Pavement layers over prepared subgrade
DESIGN TYPE : Flexible
TYPE OF SUBGRADE MATERIAL: COHESIONLESS FILL PI <= 5 AND LL <= 25
FROST PENETRATION, in. : 0.0

TRAFFIC INFORMATION

	Avg Daily Traffic	Effective ADT	Terrain: Flat (2.0)	
Group 1	0			
Group 2	0			Design Index
Group 3	50	100	Category	
Subtotal	50	100	IVA	5
Tracked (40k-60k)	0		V	
Tracked (60k-90k)	0		VI	
Tracked (90k-120k)			VII	
Total	50	100		
		X 12 %		
Design Hourly Vehicles (DHV) =		12	Class: E	Lanes: 2 DI: 5

Non-Frost

Layer No.	Layer Type	Thick	CBR	Frost Code	Frost CBR	Eqv Subb	Cumul Subb	Thk Mins	Calc Thick
1	PA-AC	2.50				2.50		2.50	0.50
2	BA-CRST	9.00	80.0	F0		9.00	2.50	4.00	9.00
3	SB-GRAN		10.0	F1	9.0		11.50		

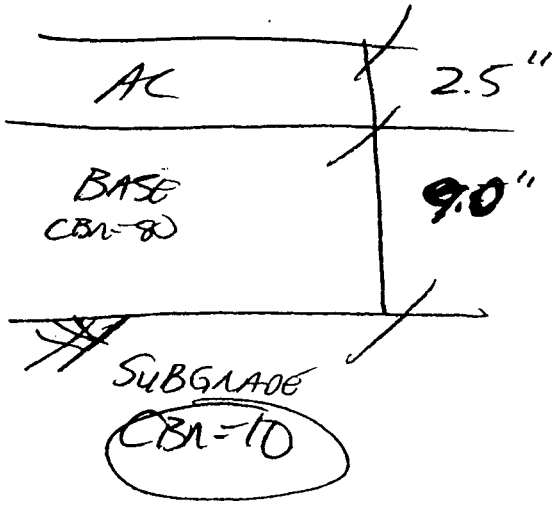
Compaction Requirement

Layer Type	Compaction	From	To	Thickness

PCASE DESIGN SOFTWARE

DI = 5

CBR = 10



(9/24

FLEXIBLE/RIGID PAVEMENT DESIGN PROGRAM
(ROADS FOR WINDOWS VERSION 1.0a)
(ENGLISH UNITS - Thickness = in)

PROJECT INFORMATION

PROJECT NAME : NBH Pavement
PROJECT INSTALLATION: New Bedford Harbor
PROJECT COMMENTS : Flexible Pavement Design for Dewatering Facility

DESIGN INFORMATION

DESIGN ID : Design A
DESIGN DESCRIPTION : Pavement layers over prepared subgrade
DESIGN TYPE : Flexible
TYPE OF SUBGRADE MATERIAL: COHESIONLESS FILL PI <= 5 AND LL <= 25
FROST PENETRATION, in. : 0.0

TRAFFIC INFORMATION

	Avg Daily Traffic	Effective ADT	Terrain: Flat (2.0) Category	Design Index
Group 1	0			
Group 2	0			
Group 3	0			
Subtotal			IVA	
Tracked (40k-60k)	50	100	V	6
Tracked (60k-90k)	0		VI	
Tracked (90k-120k)			VII	
Total	50	100		
		X 12 %		
Design Hourly Vehicles (DHV) =		12	Class: E	Lanes: 2 DI: 6

Non-Frost

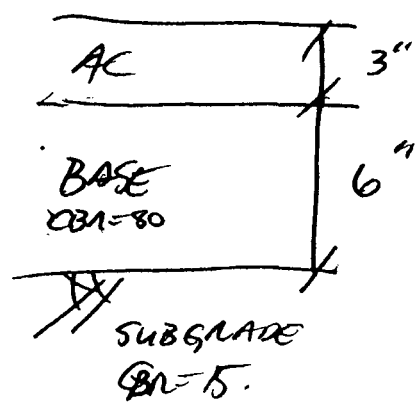
Layer No.	Layer Type	Thick	CBR	Frost Code	Frost CBR	Eqv Subb	Cumul Subb	Thk Mins	Calc Thick
1	PA-AC	3.00				3.00		3.00	0.50
2	BA-CRST	6.00	80.0	F0		6.00	3.00	4.00	6.00
3	SB-GRAN		15.0	F1	9.0		9.00		

Compaction Requirement

Layer Type	Compaction	From	To	Thickness

PCASE DESIGN SOFTWARE.

DI = 6



20/21

FLEXIBLE/RIGID PAVEMENT DESIGN PROGRAM
(ROADS FOR WINDOWS VERSION 1.0a)
(ENGLISH UNITS - Thickness = in)

PROJECT INFORMATION

PROJECT NAME : NBH Pavement
PROJECT INSTALLATION: New Bedford Harbor
PROJECT COMMENTS : Flexible Pavement Design for Dewatering Facility

DESIGN INFORMATION

DESIGN ID : Design A
DESIGN DESCRIPTION : Pavement layers over prepared subgrade
DESIGN TYPE : Flexible
TYPE OF SUBGRADE MATERIAL: COHESIONLESS FILL PI <= 5 AND LL <= 25
FROST PENETRATION, in. : 0.0

TRAFFIC INFORMATION

	Avg Daily Traffic	Effective ADT	Terrain: Flat (2.0)	
Group 1	0			
Group 2	0			Design
Group 3	0		Category	Index
Subtotal			IVA	
~~Tracked (40k-60k)~~	50	100	V	6
Tracked (60k-90k)	20	40	VI	7
Tracked (90k-120k)			VII	
Total	70	140		
		X 12 %		
Design Hourly Vehicles (DHV) =		17	Class: E	Lanes: 2 DI: 7

Non-Frost

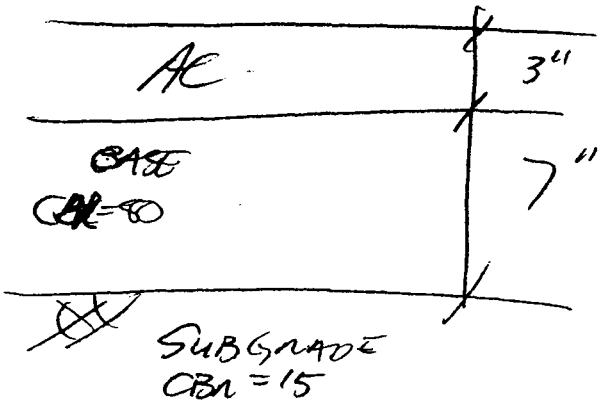
Layer No.	Layer Type	Thick	CBR	Frost Code	Frost CBR	Eqv Subb	Cumul Subb	Thk Mins	Calc Thick
1	PA-AC	3.00				3.00		3.00	0.50
2	BA-CRST	7.00	80.0	F0		7.00	3.00	4.00	7.00
3	SB-GRAN		15.0	F1	9.0		10.00		

Compaction Requirement

Layer Type	Compaction	From	To	Thickness

PCASE DESIGN SOFTWARE

DI = 7



FLEXIBLE/RIGID PAVEMENT DESIGN PROGRAM
(ROADS FOR WINDOWS VERSION 1.0a)
(ENGLISH UNITS - Thickness = in)

PROJECT INFORMATION

PROJECT NAME : NBH Pavement
PROJECT INSTALLATION: New Bedford Harbor
PROJECT COMMENTS : Flexible Pavement Design for Dewatering Facility

DESIGN INFORMATION

DESIGN ID : Design A
DESIGN DESCRIPTION : Pavement layers over prepared subgrade
DESIGN TYPE : Flexible
TYPE OF SUBGRADE MATERIAL: COHESIONLESS FILL PI <= 5 AND LL <= 25
FROST PENETRATION, in. : 0.0

TRAFFIC INFORMATION

	Avg Daily Traffic	Effective ADT	Terrain: Flat (2.0)	
Group 1	0			
Group 2	0			Design Index
Group 3	0		Category	
Subtotal			IVA	
Tracked (40k-60k)	0		V	
Tracked (60k-90k)	50	100	VI	8
Tracked (90k-120k)			VII	
Total	50	100		
		X 12 %		
Design Hourly Vehicles (DHV) =		12	Class: E	Lanes: 2 DI: 8

Non-Frost

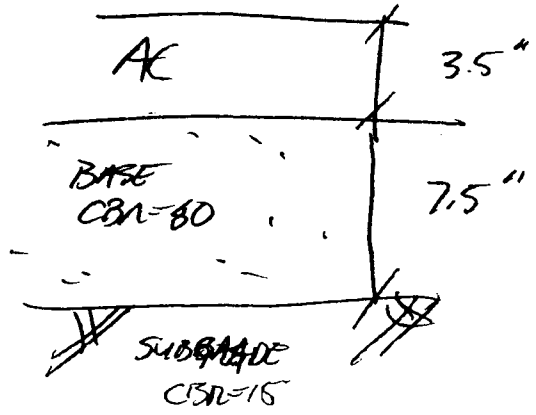
Layer No.	Layer Type	Thick	CBR	Frost Code	Frost CBR	Eqv Subb	Cumul Subb	Thk Mins	Calc Thick
1	PA-AC	3.50				3.50		3.50	1.00
2	BA-CRST	7.50	80.0	F0		7.50	3.50	4.00	7.50
3	SB-GRAN		15.0	F1	9.0		11.00		

Compaction Requirement

Layer Type	Compaction	From	To	Thickness

PCASE DESIGN SOFTWARE

DI=8



ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 9

PROJECT New Bedford Harbor-Dewatering Facility SUBJECT PARKING CALCULATIONS

CLIENT USACE

CALCULATION NO. C-04 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER DANIEL K. MAHER

REVIEWED BY _____ DATE 9-15-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES X NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DAN E. MAHER DATE _____ SHEET 2 OF 9

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR - MECHANICAL DEWATERING FACILITY

SUBJECT PARKING CALCULATIONS

DETERMINE MINIMUM PARKING REQUIREMENTS

(USE-1) MECHANICAL DEWATERING FACILITY

MAIN BUILDING = 53,550 GROSS SQ. FT

SUPPORT BUILDING = 2,700 GSF

TOTAL AREA = 56,250 GSF

(USE-2) OFFICE TRAILER (2) = 720 GSF (EACH)

TOTAL AREA = 1,440 GSF

NUMBER OF PARKING SPACES REQUIRED SHALL BE DETERMINED BY THE ZONING LAWS OF THE CITY OF NEW BEDFORD, SEC. 9-207A, "OFF-STREET PARKING AND OFF-STREET LOADING REGULATIONS"

MINIMUM PARKING REQUIREMENTS FOR USE OF LAND ARE GIVEN IN TABLE 1 (ATTACHED)

(1) PROPOSED MECHANICAL DEWATERING FACILITY (USE-1) IS LOCATED IN A WATERFRONT INDUSTRIAL DISTRICT AND PRIMARY USE IS FOR TRANSPORTATION AND DISPOSAL OR DISTRIBUTION OF MATERIALS, THEREFORE ASSUME PARKING REQUIREMENTS, BY TABLE 1, ARE THE FOLLOWING:

- ONE (1) SPACE PER 1500 SF OF GROSS FLOOR AREA UP TO 15,000 SF
- THEREAFTER, ONE (1) ADDITIONAL SPACE FOR EACH 5,000 SF OR PORTION THEREOF IN EXCESS OF 15,000 SF
- PLUS ONE (1) SPACE FOR EACH VEHICLE UTILIZED IN THE BUSINESS

MIN. PARKING REQUIREMENTS (CONT'D)

▶ USE-1 MINIMUM REQUIRED PARKING SPACES

GROSS SF	REQUIREMENT	SPACES
15,000	1 PER 1,500	10
38,550	1 PER 5,000	8 (7.71)
53,550		18 TOTAL

* NO VEHICLES UTILIZED IN THE BUSINESS ARE PLANNED TO BE PARKED ON-SITE.

(2) OFFICE TRAILERS ARE FOR GENERAL OFFICE USE. ASSUME MIN. PARKING REQ., BY TABLE 1, ARE THE FOLLOWING:

- ONE (1) SPACE PER EACH 200 GSF

▶ USE-2 MINIMUM REQUIRED PARKING SPACES

GROSS SF	REQUIREMENT	SPACES
1,440	1 PER 200	7 (7.2)
1,440		7 TOTAL

MINIMUM REQUIRED SPACES = 25

STALL SIZE = 9' × 20'

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DRM DATE _____ SHEET 4 OF 9

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR MECHANICAL DEWATERING FACILITY

SUBJECT PARKING CALCULATIONS

DETERMINE FUNCTIONAL PARKING REQUIREMENT

MINIMUM REQUIREMENT WILL BE CHECKED TO MEET FUNCTIONAL REQUIREMENTS OF ACTUAL STAFF ON-SITE

ASSUME: NUMBER OF STAFF PER SHIFT = 15-20
NUMBER OF SHIFTS PER DAY = 2

- MINIMUM PARKING REQUIREMENT IS ADEQUATE TO SERVE ONE SHIFT AT THE FACILITY.

- NUMBER OF SPACES SHOULD BE INCREASED TO PREVENT EXTENDED CIRCULATION IN THE LOT AT SHIFT CHANGES, SINCE THE LOT WOULD BE NEAR CAPACITY AT THE MINIMUM REQUIRED OF 25 SPACES.

ASSUME A MAXIMUM OF 2 TIMES THE STAFF REQUIRED FOR ONE SHIFT FOR THE NUMBER OF SPACES REQUIRED. = 20 x 2 = 40 SPACES.

SOLUTION: NUMBER OF SPACES SHALL BE INCREASED UP TO A MAXIMUM OF 40 SPACES AS SITE DESIGN ALLOWS. NUMBER OF SPACES PROVIDED SHALL NOT EXCEED 40 SPACES.

ATTACHMENTS: NEW BEDFORD CODE SEC. 9-207A

5/9

Sec. 9-207A. Off-street parking and off-street loading regulations.

(A) *Applicability of regulations.*

(1) Every building erected, enlarged, converted, relocated or changed and each use of land shall be provided with off-street parking spaces and off-street loading spaces in accordance with their use as set forth in this section, "Table I, Schedule Off-Street Parking and Off-Street Loading Regulations," following:

TABLE I

Schedule of Off-Street Parking and Off-Street Loading Facilities

Use	*Parking Requirement*	*Off-Street Loading Requirements*
One-family dwelling Two-family dwelling *Multifamily (3) or more per structure)*	Two (2) spaces per dwelling unit Two (2) spaces per dwelling unit One and one-half (1.5) spaces per dwelling unit	One (1) loading space for each multi-family dwelling containing more than ten (10) dwelling units, or more than twenty (20) housekeeping units
Hotel, motel, rooming, boarding, lodging or tourist home dormitories or other non-family residence accommodations	One (1) space per guest room	One (1) loading space for each building containing more than 20 guest rooms
OFFICE & TRAILERS Offices: General, professional, business, banks, medical clinics and laboratories, radio and television stations; offices of non-profit educational, cultural, or charitable organizations	One (1) space per each 200 sq. ft. of gross floor area but not less than two (2) spaces for each business unit intended to occupy the premises	One (1) loading space for each building containing 10,000 sq. ft. or more of gross floor area. Two (2) loading spaces for 100,000 sq. ft. or more of gross floor area
Fast-food, drive-in, carry-out restaurants	One (1) space per each full-time employee per shift for a minimum of five (5) spaces plus one (1) space per 100 sq. ft. of gross floor area	One (1) loading space for each building
Businesses engaged in retail sale of goods and services, not elsewhere enumerated herein	One (1) space per each 200 sq. ft. of gross floor area, but not less than two (2) spaces for each business use intended to occupy the premises	One (1) loading space for each building containing more than 5,000 and less than 10,000 sq. ft. of gross floor area. Thereafter, one (1) additional loading space shall be required for each additional 25,000 sq. ft. of gross floor area
Businesses engaged in the retail sale, rental, repair, servicing, storage and distribution of motor vehicles, trailers, campers, boats, furniture or building materials	One (1) space per each 400 sq. ft. of gross floor area, but not less than two (2) spaces for each business use intended to occupy the premises	

Use	*Parking Requirement*	*Off-Street Loading Requirements*
Hospital, convalescent homes, nursing homes, rest homes or homes for the aged	One (1) space per three (3) beds	One (1) loading space for each building containing 10,000 sq. ft. or more of gross floor area. Two (2) loading spaces for buildings containing 100,000 sq. ft. or more of gross floor area
Places of assembly, including theatres, veterans, faternal, social and recreational clubs and organizations not operated for a profit; facilities primarily for the education and instruction of persons 16 yrs. of age and older; taxi, bus & railroad passenger terminals; auditoriums, theatres, bowling alleys and dance halls; sports facilities; places of worship; funeral homes	One (1) space per five (5) seats for which the building is designed or one (1) space for each 200 sq. ft. of gross floor area whichever results in the greatest number	
Businesses engaged in the manufacturing, processing, assembly, fabrication of products, including research and testing laboratories and facilities	One (1) space per each 350 sq. ft. of gross floor area plus one (1) space for each vehicle used in conducting the business	Two (2) loading spaces for each building containing 10,000 sq. ft. of gross floor area. Thereafter, one (1) additional loading space shall be required for each additional 25,000 sq. ft. of gross floor area or for each fifteen (15) feet of dock, platform or opening in the building where the loading or unloading of commodities is intended to occur, whichever is the greatest
Businesses engaged in the warehousing and distribution of goods & materials including building and construction contractors, equipment & supplies on the premises, motor freight terminal, facilities for storing & servicing of motor vehicles used in conducting a business or public transportation, industrial machinery & equipment, grain, petroleum products & junkyards	One (1) space per 1500 sq. ft. of gross floor area up to 15,000 sq. ft. Thereafter, one (1) additional space for each 5,000 sq. ft. or portion thereof in excess of 15,000 sq. ft., plus one (1) space for each vehicle utilized in the business	

(2) In the event of the enlargement of a structure existing on the effective date of the ordinance from which this section is derived, or the construction or relocation of additional structures on a lot, after such effective date, the regulations of this section shall apply only to the enlargement, construction or relocation thereof, except that any off-street parking and off-street loading facilities established to serve any buildings and any uses prior to such effective date shall not be reduced below the required number.

(3) For a building or premises used for combined purposes, the number of off-street parking spaces and off-street loading spaces shall be determined as the sum of the required number of spaces in each component of the combined use.

(4) Where the computation of required parking spaces and loading spaces result in a fractional number, only the fraction of one-half (½) or more shall be counted as one.

(B) *Location and layout of off-street parking and off-street loading facilities.* Off-street parking spaces and off-street loading spaces shall be provided in structures or in open air, and shall be subject to the following regulations pertaining to their layout and location:

(1) Parking spaces shall be located on the same lot as the building or use where they are intended to serve, except that they may be provided on an adjoining lot in the same ownership. Where parking space for less than five (5) vehicles is to be provided for in the form of a driveway on a lot, there shall be a side yard of at least four (4) feet between the side lot line and the parts of the driveway nearest to such lot line.

Where parking space for one (1) or two (2) vehicles is to be provided for in the form of a driveway on a lot, the improved surface may be extended to one (1) foot of the side line.

Where parking space for three (3) or four (4) vehicles is to be provided for in the form of a driveway on a lot, the improved surface or parts of the improved surface shall not extend to within four (4) feet of the side line, and the parking of vehicles shall not take place on any part of the required front yard.

(2) If five (5) or more parking spaces are required by ordinance, and the board of appeals of the city has determined that the rule set forth in the preceding paragraph (1) of subsection (B) cannot be complied with, then parking spaces can be located on a lot in the same ownership within two hundred (200) feet of the building or lot they are intended to serve.

(3) The number of required parking spaces on a lot can be reduced, subject to the approval of the board of appeals, if the lot is located on a block which has within its boundaries a municipally-owned public parking facility, or on a lot which is located within five hundred (500) feet of a municipally-owned parking facility on an adjacent block. In either case, the total number of parking spaces included in the public parking facility cannot be exceeded by the total number of off-street parking spaces required for all the buildings and uses within five hundred (500) feet of the facility.

(4) A parking space shall be a rectangle at least eight and one-half (8½) feet by twenty (20) feet exclusive of any required drive or aisle. In parking lots where more than fifty (50) spaces are required by ordinance, as many as thirty (30) per cent of the total number of spaces required may be sized especially for compact cars.

(5) Specially designated parking spaces for the physically handicapped shall be provided in accordance with the rules and regulations of the Architectural Barriers Board, Commonwealth of Massachusetts, Department of Public Safety; except that the following shall be exempted:

(a) Residential structures with less than twenty (20) units.

(b) Businesses engaged in the manufacturing, processing, assembly, fabrication of products, including research and testing laboratories and facilities.

(c) Businesses engaged in the warehousing and distribution of goods and materials including building and construction contractors, equipment and supplies on the premises, motor-freight terminal, facilities for storing and servicing of motor vehicles used in conducting a business or for public transportation, industrial machinery and equipment, grain, petroleum products and junkyards.

(6) Where a drive or aisle, other than a street, is required to maneuver a vehicle into or out of a parking space, such drive or aisle shall be at least twenty-two (22) feet wide for parking spaces situated at right-angles, or nearly right-angles to the aisle. For parking spaces situated at an angle of thirty (30) to sixty (60) degrees to the aisle, the required width of the aisle shall be at least fifteen (15) feet.

(7) Open-air off-street parking facilities may be located in required front, rear and side yards; except that in a residential district, no open-air off-street parking space shall be located in a required front yard closer than five (5) feet from any property line.

(8) When five (5) or more parking spaces are required on a lot, the provisions of section 9-207(2) shall apply.

(9) Where five (5) or more parking spaces are required on a lot, all spaces shall be laid out so that vehicles can enter or leave any parking space directly from a drive or aisle other than a street. Additionally, all spaces shall be laid out so the vehicles entering a street may do so facing the street.

(10) Buildings on contiguous lots may be provided with common off-street parking facilities subject to approval by the board of appeals.

(11) The area of required off-street loading space is not to be included as off-street parking space in the computation of required off-street parking space.

(12) All parking spaces and loading areas or berths in the open-air and the access drives or aisles, shall be provided with a permanent dust-free surface such as concrete, asphalt or compacted gravel or stone, which will permit travel in all weather.

(13) No off-street loading areas or berths shall be laid out in such a manner as will result in loading or unloading being carried on within a street right-of-way or other public property. Each area or berth shall be sufficient size as to accommodate the largest expected truck or tractor trailer common to the building use.

The requirements of (1) through (13) aforementioned shall be considered minimum requirements and are not intended to prohibit provisions of more or larger spaces than

required consistent with other provisions of this article. (Code 1963, § 9-207A; Ord. of 10-28-65, § 1; Ord. of 4-14-66, § 1; Ord. of 11-22-66, § 1; Ord. of 8-15-74, § 1; Ord. of 9-25-80, § 1; Ord. of 2-8-90, §§ 1, 2; Ord. of 10-25-90, § 1; Ord. of 12-20-90, § 1)

Sec. 9-207B. Trailers and trailer parks.

No "trailer" shall be occupied for dwelling or sleeping purposes within any residential district, nor shall more than one trailer be parked, stored or located on any lot in a residential district. A "trailer" or a "trailer camp or park" may be permitted to locate within any district other than a residential district provided a special permit for such use is granted by the city council in accordance with the provisions of section 9-207C. (Code 1963, § 9-207B; Ord. of 4-14-66, § 1)

Sec. 9-207C. Special permit procedure.

Before granting a special permit the city council shall hold a public hearing thereon; notice of time and place of such hearing and the subject thereof, sufficient for identification shall be published in a newspaper of general circulation in the City of New Bedford once in each of two (2) successive weeks, the first publication to be not less than fourteen (14) days before the day of hearing and, also, notice of said hearing shall be sent by mail, postage prepaid, to the petitioner and to the owners of all property deemed by the city council to be affected thereby as they appear on the most recent local tax list and to the planning board. In granting any special permit provided for in this chapter the city council may issue said special permit subject to such appropriate conditions and safeguards as in its discretion will make an excepted use harmonious with the general purpose and intent of this chapter. No special permit shall be granted under this section except by a two-thirds (2/3) vote of all of the members of the city council. (Code 1963, § 9-207C; Ord. of 4-14-66, § 2; Ord. of 11-22-66, § 2)

Sec. 9-207D. Special permit for club, etc. use.

No building or buildings shall be used for club, lodge, social or community center purposes within any district, unless a special permit for such use is granted by the city council in accordance with the provisions of section 9-207C of this chapter. (Code 1963, § 9-207D; Ord. of 11-22-66, § 1; Ord. of 8-19-82, § 1)

Sec. 9-207E. Keeping unregistered motor vehicles, junk motor vehicles, motor vehicle parts.

No person or entity, corporate or otherwise, as owner or as one in control of premises situated within the limits of the City of New Bedford shall keep in the open on said premises more than one unregistered motor vehicle and shall not keep a wrecked or partially dismantled motor vehicle or junk motor vehicle or motor vehicle parts thereon except as hereinafter provided. This restriction shall apply to "stock racing cars" so-called.

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 27

PROJECT New Bedford Harbor-Dewatering Facility SUBJECT HANDICAPPED ACCESSIBILITY

CLIENT USACE

CALCULATION NO. C-05 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS ___ YES X NO PREPARER DANIEL R. MAHER

REVIEWED BY [signature] DATE 9-15-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES X NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 2 OF 27

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR MECHANICAL DEWATERING FACILITY

SUBJECT HANDICAPPED ACCESS

DETERMINE HANDICAPPED ACCESSIBILITY

PROVISION FOR HANDICAPPED ACCESSIBLE PARKING SHALL BE PROVIDED IN ACCORDANCE WITH THE FOLLOWING:

(1) ZONING LAWS OF THE CITY OF NEW BEDFORD (SEC. 9-207A(B)(5))

(2) RULES AND REGULATIONS OF THE ARCHITECTURAL ACCESS BOARD (ABB), COMMONWEALTH OF MASS., DEPARTMENT OF PUBLIC SAFETY (521 CMR)

- THE MECHANICAL DEWATERING FACILITY SHALL BE CONSIDERED EXEMPT FROM THESE REQUIREMENTS UNDER SEC. 9-207A(B)(5)(c).

- THE SUPPORT FACILITY WAS DESIGNED FOR HANDICAPPED ACCESSIBILITY UNDER TITLE III OF THE AMERICANS WITH DISABILITIES ACT (ADA)(42 U.S.C. 12181. HANDICAPPED ACCESSIBILITY SHALL BE PROVIDED FOR THIS FACILITY AND FOR THE OFFICE SUPPORT TRAILERS IN ACCORDANCE WITH (521 CMR)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY [illegible] DATE _____ SHEET 3 OF 27

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR MECHANICAL DEWATERING FACILITY

SUBJECT PARKING CALCULATIONS

DETERMINE HANDICAPPED ACCESSIBILITY (CONT'D)

- FIND NUMBER OF SPACES REQUIRED

TOTAL SPACES IN LOT SHALL BE PROVIDED FOR UP TO 40 STALLS.

TWO (2) ACCESSIBLE SPACES SHALL BE PROVIDED (BY, 521 CMR 23.2.1)

ONE (1) OF THESE SPACES SHALL BE VAN ACCESSIBLE (BY, 521 CMR 23.2.2)

NOTE: LOCATION, PARKING SPACE, SIDEWALKS AND SIGNAGE SHALL MEET THE APPLICABLE REQUIREMENTS OF (521 CMR 23)

ATTACHMENTS:

521 CMR 20 ACCESSIBLE ROUTES
521 CMR 21 CURB CUTS
521 CMR 22 WALKWAYS
521 CMR 23 PARKING
521 CMR 25 ENTRANCES
521 CMR 41 SIGNAGE

A/27

20.1 GENERAL

An *accessible route* shall provide a continuous unobstructed path connecting *accessible spaces* and *elements* inside and outside a *facility*. *Accessible routes* may include but are not limited to *walks*, halls, corridors, aisles, skywalks, and tunnels. *Accessible routes* may not include stairs, steps, or escalators, even if the stairs and steps are required to be *accessible* under 521 CMR.

20.2 LOCATION

Within the boundary of the *site*, an *accessible route(s)* shall be provided from *accessible* parking, *accessible* passenger loading zones, and public streets or *sidewalks* to the *accessible building entrance* they serve. The *accessible route(s)* shall coincide with the route for the general public.

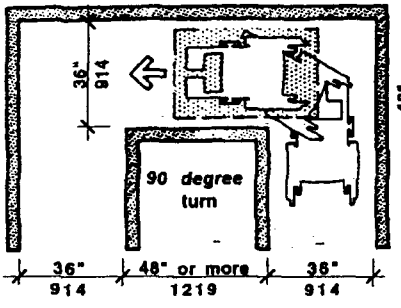
20.2.1 At least one *accessible route* shall connect *accessible buildings, facilities, elements* and *spaces* that are on the same *site*.

20.3 WIDTH

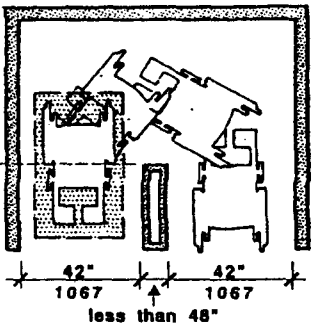
An *accessible route* shall have a minimum *clear* width of 36 inches (36" = 914 mm) except at doors and at openings less than 24 inches (24" = 610mm) deep where it shall comply with **521 CMR 26, DOORS AND DOORWAYS**.

20.4 TURNS

If a person in a wheelchair must make a turn around an obstruction, the minimum *clear* width of the *accessible route* shall comply with **Fig. 20a or 20b**.



Minimum Clearances for Turning
Figure 20a



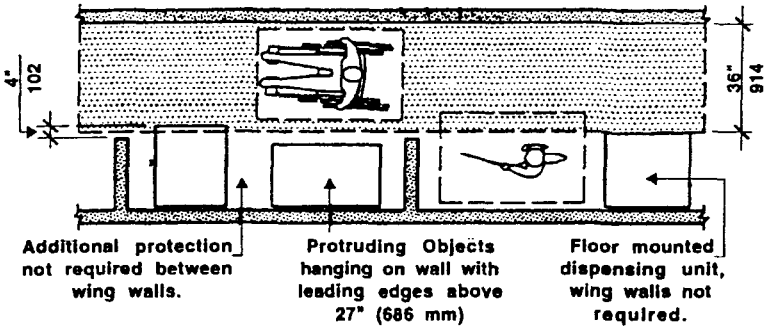
Minimum Clearances for Turning
Figure 20b

20.5 PASSING SPACE

If an *accessible route* has less than 60 inches (60" = 1524mm) *clear* width, then passing *spaces* at least 60 inches by 60 inches (60" x 60" = 1524mm by 1524mm) shall be located at intervals not to exceed 200 feet (200' = 61m). A T-intersection of two corridors or walks is an acceptable passing place.

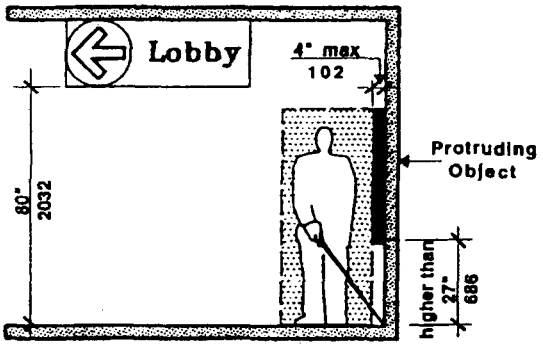
20.6 PROTRUDING OBJECTS

Objects shall not reduce the *clear* width of an *accessible route* or maneuvering *space* (see **Fig. 20c**) and must comply with **521 CMR 20.6.1**.



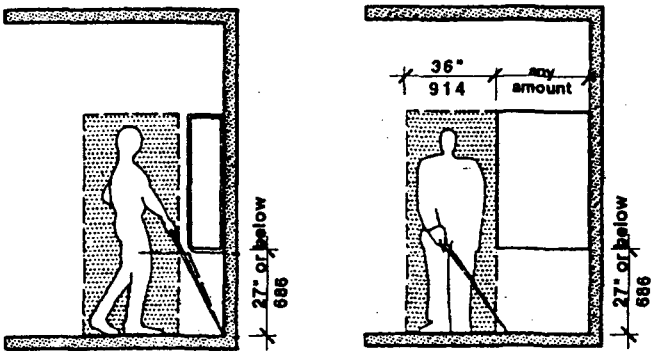
Protruding Objects
Figure 20c

20.6.1 Objects projecting from walls (for example, telephones) with their leading edges between 27 inches and 80 inches (27" and 80" = 686mm and 2032mm) above the finished floor shall protrude no more than four inches (4" = 102mm) into walks, halls, corridors, passageways, or aisles and shall not have sharp or abrupt edges. **See Fig. 20d.**



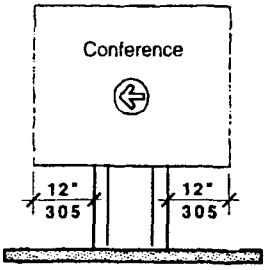
Walking Parallel to a Wall
Figure 20d

20.6.2 Objects mounted with their leading edges at or below 27 inches (27" = 686mm) above the finished floor may protrude any distance as long as they do not reduce the *accessible route* below 36 inches (36" = 914mm). **See Fig. 20e.**



Walking Perpendicular to a Wall Walking Parallel to a Wall
Figure 20e

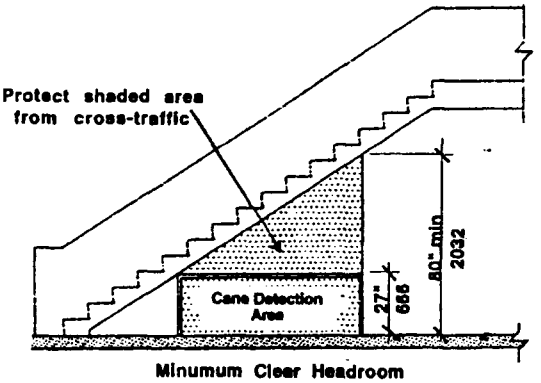
20.6.3 Free-standing objects mounted on posts or pylons may have a maximum overhang of 12 inches (12" = 305mm) measured between 27 inches and 80 inches (27" and 80" = 686mm and 2032mm) above the ground or finished floor. **See Fig. 20f.**



Objects Mounted on Posts or Pylons
Figure 20f

~~20.7~~ HEADROOM

Walks, halls, corridors, passageways, aisles, or other circulation *spaces* shall have a minimum of 80 inches (80" = 2032mm) *clear* headroom. **See Fig. 20d.** If vertical clearance of an area adjoining an *accessible route* is reduced to less than 80 inches (80" = 2032mm), a barrier shall be provided to warn blind or visually-impaired persons of the reduced headroom. **See Fig. 20g.**



Minumum Clear Headroom
Figure 20g

20.8 SURFACE TEXTURES

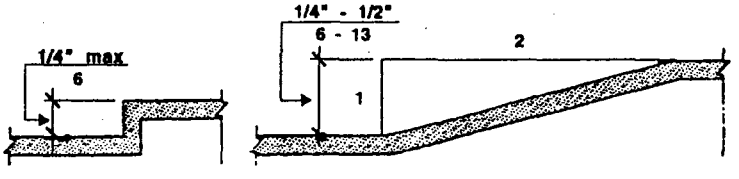
The surface of an *accessible route* shall comply with **521 CMR 29, FLOOR SURFACES.**

20.9 SLOPE AND CROSS SLOPE

An *accessible route* with a *running slope* steeper than 1:20 (5%) is a *ramp* and shall comply with **521 CMR 24, RAMPS**. Nowhere shall the *cross slope* of an *accessible route* exceed 1:50 (2%).

20.10 CHANGES IN LEVELS

Changes in levels along an *accessible route* shall comply with **521 CMR 29.2, Level Changes. See Fig 20h.**



Changes in Level
Figure 20h

20.11 EGRESS

Accessible routes serving any *accessible space* or *element* shall also serve as a *means of egress* for emergencies or connect to an *accessible area of rescue assistance*.

20.12 AREAS OF RESCUE ASSISTANCE

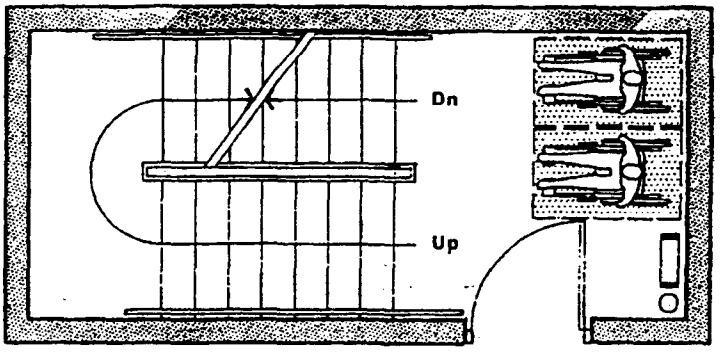
Shall be provided where an *accessible means of egress* is not provided and shall comply with the following requirements:

Exception: *Areas of rescue assistance* are not required in:

a. existing buildings undergoing alterations, remodeling, reconstruction
b. *buildings* or *facilities* having a supervised automatic sprinkler systems
c. tunnels;
d. open air parking garages and open air transit stations

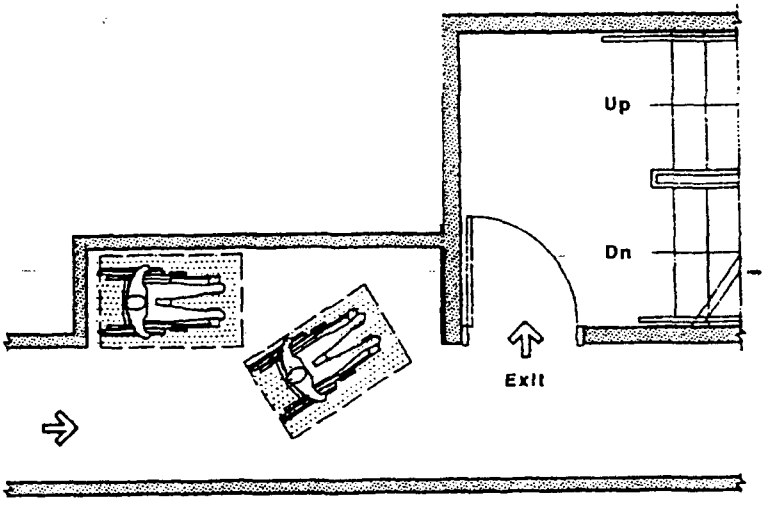
20.12.1 Location and *Construction*: An *area of rescue assistance* shall be one of the following:

a. A portion of a stairway landing within a smokeproof enclosure (complying with applicable requirements of 780 CMR: the State Building Code). **See Fig. 20i.**



Area of Rescue Assistance in Stairway
Figure 20i

b. A portion of an exterior exit balcony located immediately adjacent to an exit stairway when the balcony complies with applicable requirements of 780 CMR: the State Building Code for exterior exit balconies. Openings to the interior of the building located within 20 feet (20' = 6m) of the *area of rescue assistance* shall be protected with fire assemblies having a ¾ hour fire protection rating.
c. A portion of a one hour fire-resistive corridor (complying with applicable requirements of 780 CMR: the State Building Code for fire-resistive construction and for openings) located immediately adjacent to an exit enclosure. **(See Fig. 20j)**



Area of Rescue Assistance in Corridor
Figure 20j

d. A vestibule located immediately adjacent to an exit enclosure and constructed to the same fire-resistive standards controlling corridors and openings.

e. A portion of a stairway landing within an exit enclosure which is vented to the exterior and is separated from the interior of the building with not less than one hour fire-resistive doors.

f. When approved by the appropriate applicable building official, an area or a room that is separated from other portions of the *building* by a smoke barrier. Smoke barriers shall have a fire-resistive rating of not less than one hour and shall completely enclose the area or room. Doors in the smoke barrier shall be tight-fitting smoke- and draft-control assemblies having a fire-protection rating of not less than 20 minutes and shall be self-closing or automatic closing. The area or room shall be provided with an exit directly to an exit enclosure. Where the room or area exits into an exit enclosure which is required to be of more than one hour fire-resistive *construction*, the room or area shall have the same fire-resistive *construction*, including the same opening protection, as required for the adjacent exit enclosure.

g. An elevator lobby where elevator shafts and adjacent lobbies are pressurized as required for smokeproof enclosures by 780 CMR: the State Building Code or 524 CMR: the State Board of Elevator Regulations, and when complying with requirements herein for size, communication, and *signage*. Such pressurization system shall be activated by smoke detectors on each floor located in a manner approved by the appropriate local authority. Pressurization equipment and its duct work within the building shall be separated from other portions of the building by a minimum two-hour fire restrictive construction.

20.12.2 Size: Each *area of rescue assistance* shall provide at least two *accessible* spaces, not less than 30 inches by 48 inches (30" x 48" = 762mm by 1219mm) each.

a. The *area of rescue assistance* shall not encroach on any required exit width.

b. The total number of such 30 inch by 48 inch (30" x 48" = 762mm by 1219mm) areas per *story* shall be not less than one for every 200 persons of calculated occupant load served by the *area of rescue assistance*.

20.12.3 *Stairway* Width: Each *stairway* adjacent to an *area of rescue assistance* shall have a minimum *clear* width of 48 inches (48" = 1219mm) between handrails.

20.12.4 Two-way Communication: A method of two-way communication, with both visible and audible signals, shall be provided between each *area of rescue assistance* and the primary entrance to the *building*. The fire department or appropriate building official may approve a location other than the primary *entrance* to the *building*. Any operable mechanism shall comply with **521 CMR 39, CONTROLS**.

20.12.5 Identification: Each *area of rescue assistance* shall be identified by a sign that states "*area of rescue assistance*" and displays the international symbol of accessibility. The sign shall be illuminated when exit sign illumination is required. *Signage* shall also be installed at all inaccessible exits and where otherwise necessary to clearly indicate the direction to *areas of rescue assistance*. In each *area of rescue assistance*, instructions on the use of the area under emergency conditions shall be posted adjoining the two-way communication system.

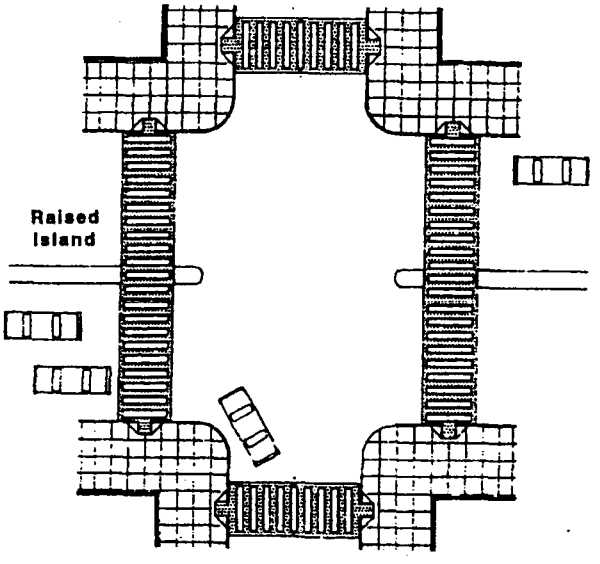
21.1 GENERAL

Whenever *sidewalks*, *walkways*, or curbs on streets and ways are *constructed*, *reconstructed*, or *repaired*, *curb cuts* are required. All *curb cuts* shall comply with the following:

21.2 LOCATION

Curb cuts shall occur wherever an *accessible route* crosses a curb and at the following locations:

21.2.1 *Curb cuts* are required at each corner of each intersection, located within the crosswalk and/or the pedestrian path of travel. *Curb cuts* shall be perpendicular to the curb at street crossings and each shall have a *level* landing at the top. At marked crossings, the bottom of the *ramp* run, exclusive of flared sides, shall be wholly contained with the marked crossing. **See Fig. 21a.** Single (i.e. diagonal or depressed corner) *curb cuts* serving two street crossing directions are not allowed.



Curb Cuts at Intersection
Figure 21a

Exception: Where pedestrian right-of-way established width will not accommodate a perpendicular *curb cut* and landing, a parallel public *sidewalk curb cut* with a *level* landing at its bottom shall be provided instead of a perpendicular *curb cut*.

21.2.2 Reciprocal *curb cuts*: When *curb cuts* or *sidewalks* are being *constructed* or *reconstructed* on one side of the street, and when such *curb cuts* or *sidewalks* are connected to an opposite side of the street by one or more pedestrian paths of travel, then at least one *curb cut* shall be provided on the opposite side of the street where such side is controlled by the same owner.

21.2.3 Driveways: *Curb cuts* are required at driveways intersecting *sidewalks* when the driveway has side curbs.

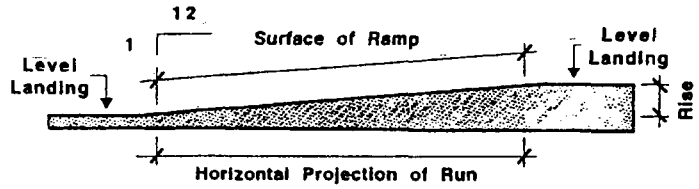
21.2.4 Raised Islands: Any raised islands in crossings shall be cut through *level* with the street or have *curb cuts* at both sides and a *level* area at least 48 inches (48" = 1219mm) long between the *curb cuts* in the part of the island intersected by the crossings.

21.2.5 Obstructions: *Curb cuts* shall be located or protected to prevent their obstruction by parked vehicles.

11/27

21.3 SLOPE

The maximum slope shall be one-in-12 (1:12) (8.3%). Where *sidewalks* are too narrow to install a straight-line *curb cut* at a slope of one-in-12 (1:12) (8.3) the sides of the *curb cut* shall not exceed one-in-12 (1:12) (8.3%). **See Fig. 21b.** The maximum cross-slope for any *curb cut* shall be 1:50 (2%). (There is no tolerance allowed on slope requirements)



Slope
Figure 21b

21.4 TRANSITIONS

Transitions from *curb cuts* to *walks*, gutters, or streets shall be flush or free of changes in *level* greater than ½ inch (½" = 13mm). Maximum slopes of adjoining gutters, road surface immediately adjacent to the curb cuts, or accessible route shall not exceed one-in-20 (1:20) (5%).

21.5 DRAINAGE

Grading and drainage shall be designed to minimize pooling of water, accumulation of ice, or flow of water across the base of the *curb cut*.

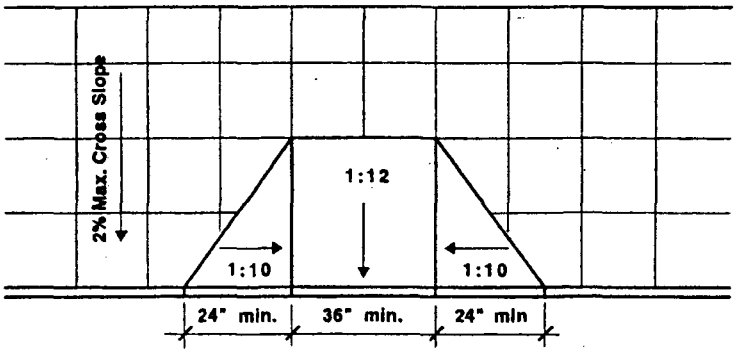
21.6 WIDTH

The minimum width of a *curb cut* shall be 36 inches (36" = 914mm), exclusive of flared sides. **See Fig. 21c.**

21.6.1 Landing width: Where a perpendicular *curb cut* is provided, a landing the width of the *curb cut* shall be provided at the top of the *curb cut*. The landing shall be 48 inches (48"= 1219mm) in length. The slope of said landing shall not exceed one-in-50 (1:50) (2%) in any direction.

21.7 FLARED SIDES

Sides of *curb cuts* shall extend at least 24 inches (24" = 610mm) at the curb. The maximum slope of the flare is one-in-ten (1:10) (10%). Curbing at the flared sides must blend with the slope of the flared sides. **See Fig. 21c.**

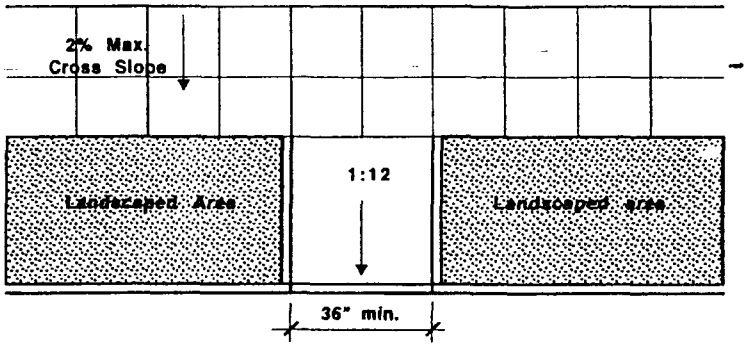


Curb Cut with Flared Sides
Figure 21c

13/27

21.8 RETURNED SIDES

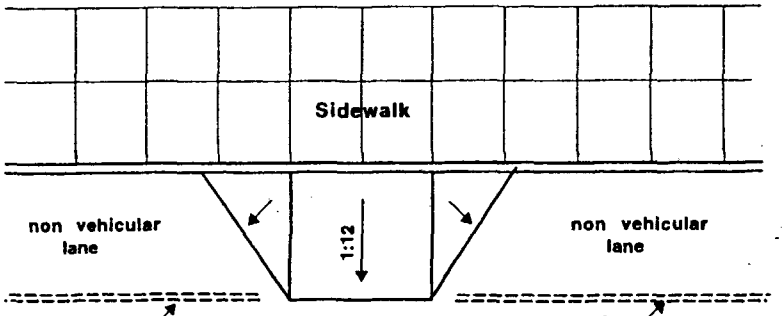
Curb cuts with returned sides are only permitted where they are protected by handrails pursuant to **521 CMR 24.5, Handrails** or where pedestrian travel across the *ramp* is obstructed by permanently installed street hardware or landscaping. **See Fig. 21d.**



Curb Cut With Returned Sides
Figure 21d

21.9 BUILT-UP CURB CUTS

Built-up *curb cuts* are allowed only where they do not project into vehicular traffic lanes. **See Fig. 21e.**



Built up curb cut
Figure 21e

21.10 PEDESTRIAN STREET CROSSINGS

Where provided, pedestrian street crossings at, above, or below grade shall comply with the following:

21.10.1 Crossing controls shall be raised from or flush with their housings and shall be a minimum of two inches (2" = 51mm) in the smallest dimension. The force required to activate controls shall be no greater than 5 lbs.

21.10.2 Location: Controls shall be located as close as practicable to the *curb cut* serving the controlled crossing and shall permit operation from a *clear* ground *space*.

21.10.3 Mounting Height: Pedestrian-actuated crossing controls shall be a maximum of 42 inches (42" = 1067mm) above the finished *sidewalk*.

21.10.4 *Clear* ground *space*: A stable and firm area, complying with **521 CMR 6.5, Forward Reach**, or **521 CMR 6.6, Side Reach** shall be provided at the controls. Where a parallel approach is provided, controls shall be within ten inches (10" =254mm) horizontally of and centered on the *clear* ground *space*. Where a forward approach is provided, controls shall abut and be centered on the *clear* ground *space*.

21.11 DETECTABLE WARNINGS - Reserved until further notice.

14/27

22.1 GENERAL

Walkways shall include but not be limited to all *walks*, *sidewalks*, overpasses, bridges, tunnels, underpasses, plazas, courts and other pedestrian pathways, and shall comply with the following requirements:

22.2 WIDTH

Width of *walkways* shall be not less than 48 inches (48"= 1219mm), excluding curb stones. An unobstructed path of travel shall be provided which is at least 36 inches (36" = 914mm) *clear*, excluding curb stones.

22.3 GRADE

Walkways with a running slope greater than one-in-20 (1:20) (5%) are ramps and shall comply with **521 CMR 24, RAMPS**.

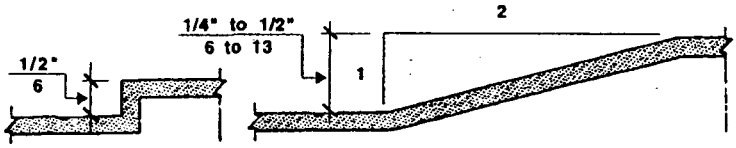
22.3.1 Nowhere shall the *cross slope* of *walkways* exceed one-in-50 (1:50) (2%).

Exception: *Sidewalks* on streets and ways shall be considered *walkways*, with the exception that if the slope of the natural topography exceeds one-in-20 (1:20) (5%) a *ramp* is not required.

22.4 LEVEL CHANGES

Walkways shall have continuous common surfaces, not interrupted by steps or changes in *level* greater than ¼ inch (¼" = 6mm).

22.4.1 Changes in *level* between ¼ inch and ½ inch (¼" and ½" = 6mm and 13mm) shall be beveled with a slope no greater than 1:2 (50%) **See Fig. 22a**.



Changes in Level
Figure 22a

22.4.2 Changes in level greater than ½ inch (½" = 13mm) shall require a *curb cut*, *walkway*, *ramp*, elevator, or platform lift that complies with **521 CMR 21 CURB CUTS, 521 CMR 22 WALKWAYS, 521 CMR 24 RAMPS** or **521 CMR 28, ELEVATORS**.

22.5 SURFACE

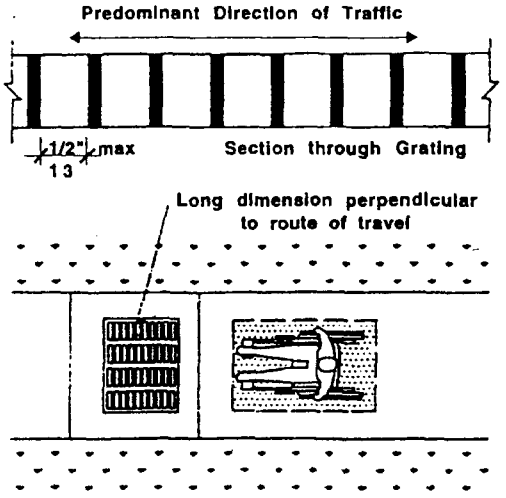
Walkway surfaces shall be stable, and firm and shall lie generally in a continuous plane with a minimum of surface warping.

22.6 DRAINAGE

Grading and drainage shall be designed to minimize pooling of water or accumulation of ice or flow of water across *walkways*.

22.7 GRATINGS

If gratings are located in walking surfaces, they shall have spaces no greater than ½ inch (½" = 13mm) wide in the direction of the flow of travel. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel. **See Fig. 22b**.



Gratings
Figure 22b

22.8 INTERSECTIONS

Wherever a *walkway* crosses or joins streets, public ways, driveways or parking lots, it shall comply with the following:

22.8.1 The intersecting surfaces shall blend to a common *level* with a slope no greater than 1:20 (5%), or a *curb cut* shall be installed in compliance with **521 CMR 21, CURB CUTS.**

23.1 GENERAL

Any person who has lawful control of improved or enclosed private property used as off-street parking for businesses, auditoriums, sporting or recreational *facilities*, cultural centers, or general *public use* where the public has the right of access as invitees or licensees, shall cause such parking areas to comply with 521 CMR. For parking related to residential and *transient lodging facilities*, see **521 CMR 8, TRANSIENT LODGING FACILITIES** and **521 CMR10.3, Parking Spaces.**

23.2 NUMBER

Accessible spaces shall be provided as follows:

23.2.1

Total Parking in Lot	Required Minimum Number of Accessible Spaces
15-25	1
26-50	2
51-75	3
76- 100	4
101-150	5
151-200	6
201-300	7
301-400	8
401-500	9
501-1,000	2% of total
1,001 and over	20 plus 1 for each 100 over 1000

23.2.2 One in every eight *accessible* spaces, but not less than one, shall be van *accessible*, See **521 CMR 23.4.7.**

23.2.3 Spaces required by the table in **521 CMR 23.2.1** need not be provided in a particular lot. They may be provided in a different location if equivalent or greater accessibility, in terms of distance from an *accessible entrance*, cost and convenience, is ensured.

23.2.4 Specialized Medical *Facilities*: At *facilities* providing medical care for persons with mobility impairments, parking spaces shall comply with the following:

a. Outpatient units and facilities: 10% of the total number of parking spaces provided to serve each such outpatient unit or facility shall be *accessible*.
b. Units and facilities that specialize in treatment or services for persons with mobility impairments: 20% of the total number of parking spaces provided, serving each such unit or facility, shall be *accessible*.

23.3 LOCATION

Accessible parking spaces shall be located as follows:

23.3.1 *Accessible* parking spaces serving a particular *building* shall be located on the shortest *accessible route* of travel from adjacent parking to an *accessible entrance*.

23.3.2 In parking *facilities* that do not serve a particular *building*, *accessible* parking shall be located on the shortest *accessible route* of travel to an *accessible* pedestrian *entrance* of the parking *facility*.

23.3.3 In buildings with multiple *accessible entrances* with adjacent parking, *accessible* parking spaces shall be dispersed and located closest to the *accessible entrances*.

Exception: Where *accessible spaces* cannot be located within 200 feet (200' = 61m) of an *accessible entrance*, an *accessible* passenger drop-off area shall be provided within 100 feet (100' = 30m) of an *accessible entrance*.

17/27

18/27

23.3.4 Garages: In multi-level garages where no elevator is provided, such spaces shall all be located near the *accessible entrance*. See special van requirement in **521 CMR 23.4.7**.

23.4 PARKING SPACES

Shall comply with the following:

23.4.1 Width: *Accessible* parking spaces shall be at least eight feet (8' = 2438mm) wide, plus the *access aisle*.

23.4.2 Length: The length of *accessible* parking spaces shall be at least the same as for parking spaces generally in accordance with 780 CMR: the State Building Code or local zoning requirements. Parked vehicles shall not reduce the *clear* width of an *accessible route* by overhanging or protruding into it.

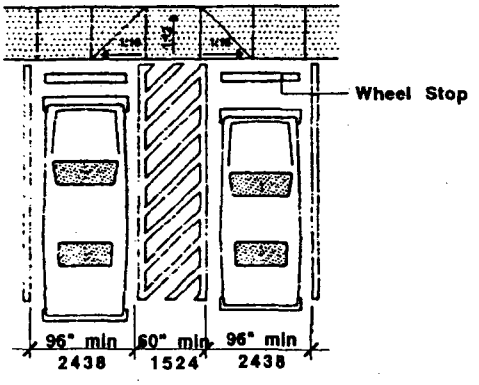
23.4.3 Slope: Parking spaces shall be *level* with surface slopes not exceeding 1:50 (2%) in all directions.

23.4.4 Surface: Spaces shall have a uniform, paved or hard packed smooth surface.

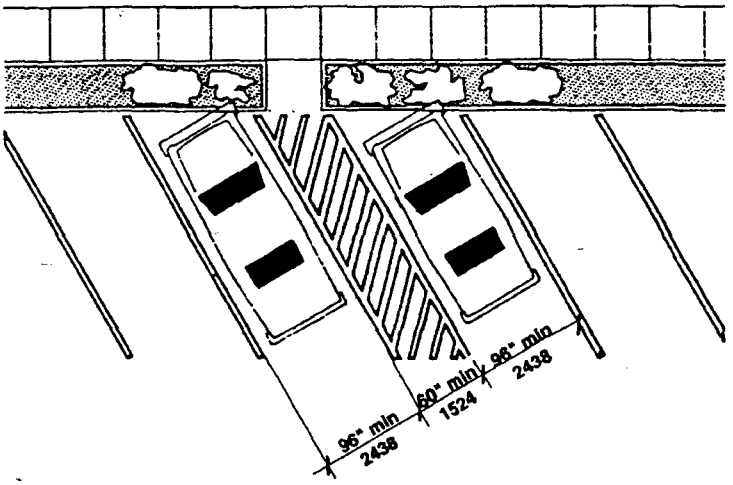
23.4.5 Delineation: *Accessible spaces* shall be marked by high contrast painted lines or other high contrast delineation.

23.4.6 *Access aisles*: All *accessible spaces* shall have *access aisles* that comply with the following:

a. Parking *access aisles* shall be part of an *accessible route* to the *building* or *facility entrance* and shall comply with **521 CMR 20, ACCESSIBLE ROUTE.**
b. *Access aisles* adjacent to *accessible spaces* shall be five feet (5' = 1524mm) wide minimum, except adjacent to van *accessible spaces* the *access aisle* shall be a minimum of eight feet (8' = 2438mm) wide.
c. Two *accessible* parking spaces may share a common *access aisle*. **See Fig. 23a and 23b.**



Alternate Stall
Figure 23a

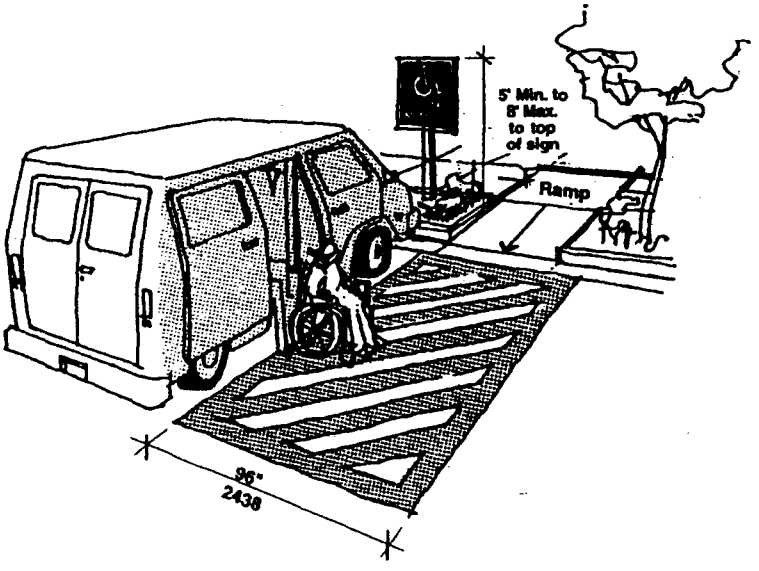


Angled Parking
Figure 23b

d. *Access aisles* shall be *level* with surface slopes not exceeding 1:50 (2%) in all directions.
e. *Access aisles* shall be clearly marked by means of diagonal stripes.

23.4.7 Van *Accessible spaces* shall comply with the following:

a. Provide minimum vertical clearance of eight feet, two inches (8'2" = 2489mm) at the parking *space* and along at least one vehicle *access route* to such spaces from site entrance(s) and exit(s). **See Fig. 23c.**



Van Accessible Space
Figure 23c

b. Each *space* shall have a sign designating it "Van Accessible" as required by **521 CMR 23.6, Signage.**
c. All such *spaces* may be grouped on one level of a parking structure.
d. Eight foot minimum (8' = 2438mm) wide *space*.
e. Provide an *access aisle* of eight feet (8' = 2438mm).

Exception: Van *accessible* spaces do not have to be separately provided if all required *accessible* parking *spaces* are 11 feet wide (11' = 3353mm) with a five foot (5' = 1524mm) *access aisle*.

23.5 SIDEWALKS

Where *sidewalks* are provided at *accessible* parking *spaces*, a *curb cut* shall be installed at the *access aisle* of each *accessible space* or pair of *spaces*.

23.6 SIGNAGE

Accessible parking *spaces* shall be identified by signs indicating that they are reserved.

23.6.1 A sign shall be located at the head of each space and no more than ten feet (10' = 3048mm) away, and at *accessible* passenger loading zones. Signs may also include wording identifying its use.

23.6.2 The sign shall show the international symbol of *accessibility*.

23.6.3 Van *accessible spaces* shall includes the words: "Van-Accessible".

23.6.4 Such signs shall be permanently located at a height of not less than five feet (5' = 1524mm), nor more than eight feet (8' = 2438) to the top of the sign.

23.7 PASSENGER LOADING ZONE

If passenger loading zones are provided, at least one of them shall comply with the following:

23.7.1 Wherever a passenger loading zone or parking area is provided, an *accessible route* to an *accessible entrance* is required.

23.7.2 Passenger loading zones shall provide an *access aisle* at least 60 inches (60" = 1524mm) wide and 20 feet (20' = 6096mm) long, adjacent and parallel to the vehicle pull-up space.

23.7.3 If there are curbs between the *access aisle* and the vehicle pull-up space, then a *curb cut* complying with **521 CMR 21, CURB CUTS**, shall be provided.

23.7.4 Vehicle standing spaces and *access aisles* shall be level with surface slopes not exceeding 1:50 (2%) in all directions.

23.7.5 Vertical Clearance: A minimum of nine feet, six inches (9'- 6" = 2896mm) of vertical clearance shall be provided at *accessible* passenger loading zones and along at least one vehicle access *route* to such areas from *site entrance(s)* and exit(s).

23.8 VALET PARKING

Valet parking *facilities* shall provide a passenger loading zone complying with **521 CMR 23.7, Passenger Loading Zone** located on an *accessible route* to the *entrance* of the *facility*. **521 CMR 23.2 Number** and **521 CMR 23.4.7 Van Accessible Spaces**, do not apply to valet parking facilities.

~~2026~~
2027

25.1 GENERAL

All public *entrance(s)* of a *building* or tenancy in a *building* shall be *accessible*. Public *entrances* are any *entrances* that are not solely service *entrances*, loading *entrances*, or *entrances* restricted to employee use only.

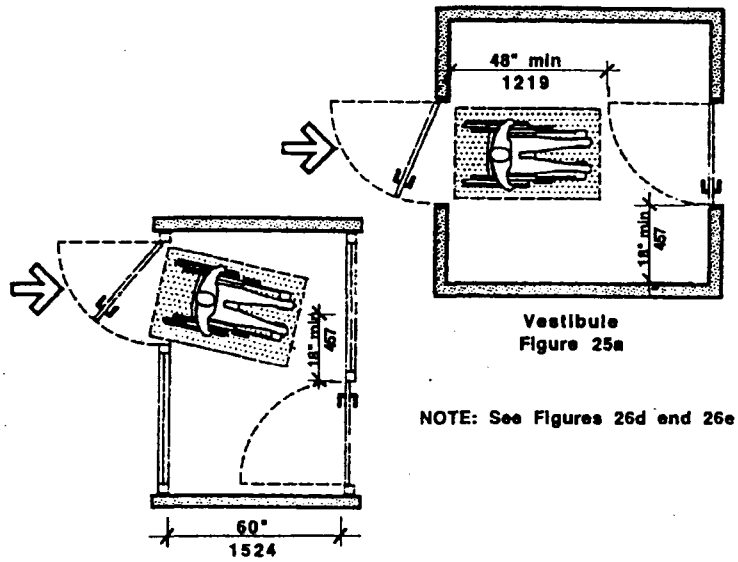
25.1.1 Service *entrances*: If the only *entrance* to a *building*, or tenancy in a *facility*, is a service *entrance*, that *entrance* shall be *accessible*.

25.2 APPROACH

The approach to an *accessible entrance* shall be a paved *walk* or *ramp* with a slip resistant surface, uninterrupted by steps. *Entrance(s)* shall have a *level space* on the interior and exterior of the *entrance* doors complying with **Fig. 25a and 25b.**

25.3 VESTIBULES

Between any two hinged or pivoted doors, there shall be a minimum of 48 inches (48" = 1219mm) plus the width of any door swinging into the space. **See Fig. 25a and 25b.**



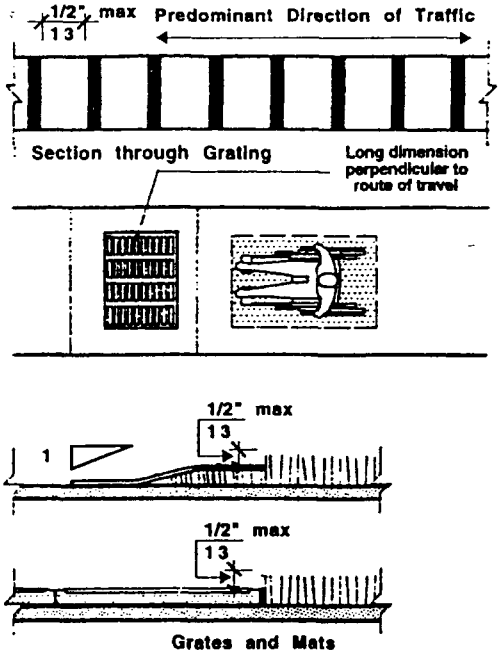
Vestibule
Figure 25a

NOTE: See Figures 26d and 26e

Vestibule (Alternate Solution)
Figure 25b

25.4 MATS AND GRATES

Door mats ½ inch (½" = 13mm) thick or less shall be securely anchored at all edges to avoid tripping. Door mats between ¼ inch (¼" = 6mm) and ½ inch (½" = 13mm) thick must be secured with beveled edging that slopes no more than 1:2 (50%). Door mats thicker than ½ inch (½" = 13mm) shall be recessed. Grates shall have openings not exceeding ½ inch (½" = 13mm) in the path of travel. **See Fig. 25c.**



Grates and Mats
Figure 25c

~~25.5~~ PROTRUDING OBJECTS

Objects that protrude into entranceways, (suspended lights, signs, fixtures, door closers, etc.) shall comply with **521 CMR 20.6, Protruding Objects.**

25.6 SIGNAGE

Any *entrance*/exit of a *facility* not *accessible* by persons in wheelchairs shall have a sign clearly indicating the location of the *accessible entrance*/exit.

41.1 GENERAL

The following types of *signage* shall be provided:

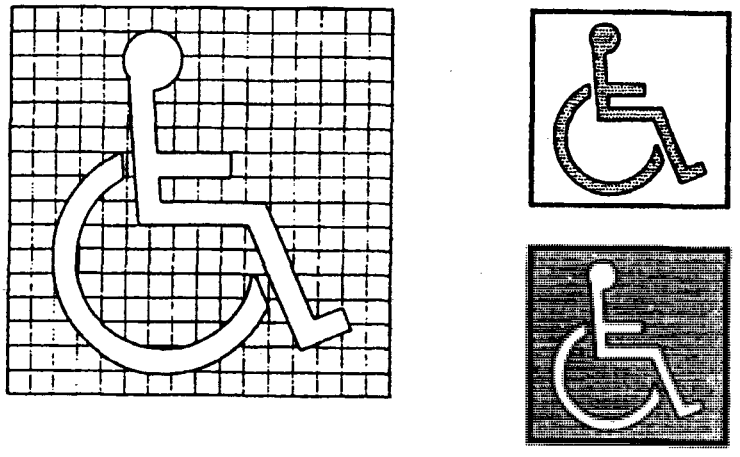
41.1.1 Signs that designate permanent rooms and *spaces* shall comply with **521 CMR 41.2, 41.5** and **41.6**. These include toilet room signs, room numbers, stair signs, etc.

Exception: *Building* directories, menus, and all other signs that are temporary are not required to comply.

41.1.2 Other signs that provide direction to, or information about, functional *spaces* of the *building* shall comply with **521 CMR 41.3, 41.4**, and **41.6**.

41.1.3 Elements and *spaces* of *accessible facilities* which shall be identified by the International Symbol of *Accessibility* (See **Fig. 41a**) and which shall comply with **521 CMR 41.7, Symbols of Accessibility** are:

a. Parking *spaces* designated as reserved for individuals with disabilities;
b. *Accessible* passenger loading zones;
c. *Accessible entrances* when not all are *accessible* (inaccessible *entrances* shall have directional *signage* to indicate the route to the nearest *accessible entrance*);
d. *Accessible* toilet and bathing facilities when not all are *accessible*.



International Symbol of Accessibility
Figure 41a

41.2 MOUNTING LOCATION AND HEIGHT

Where permanent identification is provided for rooms and *spaces*, signs shall be installed on the wall adjacent to the latch side of the door. Where there is no wall *space* to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall.

41.2.1 Mounting location shall allow a person to approach within three inches (3" = 76mm) of *signage* without encountering protruding objects or standing within the swing of a door.

41.2.2 Mounting height shall be 60 inches (60" = 1524mm) above the finish floor to the centerline of the sign.

41.3 CHARACTER PROPORTION

Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1, and a stroke-width-to-height ratio between 1:5 and 1:10.

41.4 CHARACTER HEIGHT

Characters and numbers on signs shall be sized according to the viewing distance from which they are to be read.

41.4.1 The minimum height of suspended or overhead characters is three inches (3" = 76mm) and is measured using an upper case X.

41.4.2 Lower case characters are permitted.

41.5 RAISED AND BRAILLED CHARACTERS AND PICTORIAL SYMBOL SIGNS

Shall comply with the following:

41.5.1 Letters and numerals shall be raised one thirty-second of an inch (1/32" = 0.8mm), upper case, sans serif or simple serif type.

41.5.2 Letters and/or numerals shall be accompanied with Grade 2 *Braille*.

41.5.3 Raised characters shall be at least _ of an inch (_" = 16mm) high, but no higher than two inches (2" = 51mm).

41.5.4 Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be six inches (6" = 152mm) minimum in height.

41.6 FINISH AND CONTRAST

The characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background: either light characters on a dark background or dark characters on a light background.

41.7 SYMBOLS OF ACCESSIBILITY

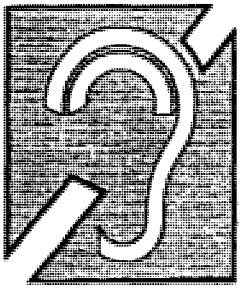
Facilities and elements required to be identified as *accessible* by 521 CMR 41.1.3 shall use the international symbol of *accessibility*. The symbol shall be displayed as shown in Fig. 41a.

41.8 VOLUME CONTROL TELEPHONES

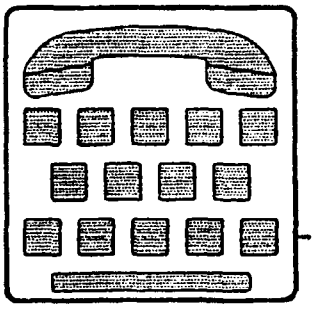
Telephones required to have a volume control under **521 CMR 37.5**, shall be identified by a sign containing a depiction of a telephone handset with radiating sound waves.

41.9 TEXT TELEPHONES (TTY)

Text telephones (*TTY*) required by **521 CMR 37.8, Text Telephones** shall be identified by the international *TTY* symbol (See **Fig. 41c**). In addition, if a facility has a public *text telephone* (*TTY*), directional *signage* indicating the location of the nearest *text telephone* (*TTY*) shall be placed adjacent to all banks of telephones that do not contain a *text telephone* (*TTY*). Such directional *signage* shall include the international *TTY* symbol. If a *facility* has no banks of telephones but a public *text telephone* (*TTY*) is available, the directional signage shall be provided at the entrance (e.g., in a *building* directory).



International Symbol of Access for Hearing Loss
Figure 41b



International TTY Symbol
Figure 41c

41.10 ASSISTIVE LISTENING SYSTEMS

In *assembly areas* where permanently installed *assistive listening systems* are required by **521 CMR 14.5, Assistive Listening Devices** the availability of such systems shall be identified with *signage* that includes the international symbol of access for hearing loss. See **Fig 41b**.

41.11 ILLUMINATION LEVELS (reserved)

NON-TEXT PAGE

CALCULATION COVER SHEET

Sheet 0 of 3

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Roof Drainage System

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. C-06 PROJECT NO. 5197.1720.9303

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____YES _____ NO

PREPARER D. Martoccia

REVIEWED BY K. Bogatch DATE 9/12/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

Estimated Drainage Flow:

- Using Rational Method[1]

  Q = CIA

  C = Rational method runoff coefficient
  I = Rainfall intensity (in/hr)
  A = Drainage area (acres)

- Estimated Drainage Area for Roofs

  Assumptions:

  1) The Process Area roof will drain to the south face of the facility.
  2) The Loadout Area roof (including the eastern portion of the Truck Loading Area) will drain to the east face of the facility.
  3) The 60'x60' area over the western overhead door (western portion of Truck Loading Area) will drain to the west and discharge to the ground surface and into the proposed swale.

  Estimated drainage area for Loadout Area Roof (90'x225') = 20,250 ft^2 = 0.46 acres
  Estimated drainage area for Process Area Roof (180'x165') = 29,700 ft^2 = 0.68 acres

- "C" Value

  For roofs[1], C = 0.95

- Rain Intensity

  I = 2.00 in/hr for 10 year storm[2]

- Estimated Drainage Flow

  To the eastern face of the facility:

  Q = (0.95)(2.00)(0.46) = **0.87 ft^3/s** for 10 year storm

  To the southern face of the facility:

  Q = (0.95)(2.00)(0.68) = **1.29 ft^3/s** for 10 year storm

Size of Lateral Pipes for Proposed Roof Drain System:

- Using Manning's Equation[1]

$Q = (1.49/n)AR^{2/3}S^{1/2}$

n = Manning's roughness coefficient. n = 0.009 for a PVC pipe[1]

A = Area of pipe

R = Hydraulic radius = ¼ Diam

S = Slope of pipe => Assume slope of pipe is 1% = 0.01

Q = Anticipated flow rate for a 10 year storm (calculated above)

Or

$D = (1.33)[(nQ)/s^{0.5}]^{3/8}$

For Eastern Lateral Piping:

$D = (1.33)[(0.009)(0.87)/(0.01)^{0.5}]^{3/8}$

= 0.51 ft = 6.1 inches

Therefore, use a 10-inch PVC lateral pipe on the eastern side of the facility

For Southern Lateral Piping:

$D = (1.33)[(0.009)(1.29)/(0.01)^{0.5}]^{3/8}$

= 0.59 ft = 7.1 inches

Therefore, use a 12-inch PVC lateral pipe on the southern side of the facility

It should be noted that MA Plumbing Codes[3] specify that the size of horizontal drains for a roof area of 20,700 ft^2 is 10-inches and 12-inches for roof area of 33,300 ft^2, hence the reason for the above specified pipe diameters. In addition, the vertical leaders are to be 8-inch diameter leaders in accordance to the MA Plumbing Codes[3].

Capacity of 12-inch PVC Line:

The roof drainage flow from the above specified 10-inch and 12-inch PVC lines will connect into the proposed manhole junction located at the southeast corner of the facility and will then flow into a 12-inch PVC line sloped at 3.76%.

- Using Manning's Equation[1]

  $Q = (1.49/n)AR^{2/3}S^{1/2}$

  n = Manning's roughness coefficient. n = 0.009 for a PVC pipe[1]

  A = Area of pipe = $(3.14/4)(Diam)^2 = (3.14/4)(12/12)^2 = 0.785\ ft^2$

  R = Hydraulic radius = ¼ Diam = ¼(12/12) = 0.25 ft

  S = Slope of pipe = 3.76% = 0.0376 ft/ft

- The capacity of 12-inch PVC line at 3.76% slope is:

  $Q = (1.49/0.009)(0.785)(0.25)^{2/3}(0.0376)^{1/2}$

  = 10.0 ft^3/s

- Total combined flow rate from above specified 10-inch and 12-inch PVC lines

  = 1.29 ft^3/s + 0.87 ft^3/s = 2.16 ft^3/s

  10.0 ft^3/s >> 2.16 ft^3/s

Therefore, the proposed 12-inch PVC line after the manhole junction has enough capacity to handle the combined flow rates from the above specified 10-inch and 12-inch PVC lines during a 10 year storm event.

References:

1. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
2. National Oceanic and Atmospheric Administration (NOAA) Technical Paper No. 40
3. Commonwealth of Massachusetts State Building Code, Fifth Edition. Section 2.17

2.17: Storm Drains

(1) Storm Water Drainage to Sewer Prohibited. Storm water shall not be drained into sewers intended for sewage only.

(2) Size of Building Storm Drain. The size of the building storm drain or any of its horizontal branches having a slope of ½ inch or less per foot, shall be based upon the maximum projected roof or paved area to be handled according to Table 1 in 248 CMR 2.17, Size of Horizontal Storm Drains.

TABLE 1
SIZE OF HORIZONTAL STORM DRAINS[1]

Diameter of drain, inches	Maximum projected roof area for drains of various slopes: ⅛ in. slope	¼ in. slope	½ in. slope
	Square feet	Square feet	Square feet
3		1,160	1,644
4	1,880	2,650	3,760
5	3,340	4,720	6,680
6	5,350	7,550	10,700
8	11,500	16,300	23,000
10	20,700	29,200	41,400
12	33,300	47,000	66,600
15	59,500	84,000	119,000

Note 1: Table 1 is based upon a maximum rate of rainfall four inches per hour.

(a) Vertical Leaders. A vertical leader shall be based upon the maximum projected roof area to be drained according to the following Table 2 in 248 CMR 2.17.

TABLE 2
SIZE OF VERTICAL LEADERS

Maximum Projected Roof Area (square feet)	Diameter of Leaders (inches)	Maximum Projected Roof Area (square feet)	Diameter of Leaders (inches)
720	2	8,650	5
1,300	2½	13,500	6
2,200	3	29,000	8
4,600	4		

(3) Values for Continuous Flow. Where there is a continuous or semicontinuous discharge into the building storm drain or building storm sewer, as from a pump, ejector, air conditioning plant, or similar device, each gallon per minute of such discharge shall be computed as being equivalent to 24 square feet of roof area, based upon a four-inch rainfall.

(4) Building Sub-drains. Building sub-drains located inside the building below the public gravity sewer level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the drainage system as required for building sumps.

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Desanding/Dewatering Facilities Electrical Power Requirements

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. E-01 PROJECT NO. 5197.1720.9302

NO OF SHEETS 2 DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. Brinkman JB

REVIEWED BY R. Otoski RO DATE 10-28-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

Estimated Desanding Facility Process Equipment Electrical Power Requirements

Equipment Description	Equipment Quantity	Motor Description	Motor Power Demand (hp)	Motor Quantity per Equipment	Power Requirement per Equipment	Total Power Requirement (hp)
V Tank	3	Auger Motor	20	1	20	60
V-Tank	3	Linear Motion Shaker	2	2	4	12
V-Tank	3	Scalping Shaker	5	1	5	15
V-Tank	3	Recycle Pumps	75	2	150	450
Transfer Pumps	2	Slurry Transfer Pumps	79	1	79	158
Mix Tank	6*	Mixer	10	4	40	240
					Total	935

Estimated Dewatering Facility Process Equipment Electrical Power Requirements

Equipment Description	Equipment Quantity	Motor Description	Motor Power Demand (hp)	Motor Quantity per Equipment	Power Requirement per Equipment	Total Power Requirement (hp)
Filter Press	4	Open/Close Plates	75	1	75	300
Filter Press	4	Feed Pumps	150	1	150	600
Mix/Press Feed Tanks	8	Mixers	10	4	40	320
Equalization Tanks	2	Recirculation Pumps	25	1	25	50
Polymer Feed	2	Feed Pumps	7.5	2	15	30
Filtrate Pumps	2	Filtrate Transfer Pumps	50	1	50	100
Transfer Pumps	2	Pump from EQ to Mix Tank	25	1	25	50
					Total	1,450

Note:

Process equipment for desanding and dewatering facilities based on conceptual design presented in Section 6.0 of the Basis of Design/Design Analysis Report.

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site

SUBJECT Dewatering Facility, Process Building Heating Load Calculation

CLIENT US Army Corps of Engineers- New England District (USACE- NED)

CALCULATION NO. M-01 PROJECT NO. _____

NO OF SHEETS 9 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES ____ NO X PREPARER J Weeks

REVIEWED BY _____ DATE 3/27/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

Table of Contents

		Page
	Cover sheet	1
	Table of Contents	2
1.0	Summary	3
2.0	Introduction and Objectives	3
3.0	Basis of Design	3
5.0	Methodology	5
6.0	Analysis/Calculation	5
7.0	Conclusion	9

1.0 Summary

This calculation determines the heating capacity required to maintain freeze protection in the New Bedford Dewatering Facility Process Building The design goal is to maintain 40°F indoor temperature down to an outdoor temperature of 11°F.

This calculation also determines summer ventilation rates required to remove internal heat gains necessary to maintain indoor temperature no more than 10°F above outdoor temperature.

2.0 Introduction and Objectives

The Process Building is bordered on the East wall by the Loadout Area and on the West wall by the Breakroom Area. The South, North, and portions of the West walls are exposed to the outside environment. Heating requirements resulting from losses through the East Wall consider the Loadout Area to be 11°F since it is unheated.

Natural gas fired unit heaters are used to replace heat losses through the walls, floor and roof in winter including heat losses associated with infiltration.

An operating goal is to maintain the Process Building at a negative pressure with respect to the Breakroom and a positive pressure with respect to the Loadout Area.

The ventilation system is sized to remove heat generated by lighting, and electrical equipment located in the Process Building during the cooling season.

3.0 Basis of Design

3.1 References:

3.1.1 2001 ASHRAE Fundamentals Handbook

3.1.2 ASHRAE GRP 158 – Cooling and Heating Load Calculation Manual

3.1.3 Industrial Ventilation – A Manual of Recommended Practice, 23rd Ed., 1998, ACGIH

3.1.4 ASHRAE Standard 62-1999, Ventilation for Acceptable Indoor Air Quality

3.1.5 Design Criteria, Scope of Work, and General Arrangement/Equipment Layout Drawings

3.2 Design Input

3.2.1 Outside design conditions are 41.6° Latitude, 11°F_{db} for Winter, and 85°F_{db}/72°F_{wb} with a 14.6 °F daily range for Summer. Average wind speed is 9 mph from 300° with an extreme wind speed of 29 mph. (Ref. 3.1.1, page 27.12 & 27.13, East Falmouth, MA)

3.2.2 Inside design conditions are 40°F_{db} for Winter freeze protection and 10 °F_{db} maximum above outdoor temperature for Summer. Relative humidity is not controlled.

3.2.3 Exterior building walls are constructed of sheet metal with an internal R-13 insulation wrap. Using an outside film coefficient of $R_o = 0.17$ for a 15 mph wind and an inside film coefficient of $R_i = 0.68$ for still air (Ref. 3.1.2, Table 3.3 page 3.12) the total resistance for winter $R_t = 0.68 + 13.0 + 0.17 = 13.85$ and $U_o = 1/R_t = 0.07$ BTU/ °F-ft^2-hr.

3.2.4 The roof is a sloped metal roof having a rise of approximately 2 in per foot with R-19 insulation below the deck. Using an outside film coefficient of $R_o = 0.17$ for a 15 mph wind and an inside film coefficient of $R_i = 0.61$ for still air (Ref. 3.1.2, Table 3.3 page 3.12) the total resistance for winter $R_t = 0.61 + 19.0 + 0.17 = 19.78$ and $U = 1/R_t = 0.05$ BTU/ °F-ft^2-hr.

3.2.5 Perimeter heat losses occur in the winter where the concrete floor slab and outside walls meet. Beginning at the SW corner the exposed perimeter,

$P = 195'_S + 165'_E + 195'_N + 72'_W = 630$ft.

Q = P (ft) x Heat Loss per Foot (Btu/(hr-ft) Ref. 3.1.2, Table 7.9A, Page 7.22

3.2.6 The East Wall faces the Load Out Area. East Wall area is determined as follows:
The ridge line of the Process Building roof runs East/West with a 30 ft wall height at the gutter.
Assuming a 2 in/ft roof rise for 165 ft/2,
wall height at the ridge would be 30 + (165 ft/2)(2 in/ft rise)(1 ft/12 in) = 43.75.
East Wall Avg height = (30 + 43.75)/2 = 37 ft
East Wall area is 165' x 37' = 6,100 ft^2

3.2.7 South Wall is 30 ft high by 195 ft long with a total area of 5,850 ft^2.

3.2.8 The West Wall area faces the Breakroom Area. Deduct the Breakroom Wall area to determine the West Wall area facing outside:

The ridge line of the Breakroom roof runs East/West.
The Breakroom East Wall Area is 92 ft long by 14 ft high at the gutter plus an assumed 2 in/ft roof rise for 92 ft/2.
Breakroom Wall height at ridge would be 14 + (92 ft/2)(2 in/ft rise)(1 ft/12 in) = 22 ft.
Breakroom East Wall Avg height = (14 + 22)/2 = 18 ft
Breakroom East Wall Area = 92' x 18' = 1,660 ft^2

Process Building West Wall Outside Area is (165' x 37') – (92' x 18') = 4,440 ft^2.

3.2.9 The North Wall area is 30 ft high by 195 ft long with a total area of 5,850 ft^2.

4.0 Methodology

4.1 Heating and cooling loads are determined based on methods contained in the 2001 ASHRAE Fundamentals Handbook, and ASHRAE GRP 158 Cooling and Heating Load Calculation Manual (References 3.1.1 and 3.1.2).

4.2 Ventilation loads for cooling are determined based on methods contained in ASHRAE Standard 62-1999 and Industrial Ventilation – A Manual of Recommended Practice, 23rd Ed., 1998, ACGIH (References 3.1.4 and 3.1.5).

4.3 Equipment sizing and selection is in accordance with standard engineering practice.

5.0 Analysis/Calculation

5.1 Winter Heat Losses

5.1.1 Determine Transmission Heat Losses:

Roof	$Q = UA\Delta T = 0.05(195' \times 165')(40-11) =$	46,650 BTU/hr
Floor	Q = 630 ft Perimeter x 55 BTU/hr-ft = Ref. 3.1.2, P. 7.22, Table 7.9a	34,650 BTU/hr
East Wall	$Q = UA\Delta T = 0.07(165' \times 37')(40-11) =$	12,390 BTU/hr
South Wall	$Q = UA\Delta T = 0.07(30' \times 195')(40-11) =$	11,880 BTU/hr
West Wall	$Q = UA\Delta T = 0.07(4{,}440\ ft^2)(40-11) =$	9,010 BTU/hr
North Wall	$Q = UA\Delta T = 0.07(30' \times 195')(40-11) =$	11,880 BTU/hr

Total Transmission Heat Losses, $Q_{Transmission}$ = 126,460 BTU/hr

5.1.2 Determine Heating Losses Due to Infiltration:

A. **Determine Curtain (Outside) Wall Infiltration due to Stack Effect:**
(Similar to Example 5.4, Page 5.4 of Reference 3.1.2)

From Fig. 5.6, Page 5.4, "Infiltration through a Curtain Wall for the Entire Building due to Stack Effect and Zero Pressurization:"

$Q/(A \times k \times f_d) = 0.24$ Building Height = 37 ft; $\Delta T = 40^oF - 11^oF$

$Q = 0.24(6{,}100ft^2_E + 5{,}850ft^2_S + 4{,}440ft^2_W + 5{,}850ft^2_N) \times 0.66 \times 0.87$
Q = 3,070 cfm Curtain Wall Infiltration due to the Stack Effect

Where:

$k = 0.66$ for an average fitting wall, Page 5.16, Fig. 5.4
A = Process Building Total Outside Wall Area
$f_d = 0.87$ Page 5.4, Fig. 5.5 for Cd = 0.8 from Example 5.4

B. **Determine Curtain Wall Infiltration due to Wind:**
(Similar to Example 5.5, Page 5.5 of Reference 3.1.2)

From Fig. 5.8, Page 5.5, "Infiltration through a Curtain Wall for the Entire Building due to Wind and Zero Pressurization:"
$Q/(A_w \times k \times f_\theta) = 0.23$ for a 37ft high wall and a 29mph wind

$Q = 0.23(A_w \times k \times f_\theta)$
$Q = 0.23(4{,}040 \times 0.66 \times 1.0)$
Q = 610 cfm West Curtain Wall Infiltration due to wind

Where:

$A_w = 4{,}040\ ft^2$ Process Building West Outside Wall Area exposed to wind
Wind Speed = 29 mph wind normal to the West Wall, Reference 3.1.1
$f_\theta = 1.0$ for $\theta = 0^o$, for the wind blowing normal to the wall, Page 5.6, Fig. 5.9

C. **Determine Infiltration through the West Wall 20 ft high by 20 ft wide overhead door:**
(Similar to Example 5.12, Page 5.11, Reference 3.1.2)

From Fig. 5.2, Page 5.1, for a 29 mph wind $\Delta p_w/C_p = 0.41$ and for $C_p = 1.0$, $\Delta p_w = 0.41$ in. wg

Crack Area = 0.25 in x (1 ft/12 in) x 2 [(20 + 20)ft] = 1.67 ft^2 Assumes a 1/4 in perimeter crack
Wind Speed = 29 mile/hr x (5,280 ft/mile) x (1 hr/60 min) = 2,550 fpm
(Compares to a Velocity Pressure $p_v = (2{,}550/4{,}005)^2 = 0.41$ in wg)
Infiltration = 1.67 ft^2 x (2,550 ft/min) = 4,250 cfm

D. **Determine Infiltration through Personnel Doors:**

1. **Determine Crack Infiltration through the West Wall 7 ft high by 4 ft wide swinging personnel door** similar to Example 5.12, Page 5.11 of Reference 3.1.2:

From Fig. 5.2, Page 5.1, for a 29 mph wind $\Delta p_w/C_p = 0.41$ and for $C_p = 1.0$, $\Delta p_w = 0.41$ in. wg

Crack Area = 0.125 in x (1 ft/12 in) x 2 [(7 + 4)ft] = 0.23 ft^2 Assumes a 1/8 in perimeter crack
Wind Speed = 29 mile/hr x (5,280 ft/mile) x (1 hr/60 min) = 2,550 fpm
(Compares to a Velocity Pressure $p_v = (2{,}550/4{,}005)^2 = 0.41$ in wg)
Door Crack Infiltration = 0.23 ft^2 x (2,550 ft/min) = 590 cfm

2. **Determine Door Traffic Infiltration through the West Wall 7 ft high by 4 ft wide swinging personnel door** similar to Example 5.12, Page 5.11 of Reference 3.1.2:

From Fig. 5.15, Page 5.8, C = 3,000 for 100 people passing through the door in 1 hour
From Fig. 5.14, Page 5.8, for C = 3,000, 100 people passing through the door in 1 hour, and 0.41 in. wg:

"Q/Door in CFM" = 2,000 cfm per 100 passages per hour
Door Traffic Infiltration = 200 cfm Assumes 10 passages per hour

3. **Determine Crack Infiltration through the South Wall 7 ft high by 4 ft wide swinging personnel door** similar to Example 5.12, Page 5.11 of Reference 3.1.2:

From Fig. 5.2, Page 5.1, for a 9 mph wind $\Delta p_w/C_p = 0.04$ and for $C_p = 1.0$, $\Delta p_w = 0.04$ in. wg

Crack Area = 0.125 in x (1 ft/12 in) x 2 [(7 + 4)ft] = 0.23 ft^2 Assumes a 1/8 in perimeter crack
Wind Speed = 9 mile/hr x (5,280 ft/mile) x (1 hr/60 min) = 790 fpm
(Compares to a Velocity Pressure $p_v = (790/4{,}005)^2 = 0.04$ in wg)
Door Crack Infiltration = 0.23 ft^2 x (790 ft/min) = 180 cfm

4. **Determine Door Traffic Infiltration through the West Wall 7 ft high by 4 ft wide swinging personnel door** similar to Example 5.12, Page 5.11 of Reference 3.1.2:

From Fig. 5.15, Page 5.8, C = 3,000 for 100 people passing through the door in 1 hour
From Fig. 5.14, Page 5.8, for C = 3,000 and 100 people passing through the door in 1 hour, and 0.04 in. wg,

"Q/Door in CFM" = 600 cfm per 100 passages per hour
Door Traffic Infiltration = 60 cfm Assumes 10 passages per hour

E. **Determine Infiltration into the Process Building occurring through the doors between the Loadout and Process Areas:**

1. Assume the 3 overhead doors are closed and the Process Building is 0.1 in. wg negative with respect to the Loadout Building:

$v_p = (V/4005)^2$
$V = [(4005)^2 v_p]^{0.5} = [(4005)^2 \times 0.1]^{0.5} = 1{,}270$ fpm
Crack Area = 0.25 in x (1 ft/12 in) x 2 [(20 + 20)ft] = 1.67 ft^2 Assumes a 1/4 in perimeter crack

Infiltration per OH Door with the door closed = 1.67 ft^2 x 1,270 fpm = 2,120 cfm per door

Total Infiltration = 3 doors x 2,120 cfm = 6,360 cfm with all 3 doors closed

2. Assume 2 overhead doors are closed and 1 is open with 100 fpm infiltration velocity occurring into the Process Building from the Loadout Building across the door opening:

Infiltration across the open door = 100 fpm x (20 ft x 20 ft) = 40,000 cfm

Infiltration across the 2 closed doors is 2 x 2,120 cfm/door = 4,240 cfm
Total infiltration for this scenario is 44,240 cfm

Infiltration occurring through the doors between the Loadout and Process Areas will be either 6,360 cfm or 44,240 cfm.

F. **Determine Intake Louver Infiltration with Louvers Shut:**

Reference: Ruskin Model ELC6375D
Air Leakage with Damper Section Closed = 0.8 cfm/ft^2 of face area with Δp = 0.3 in. wg
Louver Area = (60" high by 90" wide)/(144 in^2/ft^2) = 37.5 ft^2 each
Total Louver Leakage = 6 Louvers x 37.5 ft^2 x 0.8 cfm/ft^2 = 180 cfm

G. **Determine Total Infiltration:**

Curtain Wall Infiltration due to Stack Effect =	3,070 cfm
Curtain West Wall Infiltration due to Wind =	610
West 20' by 20' Overhead Door Infiltration =	4,250
West 4' by 7' Personnel Door Infiltration:	
Due to Crack =	590
Due to Traffic =	200
South 4' by 7' Personnel Door Infiltration:	
Due to Crack =	180
Due to Traffic =	60
Overhead Doors between Process & Loadout Buildings	6,360
Louver Leakage	180
Total Infiltration =	**15,500 cfm**

H. **Determine Infiltration Heating Load:**

$Q_{Infiltration}$ = 1.18 cfm ΔT
$Q_{Infiltration}$ = 1.18 x 15,500 cfm x (40 – 11)°F = 530,410 Btuh

I. **Determine Total Process Building Heating Load:**

Q_{Total} = SF x [$Q_{Transmission}$ + $Q_{Infiltration}$]

Use SF = 1.3 due to Building Size, Overhead Doors, and resulting Infiltration Quantity Uncertainity

Q_{Total} = 1.3 x [126,460 + 530,410]
Q_{Total} = 1.3 x 656,870 Btuh
Q_{Total} = 853,931 Btuh Heating Output

J. Heating Input = (Heating Output)/(Equipment Efficiency)

Equipment Efficiency = 80% for Natural Gas

Heating Input = 853,931 Btuh/80%
Heating Input = 1,067,400 Btuh

6.0 Conclusion

Install eleven 1,000,000 Btuh Output Unit Heaters

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site

SUBJECT Dewatering Facility, Process Building Cooling Ventilation Load Calculation

CLIENT US Army Corps of Engineers- New England District (USACE- NED)

CALCULATION NO. M-02 PROJECT NO. _____

NO OF SHEETS 6 DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO X PREPARER Junie Weeks, Jr. / J Weeks

REVIEWED BY [signature] DATE 3/29/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

Table of Contents

		Page
	Cover sheet	1
	Table of Contents	2
1.0	Summary	3
2.0	Introduction and Objectives	3
3.0	Basis of Design	3
4.0	Methodology	5
5.0	Analysis/Calculation	5
6.0	Conclusion	6
7.0	Attachments	6

1.0 Summary

This calculation determines summer ventilation rates required to remove internal heat gains necessary to maintain indoor temperature no more than 10°F above outdoor air temperatures during the cooling season inside the New Bedford Dewatering Facility Process and Loadout Buildings.

2.0 Introduction and Objectives

The Process Building is bordered on the East wall by the Loadout Area and on the West wall by the Breakroom Area. South, West, and North walls are exposed to the outside environment.

An operating goal is to maintain the Process Building at a negative pressure with respect to the Breakroom and a positive pressure with respect to the Loadout Area.

The ventilation system is sized to remove internal heat gains generated by workers, lighting, and electrical equipment located in the Process Building during the cooling season.

3.0 Basis of Design

3.1 References:

3.1.1 2001 ASHRAE Fundamentals Handbook

3.1.2 ASHRAE GRP 158 – Cooling and Heating Load Calculation Manual

3.1.3 Industrial Ventilation – A Manual of Recommended Practice, 23rd Ed., 1998, ACGIH

3.1.4 ASHRAE Standard 62-1999, Ventilation for Acceptable Indoor Air Quality

3.1.5 Design Criteria, Scope of Work, and General Arrangement/Equipment Layout Drawings

3.2 Design Input

3.2.1 Outside design conditions are 41.6° Latitude, 11°F_{db} for Winter, and 85°F_{db}/72°F_{wb} with a 14.6 °F daily range for Summer. Average wind speed is 9 mph from 300° with an extreme wind speed of 29 mph. (Ref. 3.1.1, page 27.12 & 27.13, East Falmouth, MA)

3.2.2 Inside design conditions are 40°F_{db} for Winter freeze protection and 10 °F_{db} maximum above outdoor temperature for Summer. Relative humidity is not controlled.

3.2.3 Exterior building walls are constructed of sheet metal with an internal R-13 insulation wrap. Using an outside film coefficient of $R_o = 0.17$ for a 15 mph wind and an inside film coefficient of $R_i = 0.68$ for still air (Ref. 3.1.2, Table 3.3 page 3.12) the total resistance for winter $R_t = 0.68 + 13.0 + 0.17 = 13.85$ and $U_o = 1/R_t = 0.07$ BTU/ °F-ft^2-hr.

3.2.4 The roof is a sloped metal roof having a rise of approximately 2 in per foot with R-19 insulation below the deck. Using an outside film coefficient of $R_o = 0.17$ for a 15 mph wind and an inside film coefficient of $R_i = 0.61$ for still air (Ref. 3.1.2, Table 3.3 page 3.12) the total resistance for winter $R_t = 0.61 + 19.0 + 0.17 = 19.78$ and $U = 1/R_t = 0.05$ BTU/ °F-ft^2-hr.

3.2.5 Process Building and Loadout Building Floor Areas:
Process Building Floor Area = 195' x 165' = 32,175 ft^2
Loadout Building Floor Area = (75' x 225') + (75' x 60') = 21,375 ft^2

3.2.6 The Process Building East Wall faces the Load Out Area. Area is determined as follows:
The ridge line of the Process Building roof runs East/West with a 30 ft wall height at the gutter.
Assuming a 2 in/ft roof rise for 165 ft/2,
wall height at the ridge would be 30 + (165 ft/2)(2 in/ft rise)(1 ft/12 in) = 43.75.
East Wall Avg height = (30 + 43.75)/2 = 37 ft
East Wall area is 165' x 37' = 6,100 ft^2

3.2.7 Process Building South Wall is 30 ft high by 195 ft long with a total area of 5,850 ft^2.

3.2.8 The Process Building West Wall area faces the Breakroom Area. Deduct the Breakroom Wall area to determine the West Wall area facing outside:

The ridge line of the Breakroom roof runs East/West.
The Breakroom East Wall Area is 92 ft long by 14 ft high at the gutter plus an assumed 2 in/ft roof rise for 92 ft/2.
Breakroom Wall height at ridge would be 14 + (92 ft/2)(2 in/ft rise)(1 ft/12 in) = 22 ft.
Breakroom East Wall Avg height = (14 + 22)/2 = 18 ft
Breakroom East Wall Area = 92' x 18' = 1,660 ft^2

Process Building West Wall Outside Area is (165' x 37') – (92' x 18') = 4,440 ft^2.

3.2.9 The Process Building North Wall area is 30 ft high by 195 ft long with a total area of 5,850 ft^2.

4.0 Methodology

4.1 Cooling load input parameters are determined from the 2001 ASHRAE Fundamentals Handbook, and ASHRAE GRP 158 Cooling and Heating Load Calculation Manual (References 3.1.1 and 3.1.2).

4.2 Ventilation loads for cooling are determined based on methods contained in ASHRAE Standard 62-1999 and Industrial Ventilation – A Manual of Recommended Practice, 23rd Ed., 1998, ACGIH (References 3.1.4 and 3.1.5).

4.3 Equipment sizing and selection is in accordance with standard engineering practice.

5.0 Analysis/Calculation

5.1 Summer Process Building Internal Heat Gains

5.1.1 Determine Heat Gains Due to People:

$Q_{Workers}$ = 15 Workers x 1,450 Btu/hr (Ref. 3.1.1, Table 1, Page 29.4)
$Q_{Workers}$ = 21,750 Btu/hr Total

5.1.2 Determine Heat Gains Due to Lighting:

$Q_{Lighting} = 3.41 \times W \times F_{ul} \times F_{sa}$ (Ref. 3.1.1, Eq. 1, Page 29.3)

Where:

Q_{el} = Heat Gain from Lighting (Btu/hr)
W = Total Light Wattage
F_{ul} = 1.0 Lighting Use Factor
F_{sa} = 1.23 Lighting Special Lighting Allowance Factor for 175 watt Metal Halide Fixtures (Page 29.6, Ref. 3.1.1)

Assume : 0.8 watt/ft^2 Lighting Level

$Q_{Lighting}$ = 3.41 x [0.8(195' x 165')] x 1.0 x 1.23
$Q_{Lighting}$ = 108,000 Btu/hr Total Heat Gain Due to Lighting

5.1.3 Determine Heat Gains due to Equipment:

Motor Heat Gains are determined from Reference 3.1.1, Table 3a, Page 29.7, using the "Motor In, Driven Equipment In" heat gain value:

Two 25 hp Mixing Tank Transfer Pumps	72,300 BTU/hr Each x 2 =	144,600 Btu/hr
Four 25 hp Filter Press Feed Pumps	72,300 BTU/hr Each x 4 =	289,200
Two 10 hp Eductor Motors	29,900 BTU/hr Each x 2 =	59,800
Eight 5 hp Mixer Motors	15,500 BTU/hr Each x 8 =	124,000
	Total =	617,600 Btu/hr

Total Equipment Heat Gains, $Q_{Equipment}$ = 617,600 BTU/hr

5.1.3 Determine Total Internal Heat Gains:

$Q_{Total\ Internal} = Q_{Workers} + Q_{Lighting} + Q_{Equipment}$
$Q_{Total\ Internal}$ = 21,750 Btu/hr + 108,000 Btu/hr + 617,600 BTU/hr
$Q_{Total\ Internal}$ = 747,350 Btu/hr

5.2 Determine Process Building Ventilation Requirements:

Cooling Ventilation = Q_s /1.05 x ΔT Ref. 3.1.4, Eq. 2.20, Page 2-15

Where:

$Q_s = Q_{Total\ Internal}$ Sensible Heat

Heat Transfer Factor for 85°F Air = 1.05 Based on $Q = mc_pTD$

ΔT = 10 °F (Allowed temperature rise for ventilation air passing through the Process Building)

Cooling Ventilation = 747,350 Btuh/(1.05 x 10 °F)
Process Building Cooling Ventilation = 71,200 cfm Use 72,000 cfm

5.3 Compare the Cooling Ventilation Rate to Air Changes per Hour (AC/hr):

AC/hr = [1 AC/Building Volume (ft^3)] x Airflow (cfm) x (60 min/hr)

Where: Floor Area = 32,175 ft^2 (Paragraph 3.2.5)

Average Wall Height = 37 ft (Paragraph 3.2.6)

AC/hr = [1 AC/(32,175 ft^2 x 37 ft)] x 72,000 cfm x (60 min/hr)
Process Building Air Change Rate, AC/hr = 3.6 AC/hr

5.4 Provide the Loadout Area with 60,000 cfm minimum ventilation in accordance with Mike McSherry's Dec. 10, 2001 Email to David Beck, Rich Otoski, ... (Attachment A):

Loadout Building Ventilation = 60,000 cfm

Where: Loadout Building Floor Area = 21,375 ft^2 (Paragraph 3.2.5)

Assume an average wall height of 40 ft

AC/hr = [1 AC/(21,375 ft^2 x 40 ft)] x 60,000 cfm x (60 min/hr)
Loadout Building Air Change Rate, AC/hr = 4.2 AC/hr

6.0 Conclusion

Install six 12,000 cfm Roof Exhaust Fans in the Process Building.

Install a combination of two 12,000 cfm Roof Exhaust Fans and four 10,000 cfm Wall Exhaust Fans in the Loadout Building.

7.0 Attachments

Attachment A	12/10/01 Michael McSherry Email to David Beck, Rich Otoski, identifying ventilation requirements for using diesel loaders	1 Sheet

Attachment A

Rich Otoski
12/18/01 08:32 AM

To: Joseph Francis/Boston/FWENC@FWENC
cc:
Subject: Dewatering Plant

----- Forwarded by Rich Otoski/Boston/FWENC on 12/18/2001 08:33 AM -----

Michael McSherry
12/10/2001 12:22 PM

To: David Beck/Boston/FWENC@FWENC, Rich Otoski/Boston/FWENC@FWENC, Peter Vernon/Boston/FWENC@FWENC, Tina Berceli-Boyle/Boston/FWENC@FWENC
cc: George Willant/Boston/FWENC@FWENC
Subject: Dewatering Plant

I have modified the loader emissions spreadsheet, attached, adding the minimum ventilation rate for which the CAT 966g loader with the 3306 DITA engine is approved by MSHA for use in underground coal mines. The ventilation rating for each machine is 15,000 cfm and this is meant to control emissions to CO, CO_2 and NO_x to below the permissible exposure limits. I inserted the 30,000 cfm (2 machines) in the NO_x column. I will forward the MSHA approvals later today.

I recommend we double the recommended ventilation rate to try to maintain the emissions to half the PEL, as a design critieria. This is consistent with USACE expectations in dealing with occupational exposures to air contaminants. This would give us a design criteria of 60,000 cfm for the building or about 4.5 changes per hour.

loader emissions.xl

I called CAT to check on the availability of the MSHA approved engines and also on the availability of HEPA filtration for the operator cabs, but have not heard back from them yet. The reason for the HEPA filtration is that, while the ventilation should control the gaseous contaminants, there are two types of particulates of concern that general dilution ventilation may not be adequate to control.

1. **Diesel exhaust particulate** - although the MSHA approval also includes a ventilation rate for particulate, which is less than the rate for the gaseous contaminants, the testing criteria is 1mg/M^3. The ACGIH has proposed a new TLV for diesel exhuast particulate of 0.02 mg/M^3 as elemental carbon. Should this limit be adopted, the general dilution ventilation may be insufficient to control exposures to this level.
2. The sediment samples showed **crystalline silica** content of 12 - 26%. This would give an exposure limit of as low as 0.36 mg/M^3 of respirable dust. Again, the general dilution ventilation may not be sufficient.

Even if HEPA filtered cabs are available for the operators, I am concerned about the potential for exposures to diesel exhaust particulate and silica dust for the laborers. With an excellent housekeeping program, we may be able to control the exposures to the silica, but the diesel particulate issue may remain. We should discuss the job tasks for the laborers and what, if any, additional engineering controls should be designed in. For example, if a majority of their time is spent observing/monitoring the operations then a filtered air booth should be considered so that they will not have to spend all day in respiratory protection, should the particulate exposures be above the occupational exposure limits.

Mike

CALCULATION COVER SHEET

Sheet ~~0~~ 1 of ~~97~~ 98

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Dredging, Desanding and Dewatering Mass Balance

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-01 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. BRINKMAN

REVIEWED BY R. OTOSKI DATE 5/23/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	JNB 5-15-02	RO 12-02-02	
2	ALL	JNB 11-21-02	RO 12-02-02	

I. Objective

Utilizing the data generated during the Bench Scale Dewatering Tests, mass balances were developed to determine the impacts of various process parameters on the desanding, dewatering and water treatment operations anticipated for New Bedford Harbor OU#1. Process parameters which were varied included in-situ sediment solids content (% by weight), in-situ sand (+200 Mesh) content (% by weight), and % solids (by weight) of the filter cake.

II. Assumptions

In order to develop the mass balances the following assumptions were utilized for each unit operation:

1. Physical Properties

- The 15 sediment samples collected for the bench scale dewatering tests are considered representative of the variety of in-situ conditions anticipated during the dredging. Of New Bedford Harbor OU #1.
- Specific gravity of dry solids within sediment = 2.41
- Specific gravity of seawater = 1.015
- Density of water @ 60 °F = 62.371 lbs/ft^3 (7.4805 gallon/ft^3)

2. Dredging Operations

- A mechanical excavating, hydraulic transport (MEHT) type dredge will be utilized to remove the in-situ sediments for the harbor.
- Dredging operations will be conducted in two 10 hour shifts/day, 6 days/week
- Effective operating time will be 8 hours/shift.
- Solids content of in-situ sediments will be based on sediment samples collected for bench scale dewatering tests.
- +4 inch material will be removed from dredged sediment prior to being transferred to the desanding operations.
- Dredged material will be transferred to the desanding operations in an 10% to 20% solids slurry (by weight).
- Filtrate generated by the dewatering operations will be utilized to produce the 10% to 20% solids (by weight) slurry.
- Filtrate generated by the dewatering system will be acceptable to the dredging contractor for recycle.
- Excavation bucket will be 75% effective during dredging operation (i.e., 25% of each bucket volume is excess seawater).
- Maximum allowable dredge rate limited by maximum feed rate to desanding system, maximum production rate of the dewatering system and maximum treatment capacity of water treatment plant.

3. Desanding Operations

- Desanding operations will separate the +3/8 inch and +200 Mesh material prior to transferring dredged material to the dewatering system.
- +3/8 inch material is 1.1% (by weight) dry solids. Based on data obtained during bench scale dewatering test.
- % solids (by weight) of +200 Mesh material varies from 19% to 80% based on data obtained during bench scale dewatering test.
- Desanding operations will remove 100% of the +3/8 inch material and 70% of the +200 mesh material.
- Separated material will have a solids content of 70% (by weight).
- Desanding operations will operate in parallel with the dredging operations and will be conducted in two 10 hour shifts/day, 6 days/week
- Effective operating time will be 8 hours/shift
- Maximum allowable feed rate to desanding system is 2,500 gpm with a maximum daily total of 1,600,000 gallons based on average slurry content of 15% solids by weight.

4. Dewatering Operations

- Based on the design criteria approved at the December 6, 2001 Dewatering On Board Review Meeting, the dewatering system will include four (4) 650 ft^3, 225 psig diaphragm plate and frame filter presses.
- Dewatering system will operate 24 hours/day, 6 days/week
- Maximum dewatering system production rate is 816 yd^3/day.
- Filter cake will be produced from dredged slurry with the +200 mesh material removed.
- Each filter press will generate 17 yd^3 of filter cake per operating cycle.
- Each filter press completes a full cycle every 2 hours. Therefore, the maximum number of cycles/day is 48.
- % solids of filter cake will average 65% but could vary from 45% to 70% (by weight) depending on the mechanical dewatering systems utilized.

5. Water Treatment Operations

- The existing CDF Cells #1 and #2 will be available for water treatment.
- The water treatment system will operate 24 hours/day, 7 days per week.

III. Development of Mass Balance Inputs

1. In-situ Solids and Sand Content

The maximum, minimum and average values for in-situ solids content and associated sand content (+200 mesh material) of dredged sediments were developed from the 15 sediment samples collected for the bench scale dewatering tests. In addition, values for in-situ solids and sand content for intertidal material were also developed. The sample locations are shown in Figure 1 and the physical parameters for each sample are provided in Table 1.

The minimum in-situ solids content was determined to be 37% (Sample # 3248) and an associated sand content of 19% was used.

The maximum in-situ solids content was determined to be 50% (Sample #3509) and an associated sand content of 55 was used.

The intertidal in-situ solids content was developed using Sample # 3528, 3564, 3231 and 3105. Sample #'s 3528, 3564, and 3231 were collected from an upland or sandy intertidal locations and were determined to be representative of sediment which would contain higher in-situ solids. Sample #3105 was collected from the lower harbor but was included with the other samples due to its comparable sand content. The physical properties for these sediment samples are presented in Table 2. For the purposes of the mass balance calculations an in-situ solids content of 77% and an associated sand content of 80% were utilized.

The average in-situ solids content of the non-intertidal sediments was developed from the remaining sediment samples. The average physical properties for these sediment samples are presented in Table 3. For the purposes of the mass balance calculations an in-situ solids content of 42% and an associated sand content of 32% were utilized.

2. % Solids of Filter Cake

Six filter cake solids content values were selected for performing the mass balance calculations. These values were selected based on the expected performance of the different mechanical dewatering operations as determined by the bench scale dewatering test data. The individual filed measurements for each dewatering test presented in Table 4. The % solids content values and the corresponding dewatering system used for the mass balance calculations are presented in Table 5.

VI. Mass Balance Spreadsheets

Based on the assumptions and bench scale data discussed previously, mass balance spreadsheets were developed for a variety of potential operational conditions. Spreadsheets were developed for each of the following six filter cake % solids (by weight): 45%, 50%, 55%, 60%, 65% and 70%. Process variables that were adjust for each were: a) the solids content of the transfer slurry from the SPU (10%, 15% and 20%), and b) the in-situ solids content and the associated sand content. As a result 12 mass balance spreadsheets for each filter cake % solids were developed.

The dredge rate for each mass balance was adjusted until either the maximum number of plate and frame filter press cycles or the maximum WTP capacity was achieved. A summary of each set of 12 mass balance spreadsheets is provided in Tables 6 through 11. The complete spreadsheet package is included as Attachment 1.

V. Conclusions

Based on the results of the mass balance calculations the following observations were made:

1. Dredging

- Assuming the dredge rates determined in the mass balances are achievable, the limiting factors for a MEHT dredging operation are the desanding system and the mechanical dewatering operation
- The highest dredge rate was 2,384 yd^3/day and occurred at 37% in-situ solids content, 15 and 20% solids dredge transfer slurry, and 70% solids filter cake.
- The lowest dredge rate was 605 yd^3/day and occurred at 77% in-situ solids, 10 to 20% solids dredge transfer slurry, and 45 to 70% solids filter cake.
- The average dredge rate was 2,002 yd^3/day at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

2. Desanding

- The highest flowrate to the desanding system was 1,667 gpm and occurred at a variety of operational conditions.
- The lowest flowrate to the desanding system was 540 gpm and occurred at 37% in-situ solids, 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average flowrate to the desanding system 1,423 gpm and occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

- The largest quantity of +3/8 inch material generated was 17 dry tons/day and occurred at 77% in-situ solids content, 20% solids dredge transfer slurry, and 60 to 70% solids filter cake.
- The lowest quantity of +3/8 inch material generated was 5 dry tons/day and occurred at 37% in-situ solids, 10 to 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average quantity of +3/8 inch material generated was 10 dry tons/day and occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake

- The largest quantity of +200 mesh material generated was 868 dry tons/day and occurred at 77% in-situ solids content, 20% solids dredge transfer slurry, and 65% solids filter cake.
- The lowest quantity of +200 mesh material generated was 66 dry tons/day and occurred at 37% in-situ solids, 10 to 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average quantity of +200 mesh material generated was 213 dry tons/day and occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

3. Dewatering

- The highest flowrate from the desanding operations to the dewatering operations was 1,644 gpm and occurred at 37% in-situ solids content, 10% solids dredge transfer slurry, and 60 to 70% solids filter cake.
- The lowest flowrate from the desanding operation to the dewatering operations was 525 gpm and occurred at 37% in-situ solids, 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average flowrate from the desanding operation to the dewatering operations was 1,376 gpm and occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

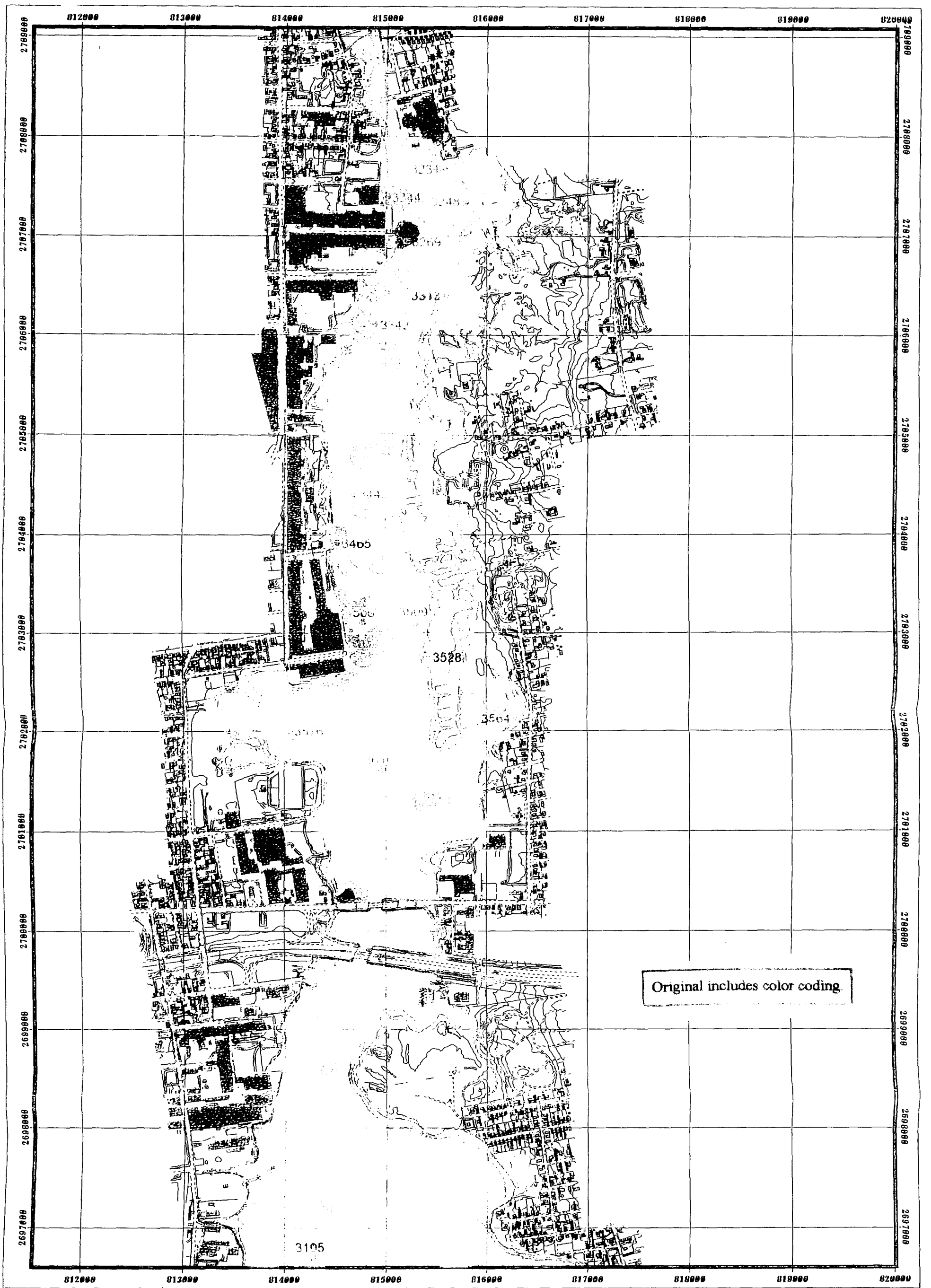
4. Dewatering System Filtrate

- The highest hourly average filtrate flowrate from the dewatering operations was 1,010 gpm and occurred at 37 to 77% in-situ solids content, 10% solids dredge transfer slurry, and 70% solids filter cake.
- The lowest hourly average filtrate flowrate from the dewatering operations was 235 gpm and occurred at 37% in-situ solids, 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average hourly average filtrate flowrate from the dewatering operations is 803 gpm and occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

5. Required WTP Capacity

- The highest required WTP capacity was 267 gpm which occurred at 37% in-situ solids content, 15 and 20% solids dredge transfer slurry, and 70% solids filter cake.
- The lowest required WTP capacity was –32 gpm which occurred at 77% in-situ solids, 15 and 20% solids dredge transfer slurry, and 45% solids filter cake.
- The average required WTP capacity is 196 gpm which occurs at 42% in-situ solids, 15% dredge transfer slurry, and 65% solids filter cake.

Table 12 provides a summary of the maximum/minimum production/flowrates for the five (5) process streams identified above. Only the desanding system will be sized for the maximum flowrate. All other processes will be designed for the average flowrate.



LEGEND

- Sampling Location
- Mean Lower Low Water
- Mean High Water
- Vegetation Line
- Index Contours

Required Dredge Depth
None Required
1 foot
2 feet
3 feet
4 feet

N

300 0 300 600 900 Feet

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION
133 FEDERAL STREET, BOSTON, MASSACHUSETTS 02110

NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

Figure 4-1
Sediment Sampling Locations

SHEET 1 OF 1

DRAFT: DEC 27, 2001

MA STATE PLANE
NAD 83 FEET
NGVD 29
5 FOOT INDEX CONTOUR INTERVAL

P:\GIS\NBH\WORKDIR\11x17phase3dewater.apr

Table 1
Homogenized Sediment Characteristics for All Sampling Locations

Sediment Location/ Sample ID	Visual Description	% Solids by weight (ASTM D2216)	Specific Gravity @ 20°C (ASTM D854)	Organic Matter, % (ASTM D2974)	PCBs (mg/kg)	Weight % Retained 3/8 inch (ASTM D422)	Weight % Retained 100 Mesh (ASTM D422)	Weight % Retained 200 Mesh (ASTM D422)
DWH-3528	silty sand	72.89	2.50	4.05	0.1	0.0	61	81
DWH-3610	silty soils	44.84	2.49	6.00	3.1	0.0	20	26
DWH-3105	silty sand	77.04	2.41	1.64	3.3	1.4	74	81
DWH-3576	silty soils	39.22	2.45	10.30	15.3	0.0	21	26
DWH-3564	silty sand	76.51	2.28	2.52	23.5	0.4	67	84
DWH-3231	silty sand	38.31	2.17	17.40	26.7	1.4	66	74
DWH-3248	silty soils	37.59	2.21	14.10	27.8	0.0	15	19
DWH-3509	silty soils	50.35	2.52	7.30	56.4	0.0	38	48
DWH-3465	silty soils	46.73	2.55	15.60	143.5	12.1	47	55
DWH-3506	silty soils	38.17	2.27	10.80	183.9	0.0	26	31
DWH-3442	silty soils	38.02	2.45	15.20	266.3	0.0	24	28
DWH-3313	silty soils	39.37	2.57	8.48	311.4	0.0	16	26
DWH-3269	silty soils	38.31	2.41	11.30	441.2	0.0	26	31
DWH-3342	silty soils	38.76	2.44	10.30	458.7	0.0	19	24
DWH-3244	silty soils	48.78	2.36	11.20	1366.0	0.0	33	43

Table 2
Homogenized Sediment Characteristics for Silty Sand Sampling Locations

Sediment Location Sample ID	Visual Description	% Solids by Weight (ASTM D2216)	Specific Gravity @ 20°C (ASTM D854)	Organic Matter % (ASTM D2974)	PAHs (mg/kg)	Weight % Retained on Tan (ASTM D422)	Weight % Retained 100 Mesh (ASTM D422)	Weight % Retained 200 Mesh (ASTM D422)
DWH-3528	silty sand	72.89	2.50	4.05	0.1	0.0	61	81
DWH-3105	silty sand	77.04	2.41	1.64	3.3	1.4	74	81
DWH-3564	silty sand	76.51	2.28	2.52	23.5	0.4	67	84
DWH-3231	silty sand	38.31	2.17	17.40	26.7	1.4	66	74

10/98

Table 3
Homogenized Sediment Characteristics for Harbor Sampling Locations

Sediment Location Sample ID	Visual Description	% Solids by Weight (ASTM D2216)	Specific Gravity @ 20°C (ASTM D854)	Organic Matter % (ASTM D2974)	PCBs (mg/kg)	Weight % Retained 3/8 Inch (ASTM D422)	Weight % Retained 100 Mesh (ASTM D422)	Weight % Retained 200 Mesh (ASTM D422)
DWH-3610	silty soils	44.84	2.49	6.00	3.1	0.0	20	26
DWH-3576	silty soils	39.22	2.45	10.30	15.3	0.0	21	26
DWH-3248	silty soils	37.59	2.21	14.10	27.8	0.0	15	19
DWH-3509	silty soils	50.35	2.52	7.30	56.4	0.0	38	48
DWH-3465	silty soils	46.73	2.55	15.60	143.5	12.1	47	55
DWH-3506	silty soils	38.17	2.27	10.80	183.9	0.0	26	31
DWH-3442	silty soils	38.02	2.45	15.20	266.3	0.0	24	28
DWH-3313	silty soils	39.37	2.57	8.48	311.4	0.0	16	26
DWH-3269	silty soils	38.31	2.41	11.30	441.2	0.0	26	31
DWH-3342	silty soils	38.76	2.44	10.30	458.7	0.0	19	24
DWH-3244	silty soils	48.78	2.36	11.20	1366.0	0.0	43	43
Average	**NA**	**42**	**2**	**11**	**298**	**1**	**27**	**32**

11/98

Table 4: Dewatering System Performance Data
Bench Scale Dewatering Test
New Bedford Harbor Superfund Site - OU#1

Sample ID	Percent Solids by Weight			
	225 psi Diaphragm Squeeze	225 psi Diaphragm Squeeze	Recessed Press with 225 psi Fill	Belt Press
3509/100	72.6	NT	62.4	NT
3509/200	71.2	66.5	65.7	50
3610/100	70.3	65.3	60.0	50
3610/200	71.8	NT	60.4	46.8
3465/100	68.1	NT	NT	NT
3465/200	NT	61.1	63.6	45.1
3248/100	NT	66.8	59.4	NT
3248/200	71.1	NT	NT	48.5
3269/100	68.4	NT	66.3	47.5
3269/200	68.2	NT	65.4	NT
3313/100	66.6	NT	64.7	54
3313/200	70.3	NT	55.0	NT
3576/100	NT	69.1	66.2	NT
3576/200	71.4	NT	64.2	50.6
3244/100	70.0	NT	65.0	NT
3244/200	72.2	NT	62.6	51.2
Average	**70.2**	**65.8**	**62.9**	**49.3**
Minimum	**66.6**	**61.1**	**55.0**	**45.1**

Notes:

1. NT = Not Tested
2. A /100 or /200 after the 4 digit ID indicates the mesh size which the slurry was screened through
3. Only results from dewatering tests performed on the 11 sample locations determined to be suitable for dredging were used.

Table 5
Range of % Solids (by weight) Within Filter Cake

% Solids (by Wt)	Dewatering Operation	Comments
70%	Diaphragm plate & frame filter press (225 psig squeeze)	Maximum attainable
65%	Diaphragm plate & frame filter press (225 psig squeeze)	Minimum attainable
60%	Diaphragm plate & frame filter press (100 psig squeeze)	Minimum attainable
55%	Recessed plate & frame filter press (225 psig fill cycle)	Minimum attainable
50%	Belt filter press	Maximum attainable
45%	Belt filter press	Minimum attainable

Table 6: Mass Balance Summary Sheet - 70% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

In-situ Sediment	% solids content by weight	% Sand by weight greater than 200 mesh	Slurry out of SPM % solids by weight	Max Dredge Production (yd³/day)	Desanding Feeding (gpm)	Filtrate to WWTP (gpm)	Filtrate Pumped to Area B (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	106	1011	620	434
			15	1849	1666	163	956	959	672
			20	2260	1479	200	797	1173	821
Low	37.0	19.0	10	1785	1666	200	1010	878	615
			15	2384	1438	267	825	1173	821
			20	2382	1043	267	562	1172	820
Avg	42.0	32.0	10	1515	1666	157	1011	785	550
			15	2262	1608	234	922	1172	821
			20	2262	1168	234	629	1172	821
InterTidal Material	77.0	81.0	10	605	1666	11	1010	433	303
			15	936	1665	17	955	670	469
			20	1289	1666	24	897	923	646

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

1/3/98

Table 7: Mass Balance Summary Sheet - 65% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment Solids Content (% weight)		% Sand by Weight greater than 200 mesh	Stand-alone Cake Solids (% weight)	Max Dredge Production (yd³/day)	Max Desanding Loading (gpm)	Max Filtrate Recycle (gpm)	Filtrate Pumped to Area 3 (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	99	1003	668	434
			15	1849	1666	153	944	1033	672
			20	2000	1309	166	692	1118	726
Low	37.0	19.0	10	1785	1666	191	999	946	615
			15	2110	1272	226	717	1118	727
			20	2110	924	226	414	1118	727
Avg	42.0	32.0	10	1515	1666	148	1001	846	550
			15	2002	1423	196	803	1117	726
			20	2002	1033	196	543	1117	726
InterTidal Material	77.0	81.0	10	605	1666	6	1005	466	303
			15	936	1665	-28	947	721	469
			20	1289	1666	14	885	994	646

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

14/98

Table 8: Mass Balance Summary Sheet - 60% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment % solids content by weight		% Sand by weight greater than 3/8 inch	Equipment Run SPM % solids by weight	Wet Dredge Production yd³/day	Desanding Feeding approx.	Filtrate Pumped to WWTP approx.	Filtrate Pumped to Weir approx.	Solids Produced Total weight tons/day	Solids Production Dry Weight tons/day
High	50.0	55.0	10	1195	1667	91	994	723	434
			15	1765	1591	135	887	1068	641
			20	1765	1155	135	597	1068	641
Low	37.0	19.0	10	1785	1666	180	986	1025	615
			15	1861	1122	187	619	1068	641
			20	1861	815	187	414	1068	641
Avg	42.0	32.0	10	1515	1666	139	989	916	550
			15	1767	1256	162	695	1068	641
			20	1767	912	162	466	1068	641
InterTidal Material	77.0	81.0	10	605	1666	1	999	505	303
			15	936	1665	2	937	782	469
			20	1280	1654	2	866	1069	641

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

Table 9: Mass Balance Summary Sheet - 55% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment % solids content by weight		% Sand by weight greater than 200 mesh	Slurry % solids by weight	Max Dredge Production (yd/day)	Max Desanding Loading (gpm)	Max Filtrate to WWT (gpm)	Filtrate Pumped to Area (gpm)	Solids Production Total weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	82	983	789	434
			15	1549	1396	106	765	1023	563
			20	1549	1014	106	510	1023	563
Low	37.0	19.0	10	1633	1524	152	888	1023	562
			15	1633	985	152	529	1023	562
			20	1633	715	152	349	1023	562
Avg	42.0	32.0	10	1515	1666	127	976	999	550
			15	1551	1102	130	596	1023	563
			20	1551	801	130	395	1023	563
InterTidal Material	77.0	81.0	10	605	1666	-5	991	551	303
			15	936	1665	-8	925	853	469
			20	1123	1451	-10	745	1023	563

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

M/98

Table 10: Mass Balance Summary Sheet - 50% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment % solids content by weight		% sand by weight greater than 200 mesh	Slurry % of SPM in solids by weight	Max Dredge Production kyd3/day	Desanding Loading (gpm)	Water Demand (gpm)	Filtrate Pumped to Area (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	71	970	868	434
			15	1351	1218	80	652	981	491
			20	1351	884	80	430	981	491
Low	37.0	19.0	10	1425	1330	120	761	982	491
			15	1425	859	120	447	982	491
			20	1425	624	120	290	982	491
Avg	42.0	32.0	10	1353	1488	101	857	982	491
			15	1882	1338	184	754	1118	727
			20	1353	698	101	330	982	491
InterTidal Material	77.0	81.0	10	605	1666	-13	982	606	303
			15	936	1665	-20	911	938	469
			20	980	1266	-21	636	982	491

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

18/96

Table 11: Mass Balance Summary Sheet - 45% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment % solids content by weight		% Sand by weight greater than 3/8 inch screen	Slurry % solids by weight	Max Dredge Production (yd3/day)	Max Desanding Loading (gpm)	Max Filtrate to WTF (gpm)	Filtrate Pumped to Area C (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1168	1629	56	933	943	424
			15	1168	1053	56	549	943	424
			20	1168	764	56	356	943	424
Low	37.0	19.0	10	1232	1150	91	642	943	424
			15	1232	743	91	371	943	424
			20	1232	540	91	235	943	424
Avg	42.0	32.0	10	1170	1287	74	725	943	424
			15	1170	832	74	422	943	424
			20	1170	604	74	270	943	424
InterTidal Material	77.0	81.0	10	605	1666	-23	971	674	303
			15	847	1507	-32	809	943	424
			20	847	1094	-32	534	943	424

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

19/98

Table 12
Summary of Project Production/Flowrates
New Bedford Harbor Superfund Site – OU#1

PROCESS STREAM DESCRIPTION	AVERAGE	MAXIMUM	MINIMUM
Dredge Production Rate (yd^3/day)	2,002	2,384	605
Desanding System Influent (gpm)	1,423	1,667	540
+3/8 inch Material Removal (dry tons/day)	10	17	5
+200 Mesh Material Removal (dry tons/day)	213	868	66
Dewatering System Influent from Desanding Operations (gpm)	1,376	1,644	525
Dewatering System Filtrate Flowrate (gpm)	803	1,010	235
Required WTP Capacity (gpm)	196	267	-32

Notes:

1. All values based on dredging, desanding, and dewatering mass balance calculation.

ATTACHMENT #1

Mass Balance Spreadsheets

21/96

Table 6: Mass Balance Summary Sheet - 70% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

In-situ Sediment % solids content by weight		% Sand by weight greater than 200 mesh	Slurry out of SPU % solids by weight	Max Dredge Production (yd3/day)	Desanding Loading (gpm)	Filtrate Recycled (gpm)	Filtrate Pumped to WWTP (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	106	1011	620	434
			15	1849	1666	163	956	959	672
			20	2260	1479	200	797	1173	821
Low	37.0	19.0	10	1785	1666	200	1010	878	615
			15	2384	1438	267	825	1173	821
			20	2382	1043	267	562	1172	820
Avg	42.0	32.0	10	1515	1666	157	1011	785	550
			15	2262	1608	234	922	1172	821
			20	2262	1168	234	629	1172	821
InterTidal Material	77.0	81.0	10	605	1666	11	1010	433	303
			15	936	1665	17	955	670	469
			20	1289	1666	24	897	923	646

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

37% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	10	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.37	lbs/ft^3
	8.5275	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,785	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,380	yd^3/day
Volume of excess seawater =	595	yd^3/day
Volume of excess seawater =	120,174	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,941	718	1,223	1,785	354	1,431	289,032
Excess water in bucket	1B	0	509	0	509	595	0.00	595	120,174
Total from dredge	**1**	**29**	**2,460**	**718**	**1,732**	**2,380**	**354**	**2,026**	**409,206**
Recycled in to SPU	2A	0	4,663	0	4,663	5,538	0	5,538	1,118,532
Out SPU	2	10	7,183	718	6,395	7,918	354	7,564	1,527,738
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	136	96	41	95	47	48	9,876
Out sand separation	3	8.74	7,035	615	6,420	7,815	303	7,512	1,517,262
Polymer addition	4	0.5							
Filter Cake	5	70	878	615	264	611	303	308	62,274
Required Press Capacity (cycles/day)*						36			
Filtrate to Sawyer St. CDFs	6	0	6,157	0	6,157	7,204	0	7,204	1,454,989
Recycling from press to SPU	2A	0	4,663	0	4,663	0	0	5,538	1,118,532
Filtrate to treatment	7	0	1,494	0	1,494	99,951	0	99,951	336,457
Required WTP Capacity (gpm)									200

* - Assumes 17 yd^3/cycle

22/46

42% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	[illegible]	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.15	
Density of water @ 60 F =	62.111	lbs/ft^3
	8.3111	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,515	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,020	yd^3/day
Volume of excess seawater =	505	yd^3/day
Volume of excess seawater =	101,997	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,711	718	992	1,515	354	1,161	234,479
Excess water in bucket	1B	0	432	0	432	505	0.00	505	101,997
Total from dredge	**1**	**34**	**2,142**	**718**	**1,424**	**2,020**	**354**	**1,666**	**336,476**
Recycled in to SPU	2A	0	4,968	0	4,968	5,900	0	5,900	1,191,681
Out SPU	2	10	7,185	718	6,392	7,920	354	7,566	1,528,156
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	230	161	69	160	79	81	16,300
Out sand separation	3	7.92	6,944	550	6,394	7,752	271	7,481	1,511,056
Polymer addition	4	0.5							
Filter Cake	5	70	785	550	236	546	271	276	55,669
Required Press Capacity (cycles/day)*						32			
Filtrate to Sawyer St. CDFs	6	0	6,158	0	6,158	7,206	0	7,206	1,455,387
Recycling from press to SPU	2A	*0*	*4,968*	*0*	*4,968*	*0*	0	5,900	1,191,681
Filtrate to treatment	7	0	1,190	0	1,190	78,339	0	78,339	263,706
Required WTP Capacity (gpm)									157

* - Assumes 17 yd^3/cycle

23/48

50% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	55	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.371	lb/ft^3
	8.3278	lb/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,195	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,593	yd^3/day
Volume of excess seawater =	398	yd^3/day
Volume of excess seawater =	80,453	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	1,437	719	719	1,195	354	841	169,832
Excess water in bucket	1B	0	340	0	340	398	0.00	398	80,453
Total from dredge	**1**	**40**	**1,778**	**719**	**1,059**	**1,593**	**354**	**1,239**	**250,285**
Recycled in to SPU	2A	0	5,329	0	5,329	6,329	0	6,329	1,278,203
Out SPU	2	10	7,186	719	6,388	7,922	354	7,568	1,528,487
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.90	3.96	813
plus 200 mesh	3B	70	395	277	119	275	136	139	28,022
Out sand separation	3	6.40	6,780	434	6,346	7,639	214	7,425	1,499,665
Polymer addition	4	0.5							
Filter Cake	5	70	620	434	186	432	214	218	43,962
Required Press Capacity (cycles/day)*						25			
Filtrate to Sawyer St. CDFs	6	0	6,160	0	6,160	7,207	0	7,207	1,455,702
Recycling from press to SPU	2A	0	5,329	0	5,329	0	0	6,329	1,278,203
Filtrate to treatment	7	0	831	0	831	52,730	0	52,730	177,500
Required WTP Capacity (gpm)									106

* - Assumes 17 yd^3/cycle

77% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	[illegible]	
% Sand =	61	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	[illegible]	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	605	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	807	yd^3/day
Volume of excess seawater =	202	yd^3/day
Volume of excess seawater =	40,731	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	933	718	215	605	354	251	50,703
Excess water in bucket	1B	0	172	0	172	202	0.00	202	40,731
Total from dredge	**1**	**65**	**1,105**	**718**	**387**	**807**	**354**	**453**	**91,435**
Recycled in to SPU	2A	0	5,988	0	5,988	7,111	0	7,111	1,436,282
Out SPU	2	10	7,183	718	6,375	7,918	354	7,564	1,527,717
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	582	407	175	405	201	204	41,248
Out sand separation	3	4.60	6,590	303	6,287	7,505	149	7,356	1,485,669
Polymer addition	4	0.5							
Filter Cake	5	70	433	303	130	301	149	152	30,700
Required Press Capacity (cycles/day)*						18			
Filtrate to Sawyer St. CDFs	6	0	6,157	0	6,157	7,204	0	7,204	1,454,969
Recycling from press to SPU	2A	0	5,988	0	5,988	0	0	7,111	1,436,282
Filtrate to treatment	7	0	169	0	169	5,551	0	5,551	18,686
Required WTP Capacity (gpm)									11

* - Assumes 17 yd^3/cycle

37% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	41	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.371	lb/ft^3
	8.4375	lb/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,384	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	3,179	yd^3/day
Volume of excess seawater =	795	yd^3/day
Volume of excess seawater =	160,502	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,593	959	1,633	2,384	473	1,911	386,023
Excess water in bucket	1B	0	679	0	679	795	0.00	795	160,502
Total from dredge	**1**	**29**	**3,272**	**959**	**2,313**	**3,179**	**473**	**2,706**	**546,525**
Recycled in to SPU	2A	0	3,077	0	3,077	3,655	0	3,655	738,176
Out SPU	2	15	6,395	959	5,390	6,833	473	6,361	1,284,701
plus 3/8 mesh (1.1% of solids)	3A	70	15.07	11	4.52	10.49	5.20	5.29	1,085
plus 200 mesh	3B	70	182	128	55	127	63	64	12,923
Out sand separation	3	13.25	6,198	821	5,377	6,696	405	6,291	1,270,710
Polymer addition	4	0.5							
Filter Cake	5	70	1,173	821	352	816	405	412	83,171
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	5,025	0	5,025	5,880	0	5,880	1,187,539
Recycling from press to SPU	2A	0	3,077	0	3,077	0	0	3,655	738,176
Filtrate to treatment	7	0	1,948	0	1,948	133,491	0	133,491	449,363
Required WTP Capacity (gpm)									267

* - Assumes 17 yd^3/cycle

24/36

42% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	42	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.03	
Density of water @ 60 F =	64.31	lbs/ft^3
	8.27	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,262	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	3,016	yd^3/day
Volume of excess seawater =	754	yd^3/day
Volume of excess seawater =	152,288	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	2,554	1,073	1,481	2,262	529	1,733	350,093
Excess water in bucket	1B	0	644	0	644	754	0.00	754	152,288
Total from dredge	**1**	**34**	**3,199**	**1,073**	**2,126**	**3,015**	**529**	**2,487**	**502,382**
Recycled in to SPU	2A	0	3,895	0	3,895	4,625	0	4,625	934,209
Out SPU	2	15	7,152	1,073	6,020	7,641	529	7,113	1,436,590
plus 3/8 mesh (1.1% of solids)	3A	70	16.86	12	5.06	11.73	5.82	5.92	1,213
plus 200 mesh	3B	70	343	240	103	239	118	120	24,338
Out sand separation	3	12.08	6,791	821	5,971	7,391	404	6,986	1,411,058
Polymer addition	4	0.5							
Filter Cake	5	70	1,172	821	352	816	404	412	83,117
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	5,619	0	5,619	6,575	0	6,575	1,327,941
Recycling from press to SPU	2A	0	3,895	0	3,895	0	0	4,625	934,209
Filtrate to treatment	7	0	1,724	0	1,724	116,965	0	116,965	393,732
Required WTP Capacity (gpm)									234

* - Assumes 17 yd^3/cycle

50% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	75%	
% Sand Removal	70%	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.371	lbs/ft^3
	8.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,849	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,465	yd^3/day
Volume of excess seawater =	616	yd^3/day
Volume of excess seawater =	124,483	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,224	1,112	1,112	1,849	548	1,301	262,778
Excess water in bucket	1B	0	527	0	527	616	0.00	616	124,483
Total from dredge	**1**	**40**	**2,751**	**1,112**	**1,639**	**2,465**	**548**	**1,917**	**387,261**
Recycled in to SPU	2A	0	4,593	0	4,593	5,455	0	5,455	1,101,812
Out SPU	2	15	7,413	1,112	6,232	7,921	548	7,373	1,489,073
plus 3/8 mesh (1.1% of solids)	3A	70	17.47	12	5.24	12.16	6.03	6.13	1,257
plus 200 mesh	3B	70	612	428	183	426	211	215	43,358
Out sand separation	3	9.90	6,784	672	6,112	7,483	331	7,152	1,444,476
Polymer addition	4	0.5							
Filter Cake	5	70	959	672	288	668	331	337	68,022
Required Press Capacity (cycles/day)*						39			
Filtrate to Sawyer St. CDFs	6	0	5,824	0	5,824	6,815	0	6,815	1,376,454
Recycling from press to SPU	2A	0	4,593	0	4,593	0	0	5,455	1,101,812
Filtrate to treatment	7	0	1,231	0	1,231	81,587	0	81,587	274,642
Required WTP Capacity (gpm)									163

* - Assumes 17 yd^3/cycle

77% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	41	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	[illegible]	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	936	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (i.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,248	yd^3/day
Volume of excess seawater =	312	yd^3/day
Volume of excess seawater =	63,016	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,443	1,111	332	936	548	388	78,444
Excess water in bucket	1B	0	267	0	267	312	0.00	312	63,016
Total from dredge	**1**	**65**	**1,710**	**1,111**	**599**	**1,248**	**548**	**700**	**141,460**
Recycled in to SPU	2A	0	5,614	0	5,614	6,668	0	6,668	1,346,697
Out SPU	2	15	7,408	1,111	6,213	7,916	546	7,368	1,488,156
plus 3/8 mesh (1.1% of solids)	3A	70	17.46	12	5.24	12.15	6.02	6.13	1,257
plus 200 mesh	3B	70	900	630	270	626	310	316	63,816
Out sand separation	3	7.22	6,491	469	6,022	7,277	231	7,046	1,423,103
Polymer addition	4	0.5							
Filter Cake	5	70	670	469	201	466	231	235	47,496
Required Press Capacity (cycles/day)*						27			
Filtrate to Sawyer St. CDFs	6	0	5,821	0	5,821	6,811	0	6,811	1,375,607
Recycling from press to SPU	2A	0	5,614	0	5,614	0	0	6,668	1,346,697
Filtrate to treatment	7	0	207	0	207	8,588	0	8,588	28,910
Required WTP Capacity (gpm)									17

* - Assumes 17 yd^3/cycle

37% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37%	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	60	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.04	
Density of water @ 60 F =	63.371	lbs/ft^3
	0.472	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,382	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	3,176	yd^3/day
Volume of excess seawater =	794	yd^3/day
Volume of excess seawater =	160,367	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,591	959	1,632	2,382	472	1,910	385,699
Excess water in bucket	1B	0	679	0	679	794	0.00	794	160,367
Total from dredge	**1**	**29**	**3,269**	**959**	**2,311**	**3,176**	**472**	**2,704**	**546,066**
Recycled in to SPU	2A	0	1,501	0	1,501	1,783	0	1,783	360,021
Out SPU	2	20	4,793	959	3,812	4,959	472	4,486	906,087
plus 3/8 mesh (1.1% of solids)	3A	70	15.06	11	4.52	10.48	5.20	5.29	1,084
plus 200 mesh	3B	70	182	127	55	127	63	64	12,912
Out sand separation	3	17.85	4,595	820	3,775	4,821	404	4,417	892,107
Polymer addition	4	0.5							
Filter Cake	5	70	1,172	820	352	816	404	411	83,101
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,423	0	3,423	4,006	0	4,006	809,006
Recycling from press to SPU	2A	0	1,501	0	1,501	0	0	1,783	360,021
Filtrate to treatment	7	0	1,922	0	1,922	133,379	0	133,379	448,986
Required WTP Capacity (gpm)									267

* - Assumes 17 yd^3/cycle

42% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	16	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.24	lbs/ft^3
	8.4776	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,262	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	3,016	yd^3/day
Volume of excess seawater =	754	yd^3/day
Volume of excess seawater =	152,288	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	2,554	1,073	1,481	2,262	529	1,733	350,093
Excess water in bucket	1B	0	644	0	644	754	0.00	754	152,288
Total from dredge	**1**	**34**	**3,199**	**1,073**	**2,126**	**3,016**	**529**	**2,487**	**502,382**
Recycled in to SPU	2A	0	2,133	0	2,133	2,533	0	2,533	511,682
Out SPU	2	20	5,364	1,073	4,259	5,549	529	5,021	1,014,064
plus 3/8 mesh (1.1% of solids)	3A	70	16.86	12	5.06	11.73	5.82	5.92	1,213
plus 200 mesh	3B	70	343	240	103	239	118	120	24,338
Out sand separation	3	16.40	5,004	821	4,183	5,299	404	4,894	988,531
Polymer addition	4	0.5							
Filter Cake	5	70	1,172	821	352	816	404	412	83,117
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,831	0	3,831	4,483	0	4,483	905,414
Recycling from press to SPU	2A	0	2,133	0	2,133	0	0	2,533	511,682
Filtrate to treatment	7	0	1,698	0	1,698	116,965	0	116,965	393,732
Required WTP Capacity (gpm)									234

* - Assumes 17 yd^3/cycle

50% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	25	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.371	lbs/ft^3
	8.5376	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,260	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	3,013	yd^3/day
Volume of excess seawater =	753	yd^3/day
Volume of excess seawater =	152,154	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,718	1,359	1,359	2,260	670	1,590	321,188
Excess water in bucket	1B	0	644	0	644	753	0.00	753	152,154
Total from dredge	**1**	**40**	**3,362**	**1,359**	**2,003**	**3,013**	**670**	**2,344**	**473,342**
Recycled in to SPU	2A	0	3,383	0	3,383	4,017	0	4,017	811,412
Out SPU	2	20	6,795	1,359	5,386	7,031	670	6,361	1,284,754
plus 3/8 mesh (1.1% of solids)	3A	70	21.36	15	6.41	14.86	7.37	7.50	1,537
plus 200 mesh	3B	70	747	523	224	520	258	262	52,996
Out sand separation	3	13.62	6,027	821	5,206	6,496	405	6,091	1,230,243
Polymer addition	4	0.5							
Filter Cake	5	70	1,173	821	352	816	405	412	83,142
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,854	0	4,854	5,679	0	5,679	1,147,102
Recycling from press to SPU	2A	0	3,383	0	3,383	0	0	4,017	811,412
Filtrate to treatment	7	0	1,471	0	1,471	99,723	0	99,723	335,690
Required WTP Capacity (gpm)									200

* - Assumes 17 yd^3/cycle

31/48

77% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 70% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77%	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	20%	
% Sand Removal =	70%	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.21	lbs/ft^3
	8.217	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,289	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,719	yd^3/day
Volume of excess seawater =	430	yd^3/day
Volume of excess seawater =	86,781	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,987	1,530	457	1,289	754	535	108,028
Excess water in bucket	1B	0	367	0	367	430	0.00	430	86,781
Total from dredge	**1**	**65**	**2,355**	**1,530**	**824**	**1,719**	**754**	**965**	**194,809**
Recycled in to SPU	2A	0	5,219	0	5,219	6,198	0	6,198	1,251,823
Out SPU	2	20	7,652	1,530	6,043	7,917	754	7,162	1,446,632
plus 3/8 mesh (1.1% of solids)	3A	70	24.05	17	7.21	16.74	8.30	8.44	1,731
plus 200 mesh	3B	70	1,240	868	372	863	428	435	87,883
Out sand separation	3	10.11	6,368	646	5,742	7,037	318	6,719	1,357,044
Polymer addition	4	0.5							
Filter Cake	5	70	923	646	277	642	318	324	65,408
Required Press Capacity (cycles/day)*						38			
Filtrate to Sawyer St. CDFs	6	0	5,465	0	5,465	6,395	0	6,395	1,291,635
Recycling from press to SPU	2A	0	5,219	0	5,219	0	0	6,198	1,251,823
Filtrate to treatment	7	0	247	0	247	11,827	0	11,827	39,813
Required WTP Capacity (gpm)									24

* - Assumes 17 yd^3/cycle

Table 7: Mass Balance Summary Sheet - 65% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Item	Sediment % solids content by weight	% Sand by weight greater than 200 mesh	Stock pile % solids by weight	Max Dredge Production (yd3/day)	Max Desanding Loading (gpm)	Max Filtrate to WWT (gpm)	Filtrate Pumped to Area C (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	99	1003	668	434
			15	1849	1666	153	944	1033	672
			20	2000	1309	166	692	1118	726
Low	37.0	19.0	10	1785	1666	191	999	946	615
			15	2110	1272	226	717	1118	727
			20	2110	924	226	414	1118	727
Avg	42.0	32.0	10	1515	1666	148	1001	846	550
			15	2002	1423	196	803	1117	726
			20	2002	1033	196	543	1117	726
InterTidal Material	77.0	81.0	10	605	1666	6	1005	466	303
			15	936	1665	-28	947	721	469
			20	1289	1666	14	885	994	646

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

37% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	12	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.24	lbs/ft^3
	8.476	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,785	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,380	yd^3/day
Volume of excess seawater =	595	yd^3/day
Volume of excess seawater =	120,174	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,941	718	1,223	1,785	354	1,431	289,032
Excess water in bucket	1B	0	509	0	509	595	0.00	595	120,174
Total from dredge	**1**	**29**	**2,450**	**718**	**1,732**	**2,380**	**354**	**2,026**	**409,206**
Recycled in to SPU	2A	0	4,663	0	4,663	5,538	0	5,538	1,118,532
Out SPU	2	10	7,183	718	6,395	7,918	354	7,564	1,527,738
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	136	96	41	95	47	48	9,676
Out sand separation	3	8.74	7,035	615	6,420	7,815	303	7,512	1,517,262
Polymer addition	4	0.5							
Filter Cake	5	65	946	615	331	690	303	387	78,241
Required Press Capacity (cycles/day)*						41			
Filtrate to Sawyer St. CDFs	6	0	6,089	0	6,089	7,125	0	7,125	1,439,021
Recycling from press to SPU	2A	0	4,663	0	4,663	0	0	5,538	1,118,532
Filtrate to treatment	7	0	1,426	0	1,426	95,207	0	95,207	320,489
Required WTP Capacity (gpm)									191

* - Assumes 17 yd^3/cycle

37 of 78

42% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	[illegible]	
% Sand =	[illegible]	
% Sand Removal =	[illegible]	

Seawater Properties

Specific Gravity =	[illegible]	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,515	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,020	yd^3/day
Volume of excess seawater =	505	yd^3/day
Volume of excess seawater =	101,997	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,711	718	992	1,515	354	1,161	234,479
Excess water in bucket	1B	0	432	0	432	505	0.00	505	101,997
Total from dredge	**1**	**34**	**2,142**	**718**	**1,424**	**2,020**	**354**	**1,666**	**336,476**
Recycled in to SPU	2A	0	4,968	0	4,968	5,900	0	5,900	1,191,681
Out SPU	2	10	7,185	718	6,392	7,920	354	7,566	1,528,156
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	230	161	69	160	79	81	16,300
Out sand separation	3	7.92	6,944	550	6,394	7,752	271	7,481	1,511,056
Polymer addition	4	0.5							
Filter Cake	5	65	845.6	550	296	617	271	346	69,943
Required Press Capacity (cycles/day)*						36			
Filtrate to Sawyer St: CDFs	6	0	6,098	0	6,098	7,135	0	7,135	1,441,113
Recycling from press to SPU	2A	0	4,968	0	4,968	0	0	5,900	1,191,881
Filtrate to treatment	7	0	1,130	0	1,130	74,098	0	74,098	249,432
Required WTP Capacity (gpm)									148

* - Assumes 17 yd^3/cycle

36/36

50% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	65	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.371	lbs/ft^3
	8.4475	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,195	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,593	yd^3/day
Volume of excess seawater =	398	yd^3/day
Volume of excess seawater =	80,453	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	1,437	719	719	1,195	354	841	169,832
Excess water in bucket	1B	0	340	0	340	398	0.00	398	80,453
Total from dredge	**1**	**40**	**1,778**	**719**	**1,059**	**1,593**	**354**	**1,239**	**250,285**
Recycled in to SPU	2A	0	5,329	0	5,329	6,329	0	6,329	1,278,203
Out SPU	2	10	7,186	719	6,388	7,922	354	7,568	1,528,487
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.90	3.96	813
plus 200 mesh	3B	70	395	277	119	275	136	139	28,022
Out sand separation	3	6.40	6,780	434	6,346	7,639	214	7,425	1,499,665
Polymer addition	4	0.5							
Filter Cake	5	65	667.8	434.1	234	487	214	273	55,235
Required Press Capacity (cycles/day)*						29			
Filtrate to Sawyer St. CDFs	6	0	6,112	0	6,112	7,152	0	7,152	1,444,430
Recycling from press to SPU	2A	0	5,329	0	5,329	0	0	6,329	1,278,203
Filtrate to treatment	7	0	783	0	783	49,381	0	49,381	166,227
Required WTP Capacity (gpm)									99

* - Assumes 17 yd^3/cycle

3 of 6

77% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	35	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.377	lbs/ft^3
	8.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	605	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	807	yd^3/day
Volume of excess seawater =	202	yd^3/day
Volume of excess seawater =	40,731	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	933	718	215	605	354	251	50,703
Excess water in bucket	1B	0	172	0	172	202	0.00	202	40,731
Total from dredge	**1**	**65**	**1,105**	**718**	**387**	**807**	**354**	**453**	**91,435**
Recycled in to SPU	2A	0	5,988	0	5,988	7,111	0	7,111	1,436,282
Out SPU	2	10	7,183	718	6,375	7,918	354	7,564	1,527,717
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	582	407	175	405	201	204	41,248
Out sand separation	3	4.60	6,590	303	6,287	7,505	149	7,356	1,485,669
Polymer addition	4	0.5							
Filter Cake	5	65	466	303	163	340	149	191	38,572
Required Press Capacity (cycles/day)*						20			
Filtrate to Sawyer St. CDFs	6	0	6,123	0	6,123	7,165	0	7,165	1,447,097
Recycling from press to SPU	2A	0	5,988	0	5,988	0	0	7,111	1,436,282
Filtrate to treatment	7	0	136	0	136	3,213	0	3,213	10,815
Required WTP Capacity (gpm)									6

* - Assumes 17 yd^3/cycle

37% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	[illegible]	
% Sand =	[illegible]	
% Sand Removal =	[illegible]	

Seawater Properties

Specific Gravity =	[illegible]	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,110	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,813	yd^3/day
Volume of excess seawater =	703	yd^3/day
Volume of excess seawater =	142,055	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,295	849	1,446	2,110	418	1,692	341,656
Excess water in bucket	1B	0	601	0	601	703	0.00	703	142,055
Total from dredge	**1**	**29**	**2,896**	**849**	**2,047**	**2,813**	**418**	**2,395**	**483,711**
Recycled in to SPU	2A	0	2,724	0	2,724	3,235	0	3,235	653,335
Out SPU	2	15	5,660	849	4,770	6,048	418	5,630	1,137,047
plus 3/8 mesh (1.1% of solids)	3A	70	13.34	9	4.00	9.29	4.60	4.68	960
plus 200 mesh	3B	70	161	113	48	112	56	57	11,437
Out sand separation	3	13.25	5,486	727	4,759	5,927	358	5,568	1,124,663
Polymer addition	4	0.5							
Filter Cake	5	65	1,118	727	391	816	358	458	92,487
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,368	0	4,368	5,110	0	5,110	1,032,177
Recycling from press to SPU	2A	0	2,724	0	2,724	0	0	3,235	653,335
Filtrate to treatment	7	0	1,644	0	1,644	112,542	0	112,542	378,841
Required WTP Capacity (gpm)									226

* - Assumes 17 yd^3/cycle

42% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	12	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.21	lbs/ft^3
	8.3111	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,002	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (i.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,669	yd^3/day
Volume of excess seawater =	667	yd^3/day
Volume of excess seawater =	134,784	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	2,261	949	1,311	2,002	468	1,534	309,853
Excess water in bucket	1B	0	570	0	570	667	0.00	667	134,784
Total from dredge	**1**	**34**	**2,831**	**949**	**1,881**	**2,669**	**468**	**2,201**	**444,637**
Recycled in to SPU	2A	0	3,447	0	3,447	4,094	0	4,094	826,828
Out SPU	2	15	6,330	949	5,328	6,763	468	6,295	1,271,465
plus 3/8 mesh (1.1% of solids)	3A	70	14.92	10	4.48	10.38	5.15	5.24	1,074
plus 200 mesh	3B	70	304	213	91	211	105	107	21,540
Out sand separation	3	12.08	6,011	726	5,284	6,541	358	6,183	1,248,867
Polymer addition	4	0.5							
Filter Cake	5	65	1,117	726	391	816	358	458	92,426
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,893	0	4,893	5,726	0	5,726	1,156,441
Recycling from press to SPU	2A	0	3,447	0	3,447	0	0	4,094	826,828
Filtrate to treatment	7	0	1,446	0	1,446	97,918	0	97,918	329,613
Required WTP Capacity (gpm)									196

polymer addition (4 lbs/dry ton) =		2905	lbs/day
	=	18	gal/hr
	=	1156	gpm @ 0.5%

* - Assumes 17 yd^3/cycle

4C/96

50% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	55	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.375	lbs/ft^3
	8.3375	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,849	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,465	yd^3/day
Volume of excess seawater =	616	yd^3/day
Volume of excess seawater =	124,483	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,224	1,112	1,112	1,849	548	1,301	262,778
Excess water in bucket	1B	0	527	0	527	616	0.00	616	124,483
Total from dredge	1	**40**	**2,751**	**1,112**	**1,639**	**2,465**	**548**	**1,917**	**387,261**
Recycled in to SPU	2A	0	4,593	0	4,593	5,455	0	5,455	1,101,812
Out SPU	2	15	7,413	1,112	6,232	7,921	548	7,373	1,489,073
plus 3/8 mesh (1.1% of solids)	3A	70	17.47	12	5.24	12.16	6.03	6.13	1,257
plus 200 mesh	3B	70	612	428	183	426	211	215	43,358
Out sand separation	3	9.90	6,784	672	6,112	7,483	331	7,152	1,444,476
Polymer addition	4	0.5							
Filter Cake	5	65	1,033	672	362	754	331	423	85,463
Required Press Capacity (cycles/day)*						44			
Filtrate to Sawyer St. CDFs	6	0	5,751	0	5,751	6,729	0	6,729	1,359,013
Recycling from press to SPU	2A	0	4,593	0	4,593	0	0	5,455	1,101,812
Filtrate to treatment	7	0	1,157	0	1,157	76,406	0	76,406	257,200
Required WTP Capacity (gpm)									153

* - Assumes 17 yd^3/cycle

77% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	81	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	0.9	
Density of water @ 60 F =	62.37	lbs/ft^3
	8.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	936	in-situ yd^3/day
Assumed excavation bucket is	100%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	936	yd^3/day
Volume of excess seawater =	0	yd^3/day
Volume of excess seawater =	0	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,443	1,111	332	936	548	388	78,444
Excess water in bucket	1B	0	0	0	0	0	0.00	0	0
Total from dredge	**1**	**77**	**1,443**	**1,111**	**332**	**936**	**548**	**388**	**78,444**
Recycled in to SPU	2A	0	5,877	0	5,877	6,980	0	6,980	1,409,713
Out SPU	2	15	7,408	1,111	6,209	7,916	548	7,368	1,488,156
plus 3/8 mesh (1.1% of solids)	3A	70	17.46	12	5.24	12.15	6.02	6.13	1,257
plus 200 mesh	3B	70	900	630	270	626	310	316	63,816
Out sand separation	3	7.22	6,491	469	6,022	7,277	231	7,046	1,423,103
Polymer addition	4	0.5							
Filter Cake	5	65	721	469	253	527	231	295	59,674
Required Press Capacity (cycles/day)*						31			
Filtrate to Sawyer St. CDFs	6	0	5,769	0	5,769	6,751	0	6,751	1,363,428
Recycling from press to SPU	2A	0	5,877	0	5,877	0	0	6,980	1,409,713
Filtrate to treatment	7	0	-108	0	-108	-13,750	0	-13,750	-46,284
Required WTP Capacity (gpm)									-28

* - Assumes 17 yd^3/cycle

A-4/48

37% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	15	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.15	
Density of water @ 60 F =	62.374	lbs/ft^3
	8.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,110	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,813	yd^3/day
Volume of excess seawater =	703	yd^3/day
Volume of excess seawater =	142,055	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,295	849	1,446	2,110	418	1,692	341,656
Excess water in bucket	1B	0	601	0	601	703	0.00	703	142,055
Total from dredge	**1**	**29**	**2,896**	**849**	**2,047**	**2,813**	**418**	**2,395**	**483,711**
Recycled in to SPU	2A	0	1,330	0	1,330	1,579	0	1,579	318,910
Out SPU	2	20	4,245	849	3,376	4,392	418	3,974	802,621
plus 3/8 mesh (1.1% of solids)	3A	70	13.34	9	4.00	9.29	4.60	4.68	960
plus 200 mesh	3B	70	161	113	48	112	56	57	11,437
Out sand separation	3	17.85	4,071	727	3,344	4,271	358	3,913	790,238
Polymer addition	4	0.5							
Filter Cake	5	65	1,118	727	391	816	358	458	92,487
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	2,952	0	2,952	3,455	0	3,455	697,751
Recycling from press to SPU	2A	0	1,330	0	1,330	0	0	1,579	318,910
Filtrate to treatment	7	0	1,623	0	1,623	112,542	0	112,542	378,841
Required WTP Capacity (gpm)									226

* - Assumes 17 yd^3/cycle

A-1/25

42% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	20	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.15	
Density of water @ 60 F =	62.31	lbs/ft^3
	8.3174	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,002	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,669	yd^3/day
Volume of excess seawater =	667	yd^3/day
Volume of excess seawater =	134,784	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	2,261	949	1,311	2,002	468	1,534	309,853
Excess water in bucket	1B	0	570	0	570	667	0.00	667	134,784
Total from dredge	**1**	**34**	**2,831**	**949**	**1,881**	**2,669**	**468**	**2,201**	**444,637**
Recycled in to SPU	2A	0	1,888	0	1,888	2,242	0	2,242	452,868
Out SPU	2	20	4,747	949	3,769	4,912	468	4,444	897,505
plus 3/8 mesh (1.1% of solids)	3A	70	14.92	10	4.48	10.38	5.15	5.24	1,074
plus 200 mesh	3B	70	304	213	91	211	105	107	21,540
Out sand separation	3	16.40	4,428	726	3,702	4,690	358	4,332	874,907
Polymer addition	4	0.5							
Filter Cake	5	65	1,117	726	391	816	358	458	92,426
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,311	0	3,311	3,874	0	3,874	782,481
Recycling from press to SPU	2A	0	1,888	0	1,888	0	0	2,242	452,868
Filtrate to treatment	7	0	1,423	0	1,423	97,918	0	97,918	329,613
Required WTP Capacity (gpm)									196

* - Assumes 17 yd^3/cycle

50% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50%	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	35	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.37	lbs/ft^3
	8.34776	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	2,000	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,667	yd^3/day
Volume of excess seawater =	667	yd^3/day
Volume of excess seawater =	134,649	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,405	1,203	1,203	2,000	593	1,407	284,238
Excess water in bucket	1B	0	570	0	570	667	0.00	667	134,649
Total from dredge	**1**	**40**	**2,975**	**1,203**	**1,772**	**2,667**	**593**	**2,074**	**418,887**
Recycled in to SPU	2A	0	2,994	0	2,994	3,555	0	3,555	718,063
Out SPU	2	20	6,014	1,203	4,766	6,222	593	5,629	1,136,950
plus 3/8 mesh (1.1% of solids)	3A	70	18.90	13	5.67	13.15	6.52	6.63	1,360
plus 200 mesh	3B	70	662	463	198	460	228	232	46,899
Out sand separation	3	13.62	5,333	726	4,607	5,748	358	5,390	1,088,711
Polymer addition	4	0.5							
Filter Cake	5	65	1,118	726	391	816	358	458	92,443
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,216	0	4,216	4,933	0	4,933	996,268
Recycling from press to SPU	2A	0	2,994	0	2,994	0	0	3,555	718,063
Filtrate to treatment	7	0	1,222	0	1,222	82,646	0	82,646	278,205
Required WTP Capacity (gpm)									166

* - Assumes 17 yd^3/cycle

A3/A13

77% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	0	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.01	
Density of water @ 60 F =	62.91	lbs/ft^3
	8.33	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,289	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,719	yd^3/day
Volume of excess seawater =	430	yd^3/day
Volume of excess seawater =	86,781	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,987	1,530	457	1,289	754	535	108,028
Excess water in bucket	1B	0	367	0	367	430	0.00	430	86,781
Total from dredge	**1**	**65**	**2,355**	**1,530**	**824**	**1,719**	**754**	**965**	**194,809**
Recycled in to SPU	2A	0	5,219	0	5,219	6,198	0	6,198	1,251,823
Out SPU	2	20	7,652	1,530	6,043	7,917	754	7,162	1,446,632
plus 3/8 mesh (1.1% of solids)	3A	70	24.05	17	7.21	16.74	8.30	8.44	1,731
plus 200 mesh	3B	70	1,240	868	372	863	428	435	87,883
Out sand separation	3	10.11	6,388	646	5,742	7,037	318	6,719	1,357,044
Polymer addition	4	0.5							
Filter Cake	5	65	994	646	348	725	318	407	82,180
Required Press Capacity (cycles/day)*						43			
Filtrate to Sawyer St. CDFs	6	0	5,395	0	5,395	6,312	0	6,312	1,274,864
Recycling from press to SPU	2A	0	5,219	0	5,219	0	0	6,198	1,251,823
Filtrate to treatment	7	0	176	0	176	6,845	0	6,845	23,041
Required WTP Capacity (gpm)									14

* - Assumes 17 yd^3/cycle

Page 26

Table 8: Mass Balance Summary Sheet - 60% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

Insitu Sediment % solids content by weight		% Sand by weight greater than 200 mesh	Slurry pH % solids by weight	Max Dredge Production (yd/day)	Desanding Loading (gpm)	Filtrate to WWTP (gpm)	Filtrate Pumped to Area 6 (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	91	994	723	434
			15	1765	1591	135	887	1068	641
			20	1765	1155	135	597	1068	641
Low	37.0	19.0	10	1785	1666	180	986	1025	615
			15	1861	1122	187	619	1068	641
			20	1861	815	187	414	1068	641
Avg	42.0	32.0	10	1515	1666	139	989	916	550
			15	1767	1256	162	695	1068	641
			20	1767	912	162	466	1068	641
InterTidal Material	77.0	81.0	10	605	1666	1	999	505	303
			15	936	1665	2	937	782	469
			20	1280	1654	2	866	1069	641

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

37% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.4	
% Sand =	77	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.15	
Density of water @ 60 F =	62.71	lb/ft^3
	8.3476	lb/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,785	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,380	yd^3/day
Volume of excess seawater =	595	yd^3/day
Volume of excess seawater =	120,174	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,941	718	1,223	1,785	354	1,431	289,032
Excess water in bucket	1B	0	509	0	509	595	0.00	595	120,174
Total from dredge	**1**	**29**	**2,450**	**718**	**1,732**	**2,380**	**354**	**2,026**	**409,206**
Recycled in to SPU	2A	0	4,663	0	4,663	5,538	0	5,538	1,118,532
Out SPU	2	10	7,183	718	6,395	7,918	354	7,564	1,527,738
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	136	96	41	95	47	48	9,676
Out sand separation	3	8.74	7,035	615	6,420	7,815	303	7,512	1,517,262
Polymer addition	4	0.5							
Filter Cake	5	60	1,025	615	410	783	303	480	96,870
Required Press Capacity (cycles/day)*						46			
Filtrate to Sawyer St. CDFs	6	0	6,010	0	6,010	7,033	0	7,033	1,420,392
Recycling from press to SPU	2A	0	4,663	0	4,663	0	0	5,538	1,118,532
Filtrate to treatment	7	0	1,347	0	1,347	89,673	0	89,673	301,860
Required WTP Capacity (gpm)									180

* - Assumes 17 yd^3/cycle

42% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	57	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.016	
Density of water @ 60 F =	63.311	lbs/ft^3
	8.3376	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,515	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,020	yd^3/day
Volume of excess seawater =	505	yd^3/day
Volume of excess seawater =	101,997	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,711	718	992	1,515	354	1,161	234,479
Excess water in bucket	1B	0	432	0	432	505	0.00	505	101,997
Total from dredge	**1**	**34**	**2,142**	**718**	**1,424**	**2,020**	**354**	**1,666**	**336,476**
Recycled in to SPU	2A	0	4,968	0	4,968	5,900	0	5,900	1,191,681
Out SPU	2	10	7,185	718	6,392	7,920	354	7,566	1,528,156
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	230	161	69	160	79	81	16,300
Out sand separation	3	7.92	6,944	550	6,394	7,752	271	7,481	1,511,056
Polymer addition	4	0.5							
Filter Cake	5	60	916	550	366	700	271	429	86,596
Required Press Capacity (cycles/day)*						41			
Filtrate to Sawyer St. CDFs	6	0	6,028	0	6,028	7,053	0	7,053	1,424,460
Recycling from press to SPU	2A	0	4,968	0	4,968	0	0	5,900	1,191,681
Filtrate to treatment	7	0	1,060	0	1,060	69,151	0	69,151	232,779
Required WTP Capacity (gpm)									139

* - Assumes 17 yd^3/cycle

49/48

50% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	55	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.15	
Density of water @ 60 F =	62.3711	lbs/ft^3
	8.3278	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,195	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,593	yd^3/day
Volume of excess seawater =	398	yd^3/day
Volume of excess seawater =	80,453	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	1,437	719	719	1,195	354	841	169,832
Excess water in bucket	1B	0	340	0	340	398	0.00	398	80,453
Total from dredge	**1**	**40**	**1,778**	**719**	**1,059**	**1,593**	**354**	**1,239**	**250,285**
Recycled in to SPU	2A	0	5,329	0	5,329	6,329	0	6,329	1,278,203
Out SPU	2	10	7,186	719	6,388	7,922	354	7,568	1,528,487
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.90	3.96	813
plus 200 mesh	3B	70	395	277	119	275	136	139	28,022
Out sand separation	3	6.40	6,780	434	6,346	7,639	214	7,425	1,499,665
Polymer addition	4	0.5							
Filter Cake	5	60	723	434	289	552	214	339	68,386
Required Press Capacity (cycles/day)*						32			
Filtrate to Sawyer St. CDFs	6	0	6,056	0	6,056	7,086	0	7,086	1,431,279
Recycling from press to SPU	2A	0	5,329	0	5,329	0	0	6,329	1,278,203
Filtrate to treatment	7	0	728	0	728	45,474	0	45,474	153,076
Required WTP Capacity (gpm)									91

* - Assumes 17 yd^3/cycle

77% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.4	
% Sand =	8	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.0	
Density of water @ 60 F =	62.37	lbs/ft^3
	8.3176	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	605	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	807	yd^3/day
Volume of excess seawater =	202	yd^3/day
Volume of excess seawater =	40,731	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	933	718	215	605	354	251	50,703
Excess water in bucket	1B	0	172	0	172	202	0.00	202	40,731
Total from dredge	**1**	**65**	**1,105**	**718**	**387**	**807**	**364**	**453**	**91,435**
Recycled in to SPU	2A	0	5,988	0	5,988	7,111	0	7,111	1,436,282
Out SPU	2	10	7,183	718	6,375	7,918	354	7,564	1,527,717
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	582	407	175	405	201	204	41,248
Out sand separation	3	4.60	6,590	303	6,287	7,505	149	7,356	1,485,669
Polymer addition	4	0.5							
Filter Cake	5	60	505	303	202	386	149	236	47,755
Required Press Capacity (cycles/day)*						23			
Filtrate to Sawyer St. CDFs	6	0	6,084	0	6,084	7,119	0	7,119	1,437,913
Recycling from press to SPU	2A	0	5,988	0	5,988	0	0	7,111	1,436,282
Filtrate to treatment	7	0	97	0	97	484	0	484	1,631
Required WTP Capacity (gpm)									1

* - Assumes 17 yd^3/cycle

51/96

37% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	15	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.03	
Density of water @ 60 F =	64.2	lbs/ft^3
	8.58	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,881	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,481	yd^3/day
Volume of excess seawater =	620	yd^3/day
Volume of excess seawater =	125,291	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,024	749	1,275	1,861	369	1,492	301,338
Excess water in bucket	1B	0	530	0	530	620	0.00	620	125,291
Total from dredge	**1**	**29**	**2,554**	**749**	**1,805**	**2,481**	**369**	**2,112**	**426,629**
Recycled in to SPU	2A	0	2,402	0	2,402	2,853	0	2,853	576,236
Out SPU	2	15	4,992	749	4,208	5,334	369	4,965	1,002,864
plus 3/8 mesh (1.1% of solids)	3A	70	11.77	8	3.53	8.19	4.06	4.13	847
plus 200 mesh	3B	70	142	100	43	99	49	50	10,088
Out sand separation	3	13.25	4,838	641	4,197	5,227	316	4,911	991,942
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	100,994
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,770	0	3,770	4,411	0	4,411	890,948
Recycling from press to SPU	2A	0	2,402	0	2,402	0	0	2,853	576,236
Filtrate to treatment	7	0	1,368	0	1,368	93,491	0	93,491	314,712
Required WTP Capacity (gpm)									187

* - Assumes 17 yd^3/cycle

42% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	[illegible]	
% Sand =	[illegible]	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	[illegible]	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,767	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (i.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,356	yd^3/day
Volume of excess seawater =	589	yd^3/day
Volume of excess seawater =	118,963	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,995	838	1,157	1,767	413	1,354	273,481
Excess water in bucket	1B	0	503	0	503	589	0.00	589	118,963
Total from dredge	**1**	**34**	**2,499**	**838**	**1,661**	**2,356**	**413**	**1,943**	**392,444**
Recycled in to SPU	2A	0	3,042	0	3,042	3,613	0	3,613	729,773
Out SPU	2	15	5,587	838	4,703	5,969	413	5,556	1,122,217
plus 3/8 mesh (1.1% of solids)	3A	70	13.17	9	3.95	9.16	4.54	4.62	948
plus 200 mesh	3B	70	268	188	80	187	93	94	19,012
Out sand separation	3	12.08	5,305	641	4,664	5,773	316	5,457	1,102,272
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	101,000
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,237	0	4,237	4,957	0	4,957	1,001,272
Recycling from press to SPU	2A	0	3,042	0	3,042	0	0	3,613	729,773
Filtrate to treatment	7	0	1,194	0	1,194	80,654	0	80,654	271,499
Required WTP Capacity (gpm)									162

* - Assumes 17 yd^3/cycle

50% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	.60	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	[illegible]	
% Sand Removal	.70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	[illegible]	lb/ft^3
	8.3578	lb/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,765	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,353	yd^3/day
Volume of excess seawater =	588	yd^3/day
Volume of excess seawater =	118,828	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,123	1,061	1,061	1,765	523	1,242	250,840
Excess water in bucket	1B	0	503	0	503	588	0.00	588	118,828
Total from dredge	**1**	**40**	**2,626**	**1,061**	**1,564**	**2,353**	**523**	**1,830**	**369,668**
Recycled in to SPU	2A	0	4,385	0	4,385	5,207	0	5,207	1,051,757
Out SPU	2	15	7,076	1,061	5,949	7,561	523	7,038	1,421,425
plus 3/8 mesh (1.1% of solids)	3A	70	18.68	12	5.00	11.61	5.75	5.85	1,200
plus 200 mesh	3B	70	584	409	175	406	201	205	41,389
Out sand separation	3	9.90	6,476	641	5,835	7,143	316	6,827	1,378,854
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	101,005
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	5,407	0	5,407	6,327	0	6,327	1,277,849
Recycling from press to SPU	2A	0	4,385	0	4,385	0	0	5,207	1,051,757
Filtrate to treatment	7	0	1,022	0	1,022	67,165	0	67,165	226,092
Required WTP Capacity (gpm)									135

* - Assumes 17 yd^3/cycle

54/43

77% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	81	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.016	
Density of water @ 60 F =	63.37	lbs/ft^3
	8.5376	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	936	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,248	yd^3/day
Volume of excess seawater =	312	yd^3/day
Volume of excess seawater =	63,016	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,443	1,111	332	936	548	388	78,444
Excess water in bucket	1B	0	267	0	267	312	0.00	312	63,016
Total from dredge	**1**	**65**	**1,710**	**1,111**	**599**	**1,248**	**548**	**700**	**141,460**
Recycled in to SPU	2A	0	5,614	0	5,614	6,668	0	6,668	1,346,697
Out SPU	2	15	7,408	1,111	6,213	7,916	548	7,368	1,488,156
plus 3/8 mesh (1.1% of solids)	3A	70	17.46	12	5.24	12.15	6.02	6.13	1,257
plus 200 mesh	3B	70	900	630	270	626	310	316	63,816
Out sand separation	3	7.22	6,491	469	6,022	7,277	231	7,046	1,423,103
Polymer addition	4	0.5							
Filter Cake	5	60	782	469	313	597	231	366	73,883
Required Press Capacity (cycles/day)*						35			
Filtrate to Sawyer St. CDFs	6	0	5,709	0	5,709	6,680	0	6,680	1,349,220
Recycling from press to SPU	2A	0	5,614	0	5,614	0	0	6,868	1,346,697
Filtrate to treatment	7	0	95	0	95	750	0	750	2,523
Required WTP Capacity (gpm)									2

* - Assumes 17 yd^3/cycle

37% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	15	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.371	lbs/ft^3
	8.4150	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,861	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,481	yd^3/day
Volume of excess seawater =	620	yd^3/day
Volume of excess seawater =	125,291	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	2,024	749	1,275	1,861	369	1,492	301,338
Excess water in bucket	1B	0	530	0	530	620	0.00	620	125,291
Total from dredge	**1**	**29**	**2,554**	**749**	**1,805**	**2,481**	**369**	**2,112**	**426,629**
Recycled in to SPU	2A	0	1,173	0	1,173	1,393	0	1,393	281,276
Out SPU	2	20	3,744	749	2,978	3,874	369	3,505	707,904
plus 3/8 mesh (1.1% of solids)	3A	70	11.77	8	3.53	8.19	4.06	4.13	847
plus 200 mesh	3B	70	142	100	43	99	49	50	10,088
Out sand separation	3	17.85	3,590	641	2,949	3,767	316	3,451	696,982
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	100,994
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	2,522	0	2,522	2,951	0	2,951	595,988
Recycling from press to SPU	2A	0	1,173	0	1,173	0	0	1,393	281,276
Filtrate to treatment	7	0	1,349	0	1,349	93,491	0	93,491	314,712
Required WTP Capacity (gpm)									187

* - Assumes 17 yd^3/cycle

42% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	42	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	62.37	lbs/ft^3
	0.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,767	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,356	yd^3/day
Volume of excess seawater =	589	yd^3/day
Volume of excess seawater =	118,963	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,995	838	1,157	1,767	413	1,354	273,481
Excess water in bucket	1B	0	503	0	503	589	0.00	589	118,963
Total from dredge	**1**	**34**	**2,499**	**838**	**1,661**	**2,356**	**413**	**1,943**	**392,444**
Recycled in to SPU	2A	0	1,666	0	1,666	1,979	0	1,979	399,709
Out SPU	2	20	4,190	838	3,327	4,335	413	3,922	792,153
plus 3/8 mesh (1.1% of solids)	3A	70	13.17	9	3.95	9.16	4.54	4.62	948
plus 200 mesh	3B	70	268	188	80	187	93	94	19,012
Out sand separation	3	16.40	3,909	641	3,268	4,139	316	3,823	772,208
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	101,000
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	2,840	0	2,840	3,323	0	3,323	671,208
Recycling from press to SPU	2A	0	1,666	0	1,666	0	0	1,979	399,709
Filtrate to treatment	7	0	1,174	0	1,174	80,654	0	80,654	271,499
Required WTP Capacity (gpm)									162

* - Assumes 17 yd^3/cycle

50% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	41	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.21	lbs/ft^3
	8.4571	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,765	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,353	yd^3/day
Volume of excess seawater =	588	yd^3/day
Volume of excess seawater =	118,828	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	2,123	1,061	1,061	1,765	523	1,242	250,840
Excess water in bucket	1B	0	503	0	503	588	0.00	588	118,828
Total from dredge	**1**	**40**	**2,626**	**1,061**	**1,564**	**2,353**	**623**	**1,830**	**369,668**
Recycled in to SPU	2A	0	2,642	0	2,642	3,137	0	3,137	633,691
Out SPU	2	20	5,307	1,061	4,206	5,491	523	4,968	1,003,359
plus 3/8 mesh (1.1% of solids)	3A	70	16.68	12	5.00	11.61	5.75	5.85	1,200
plus 200 mesh	3B	70	584	409	175	406	201	205	41,389
Out sand separation	3	13.62	4,707	641	4,066	5,073	316	4,757	960,788
Polymer addition	4	0.5							
Filter Cake	5	60	1,068	641	427	816	316	500	101,005
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,638	0	3,638	4,257	0	4,257	859,783
Recycling from press to SPU	2A	0	2,642	0	2,642	0	0	3,137	633,691
Filtrate to treatment	7	0	996	0	996	67,165	0	67,165	226,092
Required WTP Capacity (gpm)									135

* - Assumes 17 yd^3/cycle

31435

77% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 60% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	20	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.3	lbs/ft^3
	8.45	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,280	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,707	yd^3/day
Volume of excess seawater =	427	yd^3/day
Volume of excess seawater =	86,175	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,974	1,520	454	1,280	749	531	107,273
Excess water in bucket	1B	0	365	0	365	427	0.00	427	88,175
Total from dredge	**1**	**65**	**2,338**	**1,520**	**819**	**1,707**	**749**	**958**	**193,449**
Recycled in to SPU	2A	0	5,182	0	5,182	6,155	0	6,155	1,243,082
Out SPU	2	20	7,598	1,520	6,001	7,861	749	7,112	1,436,531
plus 3/8 mesh (1.1% of solids)	3A	70	23.88	17	7.16	16.62	8.24	8.38	1,718
plus 200 mesh	3B	70	1,231	862	369	857	425	432	87,269
Out sand separation	3	10.11	6,343	641	5,702	6,988	316	6,672	1,347,569
Polymer addition	4	0.5							
Filter Cake	5	60	1,069	641	428	816	316	500	101,036
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	5,275	0	5,275	6,172	0	6,172	1,246,533
Recycling from press to SPU	2A	0	5,182	0	5,182	0	0	6,155	1,243,082
Filtrate to treatment	7	0	92	0	92	1,025	0	1,025	3,451
Required WTP Capacity (gpm)									2

* - Assumes 17 yd^3/cycle

37/38

Table 9: Mass Balance Summary Sheet - 55% Solids Filter Cake
Bench Scale Dewatering Tests
New Bedford Harbor Superfund Site - OU #1

In-situ Sediment % solids content by weight		% Sand by weight greater than 200 mesh	Slurry out of SPB % solids by weight	Max Dredge Production (yd³/day)	Max Desanding Loading (gpm)	Max Filtrate to WTP (gpm)	Filtrate Pumped to Area 9 (gpm)	Solids Production Total Weight (tons/day)	Solids Production Dry Weight (tons/day)
High	50.0	55.0	10	1195	1667	82	983	789	434
			15	1549	1396	106	765	1023	563
			20	1549	1014	106	510	1023	563
Low	37.0	19.0	10	1633	1524	152	888	1023	562
			15	1633	985	152	529	1023	562
			20	1633	715	152	349	1023	562
Avg	42.0	32.0	10	1515	1666	127	976	999	550
			15	1551	1102	130	596	1023	563
			20	1551	801	130	395	1023	563
InterTidal Material	77.0	81.0	10	605	1666	-5	991	551	303
			15	936	1665	-8	925	853	469
			20	1123	1451	-10	745	1023	563

Assumptions:

Cake production fixed at 816 yd^3/day
Desanding system loading limited to 1.6 MGD based on an avg slurry content of 15% solids (wt)
Dredging and desanding operations are based on a 16 hour day
Dewatering and wastewater treatment based on a 24 hour day
Sand removal efficiency assumed to be 70%
Sediment specific gravity set to 2.41
Amount of material greater than 3/8 inch set to 1.1% of total weight
Removal efficiency of material greater than 3/8 is 100%

37% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	0	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.03	
Density of water @ 60 F =	62.371	lbs/ft^3
	8.3378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,633	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,177	yd^3/day
Volume of excess seawater =	544	yd^3/day
Volume of excess seawater =	109,941	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,776	657	1,119	1,633	324	1,309	264,419
Excess water in bucket	1B	0	465	0	465	544	0.00	544	109,941
Total from dredge	**1**	**29**	**2,241**	**657**	**1,584**	**2,177**	**324**	**1,854**	**374,360**
Recycled in to SPU	2A	0	4,266	0	4,266	5,066	0	5,066	1,023,285
Out SPU	2	10	6,571	657	5,850	7,244	324	6,920	1,397,645
plus 3/8 mesh (1.1% of solids)	3A	70	10.33	7	3.10	7.19	3.56	3.62	743
plus 200 mesh	3B	70	125	87	37	87	43	44	8,852
Out sand separation	3	8.74	6,436	562	5,873	7,150	277	6,872	1,388,061
Polymer addition	4	0.5							
Filter Cake	5	55	1,023	562	460	816	277	538	108,762
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	5,413	0	5,413	6,334	0	6,334	1,279,299
Recycling from press to SPU	2A	0	4,266	0	4,266	0	0	5,066	1,023,285
Filtrate to treatment	7	0	1,147	0	1,147	76,054	0	76,054	256,014
Required WTP Capacity (gpm)									152

* - Assumes 17 yd^3/cycle

61/73

42% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	20	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.2537	lbs/ft^3
	8.5000	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,515	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,020	yd^3/day
Volume of excess seawater =	505	yd^3/day
Volume of excess seawater =	101,997	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,711	718	992	1,515	354	1,161	234,479
Excess water in bucket	1B	0	432	0	432	505	0.00	505	101,997
Total from dredge	**1**	**34**	**2,142**	**718**	**1,424**	**2,020**	**354**	**1,666**	**336,476**
Recycled in to SPU	2A	0	4,968	0	4,968	5,900	0	5,900	1,191,681
Out SPU	2	10	7,185	718	6,392	7,920	354	7,566	1,528,156
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	230	161	69	160	79	81	16,300
Out sand separation	3	7.92	6,944	550	6,394	7,752	271	7,481	1,511,056
Polymer addition	4	0.5							
Filter Cake	5	55	999	550	450	797	271	526	106,276
Required Press Capacity (cycles/day)*						47			
Filtrate to Sawyer St. CDFs	6	0	5,944	0	5,944	6,955	0	6,955	1,404,779
Recycling from press to SPU	2A	0	4,968	0	4,968	0	0	5,900	1,191,681
Filtrate to treatment	7	0	976	0	976	63,305	0	63,305	213,099
Required WTP Capacity (gpm)									127

* - Assumes 17 yd^3/cycle

6/29/99

50% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	55	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.771	lb/ft^3
	8.5378	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,195	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (i.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,593	yd^3/day
Volume of excess seawater =	398	yd^3/day
Volume of excess seawater =	80,453	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	1,437	719	719	1,195	354	841	169,832
Excess water in bucket	1B	0	340	0	340	398	0.00	398	80,453
Total from dredge	**1**	**40**	**1,778**	**719**	**1,059**	**1,593**	**354**	**1,239**	**250,285**
Recycled in to SPU	2A	0	5,329	0	5,329	6,329	0	6,329	1,278,203
Out SPU	2	10	7,186	719	6,388	7,922	354	7,568	1,528,487
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.88	3.90	3.96	813
plus 200 mesh	3B	70	395	277	119	275	136	139	28,022
Out sand separation	3	6.40	6,780	434	6,346	7,639	214	7,425	1,499,665
Polymer addition	4	0.5							
Filter Cake	5	55	789	434	355	629	214	416	83,928
Required Press Capacity (cycles/day)*						37			
Filtrate to Sawyer St. CDFs	6	0	5,991	0	5,991	7,010	0	7,010	1,415,737
Recycling from press to SPU	2A	0	5,329	0	5,329	0	0	6,329	1,278,203
Filtrate to treatment	7	0	662	0	662	40,857	0	40,857	137,534
Required WTP Capacity (gpm)									82

* - Assumes 17 yd^3/cycle

77% In-Situ Solids, SPU = 10%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	8	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.3971	lbs/ft^3
	8.4375	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	605	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	807	yd^3/day
Volume of excess seawater =	202	yd^3/day
Volume of excess seawater =	40,731	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	933	718	215	605	354	251	50,703
Excess water in bucket	1B	0	172	0	172	202	0.00	202	40,731
Total from dredge	**1**	**65**	**1,105**	**718**	**387**	**807**	**354**	**453**	**91,435**
Recycled in to SPU	2A	0	5,988	0	5,988	7,111	0	7,111	1,436,282
Out SPU	2	10	7,183	718	6,375	7,918	354	7,564	1,527,717
plus 3/8 mesh (1.1% of solids)	3A	70	11.29	8	3.39	7.86	3.89	3.96	812
plus 200 mesh	3B	70	582	407	175	405	201	204	41,248
Out sand separation	3	4.60	6,590	303	6,287	7,505	149	7,356	1,485,669
Polymer addition	4	0.5							
Filter Cake	5	55	551	303	248	440	149	290	58,609
Required Press Capacity (cycles/day)*						26			
Filtrate to Sawyer St. CDFs	6	0	6,039	0	6,039	7,066	0	7,066	1,427,060
Recycling from press to SPU	2A	0	5,988	0	5,988	0	0	7,111	1,436,282
Filtrate to treatment	7	0	51	0	51	-2,740	0	-2,740	-9,223
Required WTP Capacity (gpm)									-5

* - Assumes 17 yd^3/cycle

64/96

37% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	8	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.02	
Density of water @ 60 F =	62.37	lbs/ft^3
	8.3372	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,633	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,177	yd^3/day
Volume of excess seawater =	544	yd^3/day
Volume of excess seawater =	109,941	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,776	657	1,119	1,633	324	1,309	264,419
Excess water in bucket	1B	0	465	0	465	544	0.00	544	109,941
Total from dredge	**1**	**29**	**2,241**	**657**	**1,584**	**2,177**	**324**	**1,854**	**374,360**
Recycled in to SPU	2A	0	2,108	0	2,108	2,503	0	2,503	505,638
Out SPU	2	15	4,381	657	3,692	4,681	324	4,357	879,999
plus 3/8 mesh (1.1% of solids)	3A	70	10.33	7	3.10	7.19	3.56	3.62	743
plus 200 mesh	3B	70	125	87	37	87	43	44	8,852
Out sand separation	3	13.25	4,246	562	3,683	4,587	277	4,310	870,415
Polymer addition	4	0.5							
Filter Cake	5	55	1,023	562	460	816	277	538	108,762
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,223	0	3,223	3,771	0	3,771	761,653
Recycling from press to SPU	2A	0	2,108	0	2,108	0	0	2,503	505,638
Filtrate to treatment	7	0	1,115	0	1,115	76,054	0	76,054	256,014
Required WTP Capacity (gpm)									152

* - Assumes 17 yd^3/cycle

65/69

42% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	42	
Volume of Solids =	0.2337	ft^3
Volume of water =	0.7663	ft^3
Weight of Solids =	35.13	lbs/ft^3
Weight of Water =	48.51	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	[illegible]	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	[illegible]	lbs/ft^3
	[illegible]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,551	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,068	yd^3/day
Volume of excess seawater =	517	yd^3/day
Volume of excess seawater =	104,420	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	42	1,751	736	1,016	1,551	362	1,189	240,051
Excess water in bucket	1B	0	442	0	442	517	0.00	517	104,420
Total from dredge	**1**	**34**	**2,193**	**736**	**1,458**	**2,068**	**362**	**1,706**	**344,471**
Recycled in to SPU	2A	0	2,670	0	2,670	3,172	0	3,172	640,565
Out SPU	2	15	4,904	736	4,128	5,240	362	4,877	985,036
plus 3/8 mesh (1.1% of solids)	3A	70	11.56	8	3.47	8.04	3.99	4.06	832
plus 200 mesh	3B	70	235	165	71	164	81	83	16,688
Out sand separation	3	12.08	4,657	563	4,094	5,068	277	4,790	967,529
Polymer addition	4	0.5							
Filter Cake	5	55	1,023	563	460	816	277	539	108,802
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	3,634	0	3,634	4,252	0	4,252	858,727
Recycling from press to SPU	2A	0	2,670	0	2,670	0	0	3,172	640,565
Filtrate to treatment	7	0	963	0	963	64,809	0	64,809	218,162
Required WTP Capacity (gpm)									130

* - Assumes 17 yd^3/cycle

30/39

50% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	50	
Volume of Solids =	0.2964	ft^3
Volume of water =	0.7036	ft^3
Weight of Solids =	44.55	lbs/ft^3
Weight of Water =	44.55	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	25	
% Sand Removal	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.7004	lbs/ft^3
	8.5175	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,549	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,065	yd^3/day
Volume of excess seawater =	516	yd^3/day
Volume of excess seawater =	104,286	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	50	1,863	932	932	1,549	459	1,090	220,142
Excess water in bucket	1B	0	441	0	441	516	0.00	516	104,286
Total from dredge	**1**	**40**	**2,304**	**932**	**1,373**	**2,065**	**459**	**1,606**	**324,428**
Recycled in to SPU	2A	0	3,848	0	3,848	4,570	0	4,570	923,043
Out SPU	2	15	6,210	932	5,221	6,635	459	6,176	1,247,471
plus 3/8 mesh (1.1% of solids)	3A	70	14.64	10	4.39	10.19	5.05	5.14	1,053
plus 200 mesh	3B	70	512	359	154	357	177	180	36,323
Out sand separation	3	9.90	5,683	563	5,121	6,269	277	5,991	1,210,110
Polymer addition	4	0.5							
Filter Cake	5	55	1,023	563	460	816	277	539	108,790
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	4,660	0	4,660	5,453	0	5,453	1,101,320
Recycling from press to SPU	2A	0	3,848	0	3,848	0	0	4,570	923,043
Filtrate to treatment	7	0	812	0	812	52,960	0	52,960	178,276
Required WTP Capacity (gpm)									106

* - Assumes 17 yd^3/cycle

File

77% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	77	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	5	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.271	lbs/ft^3
	8.3575	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	936	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	1,248	yd^3/day
Volume of excess seawater =	312	yd^3/day
Volume of excess seawater =	63,016	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,443	1,111	332	936	548	388	78,444
Excess water in bucket	1B	0	267	0	267	312	0.00	312	63,016
Total from dredge	**1**	**65**	**1,710**	**1,111**	**599**	**1,248**	**548**	**700**	**141,460**
Recycled in to SPU	2A	0	5,614	0	5,614	6,668	0	6,668	1,346,697
Out SPU	2	15	7,408	1,111	6,213	7,916	548	7,368	1,488,156
plus 3/8 mesh (1.1% of solids)	3A	70	17.46	12	5.24	12.15	6.02	6.13	1,257
plus 200 mesh	3B	70	900	630	270	626	310	316	63,816
Out sand separation	3	7.22	6,491	469	6,022	7,277	231	7,046	1,423,103
Polymer addition	4	0.5							
Filter Cake	5	55	853	469	384	680	231	449	90,674
Required Press Capacity (cycles/day)*						40			
Filtrate to Sawyer St. CDFs	6	0	5,638	0	5,638	6,597	0	6,597	1,332,429
Recycling from press to SPU	2A	0	5,614	0	5,614	0	0	6,668	1,346,697
Filtrate to treatment	7	0	24	0	24	-4,239	0	-4,239	-14,268
Required WTP Capacity (gpm)									-8

* - Assumes 17 yd^3/cycle

39/39

37% In-Situ Solids, SPU = 20%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 55% Filter Cake
New Bedford Harbor Superfund Site - OU#1

CONSTANTS are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	37	
Volume of Solids =	0.1983	ft^3
Volume of water =	0.8017	ft^3
Weight of Solids =	29.81	lbs/ft^3
Weight of Water =	50.75	lbs/ft^3
Specific Gravity Sediment =	2.41	
% Sand =	15	
% Sand Removal =	70	

Seawater Properties

Specific Gravity =	1.015	
Density of water @ 60 F =	63.371	lb/ft^3
	8.578	lb/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	1,833	in-situ yd^3/day
Assumed excavation bucket is	75%	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	2,177	yd^3/day
Volume of excess seawater =	544	yd^3/day
Volume of excess seawater =	109,941	gal/day

Diaphragm Plate and Frame Filter Press

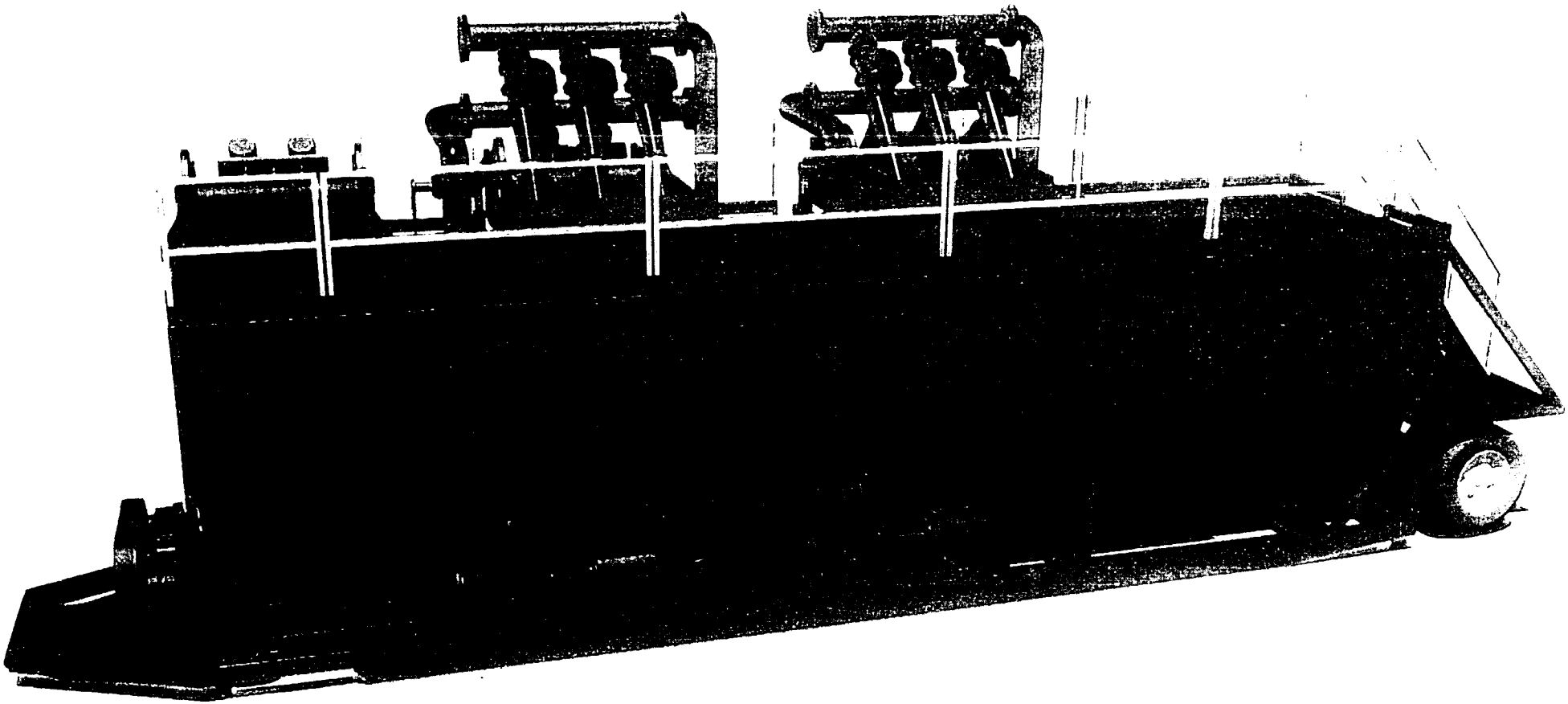
	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	37	1,776	657	1,119	1,833	324	1,309	264,419
Excess water in bucket	1B	0	465	0	465	544	0.00	544	109,941
Total from dredge	**1**	**29**	**2,241**	**657**	**1,584**	**2,177**	**324**	**1,854**	**374,360**
Recycled in to SPU	2A	0	1,029	0	1,029	1,222	0	1,222	246,815
Out SPU	2	20	3,286	657	2,613	3,399	324	3,076	621,176
plus 3/8 mesh (1.1% of solids)	3A	70	10.33	7	3.10	7.19	3.56	3.62	743
plus 200 mesh	3B	70	125	87	37	87	43	44	8,852
Out sand separation	3	17.85	3,150	562	2,588	3,305	277	3,028	611,592
Polymer addition	4	0.5							
Filter Cake	5	55	1,023	562	460	816	277	538	108,762
Required Press Capacity (cycles/day)*						48			
Filtrate to Sawyer St. CDFs	6	0	2,128	0	2,128	2,490	0	2,490	502,830
Recycling from press to SPU	2A	0	1,029	0	1,029	0	0	1,222	246,815
Filtrate to treatment	7	0	1,099	0	1,099	76,054	0	76,054	256,014
Required WTP Capacity (gpm)									152

* - Assumes 17 yd^3/cycle

Sp/116

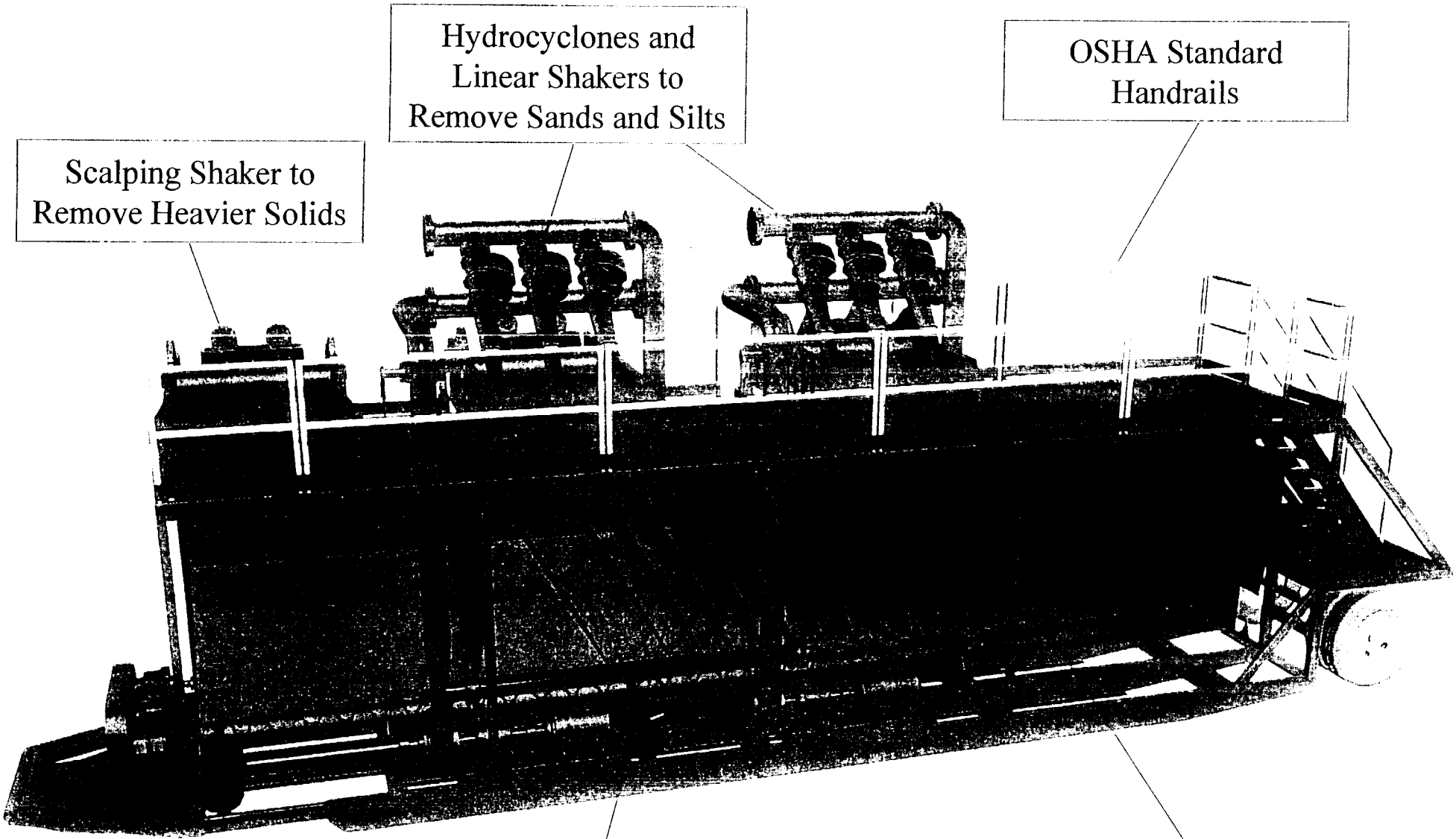
ATTACHMENT #1

DESANDING SYSTEM TECHNICAL INFORMATION



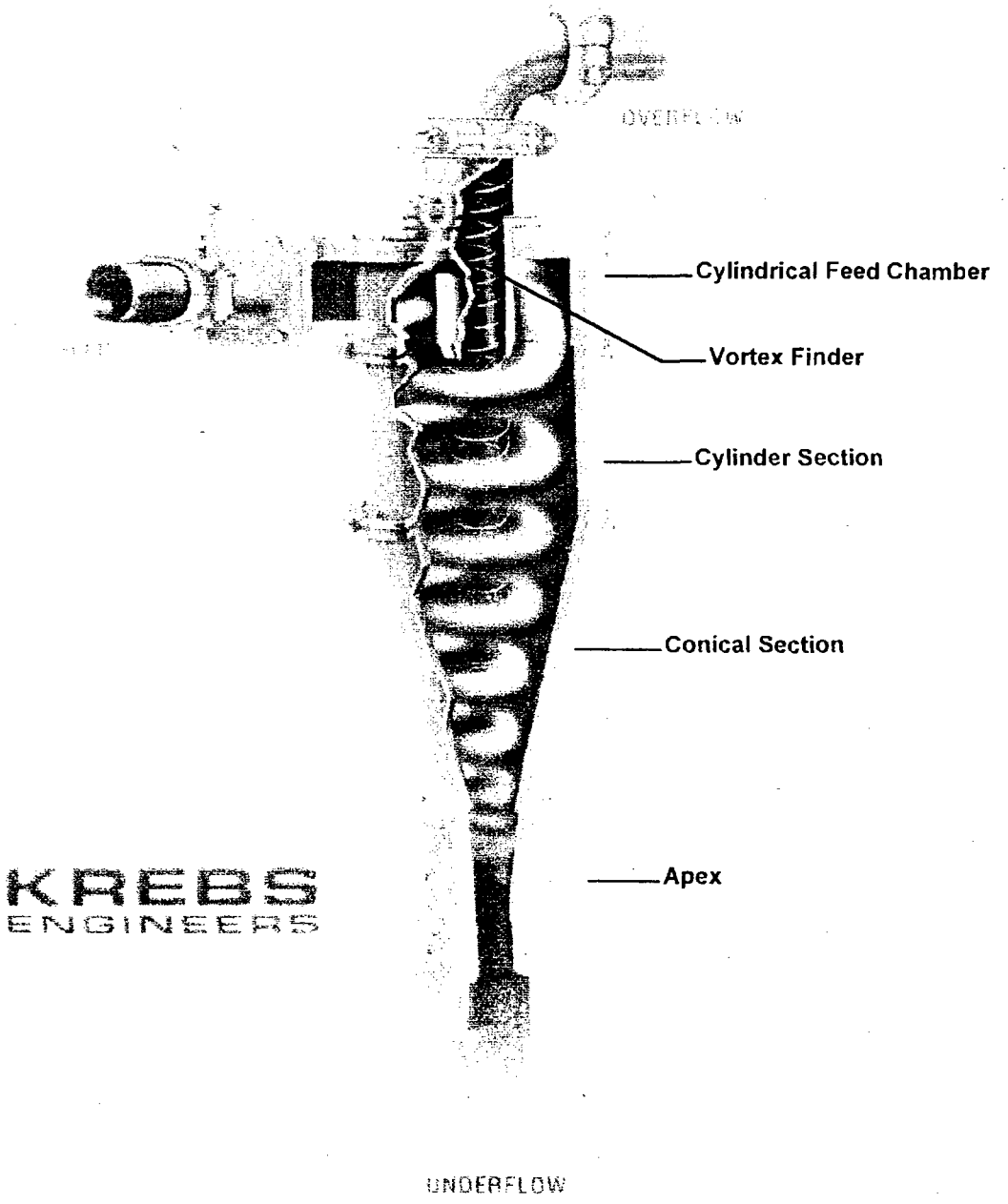
Originals in color.

V-Tank



Originals in color

FIGURE 1
CYCLONE CUTAWAY

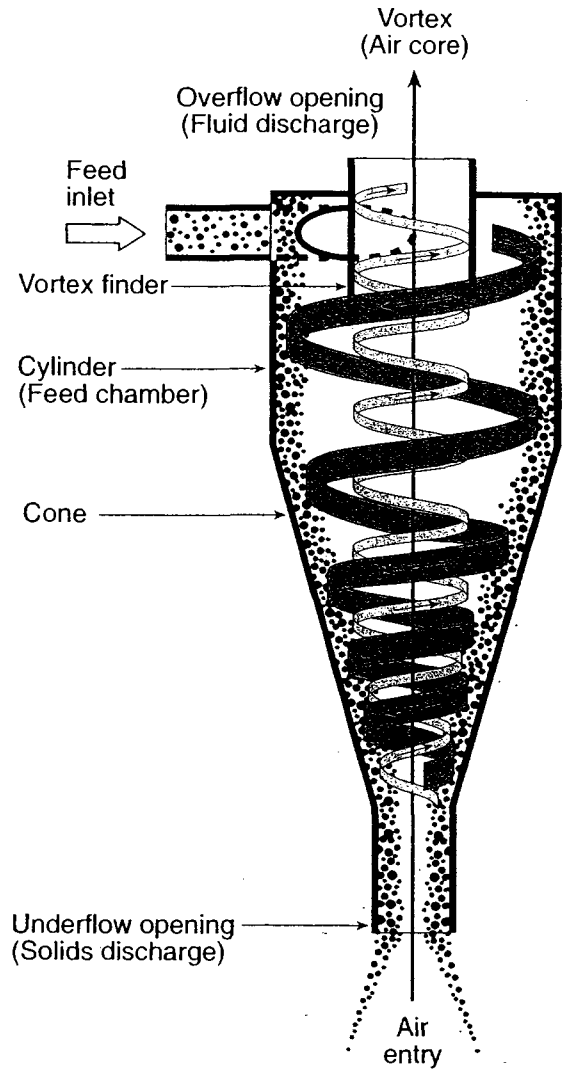


Hydrocyclones

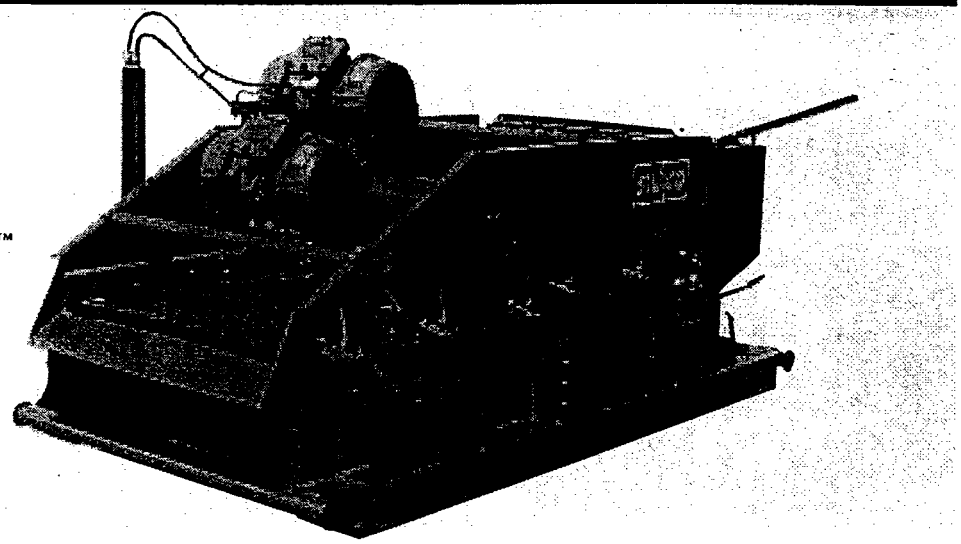
The principle of the hydrocyclone is simple and straightforward. It features a stationary cylindrical/conical separation vessel in which the feed pressure provides the sole separation force.

Due to the tangential position of the feed inlet, a strong spiraling motion is created in the feed slurry. Those solids having sufficient mass settle to the wall of the vessel and move downwards towards the cone apex, becoming more concentrated as the cone narrows. As the cross-sectional area decreases the less dense fluid nearer to the cone axis turns back towards the top of the cone and exits via the vortex finder and overflow outlet. This fluid carries with it those particles having insufficient mass to settle.

The centrifugal force developed in hydrocyclones is about 700 to 1,000 times that of gravity giving a cut-point of about 65 µm in desanders and 30 µm in desilters. The difference between the two is due to the larger diameter of the desanders and subsequently the longer settling distances.

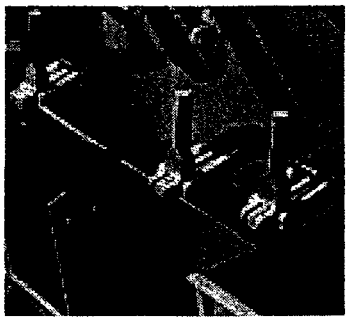


SWACO® ADJUSTABLE LINEAR SHAKER™ (ALS-II™)

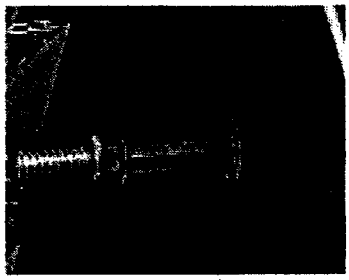


The SWACO ALS-II Adjustable Linear Motion Shaker combines field-proven ALS technology with advanced performance and control capabilities. Adjust-while-drilling features enable operators to optimize shaker performance throughout the drilling program. Designed for increased feed volumes and drier solids removal, the ALS-II improves cuttings removal at the flow line. Bonded screens provide greater solids conveyance and extend screen life, even with very fine mesh sizes.

FEATURES



Optional Quick Screen Tensioner combines simple, easy-to-use set release with exterior adjustment collar.



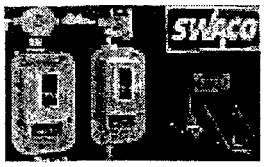
Optional Rapid Action Tensioners ensure fast screen changes and secure locking.

Three-Way Adjustment:
Deck Angle adjusts from –3° to +3° for precise control of flow rates and solids dryness, while eliminating pooling and back flow. Foot-operated jack makes adjustment easy, even while drilling, and permits the operator to view the effects of angle changes.
Vibrator Angle adjusts in 10° increments from 25° to 65° to improve conveying speed. Allows operators to optimize vibrator angle for high solids loading or for fine cuttings separation when drilling slows near TD.
Vibrator Energy is set by dial adjustment to a maximum force of 6.25 G's. Fine tuning of amplitude promotes optimal solids separation, improved cuttings dryness and extended screen life.

Two-Screen Design reduces costs by 33%. The ALS-II uses only two 4 x 4-ft screens, compared to three screens for comparable units.
Optional Quick Screen Tensioners or **Rapid Action Tensioners** allow instant setting and adjustment of screen tension for optimal shaker performance. Easy-to-use set release with exterior adjustment collar makes screen changeouts fast and simple. Adjustment collars and tension rails are stainless steel to minimize corrosion.
Louvered Weir Plate is mounted 1.5 in. above the screen deck to dissipate mud impact on screens; it evenly distributes flow and helps extend screen life.

SWACO

FEATURES (CONT)



CSA-approved A-B starters feature moisture-proof enclosures and simple hook-up to single-point electrical box.

Flow Diverters improve control and distribution of mud flow, providing a more flexible flow path during low-flow conditions and distributing flow more efficiently on crowned screens.

CSA-Approved Starters with O-ring enclosures prevent moisture intrusion. Cables are protected and routed through the skid frame, away from damage and vibration.

Replacement Screens are readily available in all standard sizes, with V-pattern, layered, oblong and plastic-bonded screens up to 325 mesh.

BENEFITS

- Increased feed volumes with drier solids removal
- Optimal performance throughout the drilling program from extensive control and adjust-while-drilling capabilities
- Improved cuttings removal at the flow line
- Improved solids conveyance and extended screen life
- Economical two-screen design
- Purchase costs, inventory and downtime for changeout are reduced by one-third
- No daily, weekly or monthly routine maintenance is required

SPECIFICATIONS

Length	128.75 in.	3,188 mm
Width	63.00 in.	1,600 mm
Height	61.00 in.	1,549 mm
Weight	3,500 lbs	1,587 kg
Flow Line Connections	10.00 in.	254 mm (pipe diameter)
Motor Rating	60 Hz	50 Hz
Horse Power	2.5	
Nominal RPM	1,800	1,500
Voltage	230/460	190/380
Nominal Screen Size (Two Screens)	4 ft x 4 ft	1,219 mm x 1,219 mm
Screen Area	32 ft^2	2.97 m^2
Screen Mounting	Overslung design/quick-release tension bolts both sides or optional quick screen tensioners and rapid action tensioners	
Support Rails	Six (6) bottom rails	
Weir Height	33.6 in.	852 mm (with adjustable vanes)

This information is supplied solely for informational purposes and SWACO makes no guarantees or warranties, either expressed or implied, with respect to the accuracy and use of this data. All product warranties and guarantees shall be governed by the Standard Terms of Sale or Standard Terms of Equipment Rental.

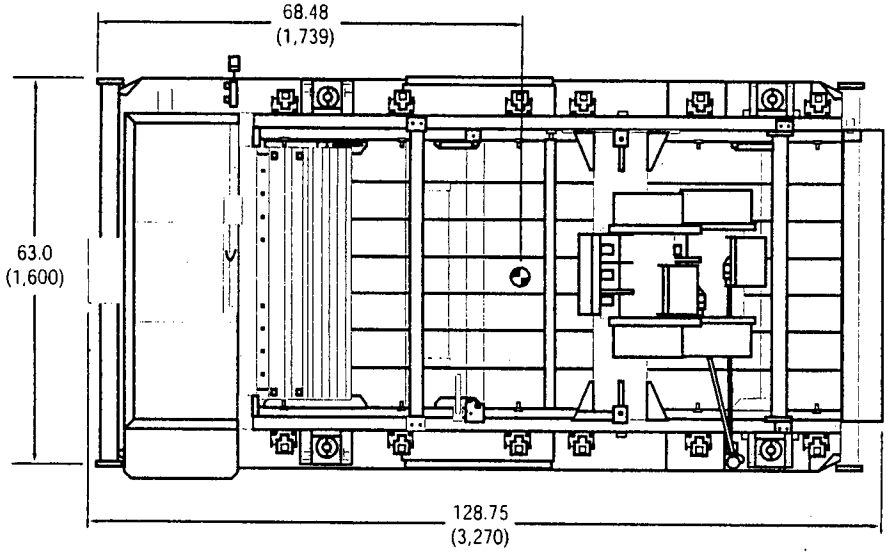
A Smith/Schlumberger Company

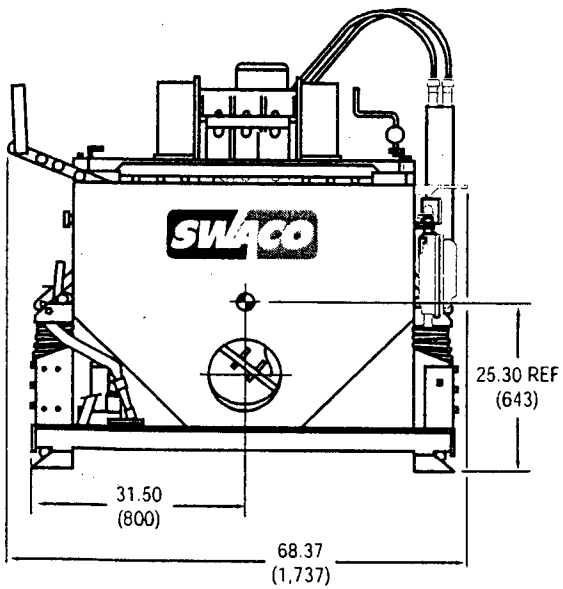
P.O. Box 42842
Houston, Texas 77242-2842
Tel: 713·308·9455
1·800·654·0660
Fax: 713·308·9463
www.swaco.midf.com

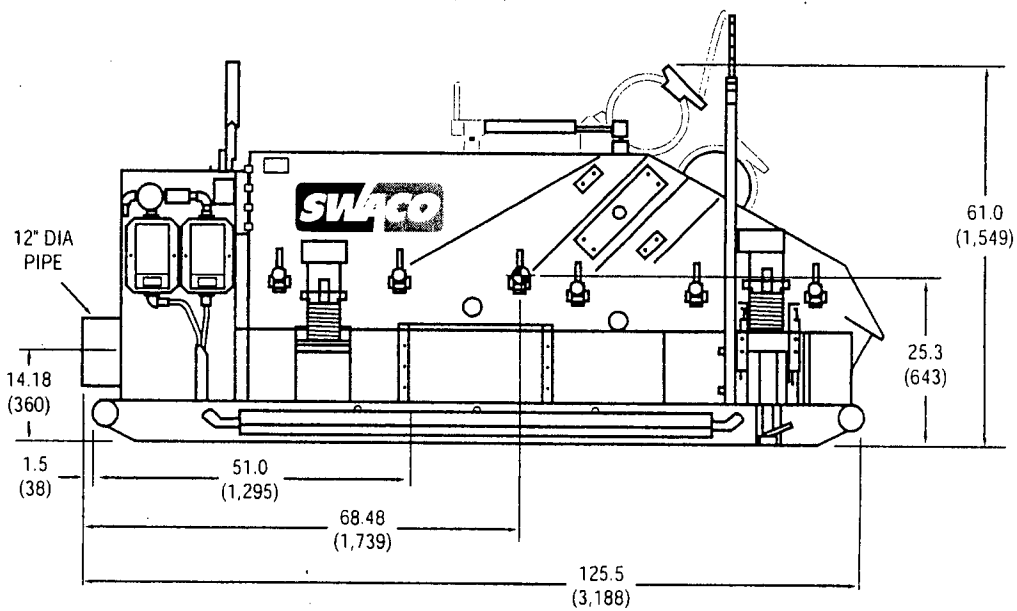
©1999 SWACO, A Division of M-I LLC All rights reserved.
®SWACO is a registered trademark of M-I LLC
™Adjustable Linear Shaker and ALS-II are trademarks of SWACO, A Division of M-I LLC
SW-7038R 2.5M 9/99 Litho in U.S.A.

SHAKER ALS II

All dimensions are expressed in inches and millimeters.







©1998 Swaco A Division of M-I, L.L.C. All rights reserved.
SW-7038A 5M1298 Litho in U.S.A.

SWACO

1/1

Engineering Drawing

CALCULATION COVER SHEET

Sheet 1 of 4

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT +3/8 Inch and +200 Mesh Storage Bins

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-03 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____YES _____ NO

PREPARER J. BRINKMAN

REVIEWED BY R. OTOSKI DATE 5/23/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	JB 11/20/02	RO 11/20/02	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/20/02 SHEET 2 OF 4

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIESY

SUBJECT +3/8 INCH AND +200 MESH STORAGE BINS

I. Objective

Based on the conclusions of the Dredging, Desanding and Dewatering Mass Balance Calculation (P-01) determine the size requirements for the +3/8 inch and +200 mesh material separated in the desanding operations.

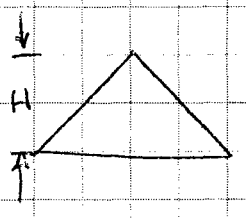
II. Assumptions

The following assumptions were utilized for sizing the storage bins for the separated materials:

- Quantity of +3/8 inch and +200 mesh material generated (dry tons/day) based on calculation P-01 – Dredging, Desanding and Dewatering Mass balance.
- Storage capacity will be based on maximum sand production rate that occurs @ 77% in-situ solids (by wt) and 81% (by wt) in-situ sand (+200 mesh).
- Per the Excavation BD/DA (October 2002) the peak hourly flow rate to the desanding facility will be limited to 2,500 gpm, subject to maximum production volume of 1.6 mgd, based on an average slurry content of 15% solids by weight.
- A total of five (5) storage bins will be provided for separated material. One (1) for oversized material separated at the dredge, one (1) for +3/8 inch material, and Three (3) for the +200 mesh material. All five (5) storage bins will be of equal size to provide for flexibility in the dredging/desanding operations.
- Storage bins will be sized to store three (3) days worth of +200 mesh material at the average dredge rate.
- Storage piles are assumed to be pyramid in shape and have a side slope of 1:1 (45 degrees).
- Sizing will neglect side wall effects.

III. Sizing

$$\text{Volume of a Pyramid} = \frac{\text{Area of Base}}{3} * H$$



where:

Area of Base = width x length
H = height of pyramid

Daily volume of +200 mesh generated when excavating in the mudflats (77% in-situ solids, 81% sand, 15% solids in slurry, 1.6 gpd) = 629 yd^3

Solution: Vary the dimensions of the base to determine the height and then calculate corresponding volume.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/20/02 SHEET 3 OF 4

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIESY

SUBJECT +3/8 INCH AND +200 MESH STORAGE BINS

Assume a base 40 ft square

Height of pile = 20 feet

Volume of the corresponding pyramid = $\frac{(40 \times 40 \times 20)}{3}$ = 10,667 ft^3 = 395 yd^3 < **629 yd^3**

Assume a base 50 ft square

Height of pile = 25 feet

Volume of the corresponding pyramid = $\frac{(50 \times 50 \times 25)}{3}$ = 20,833 ft^3 = 772 yd^3 > **629 yd^3**

Assume a base of 45 ft

Height of pile = 22.5 feet

Volume of the corresponding pyramid = $\frac{(45 \times 45 \times 22.5)}{3}$ = 15,188 ft^3 = 562 yd^3 < **629 yd^3**

Assume a base of 46.5 ft

Height of pile = 23.25 feet

Volume of the corresponding pyramid = $\frac{(46.5 \times 46.5 \times 23.25)}{3}$ = 16,757 ft^3 = 621 yd^3 $\cong$ **629 yd^3**

Therefore:

Each storage bin will be a minimum 46.5 ft x 46.5 ft and will be capable of holding a minimum 621 yd^3 of material.

77% In-Situ Solids, SPU = 15%, S.G. 2.41, +200 Mesh, 70% Sand Removal, 65% Filter Cake
New Bedford Harbor Superfund Site - OU#1

[redacted] are shown in yellow cells everything else is calculated based on highlighted numbers and percent solids by weight as

In-Situ Sediment Properties

Solids Content (% by weight) =	[redacted]	
Volume of Solids =	0.5851	ft^3
Volume of water =	0.4149	ft^3
Weight of Solids =	87.94	lbs/ft^3
Weight of Water =	26.27	lbs/ft^3
Specific Gravity Sediment =	[redacted]	
% Sand =	[redacted]	
% Sand Removal =	[redacted]	

Seawater Properties

Specific Gravity =	[redacted]	
Density of water @ 60 F =	[redacted]	lbs/ft^3
	[redacted]	lbs/gallon
	7.4805	$gallon/ft^3$

Dredging

Production Rate =	[redacted]	in-situ yd^3/day
Assumed excavation bucket is	[redacted]	effective. (I.e., 25% of each bucket volume is excess seawater)
Total volume removed =	935	yd^3/day
Volume of excess seawater =	0	yd^3/day
Volume of excess seawater =	0	gal/day

Diaphragm Plate and Frame Filter Press

	Stream	% solids (by wt)	Total Weight (tons/day)	Weight of Dry Solids (tons/day)	Water (tons/day)	Total Volume (yd^3/day)	Solids Volume (yd^3/day)	Water Volume (yd^3/day)	Water (gal/day)
From Dredge	1A	77	1,442	1,110	332	935	547	388	78,360
Excess water in bucket	1B	0	0	0	0	0	0.00	0	0
Total from dredge	**1**	**77**	**1,442**	**1,110**	**332**	**935**	**547**	**388**	**78,360**
Recycled in to SPU	2A	0	5,871	0	5,871	6,972	0	6,972	1,408,207
Out SPU	2	15	7,400	1,110	6,202	7,907	547	7,360	1,486,567
plus 3/8 mesh (1.1% of solids)	3A	70	17.44	12	5.23	12.14	6.02	6.12	1,255
plus 200 mesh	3B	70	899	629	270	626	310	316	63,747
Out sand separation	3	7.22	6,484	468	6,015	7,269	231	7,038	1,421,582
Polymer addition	4	0.5							
Filter Cake	5	65	721	468	252	526	231	295	59,611
Required Press Capacity (cycles/day)*						31			
Filtrate to Sawyer St. CDFs	6	0	5,763	0	5,763	6,743	0	6,743	1,361,972
Recycling from press to SPU	2A	0	5,871	0	5,871	0	0	6,972	1,408,207
Filtrate to treatment	7	0	-108	0	-108	-13,735	0	-13,735	-46,235
Required WTP Capacity (gpm)									-28

* - Assumes 17 yd^3/cycle

4/4

CALCULATION COVER SHEET

Sheet 1 of 3

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Desanding Dredged Slurry Storage Capacity

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-04 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. BRINKMAN

REVIEWED BY R. OPOSKI DATE 5/23/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	All	JB 11/20/02	RO 11/20/02	

I. Objective

Based on the conclusions of the Dredging, Desanding and Dewatering Mass Balance Calculation (P-01) determine the required storage capacity of desanded dredged slurry at Area C.

II. Assumptions

The following assumptions were utilized for sizing the storage bins for the separated materials:

- Effective operating time of dredge will be 8 hours/shift, two shifts/ day for a total dredge time of 16 hours/day.
- Dewatering will be conducted 24 hours/day.
- Initial storage capacity will be sized based on the average slurry flowrate to dewatering system `based on average dredge conditions: 42% in-situ solids (by wt), 29% in-situ sand (by wt), 10 to 20% transfer slurry from dredge, 65% solids (by wt) filter cake.
- Slurry storage capacity at Area D = 260,000 gallons and includes two (2) equalization tanks at 50,000 gallons each and eight (8) frac tanks with a volume of 20,000 gallons each.

III. Sizing

a.) At average dredge conditions and 15% slurry transfer, the desanding system effluent = 1,376 gpm.

Assuming 16 hours/day operation the total volume of slurry requiring dewatering =

1,376 gpm x 60 min/hour x 16 hours/day = 1,320,960 gallons

Flowrate to the dewatering system based on 24 hours/day operations =

1,320,960 gallons/day x 1 day/24 hours x 1 hour/60 min = 917 gallons/min

Required storage = (1,376 gpm – 917 gpm) x 60 min/hour x 8 hours =

220,320 gallons **< 260,000 gallons**

b.) At average dredge conditions and a 10% slurry transfer, the desanding system effluent = 1,631 gpm

Assuming 16 hours/day operation the total volume of slurry requiring dewatering =

1,631 gpm x 60 min/hour x 16 hours/day = 1,565,900 gallons

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/21/02 SHEET 3 OF 3

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIES

SUBJECT DESANDED DREDGED SLURRY STORAGE CAPACITY

Flowrate to the dewatering system based on 24 hours/day operations =

1,565,900 gallons/day x 1 day/24 hours x 1 hour/60 min = 1,087 gallons

Required storage = (1,631 gpm – 1,087 gpm) x 60 min/hour x 8 hours =

260,912 gallons > **260,000 gallons**

c.) At mudflats dredge conditions (77% in-situ solids), a 15% slurry transfer, and 65% filter cake the desanding system effluent = 1,531 gpm

Assuming 16 hours/day operation the total volume of slurry requiring dewatering =

1,531 gpm x 60 min/hour x 16 hours/day = 1,469,954 gallons

Flowrate to the dewatering system based on 24 hours/day operations =

1,469,954 gallons/day x 1 day/24 hours x 1 hour/60 min = 1,021 gallons

Required storage = (1,531 gpm – 1,021 gpm) x 60 min/hour x 8 hours =

244,900 gallons < **260,000 gallons**

If additional storage capacity is required at Area C, space is available for four (4) 20,000 gallon frac tanks.

CALCULATION COVER SHEET

Sheet 1 of 2

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Slurry Transfer Pump Sizing (Area C to Area D)

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-05 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER R. Otoski

REVIEWED BY _____ DATE 5-20-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	JJB 11/21/02	RO 12/3/02	

I. Objective

Based on the conclusions of the Dredging, Desanding and Dewatering Mass Balance Calculation (P-01) determine the required size of the desanded dredge slurry transfer pumps from Area C to Area D.

II. Assumptions

The following assumptions were utilized for sizing the slurry transfer pumps for the separated materials:

- Dewatering will be conducted 24 hours/day.
- 100% of +3/8 inch and 70% of +200 mesh material will be separated from the dredged slurry prior to transfer to the dewatering facility.
- Average flowrate to dewatering facility is 918 gpm at an average dredge rate of 2,002 yd^3/day (42% in-situ solids (by wt), 32% in-situ sand (by wt), transfer slurry solids content of 12%, and 65% solids filter cake).
- The highest flowrate to the dewatering facility = 1,096 gpm
- The average density of the desanded slurry is 75 lbs/ft^3
- The transfer pipeline will consist of a 14 inch outside diameter SDR 11 HDPE pipe.
- The headloss in the HDPE pipe is less than 1 ft/100 ft.
- The distance from Area C to Area D is approximately 7,800 ft.
- Pump efficiency will be 60%.
- Assume pump is capable of 2,000 gpm.

III. Sizing

The transfer pumps for Area C will be capable of handling 2,000 gpm.

Power required of pumping:

$$bhp = \frac{QH\rho}{(HP)e_p}$$

Where:

bhp = Braking horse power
Q = Flowrate, ft^3/sec
H = headloss in pipe, feet
ρ = density of fluid, lbs/ ft^3
HP = horsepower, 550 ft-lb/sec
e_p = pump efficiency

(Crane's Technical Paper No. 410, " Flow of Fluids Through Valves, Fittings and Pipe", p. B-9)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/21/02 SHEET 3 OF 3

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIESY

SUBJECT DESANDED DREDGED SLURRY TRANSFER PUMPS FROM AREA C TO AREA D

Therefore:

$$bhp = \frac{((2{,}000\ gal/min)*(0.1337\ ft^3/gal)*(0.0167\ min/sec))*((7{,}800\ LF)*(1\ ft/100\ ft))*(75\ lbs/ft^3)}{(550\ ft\text{-}lbs/sec)*(0.6)}$$

$$= 79\ HP$$

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Dewatering Building Sump Sizing

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-06 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. BRINKMAN

REVIEWED BY R. OTOSKI DATE 5/23/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	All	JB 11-21-02	RO 12/3/02	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/21/02 SHEET 12 OF 84

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIES

SUBJECT DEWATERING BUILDING FILTRATE SUMP SIZING

I. Objective

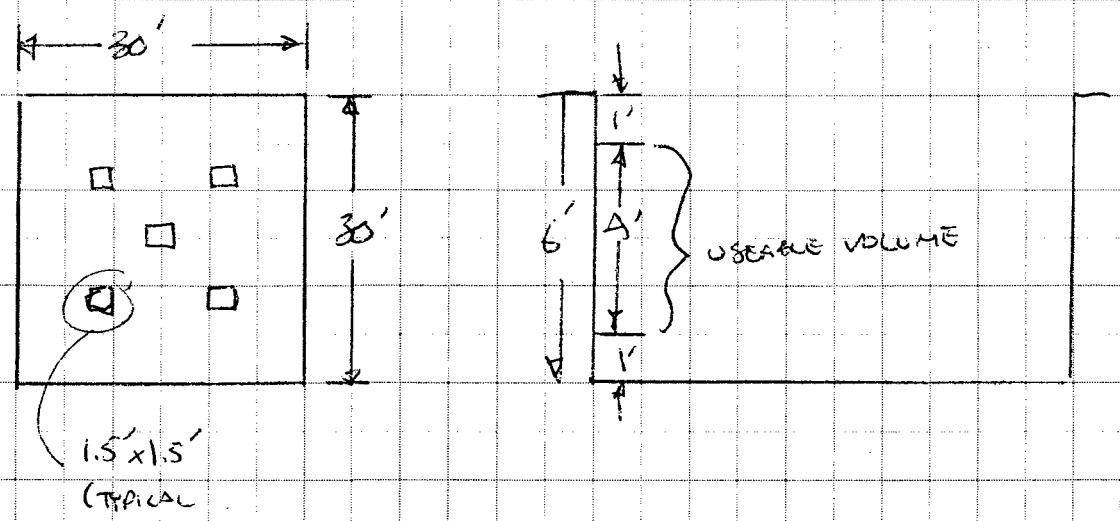
Based on the conclusions of the Dredging, Desanding and Dewatering Mass Balance Calculation (P-01) determine the required size of the filtrate sump to be installed within the dewatering facility.

II. Assumptions

The following assumptions were utilized for sizing the filtrate slurry pump:

- Maximum filtrate instantaneous flowrate from a 650 ft^3 diaphragm plate and frame filter press = 3,000 gpm. This flowrate occurs at the beginning of the dewatering operational cycle and last for approximately 5 minutes. Following this initial fill rate the filtrate flowrate decreases.
- Two (2) filter presses will not be filled at the same time.
- Based on the mass balance calculations (P-01) the average filtrate flowrate is 803 gpm. This value is based on an hourly average flowrate and does not reflect the higher initial flowrate of 3,000 gpm.
- Filtrate transfer line has been sized for a 3,000 gpm flowrate
- The filtrate transfer pumps will be rated for 1,500 gpm. .

III. Sizing



Useable volume = (30 ft)*(30 ft)*(4 ft) – (1.5 ft)*(1.5 ft)* (4 ft) = 3,555 ft^3
= 26,593 gallons

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/21/02 SHEET 2 OF 3

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIES

SUBJECT DEWATERING BUILDING FILTRATE SUMP SIZING

Assuming that a 1,500 gpm sump pump will be utilized to transfer filtrate from Area D to Area C the anticipated cycle times for the pump are provided in Table 1.

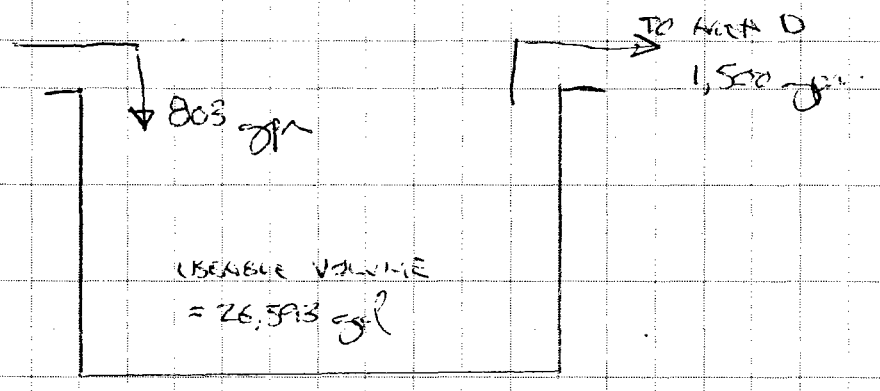


Table 1: Summary of Anticipated Sump Pump[1] Cycle Time
New Bedford Harbor Superfund Site - OU#1

Dredge Rate (yd^3/day)	In-Situ Solids (% by wt)	SPU Solids (% by wt)	Filter Cake Solids (% by wt)	Filtrate Flowrate (gpm)	Pump Cycle Time (min)
2,002	42	15	65	803	38.15
1,849	50	15	65	944	47.83
1,515	42	10	70	1,010	54.27
1,195	50	10	70	1,010	54.27

Notes: 1. Assumes 1,500 gpm sump pump

CALCULATION COVER SHEET

Sheet 1 of 2

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Filtrate Transfer Pump Sizing (Area D to Area C)

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-07 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. BLINKMAN

REVIEWED BY R. OTOSKI DATE 5/23/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	JB 11-21-02	RO 12/3/02	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JJB DATE 11/21/02 SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. 5197.1720.9302.00010 DEPT. NO. _____

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DESANDING/DEWATERING FACILITIES

SUBJECT FILTRATE TRANSFER PUMP SIZING (AREA D TO AREA C)

I. Objective

Based on the conclusions of the Dredging, Desanding and Dewatering Mass Balance Calculation (P-01) determine the size requirements for filtrate transfer pumps.

II. Assumptions

The following operational assumptions were utilized for sizing the transfer pumps:

- The system will be sized to handle the maximum anticipated flowrate from the desanding operations (1,011 gpm) based on calculation P-01 – Dredging, Desanding and Dewatering Mass Balance.
- The system will be provided with a backup system with the capability to handle 100% of the maximum flowrate.
- The density of seawater is 63.31 lbs/ft^3
- The transfer pipeline will consist of 14" outside diameter SDR 11 HDPE pipe.
- The headloss in the HDPE is less than 1 ft/100 ft.
- The distance from Area C to Area D is approximately 7,800 ft
- Pump efficiency will be 60%.
- Assume pump is capable of 1,500 gpm

III. Equipment Sizing

Power required of pumping:

$$Bhp = \frac{QH\rho}{(HP)e_p} \qquad \text{Equation \#1}$$

Where:

bhp = braking horse power
Q = flowrate, ft^3/sec
H = head loss in pipe, feet
ρ = density of fluid, lbs/ft^3
HP = horse power , 550 ft-lb/sec
e_p = pump efficiency

(Crane's Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings, and Pipe" p. B-9)

Therefore,

$$bhp = \frac{(1{,}500\ gal/min)*(0.1337\ ft^3/gal)*(0.0167\ min/sec))*((7{,}800\ LF)*(1\ ft/100\ ft))*(63.31\ lbs/ft^3)}{(550\ ft\text{-}lbs/sec)*(0.6)} = 50.12\ HP$$

CALCULATION COVER SHEET

Sheet 1 of 6

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Filtrate Transfer Piping from Area D to Area C

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-08 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J FRANCIS

REVIEWED BY _____ DATE 5-20-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	JB 11-21-02	RD 12/3/02	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY Joe F DATE 3/15/02 SHEET 1 OF 6

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NBH

SUBJECT Filtrate Line From Area D to Area C

FROM MASS BALANCE CALCS

MAX ~~2800~~ 1,010 gpm

AVG 800 gpm

MIN. 235 gpm

FROM DRAWINGS USED IN PRESENTATION

LENGTH OF PIPE = 6259 feet

25% safety factor = 1565 feet

Total for Calculation PURPOSES 7824 feet

ELEVATION CHANGE

BOTTOM OF SUMP AT D = 0 feet

TOP OF CELL #2 East Side = 16.6 feet

NET Change = +16.6 feet

FITTINGS AND VALVES

2 BUTTERFLY

8 90° Elbow

1 Check valve

Velocity, v

FROM pg 3-2 of CRANE'S

$$\frac{0.408 \times Q\ gpm}{(\text{Diameter, d, inches})^2}$$

REYNOLDS #

FROM pg 3-2 of CRANE'S

$$123.9\ \frac{dv\rho}{\mu}$$ where d = diameter, inches

v = velocity ft/sec

ρ = density, lbs/ft³

μ = viscosity in centerpoise

FWENC 581D 10/96

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY Joe F DATE 3/15/02 SHEET 2 OF 6

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT NBH

SUBJECT Filtrate Line

Resistance Coefficient, K_p for pipe only

$K = f \frac{L}{D}$ where f is friction factor for smooth pipe (see Moody Diagram pg A-24 of Crane's)

L Length, feet

D Diameter feet

Resistance Coefficient K_T TOTAL

Sum of K_p and K_1 (minor losses)

Head Loss, h_L

$$h_L = 0.00259 \frac{K_T Q^2}{d^4}$$ FROM CRANE'S pg 3-4

TOTAL Dynamic Head, H

H = static head + h_L + losses due to other elements

BRAKING HP

$$\frac{Q\,H}{3960 \times \text{Efficiency}}$$

Piping Calculations From Area D to Area C

KNOWN VARIABLES

Pipe Length (Ft) =	7824
Flow Rate (GPM) =	525
Static Head (Ft) =	16.6
Seawater Density at 60F (ρ) (lb/Ft^3) =	63.31
H_2O Viscosity centerpoise(μ) =	1.129
Seawater Specific Gravity @60F =	1.015
Pump Efficiency =	0.6

MINOR LOSSES

Elements	K	# Elements	Total K
90 Degree Elbow	0.39	6	2.34
Plug Valve	0.23	0	0
Swing Check Valve	1.3	1	1.3
Butterfly Valve	0.46	2	0.92
Flow Into T	0.78	0	0
Flow Along T	0.26	0	0
Exit	1	1	1
		Sum Total For K_1=	**5.56**

LOSSES DUE TO OTHER ELEMENTS

Element	Loss (Ft)	Quantity	Total Loss (Ft)
Flow Element	5	0	0
Static Mixer	5	0	0
		Total Elemental Loss (h_E) =	**0**

Pipe Diameter (Inches)	8.000	10.000	12.000	14.000	16.000
Velocity (Ft/Sec.)	3.347	2.142	1.488	1.093	0.837
Reynolds Number	186018.3	148814.6	124012.2	106296.2	93009.1
Friction Factor smooth pipe (f)	0.020	0.020	0.021	0.022	0.022
K_P	234.720	187.776	164.304	144.185	129.096
K_T	240.280	193.336	169.864	144.185	134.656
head loss (h_L)	41.877	13.802	5.848	2.679	1.467
Total Dynamic Head (H)	**58.477**	**30.402**	**22.448**	**19.279**	**18.067**
Braking Horse Power	**12.921**	**6.718**	**4.960**	**4.260**	**3.992**

A/6

Piping Calculations From Area D to Area C

KNOWN VARIABLES

Pipe Length (Ft) =	7824
Flow Rate (GPM) =	800
Static Head (Ft) =	16.6
Seawater Density at 60F (ρ) (lb/Ft^3) =	63.31
H_2O Viscosity centerpoise(μ) =	1.129
Seawater Specific Gravity @60F =	1.015
Pump Efficiency =	0.6

MINOR LOSSES

Elements	K	# Elements	Total K
90 Degree Elbow	0.39	6	2.34
Plug Valve	0.23	0	0
Swing Check Valve	1.3	1	1.3
Butterfly Valve	0.46	2	0.92
Flow Into T	0.78	0	0
Flow Along T	0.26	0	0
Exit	1	1	1

Sum Total For K_1= **5.56**

LOSSES DUE TO OTHER ELEMENTS

Element	Loss (ft)	# Units	Total Loss (ft)
Flow Element	5	0	0
Static Mixer	5	0	0

Total Elemental Loss (h_E) = **0**

Pipe Diameter (Inches)	8.000	10.000	12.000	14.000	16.000
Velocity (Ft/Sec.)	5.100	3.264	2.267	1.665	1.275
Reynolds Number	283456.4	226765.1	188970.9	161975.1	141728.2
Friction Factor smooth pipe (f)	0.020	0.020	0.021	0.022	0.022
K_P	234.720	187.776	164.304	144.185	129.096
K_T	240.280	193.336	169.864	144.185	134.656
head loss (h_L)	97.238	32.047	13.579	6.221	3.406
Total Dynamic Head (H)	**113.838**	**48.647**	**30.179**	**22.821**	**20.006**
Braking Horse Power	**38.329**	**16.380**	**10.161**	**7.684**	**6.736**

Piping Calculations From Area D to Area C

KNOWN VARIABLES

Pipe Length (Ft) =	7824
Flow Rate (GPM) =	1010
Static Head (Ft) =	16.6
Seawater Density at 60F (ρ) (lb/Ft^3) =	63.31
H_2O Viscosity centerpoise(μ) =	1.129
Seawater Specific Gravity @60F =	1.015
Pump Efficiency =	0.6

MINOR LOSSES

Elements	K	Elements	Total K
90 Degree Elbow	0.39	6	2.34
Plug Valve	0.23	0	0
Swing Check Valve	1.3	1	1.3
Butterfly Valve	0.46	2	0.92
Flow Into T	0.78	0	0
Flow Along T	0.26	0	0
Exit	1	1	1
		Sum Total For K_1=	**5.56**

LOSSES DUE TO OTHER ELEMENTS

Element	Loss (Ft)	Quantity	Total Loss (Ft)
Flow Element	5	0	0
Static Mixer	5	0	0
		Total Elemental Loss (h_E) =	**0**

Pipe Diameter (Inches)	8.000	10.000	12.000	14.000	16.000
Velocity (Ft/Sec.)	6.439	4.121	2.862	2.102	1.610
Reynolds Number	357863.7	286291.0	238575.8	204493.6	178931.9
Friction Factor smooth pipe (f)	0.020	0.020	0.021	0.022	0.022
K_P	234.720	187.776	164.304	144.185	129.096
K_T	240.280	193.336	169.864	144.185	134.656
head loss (h_L)	154.989	51.081	21.643	9.916	5.429
Total Dynamic Head (H)	**171.589**	**67.681**	**38.243**	**26.516**	**22.029**
Braking Horse Power	**72.940**	**28.770**	**16.257**	**11.272**	**9.364**

Piping Calculations From Area D to Area C

KNOWN VARIABLES

Pipe Length (Ft) =	7824
Flow Rate (GPM) =	1500
Static Head (Ft) =	16.6
Seawater Density at 60F (ρ) (lb/Ft^3) =	63.31
H_2O Viscosity centerpoise(μ) =	1.129
Seawater Specific Gravity @60F =	1.015
Pump Efficiency =	0.6

MINOR LOSSES

Elements	K	# Elements	Total K
90 Degree Elbow	0.39	6	2.34
Plug Valve	0.23	0	0
Swing Check Valve	1.3	1	1.3
Butterfly Valve	0.46	2	0.92
Flow Into T	0.78	0	0
Flow Along T	0.26	0	0
Exit	1	1	1
		Sum Total For K_1=	**5.56**

LOSSES DUE TO OTHER ELEMENTS

Element	Loss (Ft)	Quantity	Total Loss (Ft)
Flow Element	5	0	0
Static Mixer	5	0	0
		Total Elemental Loss (h_E) =	**0**

Pipe Diameter (Inches)	8.000	10.000	12.000	14.000	16.000
Velocity (Ft/Sec.)	9.563	6.120	4.250	3.122	2.391
Reynolds Number	531480.8	425184.6	354320.5	303703.3	265740.4
Friction Factor smooth pipe (f)	0.020	0.020	0.021	0.022	0.022
K_P	234.720	187.776	164.304	144.185	129.096
K_T	240.280	193.336	169.864	144.185	134.656
head loss (h_L)	341.853	112.667	47.737	21.872	11.974
Total Dynamic Head (H)	**358.453**	**129.267**	**64.337**	**38.472**	**28.574**
Braking Horse Power	**226.296**	**81.608**	**40.617**	**24.288**	**18.039**

12" PIPE WILL BE UTILIZED FOR DESIGN.

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Polymer Usage

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-09 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER R. OTOSKI

REVIEWED BY _____ DATE 5-20-02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

BY KPU DATE 3/19/02 SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT Polymer Usage

SUBJECT _____

Polymer – 816 LB/DAY
AT 65% SOLIDS
727 T DRY SOLIDS/DAY

AT A POLYMER CONDITIONING RATE OF

4 # POLYMER/DRY TON →

(4#/T)(727 DRY T/DAY) = 2908 # POLYMER/DAY

@ 1% SOLUTION

(2908 #)(100) = 290,800 # OF 1% SOLUTION

290,800 #/8.34 #/GAL ≈ 35,000 GAL/DAY

OR 17,500 GAL/SHIFT

USE 12' Ø X 8' HIGH TANKS

$\pi r^2 h$ (7.48) ≈ 7000 GAL/TANK

17,500 GAL SHIFT/7000 GAL/TANK = 2.5 TANKS/SHIFT

FWENC 581D 10/96

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Process Area Secondary Containment Volume

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-10 PROJECT NO. 5197.1720.9302

NO OF SHEETS 2 DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. Brinkman

REVIEWED BY [signature] DATE 10/10/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

PROCESS AREA OF DEWATERING BUILDING WILL HAVE A 6 INCH CURB AND AN AREA OF 180 FT x 165 FT.

THEREFORE THE AVAILABLE CONTAINMENT VOLUME =

$$(180\ \text{FT}) \times (165\ \text{FT})\left(\frac{6}{12}\ \text{FT}\right) \times 7.48052\ \frac{\text{gal}}{\text{FT}^3} = 111{,}085\ \text{gallons}$$

THE LARGEST HYDRAULIC UNIT WITHIN THE PROCESS AREA CANNOT EXCEED $\frac{111{,}085\ \text{gallons}}{2} = 55{,}543\ \text{gal.}$

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Filter Cake Loading Evaluation

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. P-11 PROJECT NO. 5197.1720.9302

NO OF SHEETS 2 DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. Brinkman JB 11-26-02

REVIEWED BY M Otta DATE 11/27/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

Anticipated Filter Cake Loading Sequence
New Bedford Harbor Dewatering Facility
New Bedford Harbor Superfund Site, OU#1

Assumptions

Dewatering Process

- Four (4) 650 ft^3 diaphragm plate and frame filter presses to be utilized.
- Maximum volume filter cake (65% by wt) that can be produced per press cycle is 17.5 yd^3 .
- Each filter press cycle is 2 hours.
- Each filter press operation sequence is staggered by 30 minutes.
- 70 yd^3 of filter cake is generated every two hours (17.5 yd^3 /press)
- Density of filter cake is 105 lbs/ft^3 (1.4 $tons/yd^3$).

Rail Gondolas

- Each gondola has a capacity of 100 yd^3
- Each gondola can hold 100 tons of filter cake.
- Assume 4 filter press cycles (98 tons) will fill one (1) gondola.

Gondola Loading

- Assume one (1) 5 yd^3 bucket excavator will be utilized to load gondolas.
- Assume 4 trips to load 17.5 yd^3 of filter cake.
- Assume maximum distance between filter press and gondola is 200 feet
- Assume 4 minutes (round trip) per load for a total of 16 minutes per filter press dump.
- Total time required to load gondola is 64 minutes.
- Assume liner is placed in gondolas prior to entering loadout facility.
- Assume 15 minutes to place and secure tarp over gondola.

Gondola Changeout

- Assume rail car mover operates at the low maximum speed of 2.4 mph (211 ft/min).
- Maximum distance required to transfer loaded gondola from Track #3 to Track #2 is 1,000 ft. Therefore, assume 5 minutes.
- Maximum distance to transfer empty gondola from Track #1 to Track #3 is 2,000 ft (Track #2 to Track #1 to Track #3). Therefore, assume 10 minutes.
- Assume 2 minutes required to hookup/unhook gondolas. (Two hookups and two disconnects). 8 minutes.

Gondola Decontamination

- Assume 15 minutes to decontaminate and weigh gondola prior to leaving loadout facility.
- Assume decontamination is conducted after tarp is secured on gondola

24 hour Loading Sequence

1.	Filter Press #1 discharges 17.5 yd^3 of filter cake	**0600**	
2.	Front-end loader transfers filter cake to gondola #1	**0616**	
3.	Filter press #2 discharges 17.5 yd^3 of filter cake	**0630**	
4.	Front-end loader transfers filter cake to gondola #1	**0646**	
5.	Filter press #3 discharges 17.5 yd^3 of filter cake	**0700**	
6.	Front-end loader transfers filter cake to gondola #1	**0716**	
7.	Filter press #4 discharges 17.5 yd^3 of filter cake	**0730**	
8.	Front-end loader transfers filter cake to gondola #1	**0746**	
9.	Complete loading of gondola #1	**0746**	
10.	Filter press #1 discharges 17.5 yd^3 of filter cake		**0800**
11.	Place and secure tarp over gondola #1	**0801**	
12.	Decontaminate gondola #1	**0816**	
13.	Transfer gondola #1 from Track #3 to Track #1	**0825**	
14.	Filter press #2 discharges 17.5 yd^3 of filter cake		**0830**
15.	Transfer gondola #2 from Track #2 to Track #3		**0839**
16.	Filter press #3 discharges 17.5 yd^3 of filter cake		**0900**
17.	Front-end loader transfers filter cake from presses #1, and #2 to gondola #2		**0911**
18.	Front-end loader transfers filter cake from press #3 to gondola #2		**0927**
19.	Filter press #4 discharges 17.5 yd^3 of filter cake		**0930**
20.	Front-end loader transfers filter cake from press #4 to gondola #2		**0946**
21.	Complete loading of gondola #2		**0946**
22.	Filter press #1 discharges 17.5 yd^3 of filter cake	**1000**	
23.	Place and secure tarp over gondola #2		**1001**
24.	Decontaminate gondola #2		**1016**
25.	Transfer gondola #2 from Track #3 to Track #1		**1025**
26.	Filter press #2 discharges 17.5 yd^3 of filter cake	**1030**	
27.	Transfer gondola #3 from Track #2 to Track #3	**1039**	
28.	Filter press #3 discharges 17.5 yd^3 of filter cake	**1100**	
29.	Front-end loader transfers filter cake from presses #1, and #2 to gondola #3	**1111**	
30.	Front-end loader transfers filter cake from press #3 to gondola #3	**1127**	
31.	Filter press #4 discharges 17.5 yd^3 of filter cake	**1130**	
32.	Front-end loader transfers filter cake from press #4 to gondola #3	**1146**	
33.	Complete loading of gondola #3	**1146**	
34.	Filter press #1 discharges 17.5 yd^3 of filter cake		**1200**
35.	Place and secure tarp over gondola #3	**1201**	
36.	Decontaminate gondola #3	**1216**	
37.	Transfer gondola #3 from Track #3 to Track #1	**1225**	
38.	Filter press #2 discharges 17.5 yd^3 of filter cake		**1230**
39.	Transfer gondola #4 from Track #2 to Track #3		**1239**
40.	Filter press #3 discharges 17.5 yd^3 of filter cake		**1300**
41.	Front-end loader transfers filter cake from presses #1, and #2 to gondola #4		**1311**
42.	Front-end loader transfers filter cake from press #3 to gondola #4		**1327**
43.	Filter press #4 discharges 17.5 yd^3 of filter cake		**1330**
44.	Front-end loader transfers filter cake from press #4 to gondola #4		**1346**
45.	Complete loading of gondola #4		**1346**
46.	Filter press #1 discharges 17.5 yd^3 of filter cake	**1400**	
47.	Place and secure tarp over gondola #4		**1401**
48.	Decontaminate gondola #4		**1416**
49.	Transfer gondola #4 from Track #3 to Track #1		**1425**

50.	Filter press #2 discharges 17.5 yd^3 of filter cake	**1430**	
51.	Transfer gondola #5 from Track #2 to Track #3	**1439**	
52.	Filter press #3 discharges 17.5 yd^3 of filter cake	**1500**	
53.	Front-end loader transfers filter cake from presses #1, and #2 to gondola #5	**1511**	
54.	Front-end loader transfers filter cake from press #3 to gondola #5	**1527**	
55.	Filter press #4 discharges 17.5 yd^3 of filter cake	**1530**	
56.	Front-end loader transfers filter cake from press #4 to gondola #5	**1546**	
57.	Complete loading of gondola #5	**1546**	
58.	Filter press #1 discharges 17.5 yd^3 of filter cake		**1600**
59.	Place and secure tarp over gondola #5	**1601**	
60.	Decontaminate gondola #3	**1616**	
61.	Transfer gondola #5 from Track #3 to Track #1	**1625**	
62.	Filter press #2 discharges 17.5 yd^3 of filter cake		**1630**
63.	Transfer gondola #6 from Track #2 to Track #3		**1639**
64.	Filter press #3 discharges 17.5 yd^3 of filter cake		**1700**
65.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #6		**1711**
66.	Front-end loader transfers filter cake from press #3 to gondola #6		**1727**
67.	Filter press #4 discharges 17.5 yd^3 of filter cake		**1730**
68.	Front-end loader transfers filter cake from press #4 to gondola #6		**1746**
69.	Complete loading of gondola #6		**1746**
70.	Filter press #1 discharges 17.5 yd^3 of filter cake	**1800**	
71.	Place and secure tarp over gondola #6		**1801**
72.	Decontaminate gondola #6		**1816**
73.	Transfer gondola #6 from Track #3 to Track #1		**1825**
74.	Filter press #2 discharges 17.5 yd^3 of filter cake	**1830**	
75.	Transfer gondola #7 from Track #2 to Track #3	**1839**	
76.	Filter press #3 discharges 17.5 yd^3 of filter cake	**1900**	
77.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #7	**1911**	
78.	Front-end loader transfers filter cake from press #3 to gondola #7	**1927**	
79.	Filter press #4 discharges 17.5 yd^3 of filter cake	**1930**	
80.	Front-end loader transfers filter cake from press #4 to gondola #7	**1946**	
81.	Complete loading of gondola #7	**1946**	
82.	Filter press #1 discharges 17.5 yd^3 of filter cake		**2000**
83.	Place and secure tarp over gondola #7	**2001**	
84.	Decontaminate gondola #7	**2016**	
85.	Transfer gondola #7 from Track #3 to Track #1	**2025**	
86.	Filter press #2 discharges 17.5 yd^3 of filter cake		**2030**
87.	Transfer gondola #8 from Track #2 to Track #3		**2039**
88.	Filter press #3 discharges 17.5 yd^3 of filter cake		**2100**
89.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #8		**2111**
90.	Front-end loader transfers filter cake from press #3 to gondola #8		**2127**
91.	Filter press #4 discharges 17.5 yd^3 of filter cake		**2130**
92.	Front-end loader transfers filter cake from press #4 to gondola #8		**2146**
93.	Complete loading of gondola #8		**2146**
94.	Filter press #1 discharges 17.5 yd^3 of filter cake	**2200**	
95.	Place and secure tarp over gondola #8		**2201**
96.	Decontaminate gondola #8		**2216**
97.	Transfer gondola #8 from Track #3 to Track #1		**2225**
98.	Filter press #2 discharges 17.5 yd^3 of filter cake	**2230**	
99.	Transfer gondola #9 from Track #2 to Track #3	**2239**	
100.	Filter press #3 discharges 17.5 yd^3 of filter cake	**2300**	

101.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #9	**2311**	
102.	Front-end loader transfers filter cake from press #3 to gondola #9	**2327**	
103.	Filter press #4 discharges 17.5 yd^3 of filter cake	**2330**	
104.	Front-end loader transfers filter cake from press #4 to gondola #9	**2346**	
105.	Complete loading of gondola #8	**2346**	
106.	Filter press #1 discharges 17.5 yd^3 of filter cake		**2400**
107.	Place and secure tarp over gondola #9	**0001**	
108.	Decontaminate gondola #9	**0016**	
109.	Transfer gondola #9 from Track #3 to Track #1	**0025**	
110.	Filter press #2 discharges 17.5 yd^3 of filter cake		**0030**
111.	Transfer gondola #10 from Track #2 to Track #3		**0039**
112.	Filter press #3 discharges 17.5 yd^3 of filter cake		**0100**
113.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #10		**0111**
114.	Front-end loader transfers filter cake from press #3 to gondola #10		**0127**
115.	Filter press #4 discharges 17.5 yd^3 of filter cake		**0130**
116.	Front-end loader transfers filter cake from press #4 to gondola #10		**0146**
117.	Complete loading of gondola #10		**0146**
118.	Filter press #1 discharges 17.5 yd^3 of filter cake	**0200**	
119.	Place and secure tarp over gondola #10		**0201**
120.	Decontaminate gondola #10		**0216**
121.	Transfer gondola #10 from Track #3 to Track #1		**0225**
122.	Filter press #2 discharges 17.5 yd^3 of filter cake	**0230**	
123.	Transfer gondola #11 from Track #2 to Track #3	**0239**	
124.	Filter press #3 discharges 17.5 yd^3 of filter cake	**0300**	
125.	Front-end loader transfers filter cake from presses #1 & #2 to gondola #11	**0311**	
126.	Front-end loader transfers filter cake from press #3 to gondola #11	**0327**	
127.	Filter press #4 discharges 17.5 yd^3 of filter cake	**0330**	
128.	Front-end loader transfers filter cake from press #4 to gondola #11	**0346**	
129.	Complete loading of gondola #11	**0346**	
130.	Filter press #1 discharges 17.5 yd^3 of filter cake		**0400**
131.	Place and secure tarp over gondola #11	**0401**	
132.	Decontaminate gondola #11	**0416**	
133.	Transfer gondola #10 from Track #3 to Track #1	**0425**	
134.	Filter press #2 discharges 17.5 yd^3 of filter cake		**0430**
135.	Transfer gondola #12 from Track #2 to Track #3		**0439**
136.	Filter press #3 discharges 17.5 yd^3 of filter cake		**0500**
137.	Front-end loader transfers filter cake from presses #1, #2 & #3 to gondola #12		**0511**
138.	Filter press #4 discharges 17.5 yd^3 of filter cake		**0530**
139.	Front-end loader transfers filter cake from press #4 to gondola #12		**0546**
140.	Complete loading of gondola #12		**0546**
141.	Filter press #1 discharges 17.5 yd^3 of filter cake	**0600**	
142.	Place and secure tarp over gondola #12		**0601**
143.	Decontaminate gondola #12		**0616**
144.	Transfer gondola #12 from Track #3 to Track #1		**0625**
145.	Filter press #2 discharges 17.5 yd^3 of filter cake	**0630**	
146.	Transfer gondola #1 from Track #2 to Track #3	**0639**	
147.	Filter press #3 discharges 17.5 yd^3 of filter cake	**0700**	
148.	Front-end loader transfers filter cake from presses #1, #2 & #3 to gondola #1	**0711**	
149.	Filter press #4 discharges 17.5 yd^3 of filter cake	**0730**	
150.	Front-end loader transfers filter cake from press #4 to gondola #1	**0746**	
151.	Complete loading of gondola #1	**0746**	

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT New Bedford Harbor SUBJECT Rail Design

CLIENT USACE/EPA

CALCULATION NO. R1 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS ___ YES ✓ NO PREPARER Lucine Toroyan

REVIEWED BY [signature] DATE Nov. 29, 2001

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ✓ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
01	~~2-5~~ ALL	9-20-02 LT	JB 10-28-02	

CALCULATION SUMMARY FOR BALLASTED TRACK

1. Rail Size = 115 RE
2. Wood Tie Size
    a. Cross-Sectional = 7.0 inch x 9.0 inch
    b. Length = 8.5 feet
3. Wood Tie Spacing = 21 inch
4. Subgrade must withstand 33 pounds per square inch
5. AREMA 12 inch tie plate for 5½ inch rail base width – Plan No. 6
6. Elevation Above Top of Tie = 7½ inch
7. Total Load (Gondola + Load) = 266,000 pounds
8. Design Wheel Load = 33,250 pounds

(4) The AREMA track design method uses the beam-on-elastic-foundation model. In this model, the track has two components: the beam, which is the rail, and the elastic foundation, which represents everything below the rail combined. The basic expression in the model relates three main variables: the load on the rail, the stiffness of the track system, and the amount of vertical rail deflection, as shown in equation 6-4.

$$Y = \frac{P}{(64\ EIu^3)^{0.25}} \qquad \text{Eq 6-4}$$

Y = vertical rail deflection at a point (inches).

P = applied wheel load (including contributions from adjacent wheels) (lb).

EI = stiffness of the rail, where:

E = modulus of elasticity for steel (30×10^6 psi).

I = vertical moment of inertia of the rail section (inches^4).

u = stiffness of rail support, or track modulus (psi).

In this equation, EI represents the stiffness of the "beam" and u the stiffness of the "elastic foundation."

c. Design Load and Wheel Spacing.

(1) Select the design wheel load from table 2-2, based on the most common, heaviest car expected to travel over the track.

(2) Figure 6-13 shows the two most common wheel configurations. Most cars have two-axle trucks and the design wheel configuration is that in drawing (a), with an average 75-in. wheel spacing. The 140-ton series flat cars (for carrying M-1 tanks and other heavy vehicles) and some 100-ton flat cars have 3-axle trucks; their design wheel configuration is that in drawing (b), with 66-in. wheel spacing.

Weight of Railcar = 66,000 lb
Weight of Load = 200,000 lb
266,000 lb

4 pairs of wheels = 266,000 lb / 4 = 66,500 lb/pair
Each wheel in a pair shares equal weight
= 66,500 lb / 2 = 33,250 lb each

Applied Wheel Load (P) = 33,250 lb

Design Wheel Load (P_D) = 33,250 lb

Gondola has 2 axles
See Figure R1-1

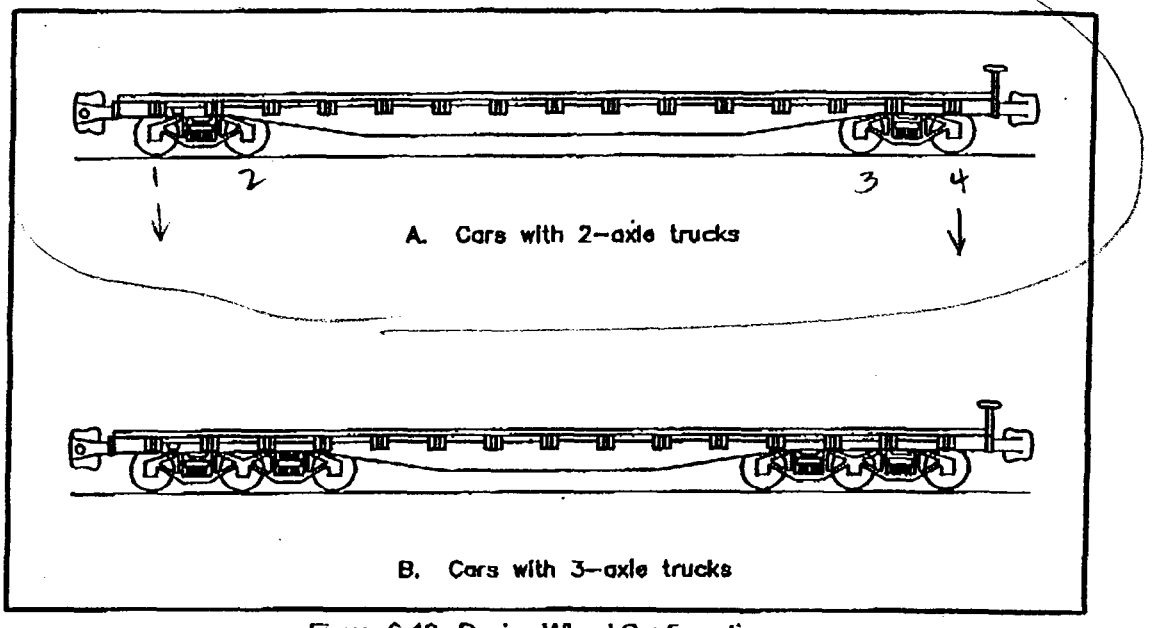


Figure 6-13. Design Wheel Configurations

(3) The track is evaluated assuming that a wheel is centered over a tie, with an adjacent wheel on either side contributing to the loads, deflections, and stresses — as occurs when two cars are coupled together. Referring to figure 6-13(a), the maximum tie, ballast, and subgrade loads will occur under wheels one and four (counting from the left), while the maximum rail bending stress will occur at wheels two and three. For the wheel configuration in figure 6-13(b), the maximum tie, ballast, and subgrade loads will occur under wheels two and five, while the maximum rail bending stress will occur at wheels three and four.

(4) The effect of wheels farther than 100 in. from the design wheel is negligible.

d. Select Trial Track Modulus (u). The track modulus values listed in table 6-6 are suggested starting points for design. In the table, track type "main" refers to main running tracks, while "auxiliary" includes sidings, wyes, loading, spur, storage, interchange, and light use tracks.

Table 6-6. Suggested Design Track Modulus Values

	Design Wheel Load Range (1,000's of pounds)					
Track Type	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50
Main	1500	1800	2000	2300	2600	2900
Auxiliary	1200	1300	1500	1700	2000	2200

u = 1500 psi

e. Select Rail Size.

(1) Use equation 6-5 to determine a minimum rail weight:

$$W_o = 315 - \frac{21200}{(\frac{P}{1120})(\alpha)+67} = 315 - \frac{21200}{(\frac{33250}{1120})(1)+67} = 96 \frac{lb}{yd}$$

Eq 6-5

W_0 = Weight of rail (lb/yd) 96 lb/yd

P = Design wheel load (lb) 33,250 lb

α = Impact factor, where:

α = 1, where design operating speed is 25 mph or less. ← < 10mph @ Dewatering Facility

α = 1.4, where design operating speed is more than 25 mph.

(2) Select a rail section from table 6-7 of equal or greater weight than calculated above.

* Use AREMA Manual (see Figure R1-2)

Table 6-7. Rail Sections

Rail Section	Moment of Inertia: I (inches^4)	Section Modulus to Base: Z_b (inches^3)
100 ARA-B	41.3	15.7
112 RE	65.5	21.8
* 115 RE	65.6	22.0 *
130 RE	77.4	25.5
132 RE	88.2	27.6
133 RE	86.0	27.0
136 RE	95.4	28.4

f. Determine Moment and Loading Coefficients.

(1) The moment and loading coefficients account for the affects of wheels adjacent to the design wheel. Adjacent wheels reduce rail moment and increase tie, ballast, and subgrade load.

(2) Calculate X1 using equation 6-6. (X1 should normally range between 28 and 40):

$$x_1 = 82\sqrt[4]{\frac{I}{u}} = 82\left(\frac{65.6 in^4}{1500 psi}\right)^{.25} = 37.5 in$$

Eq 6-6

X_1 = Distance from design wheel load to point of zero bending moment (inches).

I = Vertical moment of inertia of rail section (in.^{4}). 65.6 in^4

u = Stiffness of rail support, or track modulus (psi). 1500 psi

(3) Determine coefficients C_m and C_d as follows:

(a) For most design situations, and for cars with either 2-axle or 3-axle trucks, the rail moment coefficient (Cm) can be taken as 0.8.

(b) The load coefficient Cd can be taken from the following:

X1 =		28	30	32	34	36	38	40
Design Wheel Spacing	66:	1.24	1.30	1.36	1.44	1.54	1.62	1.70
	75:	1.08	1.15	1.22	1.30	1.36	1.42	1.50

75 in wheel spacing for 2-axle railcar

g. Check Rail Bending Stress. Use equation 6-7 to check that rail bending stress is less than 32,000:

$$f_o = \frac{(0.318 P_d C_m X_1)}{Z_b} \qquad \text{Eq 6-7}$$

f_0 = Maximum flexural stress (psi).

P_d = Dynamic (design) wheel load (lb) ~~from table 2-2~~. 33,250 lb

C_m = Moment coefficient. 0.8

X_1 = Distance from wheel load to point of zero bending moment (inches). 38 in

Z_b = Section modulus of rail base, from table 6-7 (cu in.). 22.0 in^3

$$f_o = \frac{(0.318)(33{,}250\,\text{lb})(0.8)(38\,\text{in})}{22.0\,\text{in}^3} = \boxed{14{,}611\ \text{psi}}$$

h. Ties and Tie Spacing.

(1) Choose a trial tie spacing and calculate the maximum rail seat load using equation 6-8:

$$q_o = \frac{0.39 P_d C_d S}{X_1} \qquad \text{Eq 6-8}$$

q_0 = Maximum rail seat load (lb).

P_d = Dynamic (design) wheel load (lb) ~~from table 2-2~~. 33,250 lb

C_d = Load coefficient for adjacent wheels. 1.42

S = Tie spacing (inches). Assume 21 in.

X_1 = Distance from wheel load to point of zero bending moment (inches). 38 in

$$q_o = \frac{(0.39)(33{,}250\,\text{lb})(1.42)(21\,\text{in})}{38\,\text{in}} = \boxed{10{,}176\,\text{lb}}$$

(2) Select tie size, either 6-in. x 8-in. x 8.5 ft, or 7-in. x 9-in. x 8.5 ft.

(3) Check tie bending stress using equation 6-9a or 6-9b, and f_t = 1100 psi as a suggested limit:

$$\text{For } 6x8 \text{ Ties}: f_t = \frac{q_o}{29} \qquad \text{Eq 6-9a}$$

$$\longrightarrow \text{For } 7x9 \text{ Ties}: f_t = \frac{q_o}{52} \qquad \text{Eq 6-9b}$$

f_t = Flexural stress on underside of tie below rail seat (psi).

q_o = Maximum rail seat load (lb).

$$f_t = \frac{10{,}176\,lb}{52} = 196\ psi$$

(4) If f_t > 1100, choose a larger tie size or decrease tie spacing.

196 < 1100 ✓ OK

i. Ballast and Subgrade.

(1) Determine ballast surface stress from equation 6-10, with p_m = 65 psi as a suggested limit:

$$p_m = \frac{q_o}{A_b} \qquad \text{Eq 6-10}$$

p_m = Ballast surface stress (psi).

q_o = Maximum rail seat load (lb).

A_b = Effective bearing area of ½ tie on ballast (sq in.).

For 6 x 8 ties, A_b = 270.

For 7 x 9 ties, A_b = 312.

$$p_m = \frac{10{,}176\,lb}{312\ in^2}$$

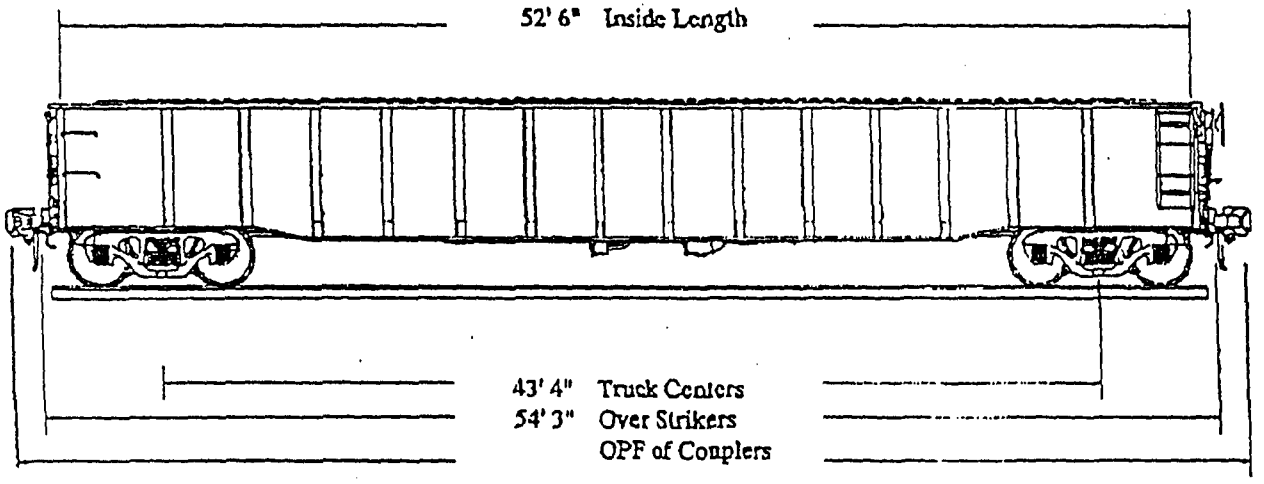
$$p_m = 33\ psi < 65\ psi \checkmark OK$$

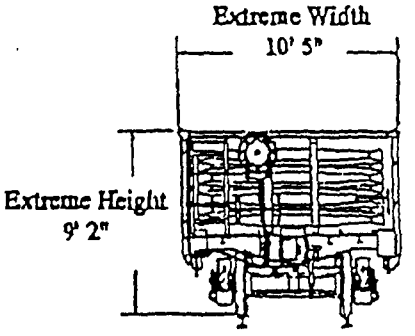
(2) If p_m exceeds 65 psi, choose a larger tie and/or decrease tie spacing.

(3) Select design subgrade bearing capacity (p_c) according to results of soil tests or other data. (In the absence of other guidance, the design bearing capacity for cohesive soils may be the same as the unconfined compressive strength).

Subgrade must withstand 33psi

CAR DESCRIPTION:





Inside Width: 9' 6"
Inside Height: 5' 6"

DESCRIPTION:

AAR MECHANICAL DESCRIPTION:	GBS	SPRING ARRANGEMENT:	
CAR TYPE CODE:	E 534	SPRING SIZE:	D-5
BUILDER:	Thrall	BRAKE SYSTEM:	DB-60
DATE BUILT: NEW:	1999	COUPLER:	SBE-60 DC
REBUILT		BULKHEAD OR CONTAINER:	
CUBIC FOOT CAPACITY:	2,743	TOP WIDTH:	
NOMINAL CAPACITY:	220,000	HEIGHT ABOVE PLATFORM:	
LIGHT WEIGHT:	~66,000 ←	LENGTH BETWEEN PULLING FACES:	56' 11"
CLEARANCE DIAGRAM:	Plate "B"	MINIMUM CURVE NEGOTIABILITY:	
LINING TYPE:		OVER PULLING FACE OF COUPLERS:	
DOOR TYPE:		OVER STRIKERS:	54' 3"
BEARINGS:	Roller	INSIDE LENGTH:	52' 6" TRUCK CENTERS: 43' 4"
ROOF TYPE:		INSIDE: Height -	5' 6" Width - 9' 6"
FLOOR TYPE:	Steel	EXTREME: Height -	9' 2" Width - 10' 5"
JOURNAL SIZE:	6 1/2" X 12"		
DRAFT GEAR:	Group "J"		
CAR CLASS:			

MISCELLANEOUS:

Figure R1-1

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 9/20/02 SHEET 9 OF 12

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE/EPA

PROJECT New Bedford Harbor

SUBJECT Top of Rail Calculation

Reference:

1) American Railway Engineering and Maintenance-of-Way Association (AREMA), Volume I, Chapters 4 and 5

* Figure 4-1-1 115 RE Rail Section (Figure R1-2)
* Section 1.3, pgs 5-1-7 and 5-1-9 (Figure R1-3)

Calculation:

Height of 115 RE Rail is 6-5/8 inch.

Tie plate holds rail in place. To fit the width of a 115 RE Rail, a 6in. x 14in. tie plate is needed.

The height of an AREMA 12 in. tie plate for a 6in. rail base width is 3/4 inch.

Rail height + Tie plate height =

$6 - 5/8'' + 3/4'' = 7.375$ inches

Top of Tie in yard is = 9'-0"

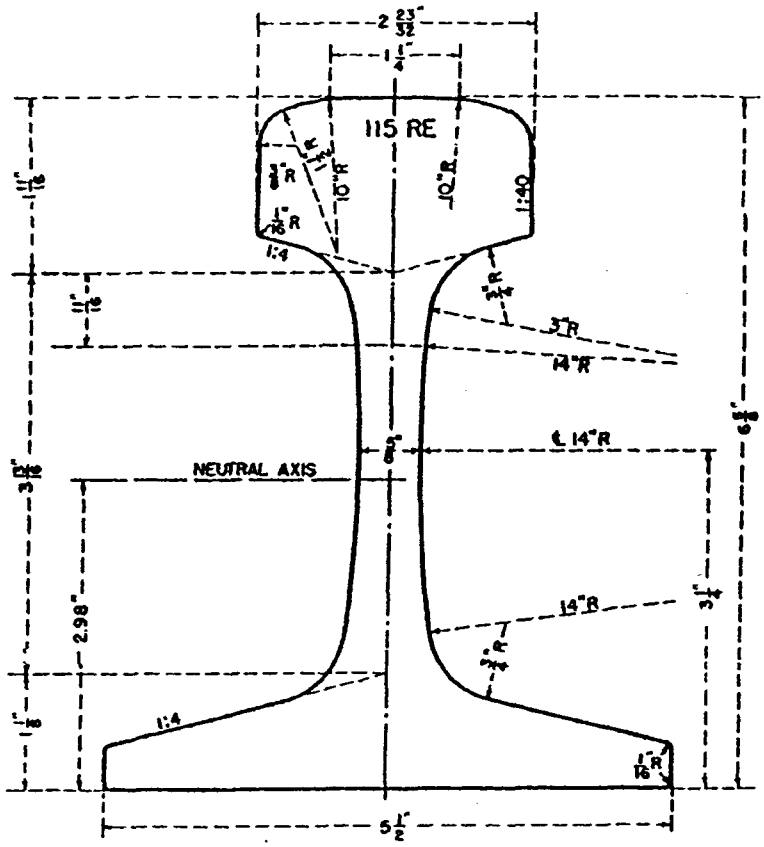
Top of Rail in yard is = 9'-0" + 7.375"

= 9' - 7 3/8"

For tolerance purposes, assume 9' - 7 1/2"

Elevation above top of rail = 7 1/2"

Figure R1-2



1. Rail Area (square inch)	
Head	3.9156
Web	3.0363
Base	4.2947
Whole Rail	11.2465
2. Rail Weight (lb/yd) (based on specific gravity of rail steel = 7.84)	114.6758
3. Moment of Inertia about the neutral axis = I	65.9 *
4. Section modulus of the head	18.1
Section modulus of the base	22.0
5. Height of neutral axis above base	3.00
6. Lateral moment of inertia	10.7
7. Lateral section modulus of the head	7.90
Lateral section modulus of the base	3.90
8. Height of shear center above base	1.45
9. Torsional rigidity is 'KG where G is the modulus of rigidity and K = (error for K greater than 10%)	4.69

Figure 4-1-1. 115 RE Rail Section[1]

[1] References, Vol 16, 1915, pp. 399, 1117; Vol. 35, 1934, pp. 875, 1144; Vol 38, 1937, pp. 251, 635; Vol 48, 1947, pp. 660, 908; Vol. 54, 1953, pp. 1177; Vol. 63, 1962, pp. 498, 768; Vol. 92, 1991, p. 49.

© 2001, American Railway Engineering and Maintenance-of-Way Association

Figure R1-3a

SECTION 1.3 DESIGN OF TIE PLATES FOR USE WITH AREMA RAIL SECTIONS (1992)

Refer to Table 5-1-3 and Figure 5-1-1 through Figure 5-1-12 for tie plate design.

Table 5-1-3. Tie Plate Designs for use with AREMA Rail Sections

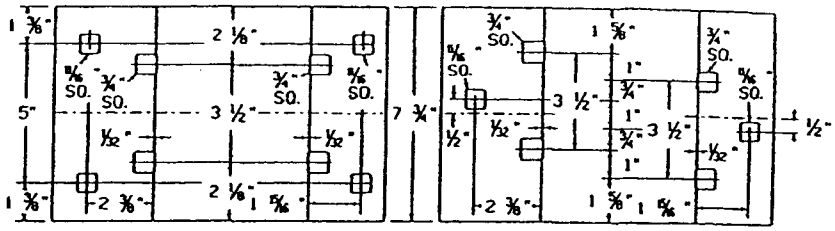
Plan Number	Figure No.	Length
1	5-1-1	10 Inch For Use With Rail Having a 5⅛ Inch Base
2	5-1-2	11 Inch For Use With Rail Having a 5⅛ to 5⅜ Inch Base
3	5-1-3	12 Inch For Use With Rail Having a 5⅜ Inch Base
6	5-1-4	12 Inch For Use With Rail Having a 5½ Inch Base
7	5-1-5	13 Inch For Use With Rail Having a 5½ Inch Base
8	5-1-6	14 Inch For Use With Rail Having a 5½ Inch Base
11	5-1-7	13 Inch For Use With Rail Having a 6 Inch Base
12	5-1-8	14 Inch For Use With Rail Having a 6 Inch Base
13	5-1-9	14¾ Inch For Use With Rail Having a 6 Inch Base
20	5-1-10	15 Inch For Use With Rail Having a 5½ Inch Base
21	5-1-11	16 Inch For Use With Rail Having a 6 Inch Base
22	5-1-12	18 Inch For Use With Rail Having a 6 Inch Base

Rail		Plate	
AREMA Rail Sections	Base Widths	Plan Number	Length Inches
140RE, 136RE, 133RE, 132RE	6 inch	22	18
		21	16
		13	14¾
		12	14
		11	13
119RE, 115RE	5½ inch	20	15
		8	14
		7	13
		6	12 *
100RE	5⅜ inch	3	12
		2	11
90RA-A	5⅛ inch	2	11
		1	10

Note 1: Tie plates are double shoulder except for plan number 1 and 2 which are single shoulder.
All tie plate sections canted 1: 40.
All tie plate sections have inclined ends.

© 2001, American Railway Engineering and Maintenance-of-Way Association

Figure R1-3b



ESTIMATED WEIGHTS IN POUNDS	
PER FOOT	25.84
PER 7 ¾"	16.69
PUNCHED	
8 HOLES	15.86
6 HOLES	15.99
4 HOLES	16.12
ADD FOR RIBS	
PER FOOT	0.34
PER 7 ¾"	0.22

ALL SQUARE SPIKE HOLES WILL HAVE 1/16" FILLETS IN CORNERS.
WHEN SPECIFIED -
SUPPLY SECTION WITH RIBS ON BOTTOM OF PLATE.
CENTERLINE DISTANCE BETWEEN HOLD DOWN SPIKE HOLES 4 ½" INSTEAD OF 5".
ROUND HOLES MAY BE SUBSTITUTED FOR SQUARE HOLD DOWN SPIKE HOLES.

Size and location of spike holes to be optional with maximum of eight.

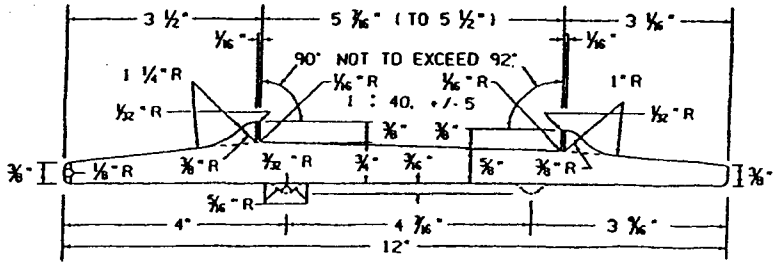
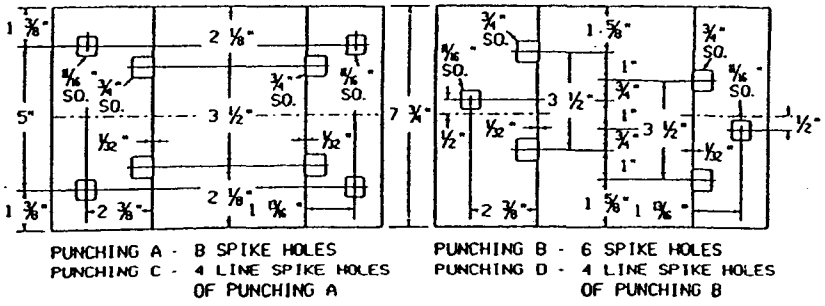


Figure 5-1-3. Plan No. 3 - AREMA 12 Inch Tie Plate for 5⅜ Inch Rail Base Width



ESTIMATED WEIGHTS IN POUNDS	
PER FOOT	25.95
PER 7 ¾"	16.76
PUNCHED	
8 HOLES	15.94
6 HOLES	16.06
4 HOLES	16.19
ADD FOR RIBS	
PER FOOT	0.34
PER 7 ¾"	0.22

ALL SQUARE SPIKE HOLES WILL HAVE 1/16" FILLETS IN CORNERS.
WHEN SPECIFIED -
SUPPLY SECTION WITH RIBS ON BOTTOM OF PLATE.
CENTERLINE DISTANCE BETWEEN HOLD DOWN SPIKE HOLES 4 ½" INSTEAD OF 5".
ROUND HOLES MAY BE SUBSTITUTED FOR SQUARE HOLD DOWN SPIKE HOLES.

Size and location of spike holes to be optional with maximum of eight.

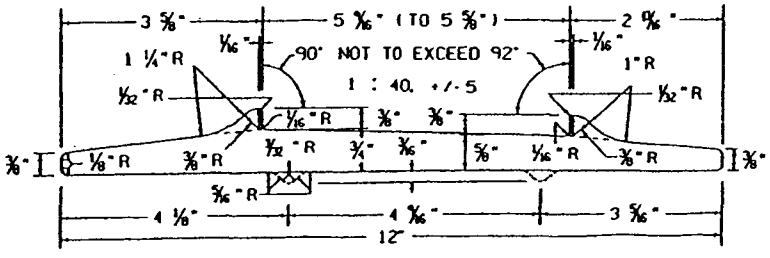


Figure 5-1-4. Plan No. 6 - AREMA 12 Inch Tie Plate for 5½ Inch Rail Base Width

© 2001, American Railway Engineering and Maintenance-of-Way Association

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 4

PROJECT New Bedford Harbor SUBJECT Rail Design

CLIENT USACE/EPA

CALCULATION NO. R2 PROJECT NO. 5197.1720.9302

NO OF SHEETS 2 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES ✓ NO PREPARER Lucine Toroyan

REVIEWED BY A. Nicholson DATE May 22, 2002

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES X NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	L. TOROYAN 10/10/02	JB 10/28/02	

Track Structural Evaluation Program Report
10-10-2002

Description of Track Conditions and Loading - Input:	
Track Loading	
Car Type	263,000 lb car (100 ton)
Operating Level	Light Use
Design Wheel Load	32,900 lbs
Rail	
Rail Weight	115 lbs/yd
Rail Section Type	AREMA
Joint Bolt State	Tight
Ties	
Cross Section Dimensions	7 in x 9 in
Wood Type	Hardwood
Tie Plate Size	8.0 in x 6.0 in
Spacing	21.0 in
Age	0 years
Average Remaining Tie Life	35 years
Tie Modulus/Stress Reduction Factor	1.00
Decay Hazard	2
Typical Tie Condition	Uniform
Tie Grade	AREMA mainline
Most Important Defect Type	None
Moment of Inertia	257.25 in^4
Modulus of Elasticity	1,000,000 psi
Ballast	
Ballast Depth	8 in
Ballast Grade	1
Drainage Quality	Good
Number of Wet Days	120
Modulus of elasticity	36,083 psi
Subgrade	
Classification System	ASTM
Source of Allowable Subgrade Stress	Program
Subgrade Drainage Quality	Good
Modulus of Elasticity	11,000 psi
Soil Classification	SW -Well graded Sands

Analysis Results:

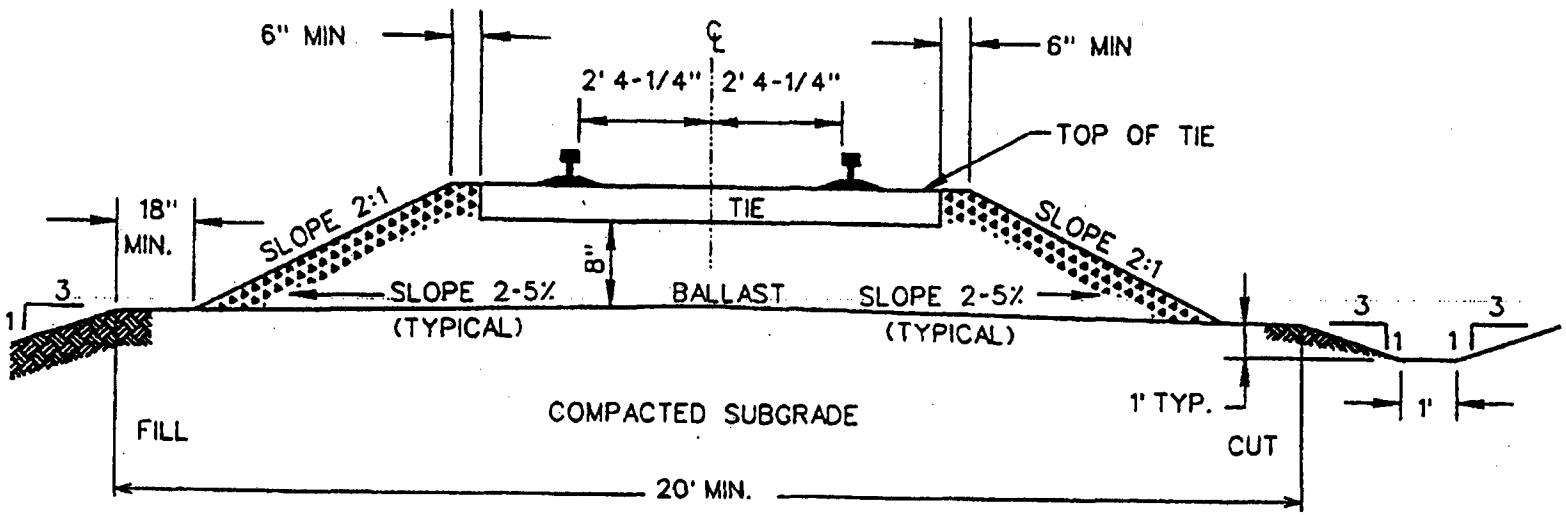
Description	Stresses and Loads	Suggested Limits	% of Limits
At rail section			
Rail Bending Stress	7,723 psi	32,000 psi	24%
Tie Reaction	14,433 lbs	26,400 lbs	55%
Tie Bending Stress	779 psi	2,500 psi	31%
Ballast Surface Stress	50 psi	70 psi	72%
Subgrade Stress	21.5 psi	43.0 psi	50%
At a joint			
Jt. Bar Bending Stress	18,205 psi	45,000 psi	40%
Tie Reaction	16,454 lbs	26,400 lbs	62%
Tie Bending Stress	881 psi	2,500 psi	35%
Ballast Surface Stress	58 psi	70 psi	83%
Subgrade Stress	23.7 psi	43.0 psi	55%

FINAL DESIGN CRITERIA

These final design criteria will be used to complete the drawings.

DESCRIPTION	DATA
General	
Design Load	263,000 lb car (100 ton)
Rail Gage	
Rail Weight	AREMA section 115 lbs/yd
Rail Gage Spacing	4' 8-1/2"
Rail Length	33 ft or 39 ft
Ties	
Tie Cross-Section	7 in x 9 in
Tie Length	8'- 6"
Wood Tie	New Hardwood (Oak) tie for outdoor use
Concrete Tie	New concrete tie for indoor use
Tie Spacing	21 in
Ballast	
Ballast Depth	8 in
Ballast Grade	AREMA No. 5 (1/4 in to 1 in)
Drainage Quality	Good
Modulus of Elasticity	36,083 psi
Subgrade	
Subgrade Soil Classification	ASTM SW-Well graded sands
Subdrainage Quality	Good
Modulus of Elasticity	11,000 psi

FINAL TYPICAL CROSS-SECTION DESIGN



TYPICAL SECTION

NOT TO SCALE

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT New Bedford Harbor SUBJECT General - Rail Design

CLIENT USACE / EPA

CALCULATION NO. R3 PROJECT NO. 5197.1720.9302

NO OF SHEETS 10 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER Lucine Toroyan

REVIEWED BY G. Nicholson DATE May 23, 2002

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES X NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ALL	L. TOROYAN 10/18/02	JB 10/28/02	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 10/10/02 SHEET 2 OF 10

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT New Bedford Harbor / Dewatering / Rail Design

SUBJECT Rail Size / Coordination w/ STV / Compromise Joints

Rail was sized in calculation package no. R1.

Minimum requirement per R1 is 96 lb/yd.

Army manual ARMY TM 5-850-2 states that rail gage is no longer made under 100 lb/yd.

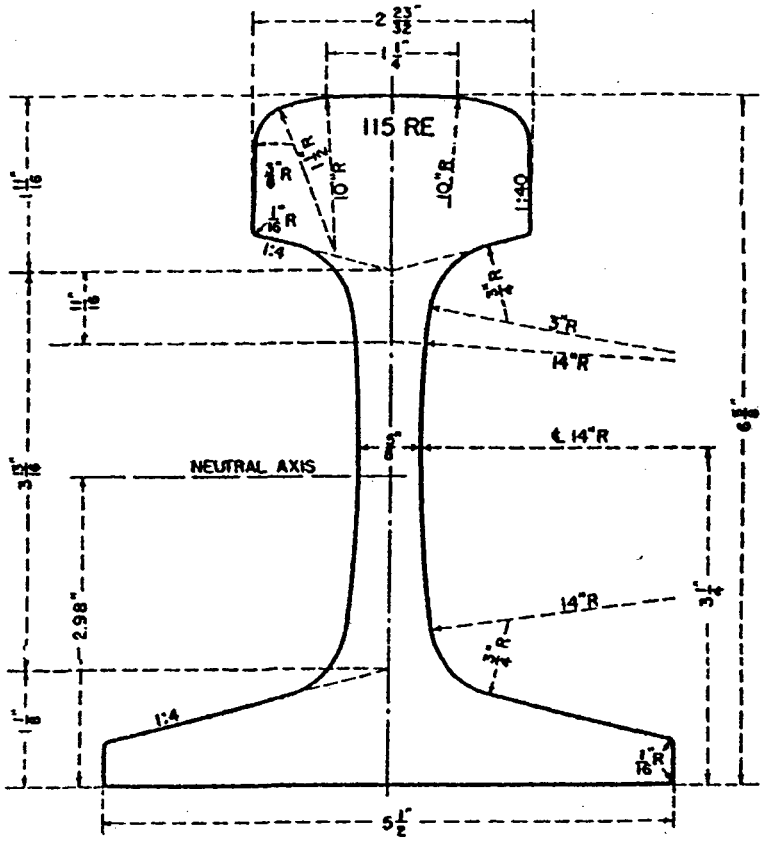
I picked out of the AREMA manual section 115 RE. The manual shows only rail sections 115 RE or greater. (see Figure R3-1)

VHB has chosen 132 RE for the MBTA rail line. Our rail yard track and the City of New Bedford's rail yard track does not need to be 132 RE. It would be an additional cost and overdesigned. It is standard practice to meet two different rail sizes.

Our design is being coordinated with STV's design for the City, and therefore, both rail yards will have AREMA Section 115 RE.

Because both designs will have the same rail size, compromise joints will not be needed. Compromise joints are used to combine two different sizes of rail. (See Figure R3-2)

Figure R3-1



1. Rail Area (square inch)	
Head	3.9156
Web	3.0363
Base	4.2947
Whole Rail	11.2465
2. Rail Weight (lb/yd) (based on specific gravity of rail steel = 7.84)	114.6758
3. Moment of Inertia about the neutral axis	65.9
4. Section modulus of the head	18.1
Section modulus of the base	22.0
5. Height of neutral axis above base	3.00
6. Lateral moment of inertia	10.7
7. Lateral section modulus of the head	7.90
Lateral section modulus of the base	3.90
8. Height of shear center above base	1.45
9. Torsional rigidity is 'KG where G is the modulus of rigidity and K = (error for K greater than 10%)	4.69

Figure 4-1-1. 115 RE Rail Section[1]

[1] References, Vol 16, 1915, pp. 399, 1117; Vol. 35, 1934, pp. 875, 1144; Vol 38, 1937, pp. 251, 635; Vol 48, 1947, pp. 660, 908; Vol. 54, 1953, pp. 1177; Vol. 63, 1962, pp. 498, 768; Vol. 92, 1991, p. 49.

© 2001, American Railway Engineering and Maintenance-of-Way Association

Figure R3-2

ATLANTIC TRACK & TURNOUT CO.

Connectors

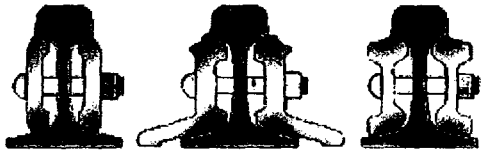
Rail Sections | Trackwork | Transit Systems
Crane Runway Systems | Railroad Accessories

Joint Bars | Compromise Joints | Tie Plates | Bolts | Spikes

Joint bars and bolts are used to fasten rails together. Tie plates and spikes attach rails and ties to produce track. Compromise bars join rails of unequal size.

Joint Bars

Illustrated are the three types of standard joint bars which are currently in service. Six-hole joint bars are provided for all crane rail and new tee rail sections over 100-lb. per yard. New rail 100-lb. per yard and less is furnished with four-hole joint bars. All relay rail is supplied with matching joint bars.



Splice Full Toe Short Toe

Back To Top

Compromise Joints

Heat-treated compromise joints are used to connect and align rails of unequal size and drilling. A standard bar is re-formed by a custom forging process in both the vertical and horizontal planes so that the gage and running surfaces of the joined rails are in true alignment.

Compromise Joint

Atlantic Track can also supply compromise weld joint kits or shop-fabricated transition rail joints as suitable alternates to the standard joint.

Back To Top

Tie Plates

Tie plates fasten the rail to the tie and maintain gage and alignment of rails in track. New double shoulder tie plates are available for 5-1/2" and 6" base rail and are manufactured according to AREA

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 5/2/02 SHEET 5 OF 10

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT New Bedford Harbor / Dewatering / Rail Design

SUBJECT Rail Gauge

Rail gauge shall be 4' - 8 1/2".

Excerpt From Railroad Engineering

space and operating at lower costs per ton mile and more ton miles per train hour.

Regardless, standard gage is the accepted rail spacing, and it is important that this spacing be maintained. Wide gage results in rough-riding trains because the greater nosing action increases lateral stresses and bending. When the wideness is irregular, rail head wear will also be irregular. Wide gage is likely to initiate and further poor line and surface. Because of the wide wheel treads, there is little danger of a locomotive or car falling between the rails unless the gage is $3\frac{1}{2}$ in. wide or more. However, no track should be permitted a gage wider than 1 in.

Gage may be widened on sharp curves to reduce wheel binding. There is less need for this practice with the disappearance of steam locomotives with long trains of drivers, but 3-axle power trucks on diesel-electric locomotives can create problems on high-degree curves. The amount of widening varies. One road has used $\frac{1}{2}$ in. for curves over 10°. Another widens $\frac{1}{8}$ in. for each degree over 6° to a maximum of 4 ft $9\frac{1}{8}$ in. The AREA makes no recommendation at this writing. FRA Safety Standards permit no gage less than 4 ft 8 in. and no wider than 4 ft $9\frac{3}{4}$ in. (for Class 1, 2, and 3 tracks—Rule 213.53). Regaging is usually not attempted unless it is $\frac{1}{2}$ in. or more wide.

Wide gage may result from several causes. Unfortunately carelessness of the workmen in using the track gage is not the least common of these causes. Close supervision and instruction are necessary to maintain a snug but not tight fit on the track gage and to have the rail and the plate both firmly and squarely seated. In gaging track one rail is taken as the gage rail (by railroad standard) and the other rail is gaged to it, regardless of the effects on line. The line rail should be initially in good alignment.

The lateral component or side thrust on the head of rail has an overturning moment intensified on curves that forces the rail base or outside edge of tie plate into the tie and spreads the rail heads apart. Hunting intensifies the process. The tie damage resulting is fully as serious as the wide gage. Wide gage is likely to occur at those locations where decayed ties do not provide sufficient holding power for the spikes. In extreme cases, where several such ties are together, spread track and derailments may occur.

In regaging, the cut surfaces of the tie must be smoothed by hand or machine to provide a smooth, flat bearing surface for the tie plate (or rail base) and the rail drawn in to proper gage. In spot gaging it is hardly economical or feasible to regage spots less than $\frac{1}{2}$ in. in width.

Tie Cross-Section:

AREMA Manual → Tie cross-section 7" x 9"
Ties shall be square-sawn

"Railroad Engineering", Hay → Has an AREMA Recommended Tie Table Below

TABLE 22.2 AREA Recommended Tie Grading

Size	Dimensions: Sawed or Hewed Four Sides	Dimensions: Sawed or Hewed Top and Bottom Only	Usual Assignments
1	6 in. depth by 6 in. width on top	6 in. depth by 6 in. width on top	Yard tracks and side tracks
2	6 in. depth by 7 in. width on top	6 in. depth by 7 in. width on top	Yard tracks and side tracks
3	6 in. depth by 8 in. width on top	6 in. depth by 8 in. width on top 7 in. depth by 7 in. width on top	Sidings and secondary side lines
4	7 in. depth by 8 in. width on top	7 in. depth by 8 in. width on top	Primary main lines
5 →	7 in. depth by 9 in. width on top	7 in. depth by 9 in. width on top	Primary main lines (especially on curves)

Decided to use mainline track to be compatible with MBTA mainline track and for additional strength to withstand railcar loading.

Tie Length:

AREMA Manual → Ties shall be 8'-0", 8'-6", or 9'-0" along straight lines.

Tie length to be 8'-6" unless different lengths are needed for curves and lap turnout.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 5/2/02 SHEET 7 OF 10

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE

PROJECT New Bedford Harbor / Dewatering / Rail Design

SUBJECT Tie Size + Material

Type of Tie:

Ties are to be wood ties outside of dewatering facility, and no ties are needed inside the dewatering facility. Rail shall be attached to slab inside dewatering facility. See calculation package R5 for details.

Wood ties should be made of hardwood and specifically out of oak. Oak will last longer and is used more often then any other type of wood.

Excerpt from Railroad Engineering

3. Types of Ties

Wood ties may be classified according to species, the method of cutting and dressing the timber, use, and according to an AREA grading system based on cross section.

Wood Species. The use of various woods is indicated in Table 22.1, which shows the number of cross ties given preservative treatment in 1975 and 1976. Not all of these were used in maintenance in those years; some went into new construction and others were held in storage for later use. Hardwood ties check more readily than softwoods and resist the penetration of treating compounds. Softwoods accept treating penetration more readily, but they are more susceptible to wear.

Oak has long been a favorite material, preferably white oak. Other hardwoods, including chestnut (now practically extinct) and gum, have been popular. Softer woods must of necessity be used when hardwoods

TABLE 22.1. Cross Ties Treated (thousand ties)[a]

Tie Wood	1975	1976
Douglas fir	171	354
Gum[b]	471	398
Hemlock	143	146
Oak	12,336	13,435
Ponderosa pine	253	341
Southern pine	1,854	738
Mixed hardwoods[b]	10,022	10,976
Mixed softwoods	2,546	1,130
Not specified	698	653
Total	27,884	28,171

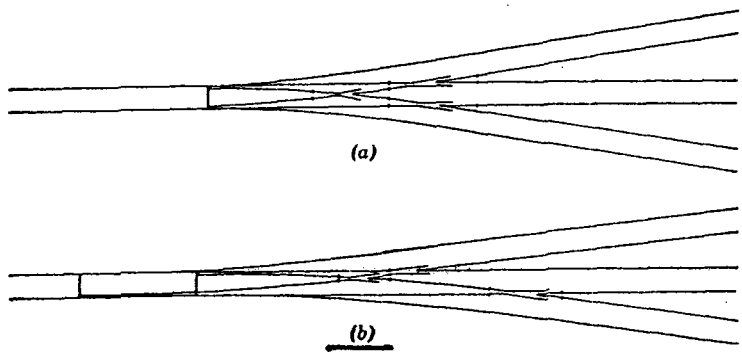
[a] *Crossties*, Railway Tie Association, St. Louis, Missouri, April 1978, p. 14.

[b] A great deal of gum may be reported in the mixed hardwoods category.

Due to the dewatering facility length, normal curves that meet minimum requirements by AREMA and CSX are not possible. Therefore, a No.8 lap turnout is utilized to maintain minimum requirements and to save space. Due to the lap turnout, two 12° curves fit in the track geometry.

17. Three-Way and Lapped Turnouts

The three-way switch is used where space is limited and where right-hand and left-hand diversions are desired at the same point. The exam-



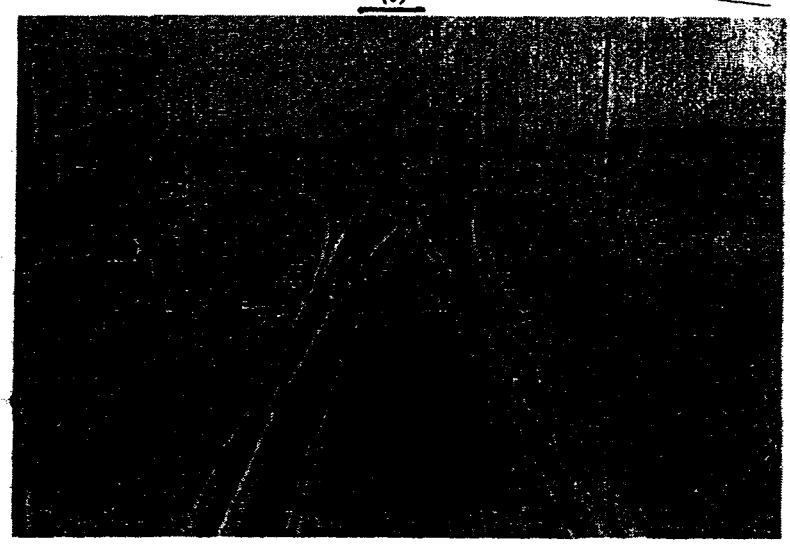


Figure 27.17. Three-way and lap turnouts.

ple illustrated in Figure 27.17*a* has some limited use in the yards of Europe, where the type of the yard layout is definitely related to this design of switch. As can be seen, three frogs and two sets of points are required, with one set of points acting as stock rails for the other set. Two throw rods and stands are also required. This layout is structurally weak, complicated to install, and difficult to maintain.

A much simpler and structurally sound three-way or lap turnout is being used by U.S. railroads, as seen in Figure 27.17*b*. Here the switches are separated with the points bearing against conventional stock rails instead of other switch points.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 5/2/02 SHEET 9 OF 10

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT New Bedford Harbor / Dewatering / Rail Design

SUBJECT Track Geometry

The criteria below is from CSX's "Guidelines and Specifications For Design and Construction of Commercial Tracks". Our track geometry consists of two 12° curves and one No. 8 Pap turnout, which meets CSX's minimum requirements for rail yards.

8.0 Design Criteria

Design criteria to be used for sidetracks with operating speeds not to exceed 15 mph are listed in the following table. The criteria are not intended for Yard and Terminal track, Intermodal track, Branch or Spur Lines, nor any trackage with operating speed greater than 15 mph.

CRITERIA	INDUSTRY TRACK	LEAD TRACK	LOAD / UNLOAD IN MOTION
Turnout Size			
	Number 8	Number 10	Number 10
Note: turnouts in **main tracks** shall be **No.10** or larger			
Maximum Curve			
Degree	12°-00'-00"	10°-00'-00"	10°-00'-00"
Radius	478.34'	573.69'	573.69'
	(Chord Definition: R=50/sin½D)		
Tangent Between Reverse Curves			
Preferred	100'	100'	
Minimum	60'	60'	100'
Maximum Grade			
	2.5% †	2.5% †	1.5% †
Loop Track			0.7% ‡
† Uncompensated	‡ Compensated at 0.04% per degree of curve		
Vertical Curve			
Summits	40 x algebraic difference in grades	40 x algebraic difference in grade	400 x algebraic difference in grades
Sags	50 x algebraic difference in grades	50 x algebraic difference in grades	500 x algebraic difference in grades
Length	100' minimum	100' minimum	100' minimum

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 5/16/02 SHEET 10 OF 10

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT NBH/Dewatering/Rail Design

SUBJECT Track Geometry - Superelevation

No Superelevation will be required along curves or leptunout.

TM 5-850-2/AFJMAN 32-a046

Table 7-2. Design Superelevation for Curved Track.

Degree of Curvature	Maximum Operating Speed, mph						
	10	15	20	25	30	35	40
0.50							
1.00							
1.50		NO SUPERELEVATION REQUIRED					1.0
2.00						1.0	1.0
2.50					1.0	1.0	1.5
3.00					1.0	1.5	2.0
3.50				1.0	1.0	2.0	2.5
4.00				1.0	1.5	2.0	3.0
4.50			1.0	1.0	1.5	2.5	3.5
5.00			1.0	1.0	1.5	2.5	
5.50			1.0	1.5	2.0		
6.00			1.0	1.5	2.0		
6.50			1.0	1.5			
7.00			1.0	2.0			
7.50			1.0				
8.00			1.5				
8.50					DO NOT DESIGN FOR OPERATION IN THIS RANGE		
9.00							
9.50							
10.00							
10.50							
11.00							
11.50							
12.00							

Note: Table entries are superelevation in inches.

(2) Full superelevation must be provided around the entire curve. For curves with 1-inch superelevation, that elevation may be run out (transitioned back to level) in 40 feet of tangent at the beginning and end of the curve. Where superelevation is more than 1 inch, spirals will be provided at each end of the curve.

f. Increase in Gage on Very Sharp Curves. Where curves of 12 degrees or more cannot be avoided, finished track gage will be as follows:

Curvature Range (degrees)	Track Gage (Inches)
12 to 14	56 5/8

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 9

PROJECT New Bedford Harbor SUBJECT Rail Design

CLIENT USACE/EPA

CALCULATION NO. R4 PROJECT NO. 5197.1720.9308

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES ✓ NO PREPARER Lucine Toroyan 5/17/02

REVIEWED BY A. Nicholson DATE May 23, 2002

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 5/17/02 SHEET 2 OF 9

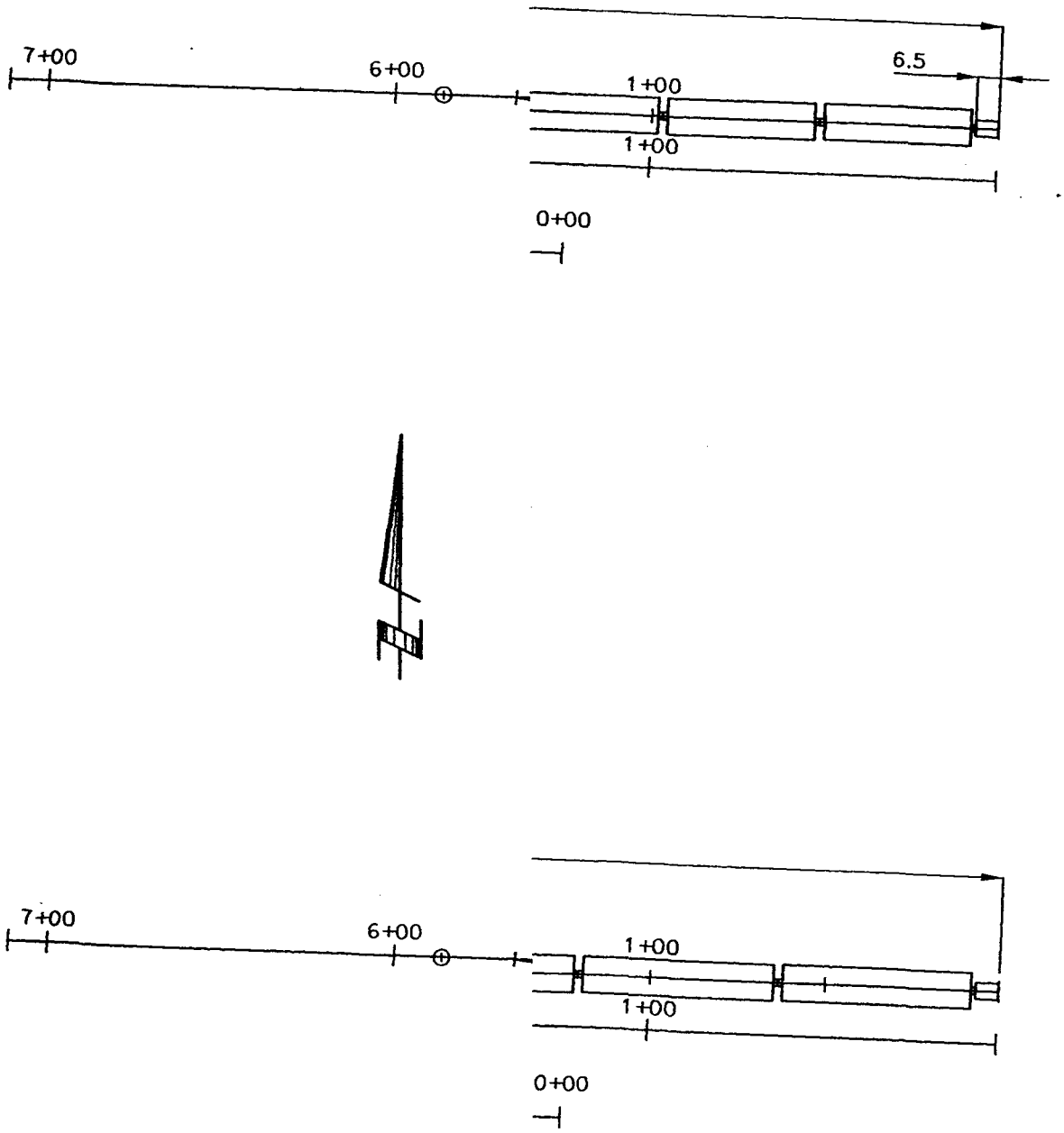
CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT New Bedford Harbor

SUBJECT Rail Layout & Equipment

Page#	Description
1	Cover Sheet
2	Table of Contents
3	Railcar Layout Gondolas & Intermodals
4	Gondola Spec Sheet
5	Intermodal Spec Sheet
6	Trackmobile Model 4250 TM Spec Sheet
7	Trackmobile - Resistances & Capacities
8	Bumping Posts Spec Sheet
9	Hinged Car Stops Spec Sheet

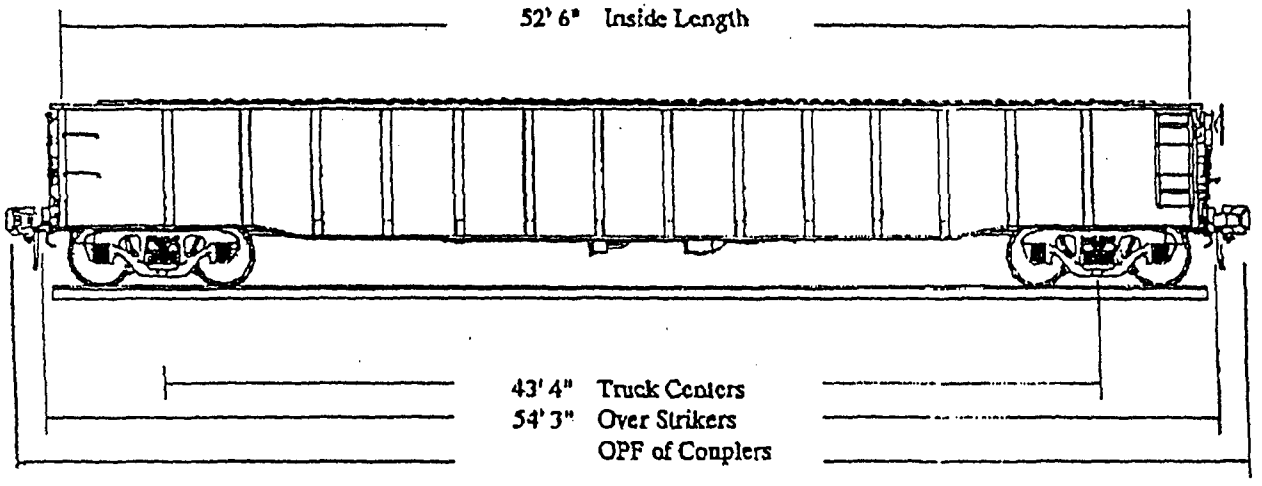


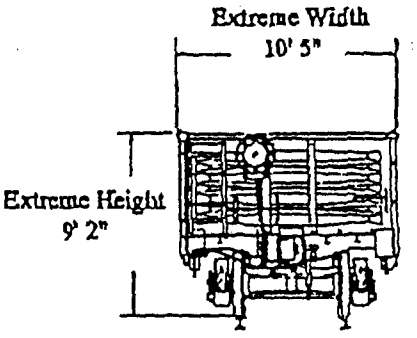
NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

RAILCAR LAYOUT
GONDOLAS AND INTERMODALS

SCALE:	1" = 50'

CAR DESCRIPTION:



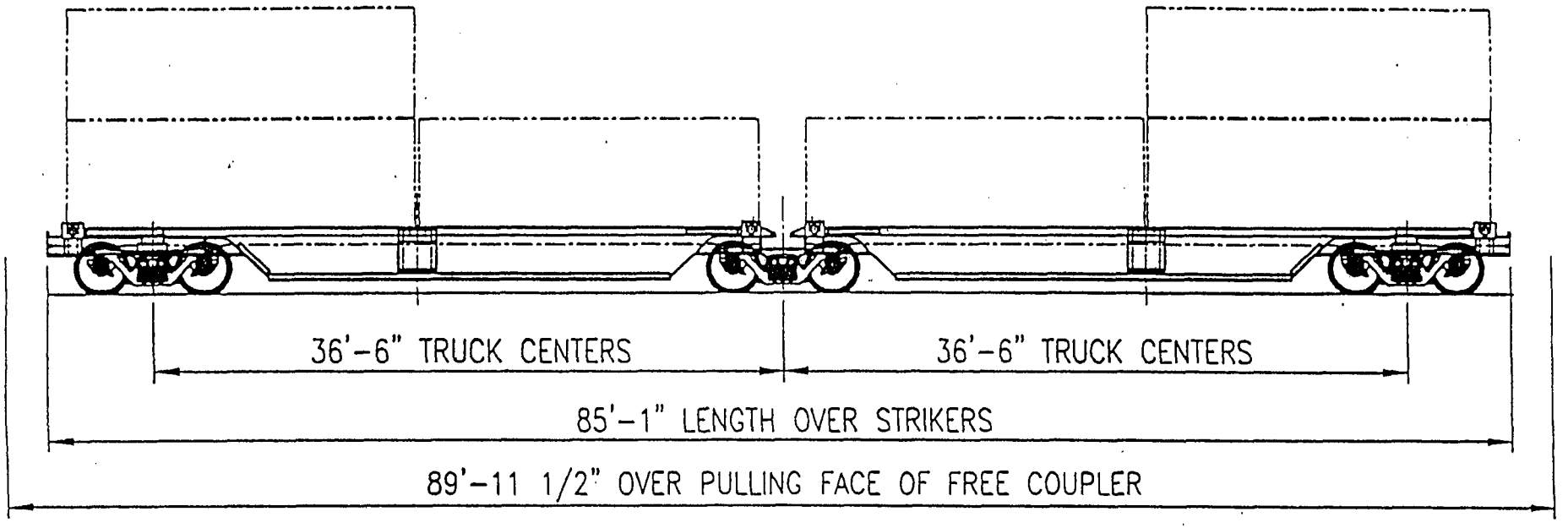


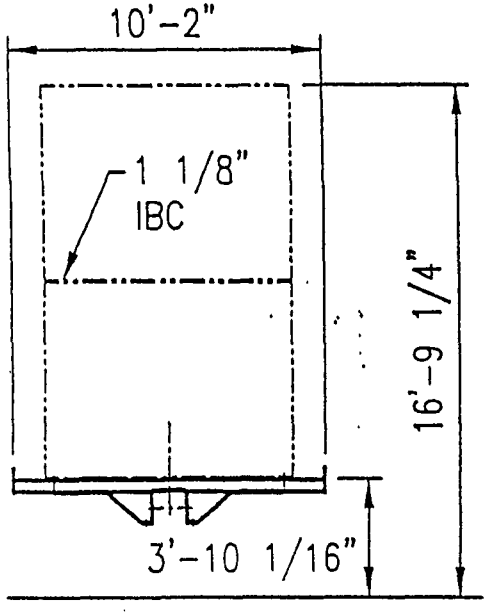
Inside Width: 9' 6"
Inside Height: 5' 6"

DESCRIPTION:

AAR MECHANICAL DESCRIPTION:	GBS	SPRING ARRANGEMENT:	
CAR TYPE CODE:	E 534	SPRING SIZE:	D-5
BUILDER:	Thrall	BRAKE SYSTEM:	DB-60
DATE BUILT: NEW:	1999	COUPLER:	SBE-60 DC
REBUILT		BULKHEAD OR CONTAINER:	
CUBIC FOOT CAPACITY:	2,743	TOP WIDTH:	
NOMINAL CAPACITY:	220,000	HEIGHT ABOVE PLATFORM:	
LIGHT WEIGHT:	~66,000	LENGTH BETWEEN PULLING FACES:	56' 11"
CLEARANCE DIAGRAM:	Plate "B"	MINIMUM CURVE NEGOTIABILITY:	
LINING TYPE:		OVER PULLING FACE OF COUPLERS:	
DOOR TYPE:		OVER STRIKERS:	54' 3"
BEARINGS:	Roller	INSIDE LENGTH:	52' 6" TRUCK CENTERS: 43' 4"
ROOF TYPE:		INSIDE: Height -	5' 6" Width - 9' 6"
FLOOR TYPE:	Steel	EXTREME: Height -	9' 2" Width - 10' 5"
JOURNAL SIZE:	6 1/2" X 12"		
DRAFT GEAR:	Group "J"		
CAR CLASS:			

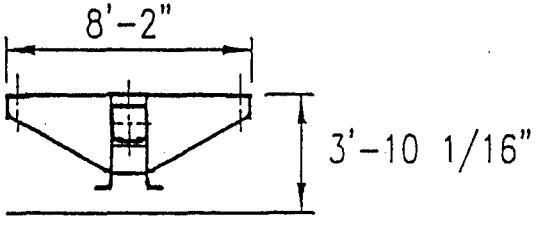
MISCELLANEOUS:





SECTION AT END SILL

GROSS RAIL .....429,000#
LT. WT. .....70,900#
MAX LD. LMT.....☆354,000#
(6 - 59,000 CONTAINERS)



SECTION AT CENTER CROSSBEARER

A.B.C. CAR

Sheet 5 of 9

Trackmobile Model -
4250 TM Rail Car Mover

www.trackmobile.com

42,814 lbs. [19,420 kg] Double Coupled Tractive Effort

27,139 lbs. [12,310 kg] Single Coupled Tractive Effort

34,740 lbs. [15,758 kg] Vehicle Weight

6 cylinder Turbo-charged Diesel Engine

Four Speed Electronically Controlled forward & reverse Transmission

Two heavy duty, cast steel Weight Transfer Couplers

Dual controls for rail operation

DIMENSIONS

	ON RAIL AAR Clearance Pattern Maintained		ON ROAD	
Wheelbase	121"	3073 mm	59.2"	1505 mm
Length	154.2"	3917 mm	154.2"	3917 mm
Width	122.5"	3111 mm	122.5"	3111 mm
Height	136"	3455 mm	146"	3701 mm
Weight	34,740 lbs. (15,758 kg)			

TABLE OF PERFORMANCE

Max Speed* (Both Directions)	ON RAIL		ON ROAD	
Low	2.4 mph	3.9 Km/H	1.5 mph	2.4 Km/H
2nd Range	4.0 mph	6.4 Km/H	2.5 mph	4.0 Km/H
3rd Range	8.0 mph	12.9 Km/H	5.1 mph	8.2 Km/H
4th Range	13.6 mph	21.9 Km/H	8.7 mph	14.0 Km/H

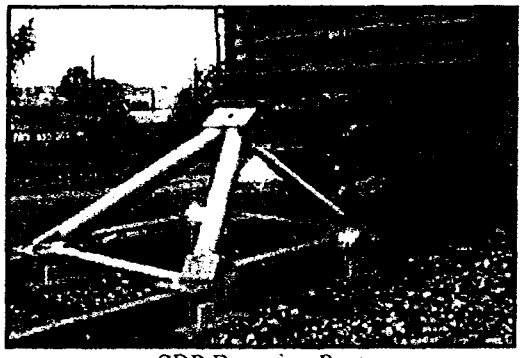
Resistances and Capacities

Bearings: Rolling Resistance for low friction roller bearings = 10.0; if your railcars have older style bushing-type bearings, enter 20.0	10.0	
Curves: Enter the degrees of curvature of the tightest curve through which you will be moving the railcars. If you only know the radius of curvature, refer to the conversion chart button above to obtain the number of degrees. Don't forget to include curvature for switch turnouts even if your track is otherwise straight.	12.0	
Grades: Enter the percent of grade for the steepest grade up which you will be moving railcars. If you only know the rise (the amount of vertical distance above true horizontal) and the distance overwhich the rise takes place, divide the rise by the run and enter the percentage as a whole number. For example, if the grade is 0.8% enter 0.8 in the box (that would be a rise of 8 inches over a run of 100 inches).	0.02	
If you will pull the load through the curve and grade at the same time, enter Y in the box. If you will pull through the grade, then the curve or curve then grade, leave blank.		
Weather and Track Conditions: If you encounter frequent ice and snow conditions during the winter months, put 10.0 in the box. If your track has gaps between rails and/or dips over the length of individual rails, use 5.0. Use 15 for both bad track and ice conditions.	10.0	
Enter the total weight in tons that you want to move. For example, if your railcars weigh 100 tons each (CAR + LOAD) and you want to move 8 cars, enter 800 (100 x 8)	600	TONS

In the matrix below the models and conditions (single or double coupled operation) that meet the tractive effort requirements will be maked with 'Y'

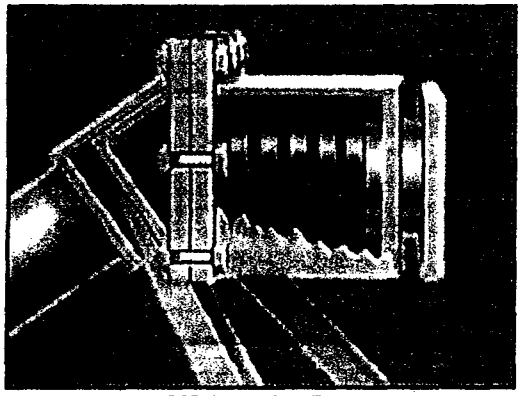
[illegible]	POUNDS			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

bumping posts



SBP Bumping Post

Nolan offers a range of bumping posts, some of which can be installed with ordinary hand tools. There is no center rail and spiking is unnecessary. The SBP model clamps to the rails at all four corners. Attached pads rest securely against the ties. Impact force is transferred down into the ties, providing a cushioned stopping action. The SBP-TR model bolts through the rails at all four corners. A cushion head is available for all models.



CH Bumping Post

SPECIFICATIONS*

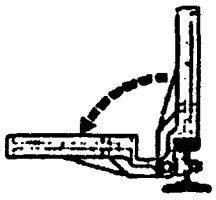
Model	Type	Length in. (mm.)	Weight lbs. (kgs.)	Yield point lbs. (kgs.)
SBP	Standard	76-5/8 (1,946)	1,045 (474)	486,000 (220,449)
HDBP	Heavy Duty	76-5/8 (1,946)	1,150 (522)	804,000 (364,694)
TBP	Transit	Built to Specifications and Orders		
SBP-TR	Standard Bolt on	76-5/8 (1,946)	1,045 (474)	486,000 (220,448)
HDBP-TR	Heavy Duty Bolt on	76-5/8 (1,946)	1,150 (522)	804,000 (364,692)
TBP-TR	Transit Bolt on	Built to Specifications and Orders		
CH	Cushion Head (Optional)	N/A	500 (227)	N/A

Note: When ordering the TR Models, please specify rail size. **Note:** When ordering a bumping post with optional cushion head, add "CH" to model number of post being

car stops

CS-60 Car Stop

Model CS-60



Nolan's model CS-60 is a hinged-type car stop designed for permanent installation on either flush or exposed rails. In the raised position, the CS-60 protects workers, warehouse doors, crossover walks, etc., or it swings down out of the way. The CS-60 may be padlocked in either the up or down position.

SPECIFICATIONS*

WEIGHT EACH: lbs. (kgs.).....91 (41)

FOR USE ON RAILS: lbs. (kgs.)....Specify rail size

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT New Bedford Harbor SUBJECT Rail Design

CLIENT USACE / EPA

CALCULATION NO. R5 PROJECT NO. 6197.1720.9303

NO OF SHEETS 17 DESIGN LEVEL 2

CALCULATION BY OTHERS ____ YES ✓ NO PREPARER Lucine Toroyan

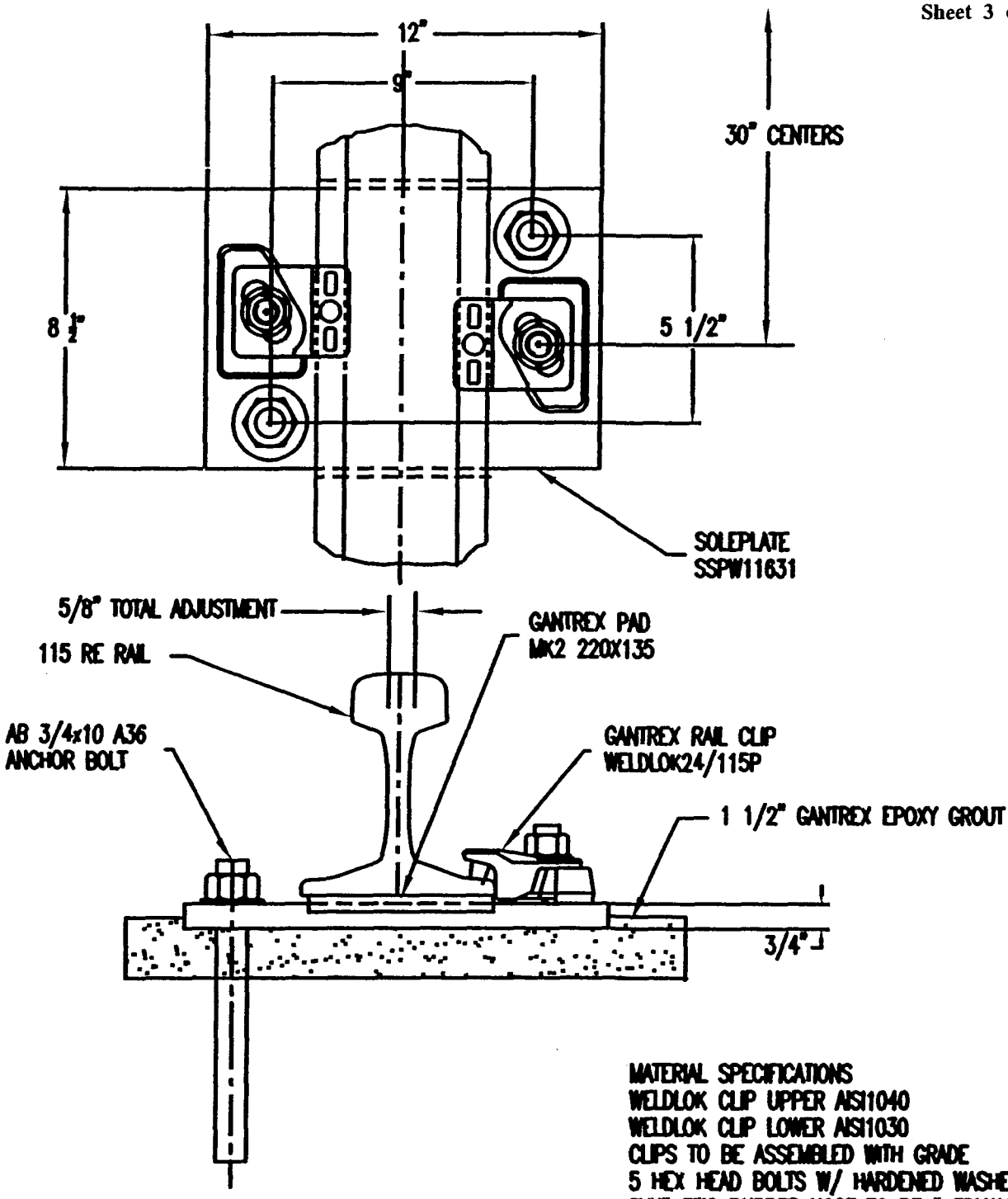
REVIEWED BY [illegible] DATE 10/22/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ✓ NO

ASSUMPTIONS CONFIRMED BY NA DATE NA

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
1	ATTACHMENT	12/2/02	[illegible] 12/4/02	



MATERIAL SPECIFICATIONS
WELDLOK CLIP UPPER AISI1040
WELDLOK CLIP LOWER AISI1030
CLIPS TO BE ASSEMBLED WITH GRADE
5 HEX HEAD BOLTS W/ HARDENED WASHER
SYNTHETIC RUBBER NOSE TO BE THERMALLY
VULCANIZED TO THE UPPER CLIP COMPONENT
A GANTREX REP WILL PERFORM AN ONSITE
INSPECTION AND ISSUE A WRITTEN REPORT

CLIP LOWERS TO BE WELDED TO SOLEPLATE
IN FABRICATION SHOP

GANTREX
Gantrex Group

This drawing shows the best arrangement, in Gantrex opinion, for the system installation. Gantrex is not responsible in any way for any product or design not purchased from Gantrex or through one of its agents, associates or distributors.

TITLE: TYPICAL SOLEPLATE		
CUSTOMER: FOSTER WHEELER		
DWN. BY: Trev	DATE: 9-18-02	SCALE:
APP'D. BY:	DWG. NO. 11631	REV. P1

SUMMARY FOR RAIL ATTACHMENT IN BUILDING

1. Rail Size = 115 RE
2. Top of Rail Elevation = 9' - 7½ "
3. Total Load (Gondola + Load) = 266,000 pounds
4. Design Wheel Load = 33,250 pounds
5. Discontinuous rail support on slab every 30 inches
6. Description of Attachment:
    a. Weldok 24 rail clips to hold rail in place
    b. Weldok 24 rail clips are pre-welded in factory to soleplates sized for 115 RE rail
    c. MK2 pad placed under rail on soleplate to reduce local bearing stress, noise, and vibration.
    d. Gantrex Epoxy Grout placed on dry clean slab and soleplate is placed on grout for easy leveling.
    e. Adhesive Anchor Bolts are used to secure rail attachment system in place. A hole is air-drilled 1/8 inch larger than required ¾ inch bolt using the soleplate as guide. The adhesive is poured and bolt is set in place and left to dry. This allows for the rail contractor to come in and place bolts where needed after foundation slab has been constructed.
7. Included attachments in this calculation
    a. Gantrex drawing of rail attachment
    b. Gantrex structural calculations and fax cover sheet from Bob St. Lawrence (2 pages)
    c. Weldlok 24 weldable clips specification sheet (2 pages)
    d. Standard Steel Soleplate for discontinuous rail support specification sheet (2 pages); Standard soleplates in table do not fit a 115 RE rail width. Correct X and Y dimensions for bolthole locations and size of plate are specified on Gantrex drawing.
    e. MK2 Pad for discontinuous rail support specification sheet for MK2 220x135 (2 pages)
    f. K3 Epoxy Grout (4 pages)
    g. Adhesive Anchor Bolts specification sheet for AB ¾ x 10-A36 (2 pages)

GANTREX®
A RAILWORKS COMPANY

17 DAPHNE DRIVE
NORWALK, CT 06851
PH: 203 849-9160 FX: 203 846-8228

TO NAME	Mrs Lucy Toroyan	DATE:	9-19-02
COMPANY	FWENC	FAX #:	561-237-1890
FROM	Bob St. Lawrence	Pages Including This Page	
SUBJECT	New Bedford, MA Army Corp		
cc:	Co.:	Fax #:	

FYI

Bob

SAINT

All information contained in this fax is proprietary and confidential. It is intended solely for use by Gantrex and the individual recipient noted herein. If you receive this information in error, please immediately and permanently discard it.

Quality on Track®

Component Selection and Calculation Results

Name of Customer : Foster Wheller Env-New Bedford,Ma Army Corp
Rail Type : AREA115
Rail Base : 5.50 inches 140 mm
Rail Support : Discontinuous
Rail Installation : With pad
Crane Loading Cycle : Above 500,000
Crane Wheel Diameter : 33 inches
Crane Wheels / Corner: 2
End Truck Dimension : a1 240 inches a2 72 a3 ????
Loads / Wheel (kips) : Vertical 36.0, Thrust 5.4 Longitudinal 3.6

WELDLOK 24/115 P

Clip Assembly : ~~9119/13/41/15~~ Nose Compression: 211 x .001 inches
Upper : 9120/15/38/15 : 5.3 mm
Lower : 9119/- -/27
Lateral adjust: 5/8 inches
Sole Plate : 2 Holes, 12.00 x 8.500 x 0.75"
MK2 Pad : 220 x 135

Clamping Force per Clip : 550 lbf
Resistance to Pullthru Force: 803 lbf
Resistance to Lateral Force : Max.24 kips
Pressure on Grout : 0.55 ksi

Clip spacing calculated by computer: 30.0 inches

Rail Yield Stress : 70.0 ksi
Admissible Yield Stress : 23.3 ksi
Stress In This Application : 15.9 ksi ✓ ok
Rail Admissible Deflection : 0.0300"
Rail Deflection - Horizontal : 0.0075" ✓ ok
- Vertical : 0.0105"

Rail Ultimate Stress : 116.7 ksi
* Rail/Wheel Contact Stress : 65.3 ksi

Type of Grout Required: Epoxy
Grout Thickness : 1.00 inches
Concrete Quality : 4.0 ksi
Adm. Concrete Pressure: 1.00 ksi
Anchor Bolt Diameter : 0.75 inches AB 3/4 x 10 A-36
Tightening Torque : 75.0 ft-lb

Hardware:
Bolt: 1 Grade 5 hex. cap screw, Diameter 3/4" x 1 3/4"
Nut: 1 A325 hex. nut, Diameter 3/4"
Washer: 1 hardened structural washer, Diameter 3/4"
Torque: 250 ft-lb (35 kg-m)

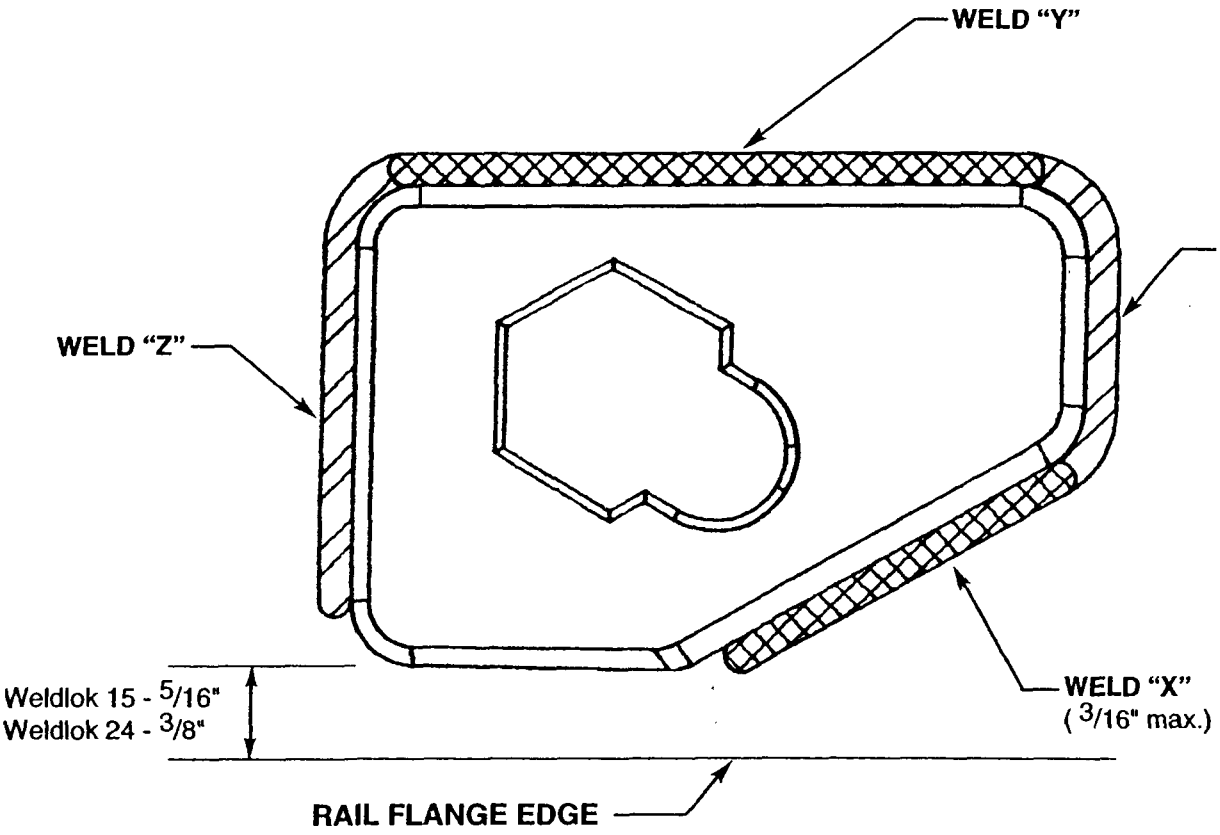
* Rail and wheel after "wear in period"

GANTREX®
A RAILWORKS COMPANY

Weldlok™ 15 & 24 weldable clips

SUGGESTED WELD

- The lower component of the GANTREX Weldlok Series clip is welded to the support structure. The weld size on the side facing the rail must not exceed 3/16". This will avoid any interference with the locating lug on the upper component. Welds on the back and sides of the clip may be as large as required to accommodate the imposed side thrust and to meet governing welding code requirements.
- The following are welds suggested by GANTREX. The actual weld size (which is dictated by design thrust) and the welding procedure should be specified by the designer.



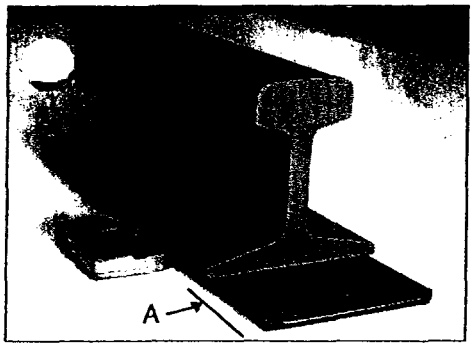
WELD	SIZE	SIDE THRUST CAPACITY (Lbs/Clip)	
		WELDLOK 15 →	WELDLOK 24 ←
X + Y	3/16"	5,900	9,900
X + Y + Z	3/16"	8,000	14,600

- The suggested weld is along the front of the clip and along the back: Weld "X" and Weld "Y".
- Completing the weld along both sides of the clip, Weld "Z", brings the side thrust capacity to the value stated in the table above.
- WELDLOK 15 SERIES - The maximum side thrust capacity of 15,000* lbs can be obtained by increasing Weld "Y" & "Z" to 3/8".
- WELDLOK 24 SERIES - The maximum side thrust capacity of 24,000* lbs can be obtained by increasing Weld "Y" & "Z" to 3/8".

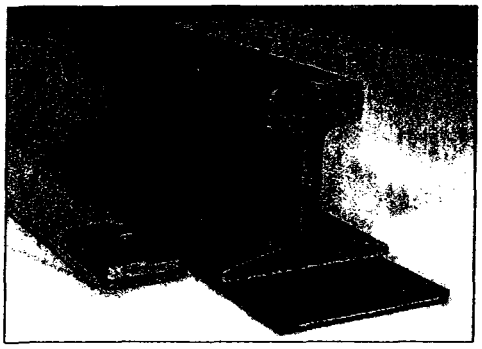
* Limited by the side thrust capacity of the clip.

NOTE: Side thrust capacities shown above are based on allowable weld stress of 15,000 psi for up to 100,000 full load cycles. AISC requires a reduction for up to 500,000 cycles and a further reduction for up to 2,000,000 cycles.

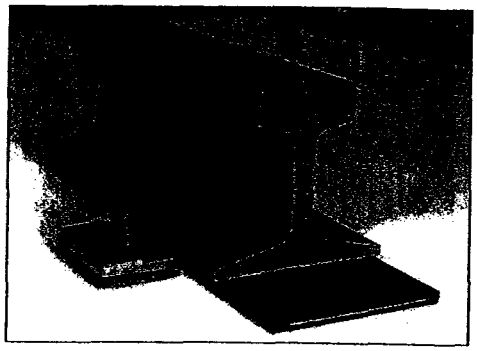
SUGGESTED WELD AND INSTALLATION INSTRUCTIONS WELDLOK™ 15 & 24 RAIL CLIPS



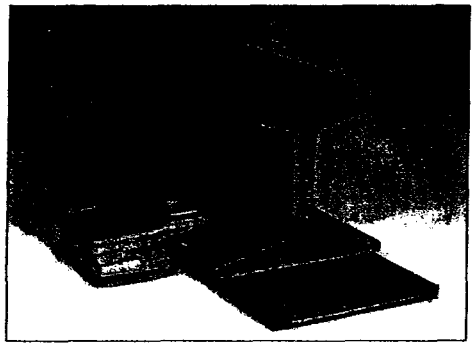
1. Position lower component with gap "A" from Table and tack weld in place.



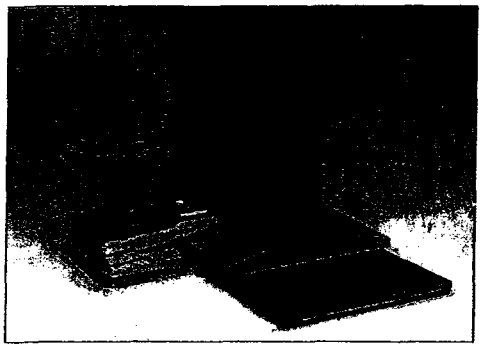
2. Weld as shown on the fabrication drawing, ensuring that the clip lower does not lift..



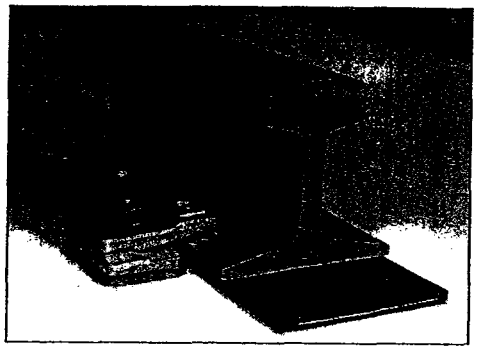
3. After installing the bolt make sure it is pushed as far forward as possible.



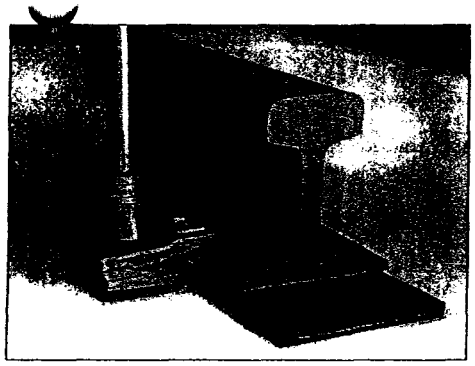
4. Install upper component.



5. Install washer and nut finger tight.



6. Adjust upper component to <u>ensure</u> tight contact with rail flange edge.



7. Torque nut as shown in Table.

CLIP	BOLT	TORQUE ft lbs	"A" DIMENSION (ins)
WELDLOK 15	5/8" Dia Gr 5	150	5/16
WELDLOK 24	3/4" Dia Gr 5	250	3/8

- The correct bolt assembly consists of a Grade 5 hex head capscrew with A325 structural nut and washer.
- Weld rod: any low hydrogen rod suitable for use with structural steel may be used. Typical designations include E7018.
- Clips MUST be installed in opposing pairs. They should NEVER be staggered.
- For new installations the lower component should be welded in the fabrication facility (steps 1 and 2).
- Welding should be completed prior to pad installation, as excessive heat could damage the pad.
- Painting the lower component <u>may</u> reduce side thrust capacity.

It is imperative that the clips be adjusted to ensure ZERO lateral rail float as shown in Figure 6. Improper adjustment will cause pad failure. Verification of the required hardware torque and clip upper adjustment should be performed within the first three months of running operations.

For clarification on any of the above or for more comprehensive suggestions on repair or rerail projects, consult GANTREX.

GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligation whatsoever.

Quality on Track®

PITTSBURGH
Corporate Headquarters
Sales/Warehouse
Ph: (412) 655-1400
Fx: (412) 655-3814

ATLANTA
Ph: (770) 591-9010
Fx: (770) 591-9353

CHICAGO
Ph: (630) 493-1414
Fx: (630) 493-1212

CLEVELAND
Ph: (440) 543-7958
Fx: (440) 543-7963

HALIFAX
Ph: (902) 468-6689
Fx: (902) 468-6546

TORONTO
Sales/Warehouse
Ph: (905) 686-0560
Fx: (905) 686-0962

HOUSTON
Ph: (281) 893-0027
Fx: (281) 893-4512

MONTREAL
Ph: (450) 441-7043
Fx: (450) 441-0421

NEW YORK
Ph: (203) 849-9160
Fx: (203) 846-8228

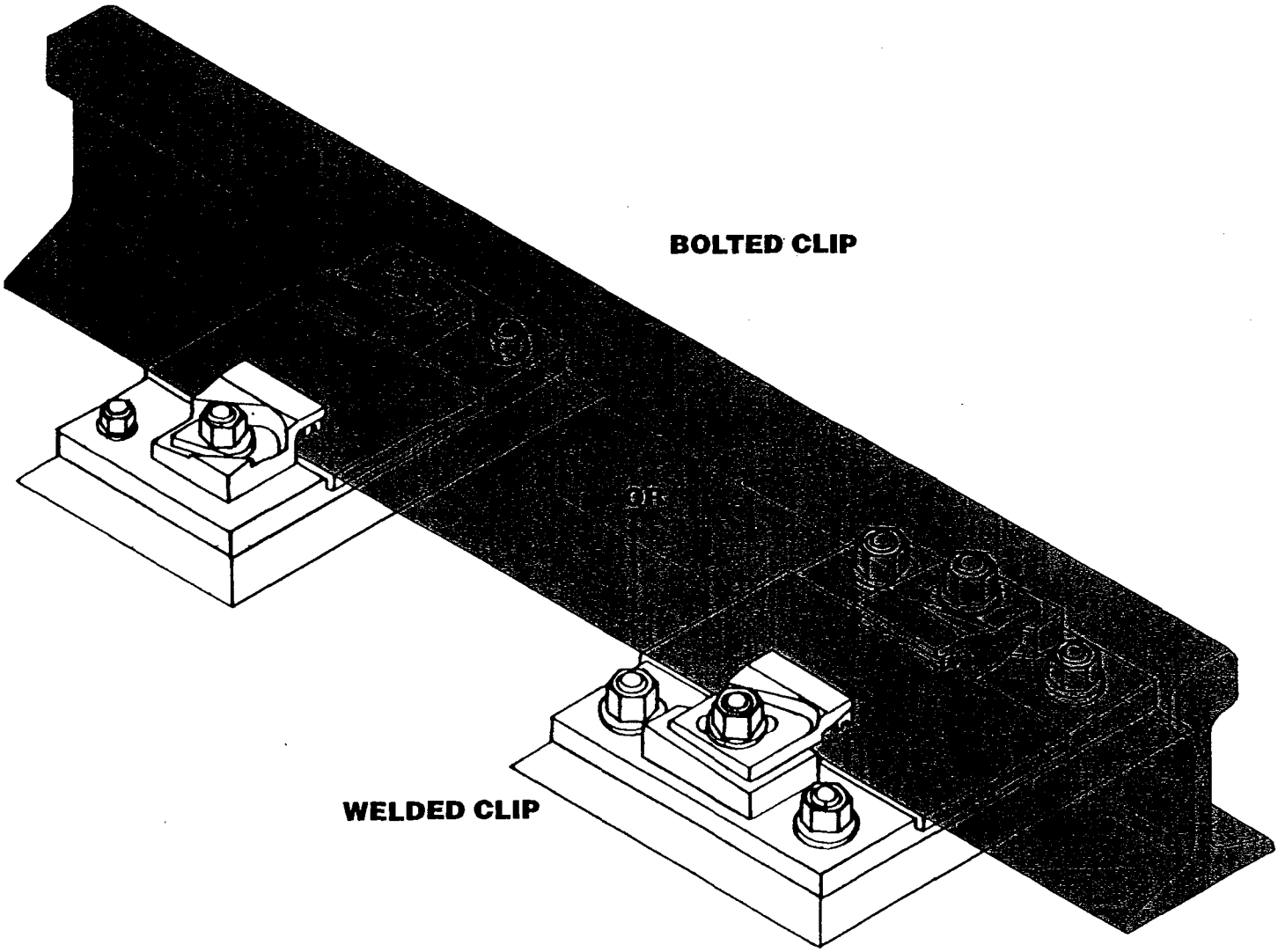
PHOENIX
Ph: (520) 684-2815
Fx: (520) 684-2750

©GANTREX, 2002

GANTREX®
A RAILWORKS COMPANY

Steel Soleplate

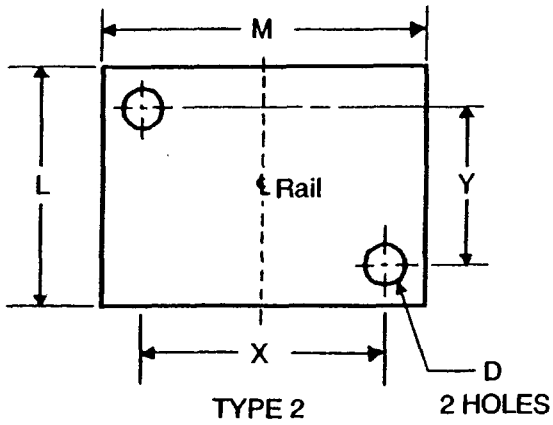
For Discontinuous Rail Support

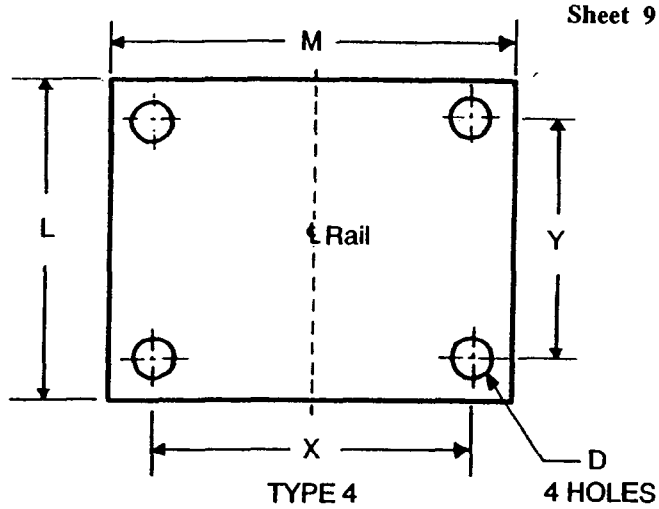


FEATURES:

- Pre-assembled with studs or welded lower components
- Pre-drilled for two or four anchor bolts
- Pre-coated to customer specification (eg. primer or hot dip galvanized)
- Standard or custom designed to suit all rails

STANDARD SOLEPLATES:





RAIL SIZE (lbs/yd)	FLANGE WIDTH (ins)	FLANGE WIDTH (mm)	SOLEPLATE MODEL NO.	DIMENSIONS (ins) D	L	M	X	Y	THICKNESS (STANDARD)	ANCHOR BOLT DIA.
30 ASCE	3 1/8	80	B2 STELCAM 9-AS30	7/8"	6 3/8	9	6	4 1/2	1/2"	5/8"
			W2 WELDLOK 15-AS30	"	6 3/8	9	6	4 1/2	"	"
40 ASCE	3 1/2	89	B2 STELCAM 9-AS40	"	6 3/8	9	6	4 1/2	"	"
			W2 WELDLOK 15-AS40	"	6 3/8	9	6	4 1/2	"	"
60 ASCE	4 1/4	108	B2 STELCAM 9-AS60	"	6 3/8	9	6 1/2	4 1/2	"	"
			W2 WELDLOK 15-AS60	"	6 3/8	9 1/2	6 1/2	4 1/2	"	"
85 ASCE	5 3/16	132	B2 STELCAM 13-AS85	"	6 3/8	11	8	4 1/2	"	"
			W2 WELDLOK 24-AS85	"	8 1/2	12	9 1/2	6 1/2	"	"
104 CR	5	127	B2 STELCAM 17-CR104	1"	8 1/2	12	9	6	3/4"	3/4"
			B4 STELCAM 17-CR104	"	9 3/4	12	9	7	"	"
			W2 WELDLOK 24-CR104	"	8 1/2	12	9	6	"	"
			W4 WELDLOK 24-CR104	"	9 3/4	12	9	7	"	"
105 CR	5 3/16	132	B2 STELCAM 17-CR105	"	8 1/2	12	9	6	"	"
			B4 STELCAM 17-CR105	"	9 3/4	12	9	7	"	"
			W2 WELDLOK 24-CR105	"	8 1/2	12	9	6	"	"
			W4 WELDLOK 24-CR105	"	9 3/4	12	9	7	"	"
135 CR	5 3/16	132	B2 STELCAM 17-CR135	"	8 1/2	12	9	6	"	"
			B4 STELCAM 17-CR135	"	9 3/4	12	9	7	"	"
			W2 WELDLOK 24-CR135	"	8 1/2	12	9	6	"	"
			W4 WELDLOK 24-CR135	"	9 3/4	12	9	7	"	"

B = Bolted Clip W = Welded Clip

OTHER RAILS: GANTREX soleplates are available to suit any rail size. If rail size is not shown in above table, consult your nearest GANTREX office.

NON-STANDARD: Available with removable jacking bolts upon request. For unusual applications e.g., if side thrust on the rail is more than 15% of the vertical wheel load, or if side rollers are to be used, consult your nearest GANTREX office for custom-design.

OTHER PRODUCTS: Consult GANTREX for information on complete rail system material packages, including rails, soleplates, rail clips, rail pads, anchor bolts and epoxy grout.

GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligation whatsoever.

Quality on Track®

PITTSBURGH Corporate Headquarters Sales/Warehouse Ph: (412) 655-1400 Fx: (412) 655-3814 • ATLANTA Ph: (770) 591-9010 Fx: (770) 591-9353 • BOSTON Ph: (781) 826-0848 Fx: (781) 826-0740 • CHICAGO Ph: (630) 493-1414 Fx: (630) 493-1212 • CLEVELAND Ph: (440) 543-7958 Fx: (440) 543-7963 • HALIFAX Ph: (902) 468-6689 Fx: (902) 468-6546

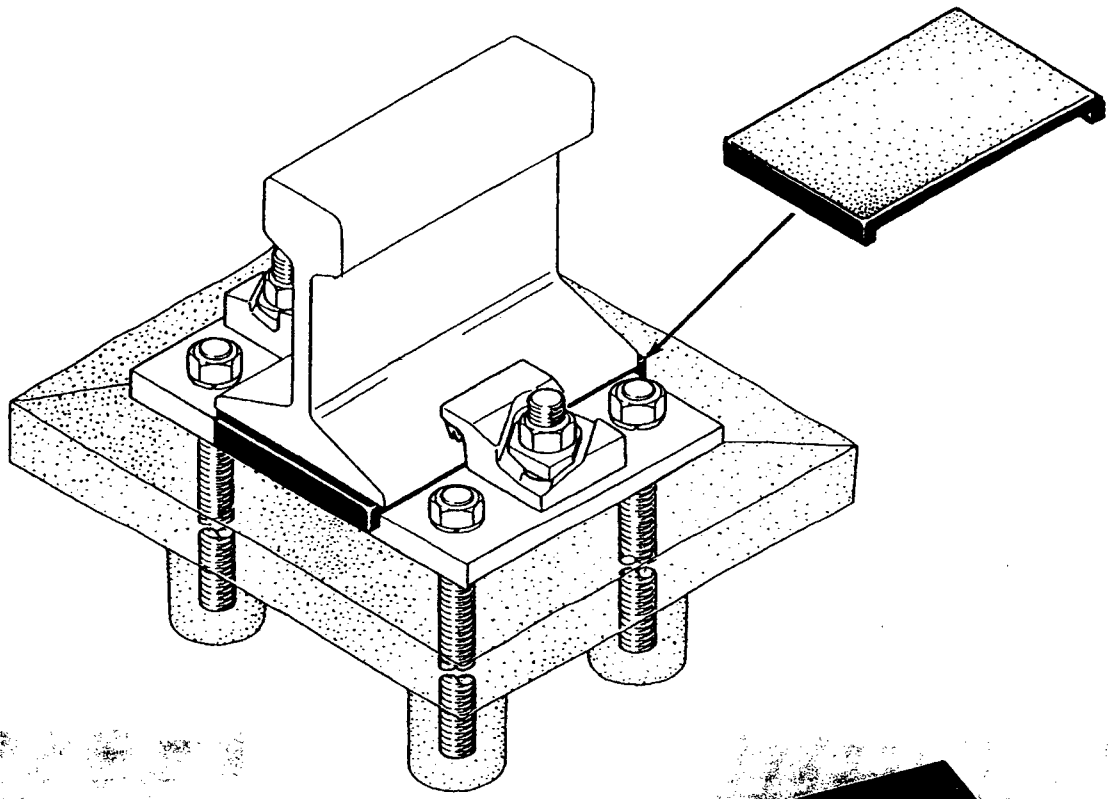
TORONTO Sales/Warehouse Ph: (905) 686-0560 Fx: (905) 686-0962 • HOUSTON Ph: (281) 893-0027 Fx: (281) 893-4512 • MONTREAL Ph: (450) 441-7043 Fx: (450) 441-0421 • NEW YORK Ph: (203) 849-9160 Fx: (203) 846-8228 • PHOENIX Ph: (520) 684-2815 Fx: (520) 684-2750 • VANCOUVER Ph: (604) 253-8400 Fx: (604) 253-2965

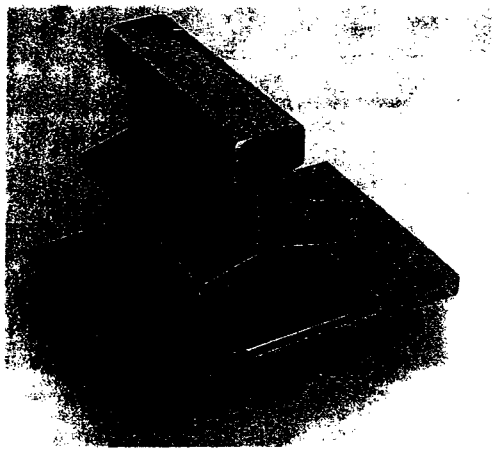
TOLL FREE: 800 2 GANTREX (800) 242-6873 — Web site: www.gantrex.com email: sales@gantrex.com

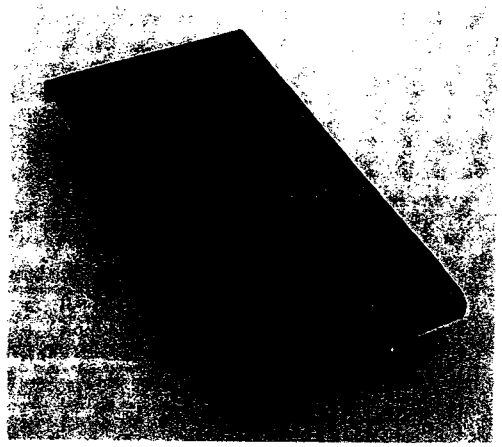
©GANTREX, 1999

GANTREX®
A RAILWORKS COMPANY

MK 2 Pad
For Discontinuous Rail Support







GANTREX MK2 Pad is specifically developed to overcome the problems associated with discontinuous rail support.

- CROWNED CONSTRUCTION centers load on pedestal and eliminates edge load on concrete pedestals.
- MOLDED END-STOPS prevent longitudinal creep.
- ELASTOMER CONSTRUCTION reduces:
  - Shock and vibration
  - Noise
  - Local bearing stress on concrete

MK 2 Pad available to suit all rails. For best results, use in conjunction with GANTREX clips.

MATERIALS

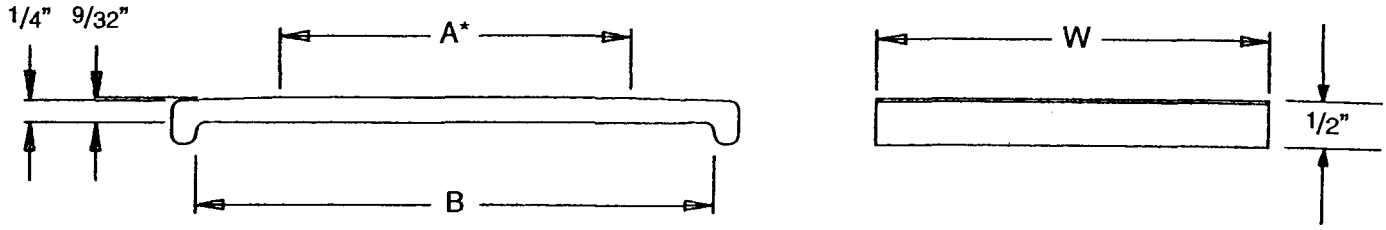
EVA COPOLYMER

MECHANICAL

Durometer A..... 94
Elastic Modulus ..... 92,000 psi

SERVICE TEMPERATURE

-15° to +165°F



* A = Crown as described on front

TABLE 1

MODEL NO	DIMENSIONS (ins)		PEDESTAL LENGTH (ins)
	A	B	
MK2 - 85x**	2 3/8	3 3/8	3 1/4
MK2 - 115x**	3 1/2	4 1/2	4 3/8
MK2 - 165x**	4 3/4	6 1/2	6 3/8
MK2 - 220x**	6 3/4	8 5/8	8 1/2
MK2 - 250x**	6 3/4	9 7/8	9 3/4
MK2 - 320x**	9 1/2	12 5/8	12 1/2

TABLE 2

RAIL SIZE (lbs / yd)	RAIL FLANGE WIDTH (ins)	PAD WIDTH W (ins)	PAD WIDTH W (mm)
40 ASCE	3 1/2	3 3/8	85
60 ASCE	4 1/4	4 1/8	105
85 ASCE	5 3/16	5	125
104 CR	5	4 3/4	120
105 CR	5 3/16	5	125
135 CR	5 3/16	5	125
171/175 CR	6	5 3/4	145

** Pad width in mm from Table 2

The correct Model No. for a particular application is based on the pedestal length from Table 1 and the rail size from Table 2.

e.g. For 60 ASCE rail on a 6 3/8" pedestal, use Pad Model MK2-165 x 105
For 104 CR rail on a 8 1/2" pedestal, use Pad Model MK2-220 x 120

OTHER RAILS

GANTREX MK2 Pads are available to suit any rail sizes. If rail size is not shown in above table, please consult your nearest GANTREX office.

APPLICATION

GANTREX MK2 Pad is specifically developed to overcome the problems associated with discontinuous rail support. It is designed to be used on a steel soleplate with shim packs or grout. For best results, ensure that the maximum total overlap between the pad endstops and pedestal is 1/4".

GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligation whatsoever.

PATENTS APPLIED FOR IN MOST COUNTRIES INCLUDING THE UNITED STATES AND CANADA.

Quality on Track®

PITTSBURGH Corporate Headquarters Sales/Warehouse Ph: (412) 655-1400 Fx: (412) 655-3814 • ATLANTA Ph: (770) 591-9010 Fx: (770) 591-9353 • BOSTON Ph: (781) 826-0848 Fx: (781) 826-0740 • CHICAGO Ph: (630) 493-1414 Fx: (630) 493-1212 • CLEVELAND Ph: (440) 543-7958 Fx: (440) 543-7963 • HALIFAX Ph: (902) 468-6689 Fx: (902) 468-6546

TORONTO Sales/Warehouse Ph: (905) 686-0560 Fx: (905) 686-0962 • HOUSTON Ph: (281) 893-0027 Fx: (281) 893-4512 • MONTREAL Ph: (450) 441-7043 Fx: (450) 441-0421 • NEW YORK Ph: (203) 849-9160 Fx: (203) 846-8228 • PHOENIX Ph: (520) 684-2815 Fx: (520) 684-2750 • VANCOUVER Ph: (604) 253-8400 Fx: (604) 253-2965

©GANTREX, 1999

GANTREX®
A RAILWORKS COMPANY

K3 Epoxy Grout

DESCRIPTION:

GANTREX Epoxy Grout is a self-leveling, readily pourable, 100% solids epoxy grout consisting of epoxy resin, hardener and carefully graded aggregate.

ADVANTAGES:

- High early strengths
- Aggregate content can be field-modified
- Low resin crystallization temperature
- Excellent flow characteristics
- Possible to clean tools/equipment with water/soap solution, prior to set
- Available in economic 3 cubic foot units for high volume applications
- User friendly packaging

APPLICATIONS:

GANTREX Epoxy Grout may be used where a pourable, non-shrink, chemical-resistant, high-strength grout is required. Typical applications include ports, shipyards, crushers, pulp and paper machinery, compressors and refinery equipment.

SURFACE PREPARATION AND FORMING:

All concrete surfaces must be sound, dry, free of all oil, dirt, grease, laitance and other foreign matter. Prepare the surface to be grouted by mechanical means to remove all contaminants and weak surface material. All surfaces should be dry prior to grouting. Wood or metal forms may be used. Forms must be leak free. The contact surfaces of the forms should be coated with two coats of common paste wax to prevent bonding. Exercise care to ensure that the paste wax does not contaminate any surface that requires bonding. Control joints vary by application - consult your GANTREX representative.

MIXING AND PLACING:

Condition all grout components to 70°F (21° C), prior to mixing.

For the 1cf unit (28.3 liter), add the hardener (Part "B") to the base resin (Part "A"). Mix the combined resin and hardener using a low speed paddle mixer for a minimum of three minutes. Pour the thoroughly mixed resin and hardener into a clean mortar mixer and add the aggregate while it is in motion. Mix for approximately one additional minute ensuring that all the aggregate is thoroughly wetted. When using a mortar mixer, mix three 1 cf units at the same time. For quantities less than three cubic feet, use a galvanized 25 gallon, flat bottomed can or pail.

MIXING AND PLACING (cont'd):

For the 3cf unit (84.9 liter), place the resin (Part "A") into a clean mortar mixer and add the hardener (Part "B"), while the mixer is in motion. Mix for two to three minutes. Add the aggregate while the mixer is in motion. Mix for approximately two additional minutes ensuring that all the aggregate is thoroughly wetted. Do not over-mix.

All grout should be placed within 30 minutes.

It is important that grout be poured only from one side of the soleplate (or base plate) to avoid air entrapment under the plate. If for any reason this is not possible, please consult GANTREX for air relief hole locations.

Consult your GANTREX representative when either a plastic mix or a high flow mix is required.
(Do not alter the mix proportions without consulting GANTREX)

PRECAUTIONS:

- Gantrex epoxy grout must be placed on dry surfaces only.
- Avoid exposure to water for 24 hrs after placement.
- Do not reduce the aggregate content without consulting Gantrex.

The minimum temperature required for curing Epoxy Grout is 50°F (10°C). For pours at temperatures lower than 50°F or higher than 105°F (40°C) and/or depths greater than 4" (100mm), please consult GANTREX.

CLEAN UP:

Clean all tools, equipment and spills with a water/soap solution, prior to set. Dispose of all containers and packaging in accordance with local rules and regulations. For mortar mixer clean up, please consult GANTREX.

SHELF LIFE:

Shelf life of GANTREX Epoxy Grout is 2 years if liquid containers are hermetically sealed and stored in normal heated warehouse conditions.

CAUTION:

In case of skin contact, scrub affected area thoroughly with soap and water. In case of eye contact, flush with water for 15 minutes and immediately consult your local physician. Use eye goggles and rubber gloves while working with epoxy grout. Avoid inhaling fumes. Provide adequate ventilation. **Do not smoke** while working with epoxy grout. Read product material safety data sheets before using product.

FREIGHT CLASSIFICATION:

Part "B" Hardener only (Triethylene Tetramine) - Class 8 UN 2259 PGII.

WARRANTY:

The information and recommendations made are based on GANTREX research and are believed to be accurate. However, no guarantee of their accuracy is offered since GANTREX cannot cover every possible application of its products, nor anticipate every variation encountered in masonry surfaces, job conditions, and methods used. The purchasers shall perform their own tests to determine the suitability of such products for a particular purpose.

WARRANTY (cont'd):

GANTREX warrants this product to be free from defects. GANTREX makes no other warranties with respect to this product, express or implied, including without limitation, the implied warranties of merchantability or fitness for particular purpose. GANTREX's liability shall be limited in all events to supplying sufficient product to re-treat and/or repair the specific areas to which defective product has been applied. GANTREX shall have no other liability, including liability for incidental, consequential or resultant damages whether due to breach of warranty, negligence or strict liability. This warranty may not be modified or extended by representatives of GANTREX, its distributors or dealers.

PHYSICAL PROPERTIES:*

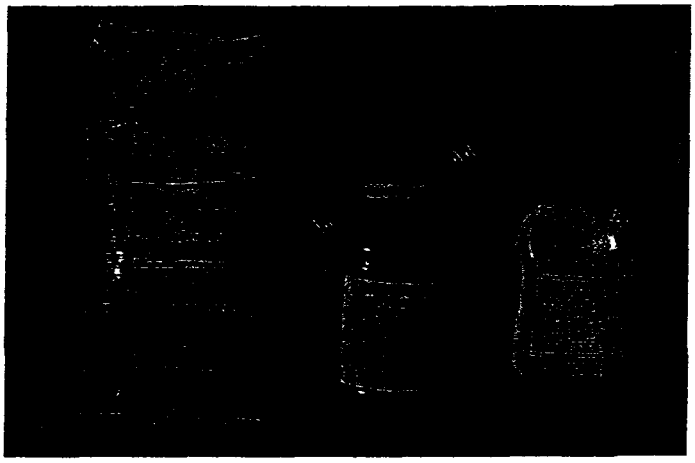
Unconfined Compressive Strength (ASTM C579-B)

Cure Time	Curing Temperature	psi (MPa)
1 day	104°F (40°C)	14,535 (100)
3 days		14,815 (102)
7 days		15,065 (104)
28 days		15,895 (109)
1day	70°F (21°C)	11,490 (79)
3 days		13,275 (91)
7 days		13,900 (96)
28 days		14,400 (99)
1day	50°F (10°C)	1,785 (12)
3 days		10,340 (71)
7 days		12,685 (87)
28 days		13,835 (95)
3 days	39°F (4°C)	5,750 (40)
7 days		10,875 (75)
28 days		12,915 (89)

* MPa values rounded off (for all test data) (145 psi = 1 MPa)

- **Tensile Strength** (ASTM C307)
  7 days 2,262 psi (15 MPa)
- **Flexural Strength** (ASTM C580)
  7 days 4,265 psi (29 MPa)
- **Modulus of Elasticity** (ASTM C580)
  7 days 2,110,000 psi (14,500 MPa)
- **Coefficient of Thermal Expansion** (ASTM C531)
  13.1 x 10^6 in/in per °F (23.6 x 10^6 mm/mm per °C)
- **Linear Shrinkage** (ASTM C531)
  28 days 0.017in/in (.432 mm/mm)
- **Creep** (ASTM C1181-91)
  Loading: 2500 psi (14MPa) @ 80°F (27°C)
  1 year less than 0.3%
- **Bond to concrete:** Greater than tensile strength of concrete.
- **Control Joints:** Varies by application, please consult your GANTREX representative.

NOTE: The above data is representative and based on results from actual tests conducted in the lab, on a specific batch. Individual test results may vary due to variations in lab testing conditions and for individual product batches.



ONE CUBIC FT UNIT

THREE CUBIC FT UNIT

YIELD AND NET WEIGHTS:

One cubic ft unit (28.3 liters)

Part "A" Resin	1.62 U.S. gallons (6.1 liters)	15 lbs (6.8kg) Net weight
Part "B" Hardener	0.35 U.S. gallon (1.3 liters)	3.0 lbs (1.36 kg) Net weight
Aggregate	2-55 lb (25 kg) bags of aggregate	110 lbs (50 kg) Net weight

Total Net Weight: 128 lbs (58 kg), per unit

Three cubic ft unit (84.9 liters)

Part "A" Resin	4.86 U.S. gallons (18.3 liters)	45 lbs (21.8 kg) Net weight
Part "B" Hardener	1.05 U.S. gallons (3.9 liters)	9 lbs (4.1 kg) Net weight
Aggregate	6-55 lb (25 kg) bags of aggregate	330 lbs (150 kg) Net weight

Total Net Weight: 384 lbs (174 kg), per unit

For clarification on any of the previous instructions, or for more comprehensive installation instructions, consult GANTREX. GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligations whatsoever.

Quality on Track®

PITTSBURGH
Corporate Headquarters
Sales/Warehouse
Ph: (412) 655-1400
Fx: (412) 655-3814

ATLANTA
Ph: (770) 591-9010
Fx: (770) 591-9353

CHICAGO
Ph: (630) 493-1414
Fx: (630) 493-1212

CLEVELAND
Ph: (440) 543-7958
Fx: (440) 543-7963

HALIFAX
Ph: (902) 468-6689
Fx: (902) 468-6546

TORONTO
Sales/Warehouse
Ph: (905) 686-0560
Fx: (905) 686-0962

HOUSTON
Ph: (281) 893-0027
Fx: (281) 893-4512

MONTREAL
Ph: (450) 441-7043
Fx: (450) 441-0421

NEW YORK
Ph: (203) 849-9160
Fx: (203) 846-8228

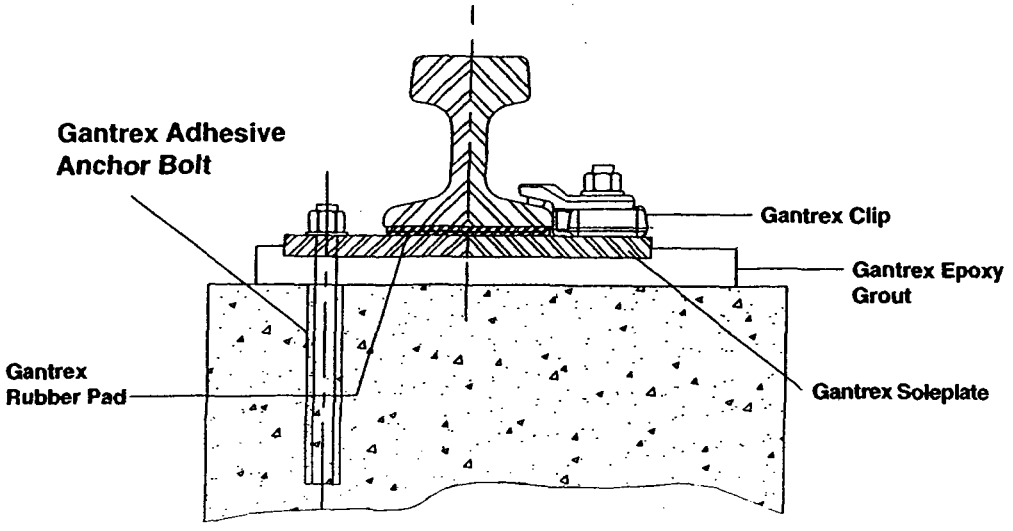
PHOENIX
Ph: (520) 684-2815
Fx: (520) 684-2750

©GANTREX, 2002

GANTREX®
A RAILWORKS COMPANY

Adhesive Anchor Bolts

For Crane Rail on Concrete Applications



INTRODUCTION

A Gantrex Anchor Bolt is a resin set anchor. It is installed by drilling a hole in the concrete deck, filling the hole with polyester resin, which acts as an adhesive, suspending a bolt in the resin and allowing the resin to cure, to complete the process. Unlike anchors using epoxy based resin, Gantrex anchors can be placed in temperatures as low as 10°F.

The bolt itself is an all-thread steel rod, complete with a nut and a washer. Bolts can be supplied in different diameters and lengths. The polyester-based resin supplied in US quart cans, can be poured directly from the container, into the hole.

MATERIALS

Anchor bolt

Material	: A36: F_y (min) = 36,000 psi F_t (min) = 58,000 psi
	: B7 : F_y (min) = 105,000 psi F_t (min) = 125,000 psi
Finish	: Zinc plated or hot dipped galvanized.
Freight classification	: Class 50

Polyester-based resin

Packaging	: Supplied in US quart cans, four cans per carton.
Freight classification	: UN 1866, packing group III, Class 3

Catalyst

Packaging	: Supplied in pill bottle type containers, four per carton, packaged separately.
Freight classification	: UN 3102, packing group II, Class 5.2

PLACEMENT PROCEDURE

Holes are air-drilled in concrete deck, using a soleplate as template. The drilled holes are ⅛" greater in diameter, than the anchor bolt diameter. These holes are cleaned to remove dust and debris.

One container of catalyst is added to one can of polyester resin and mixed in the can for 60 seconds to 90 seconds. The mixture is poured into the hole, to about one third the depth. The anchor bolt is suspended from the soleplate, and placed in the resin in the hole. The resin cures and sets in about 1 hour. The anchor must not be disturbed during this time. Full cure occurs in 24 hours.

SUGGESTED EMBEDMENT

It is important that anchor bolts are embedded to a proper depth to achieve adequate strength. In 5 ksi concrete, for example, we suggest that A36 anchor bolts be embedded to at least 8 times their diameter (a ¾" rod will require an embedded length of at least 6"). This is adequate to achieve enough bond with the concrete such that, in a pullout test, the anchor bolt will yield before the bond with the concrete. Similarly, the suggested embedment for B7 bolts is 12 times the bolt diameter.

TECHNICAL INFORMATION

Gantrex Anchor Bolt Table

Gantrex Anchor Bolt Part Number *Notes (1, 2)*	Bolt Diameter (inches)	Hole Diameter (inches)	Bolt Length (inches)	Embed. Length (inches)	Rod Assy. Wt. (lbs.) A36 *Note (3)*	Rod Assy. Wt. (lbs.) B7 *Note (3)*	Resin Vol./Bolt (cu. ins.) *Note (4)*	Resin Weight (lbs.)	Anchor Bolts per can	Anchor Bolts / carton
AB ⅝ x 10-A36*	⅝	¾	10	6	0.86	0.91	1.38	0.12	38	153
AB ⅝ x 12-A36*			12	8	1.01	1.05	1.85	0.16	29	115
AB ⅝ x 14-A36*			14	10	1.16	1.20	2.31	0.20	23	92
AB ¾ x 10-A36*	¾	⅞	10	6	1.16	1.24	1.94	0.16	27	109
AB ¾ x 12-A36*			12	8	1.36	1.43	2.59	0.22	20	82
AB ¾ x 14-A36*			14	10	1.56	1.63	3.23	0.27	16	66
AB ¾ x 16-A36*			16	12	1.76	1.83	3.88	0.33	14	55
AB ⅞ x 12-A36*	⅞	1	12	8	1.92	2.03	3.07	0.26	17	69
AB ⅞ x 14-A36*			14	10	2.20	2.31	3.84	0.33	14	55
AB ⅞ x 16-A36*			16	12	2.48	2.59	4.61	0.39	12	46
AB ⅞ x 18-A36*			18	14	2.76	2.86	5.37	0.46	10	39
AB 1 x 12-A36*	1	1⅛	12	8	2.54	2.68	3.72	0.32	14	57
AB 1 x 14-A36*			14	10	2.90	3.04	4.65	0.39	11	46
AB 1 x 16-A36*			16	12	3.26	3.40	5.58	0.47	9	38
AB 1 x 18-A36*			18	14	3.62	3.76	6.51	0.55	8	33
AB 1¼ x 14-A36*	1¼	1⅜	14	10	4.73	4.97	6.03	0.51	9	35
AB 1¼ x 16-A36*			16	12	5.30	5.55	7.24	0.61	7	29
AB 1¼ x 18-A36*			18	14	5.88	6.12	8.45	0.72	6	25
AB 1¼ x 20-A36*			20	16	6.46	6.70	9.65	0.82	5	22

NOTES:

(1) Replace A-36 with B7 for high strength material.
(2) Suffix with 'Z' for Zinc plated or 'G' for hot dipped galvanized.
(3) Rod assembly consists of one rod + 1 nut + 1 washer.
(4) Resin volume shown includes 30% for waste.

HOW TO SPECIFY AND ORDER

1. To specify and order a Gantrex adhesive anchor bolt assembly, determine the correct diameter and length.
2. Determine correct part number from the above table and notes. For example, AB 1x14-A36G would be the part number for a 1" x 14" long, diameter bolt of A36 material, with one nut and one washer, all hot dipped galvanized.
3. If substrate temperature is likely to be below 45°F, at time of actual installation, please double the quantity of catalyst, at time of order placement.

While the steel hardware can be shipped at any time, due to the nature of the resin/catalyst system, it is recommended that the adhesive be shipped 3-4 weeks prior to actual installation.

GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligation whatsoever.

Quality on Track®

PITTSBURGH *Corporate Headquarters* Sales/Warehouse Ph: (412) 655-1400 Fx: (412) 655-3814 • **ATLANTA** Ph: (770) 591-9010 Fx: (770) 591-9353 • **BOSTON** Ph: (781) 826-0848 Fx: (781) 826-0740 • **CHICAGO** Ph: (630) 493-1414 Fx: (630) 493-1212 • **CLEVELAND** Ph: (440) 543-7958 Fx: (440) 543-7963 • **HALIFAX** Ph: (902) 468-6689 Fx: (902) 468-6546

TORONTO Sales/Warehouse Ph: (905) 686-0560 Fx: (905) 686-0962 • **HOUSTON** Ph: (281) 893-0027 Fx: (281) 893-4512 • **MONTREAL** Ph: (450) 441-7043 Fx: (450) 441-0421 • **NEW YORK** Ph: (203) 849-9160 Fx: (203) 846-8228 • **PHOENIX** Ph: (520) 684-2815 Fx: (520) 684-2750 • **VANCOUVER** Ph: (604) 253-8400 Fx: (604) 253-2965

TOLL FREE: 800 2 GANTREX (800) 242-6873 - Web site: www.gantrex.com email: sales@gantrex.com

©GANTREX, 2000

Attachment 1

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY L. Toroyan DATE 12/2/02 SHEET 1 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USACE / EPA

PROJECT New Bedford Harbor - Rail Design

SUBJECT Slab Height in Building in Rail Section

Height of 115 RE = 6.625 in 6-5/8

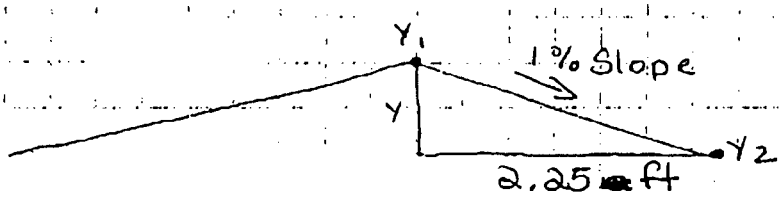
Height of MK2 = 0.28125 in 9/32

Height of Sole plate = 0.75 in 3/4

Total Height w/o Grout 7.65625 in

Height above ties outside of bldg - 7.50 in

0.15625 in 5/32



Y_2 location of Rail Attachment

$$\frac{Y_1 - Y_2 = Y}{2.25} = 0.01 \qquad Y = 0.01(2.25) = 0.0225 \text{ ft}$$

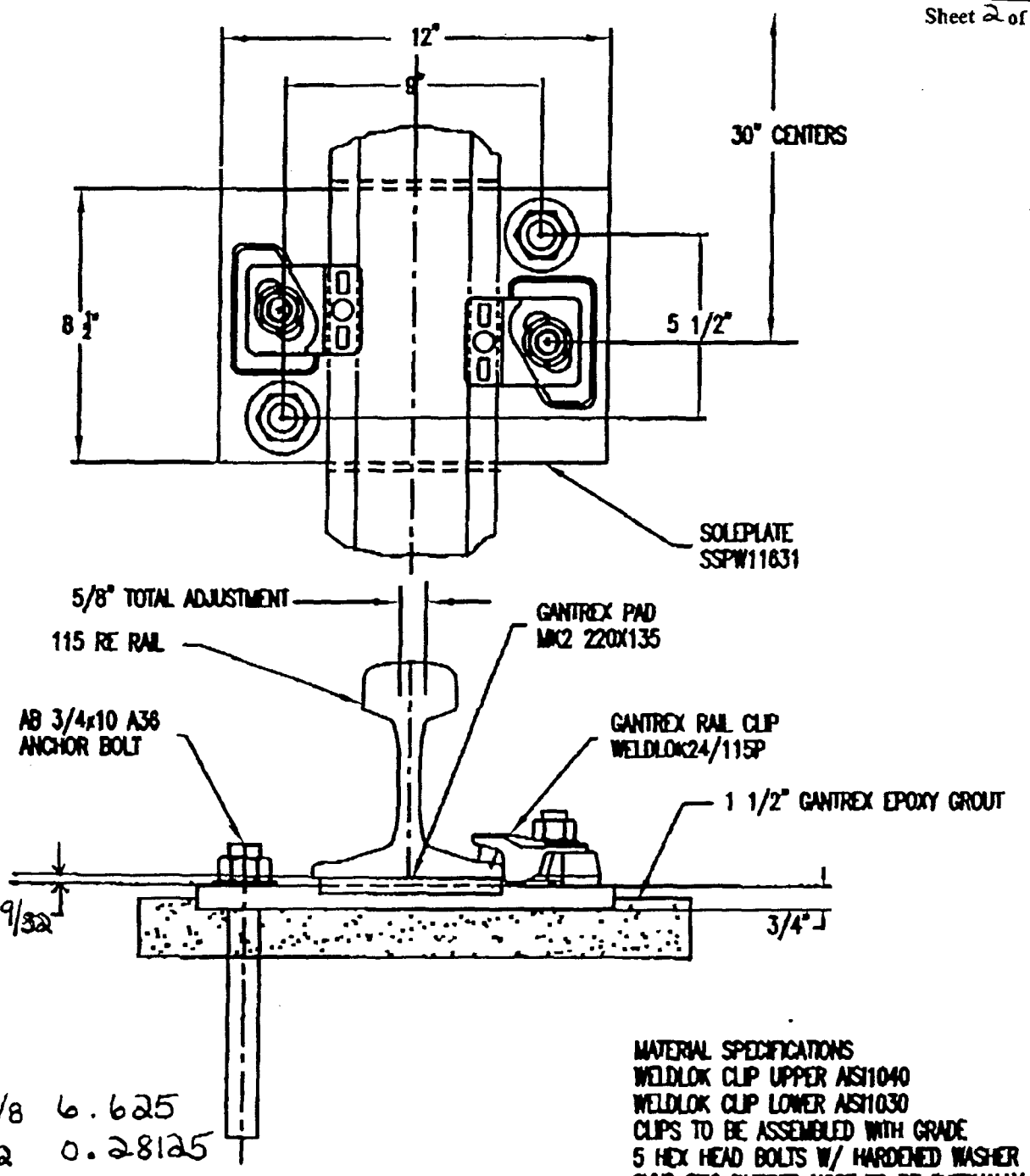
$$9 \text{ ft} - 0.0225 \text{ ft} - \left(0.15625 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}}\right)$$

$Y_1 = 8.9644$ ft w/o Grout

$Y_1 = 8'-11''$ to allow room for grout

FWENC 581D 10/96

Sheet 2 of 2



6 - 5/8 6.625
+ 9/32 0.28125
+ 3/4 0.75
7.65625"
- 7.5
0.15625 = 5/32"

MATERIAL SPECIFICATIONS
WELDLOK CLIP UPPER AISI1040
WELDLOK CLIP LOWER AISI1030
CLIPS TO BE ASSEMBLED WITH GRADE 5 HEX HEAD BOLTS W/ HARDENED WASHER
SYNTHETIC RUBBER NOSE TO BE THERMALLY VULCANIZED TO THE UPPER CLIP COMPONENT
A GANTREX REP WILL PERFORM AN ONSITE INSPECTION AND ISSUE A WRITTEN REPORT
CLIP LOWERS TO BE WELDED TO SOLEPLATE IN FABRICATION SHOP

GANTREX
Gantrex Group

This drawing shows the best arrangement, in Gantrex opinion, for the system installation. Gantrex is not responsible in any way for any product or design not purchased from Gantrex or through one of its agents, associates or distributors.

TITLE: TYPICAL SOLEPLATE		
CUSTOMER: FOSTER WHEELER		
DWN. BY: Trev	DATE: 9-18-02	SCALE:
APP'D. BY:	DWG. NO. 11631	REV. P1

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT New Bedford Harbor SUBJECT Rail Design

CLIENT USACE / EPA

CALCULATION NO. R6 PROJECT NO. 5197.1720.9303

NO OF SHEETS 17 DESIGN LEVEL 2

CALCULATION BY OTHERS ____ YES ✓ NO PREPARER Lucine Toroyan

REVIEWED BY [illegible] DATE 10/22/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ✓ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

SUMMARY FOR WEIGH SCALE IN BUILDING

1. Design Requirements

    a. Minimum rail size is 115 RE

    b. Subgrade bearing capacity of 4,000 pounds per square foot under foundation slab

    c. 50 feet of concrete approaches on a two draft static scale

    d. Meets Association of American Railroads Scale Handbook and National Institute of Standards and Technology Handbook 44

2. SAI Model NP 1260 Railcar Weighbridge

    a. Two draft static scale

    b. Capacity of 85 tons

    c. Weight of scale is 9,900 pounds

    d. Withstands Cooper E-80 live load

    e. Materials: ASTM A-36 steel with A-325 hardware

    f. Load cells hermetically sealed and constructed of stainless less

    g. Standard accessories are rail plates, rail clips, shallow pit deck covers, anti-creep rail anchors, and anchor bolts.

    h. SAI Model 530 Digital Weight Indicator is used in industrial weighing applications

3. A two draft static scale is a single scale that measures each axle. The operator adds up the weight of each axle of a railcar to provide a total weight for the shipping papers. A single scale was chosen due to the length limitations inside and outside of the facility. The scale foundation must have a straight alignment. It is preferred to keep the scale inside the building so to avoid issues with weather during operations and to prolong the life of the scale. It has also been chosen to keep the scale close to the west entrance of the building. The reason for this is to keep the decontamination water off the scale and electronics. This compartmentalizes the track area within the building to keep the loading and decontamination area separate from the weighing and paperwork area. The static part of the two draft static scale is for weighing a non-rolling railcar.

4. Due to the foundation slab being built before the rail is constructed, a letter accepting the use of Hilti HVA adhesive anchor bolts or equivalent is attached from the vendor. The structural drawings include the anchor bolt pattern for the weigh scale so that the foundation slab contractor may avoid placing the rebar in the anchor bolt locations. A specific vendor has been chosen so that proper installation can occur years after the

slab is constructed. Gantrex adhesive anchor bolts shall be used to be consistent with the rest of the installation inside the dewatering facility.

5. Included attachments in this calculation

    a. Letter from SAI stating equipment, services, and costs of specific products; it is up to the contractor whether he will do the installation. (4 pages)
    b. SAI Installation and Service Rate Schedule
    c. SAI data sheet for NP Series Railcar Weighbridges
    d. SAI drawing of NP 1260 two draft static scale
    e. Letter from Structural Engineer at SAI accepting the use of adhesive anchor bolts
    f. Gantrex data sheet for Adhesive Anchor Bolts (2 pages)
    g. SAI data sheet for Model 530 Digital Weight Indicator (2 pages)
    h. SAI drawing of foundation details for NP 1260 weigh scale

systems
associates,
inc.

June 13, 2002

Foster Wheeler Environmental Corp.
5300 Broken Sound Blvd., Suite 110
Boca Raton, FL 33487

Attn: Lucine Toroyan, Coastal Engineer

Subject: NP1260 Two Draft Static Track Scale
EPA / Army Corps of Engineers. - New Bedford, MA
SAI Project FWE-2090

Dear Lucine:

I thought I would prepare a budgetary quote for a complete weighing system for your railcar scale application. You stated that you would like to locate the scale outside the building now instead of inside the building. You requested pricing for a two draft NP1260 static railcar scale. I have quoted the equipment for a certified two draft static railcar scale. Of course a non-certified check scale version would be similar as far as equipment goes, just with a reduction in the approach steel quantities.

As I explained on the phone, the railroad that would approve and test/certify the scale will require 50 ft concrete approaches on each end of the scale platform. A special variance form the railroad would have to be requested and approved before proceeding with a non-standard installation. You believe that CSX would be the servicing railroad. I previously emailed foundation drawings for both a certified two draft and a non-certified check scale. If you did not need certified weights then you could install it as a check scale with shortened approaches.

Prior to accepting an order we will need to know the following:

1. The governing / servicing / testing railroad.
2. The soil test report - the foundation design requires $\geq$ 4,000 psf. bearing capacity.
3. The rail type and size.

SAI is a leader in the railcar weighing system business. SAI Railcar Weighing Systems are used by all Class I Railroads, many Regional and Short Line Railroads and Industrial users. All of our systems meet or exceed the requirements of the AAR Scale Handbook and NIST Handbook 44. All of our systems are NTEP approved to allow certified weighing.

The AAR scale handbook requires 50 ft. concrete approaches on a two draft static scale. The servicing railroad may require 75 ft. of tangent track on each end of a static scale.

Per the AAR Scale Handbook, the required soil bearing capacity at the base of concrete must be 4,000 psf or greater. The customer's soils report will determine whether additional foundation work or design should be necessary and is not included in this quotation.

-continued-

1932 Industrial Drive / Libertyville, Illinois 60048 / **(847) 367-6650** / Fax: (847) 367-6960
E-Mail: mail@systemsassoc.com

The customer is responsible for obtaining a geotechnical firm to perform a soils test. SAI will review the soils data and recommendations by the geotechnical firm. SAI will submit all details to the servicing railroad for approval. We will need to know who the governing/servicing/testing railroad is.

Rail for the weighbridge and concrete approaches is not included with this quotation and is to be supplied by others. The minimum rail size required is 115#RE over the weighbridge and approaches as required by the AAR Scale Handbook.

Equipment and Pricing are as follows:

NP1260 Two Draft Static System (equipment only)

Weighbridge & Accessories

Model NP1260 Weighbridge
- 12'-6" Weighbridge
- Standard above grade shop welded design
- Two section - 85 ton sectional capacity
- AAR design for Cooper E-80 loading
- NTEP COC# 88-084
- 4 - Precision load cells
  - Capacity: 100,000 lbs.
  - NTEP COC# 91-001A3
- 4 - Load cell protection kits
- 4 - Bearing kits
- Complete with anchor bolts and mounting plates
- Does not include rail

Approach Steel
- For AAR approved installation (for both 50 ft. approaches)
- Rail plates 28" x 11" x 3/4"
- Anchor bolts
- Less rail

Rail Clips
- For 113 ft. of track (for weighrails and approach rails)
- Type 62 for 115 lb. or 132 lb. rail
- Less rail

Anti-Creep Rail Anchors
- 2 - Weighrail anchor sets
- 4 - Approach/center rail anchor sets
- Less rail

Paint

All fabricated steel work (except rail plates and anchor bolts) will be provided with one (1) coat of red oxide primer and one (1) finish coat of gray machinery enamel. Does not include embedded items. Rail plates receive red oxide primer only. Anchor bolts are unfinished.

-continued-

Instrumentation

Model 530A Digital Weighing System w/accumulator
- Wall mount Industrial Nema 12 enclosure
- Weight display: 400,000 lbs. x 100 lbs.
- NTEP COC# 97-134
- Pushbutton zero and auto zero tracking
- RS232 output for dot matrix printer
- Power supply for excitation of the required load cells
- Two draft weight accumulation

Model SAI 190 Printer
- Dot matrix printout of individual weights
- Full forms control for formatted printouts
- Includes 6 ft. interconnecting cable

Load Cell Summing Box
- Nema 12 enclosure
- 4 Load cells or two sections
- Lightning protection

Load Cell Cable
- 200 Ft. load cell cable, 4 conductor

Lightning Protection
- Load cell protection at summing box
- AC protection at digital indicator
- Electrical isolation kits at load cells

NP1260 System Equipment Only Price $24,600

The above quotation is for equipment only and does not include any of the labor or materials required to complete the construction of the approaches or scale foundation, nor install the weighbridges or electronic equipment, nor provide any on-site start-up assistance or installation supervision. We gladly offer field assistance at our standard field service rates. Pricing does not include freight or any applicable taxes, permits or fees.

Estimated freight costs for the equipment listed above to the New Bedford, MA area would be in the range of $1,500 to $1,800.

Construction and Installation (preliminary/budgetary)

SAI can provide a complete turnkey installation of the railcar weighing system. Although the material quantities and magnitude of work will vary for each type of weighing system, the basic scope of work is the same. The actual project description is also subject to change depending upon the final installation requirements. A typical SAI provided Scope of Work would include the following and is based on a 4,000 PSF soil bearing capacity:

A. Complete all excavation as required to the base of concrete elevations. Compact the base of excavation.

-continued-

B. Furnish all materials, labor and equipment to complete the reinforced concrete foundation construction. Place previously excavated materials around the finished foundation as perimeter backfill.

C. Assemble, install, level and align the complete weighbridge assembly. Install and level the approach rail plates.
Note: Rails and complete rail installation is to be provided by others.

D. Furnish and install epoxy grout beneath the load cell base plates and approach rail plates.

E. Furnish and install all conduits, boxes and fittings as required.

F. Install instrumentation. Install control cables and complete all hook-ups.

G. Complete all system start-up, calibration and certification.
Note: Test car, test train and scale inspector is not included.

H. Full time project supervision by an SAI field engineer.

Budgetary Construction & Installation Price Two Draft Static $75,000

Delivery of the proposed equipment is 4-6 weeks after receipt of order. Construction and installation can typically be completed within 8-10 weeks after receipt of order. Terms are F.O.B., point of manufacture with net payment due 30 days after invoicing, subject to credit approval. Steel is normally fabricated in Charleston, WV while all the instrumentation is produced in Libertyville, IL. Prices do not include any applicable taxes or other fees. Our standard one (1) year limited equipment warranty applies to all proposed equipment.

I hope this budgetary proposal provides you with sufficient information for your review of this project. If you have any questions regarding this submittal or if I can be of any further assistance, please give me a call. SAI looks forward to the opportunity to work with you on this project.

Respectfully submitted.

SYSTEMS ASSOCIATES, Inc.

W. J. Barbera

W. J. Barbera
Sales Engineer
kf1301hb.wpd

Enclosure: Field Service Rates
Data Sheets: NP Series, Model 530

cc: Bob Wynn

systems associates, inc.

US Domestic

INSTALLATION AND SERVICE RATE SCHEDULE

Systems Associates, Inc. will furnish the services of a field engineer to supervise and assist in the installation, repairs, and/or calibration at your facility at the following rates:

- $70.00 per hour for all hours worked during a normal eight hour work day.
- Time and one half will be charged for any hours worked in excess of the normal eight hour day and all Saturday hours.
- Double time will be charged for Sunday and Holidays with a minimum charge of eight hours.
- $60.00 per hour for all travel hours during a normal eight hour work day.
- $0.48 per mile for ground travel by private or company owned vehicles.
- Public transportation and subsistence at cost plus 10%

Prices are subject to change without notice.
Terms are Net 30 days after invoicing.
Effective January 2002

PL-13-1201

1932 Industrial Drive / Libertyville, Illinois 60048 / **(847) 367-6650** / Fax: (847) 367-6960
E-Mail: mail@systemsassoc.com

sai DATA SHEET

NP SERIES
Railcar Weighbridges

SYSTEMS ASSOCIATES, INC. / 1932 Industrial Drive / Libertyville, Illinois 60048 / (847) 367-6650 / FAX: (847) 367-6960

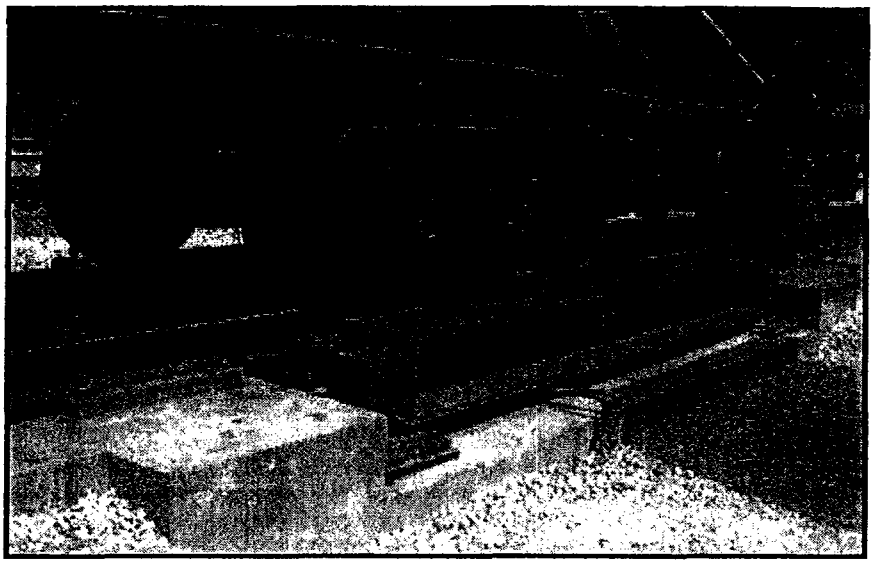
DESCRIPTION

The NP Series weighbridge is a very cost effective solution to your railcar weighing application. Three standard 12'-6", 20'-0" & 26'-0" weighbridges provide the flexibility to efficiently accommodate both in-motion and static weighing. Coupled-in-motion (CIM) systems utilize a single NP1260 weighbridge, uncoupled-in-motion (UCIM) systems are typically handled with either an NP2000 or an NP2600 weighbridge and static systems use any pair of these weighbridges. Special order lengths up to 93'-6" are also available. Used in combination with SAI's standard instrumentation systems, the NP Series weighbridge is the economical solution for your certified weighing requirements.

The 15" scale height of the NP Series design offers the lowest profile available for railcar weighbridges. This configuration is ideal for an above grade installation which accommodates a simple and economical slab type foundation. This type of construction reduces your critical track downtime and rail traffic interruptions. This is an important item that needs to be considered when you calculate the total cost of the system.

In addition to its other built in features, the NP Series weighbridge is designed to withstand the rigors of daily railcar and locomotive traffic. This includes hermetically sealed, compression load cells, rigid checking, steel approach rail supports, massive base plates and heavy weighbridge beams. This equipment is built to last.

Compliance with the requirements of the various regulatory and governing bodies is of primary concern to SAI. With the installation of an NP Series weighbridge you can be assured that your system will be accepted for commercial railcar weighing purposes.



FEATURES

- **Three Standard Weighbridge Lengths** accommodate virtually every application and most car length combinations. Special order lengths are also available.
- **Lowest Profile Available** of any commercially manufactured railcar weighbridge. This design allows the construction of an efficiently designed, monolithic slab type, reinforced concrete foundation.
- **Standard Above Grade** configuration simplifies maintenance access and minimizes confined space issues. Open sides provide free flow ventilation and gravity water runoff. Sump pump requirements are eliminated.
- **Outboard Load Cell Design** reduces the transfer of wheel impact forces to the weighing system. The included load cell isolation kits provide additional impact dampening and electrical surge protection.
- **Rigid Weighbridge Checking** assures that rail and load cell alignments are maintained. This minimizes mitered rail end batter, extends load cell life and maintains long term system integrity.
- **Factory Assembled Weighbridge Modules** enable a quick and easy installation process. Upon delivery, the units are ready to be set in place. Installation can normally be completed in one day.
- **Designed Per AAR/AREMA Specifications** for Cooper E-80 loading. Complies with the requirements of all major railroads. Heavy capacity, Cooper E-100 designs are available as a standard option.
- **NTEP Approved** since 1988 (current CC #88-084A1). Meets all NIST Handbook-44 railcar weighing requirements for Class IIIL devices.
- **Complete Weighing System** is the standard equipment package provided by SAI. This includes site specific documentation, embedded anchors, rail attachment components, system accessories and the appropriate static or in-motion instrumentation.

NP SERIES — Railcar Weighbridges

STANDARD MODELS

Model	Weighrail	Sections	Capacity*	Assem. Wt.
NP1260	12'-6"	2	85T	9,900 lb.
NP2000	20'-0"	3	170T	14,200 lb.
NP2600	26'-0"	3	170T	17,400 lb.

Weighbridge lengths ranging from 39'-6" to 93'-6" are available on a special order basis. Contact the factory for details.

SPECIFICATIONS

Design: Cooper E-80* live load/Fb 10 KSI *
Section Cap: 85 tons*
Material: ASTM A-36 steel w/ A-325 hardware
Surface Finish: Industrial grade gray enamel
Load Cells: 100,000 lb. compression/hermetically sealed
Stainless steel construction
NTEP CC #91-001A3
Foundation: 4,000 PSF*/Cooper E-80 live load*

* Design criteria and rated capacities are based on AAR specifications

SYSTEM COMPONENTS

Factory assembled weighbridge module
Load cells, bearing kits & isolation kits
Base plates & anchor bolts
Approach rail support beams
Rigid checking assembly
Removable safety steel deck plates
Rail attachment hardware

STANDARD ACCESSORIES

Approach rail plates & anchor bolts
Rail clips & anti-creep rail anchors
Shallow pit deck covers

EQUIPMENT & DESIGN OPTIONS

Cooper E-100 weighbridge design
200,000 lb. cap. load cells
Galvanized surface finish
Rails (115# RE min.) w/ mitered ends
Pandrol® rail fastening systems
Custom foundation designs

TURNKEY INSTALLATIONS

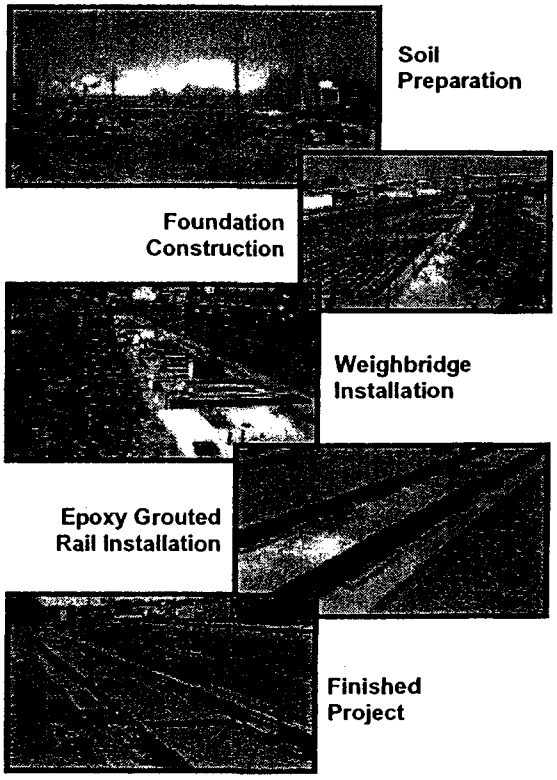
Delivery of the complete SAI equipment package to your facility is only the first step in weighing railcars. A significant portion of the project still remains to be completed. This includes the foundation construction, equipment installation, electrical work and system startup.

SAI is also your source for a complete turnkey installation. This would typically include soil preparation, concrete foundation construction, weighbridge assembly & installation, rail installation, grouting and electrical work. We'll also complete the system startup and assist with the certification process. After the system is up and running, we'll conduct an informal training session for your operations and maintenance personnel.

Generally, every site will have different requirements. This could include a foundation support system such as piling or caissons, some track reconstruction or a trackside equipment building, just to name a few. Whatever the specific requirements of your site may be, SAI has the capabilities and expertise to handle them.

All SAI turnkey projects are supervised from start to finish by one of our expert field engineers. In addition to keeping the work on schedule and assuring the proper installation, our field engineer will also act as a local liaison with your staff. Day to day issues and concerns are quickly resolved with this on-site presence.

A complete SAI equipment and turnkey package assures you that the final product will provide the most accurate and reliable railcar weighing system possible.



Soil Preparation

Foundation Construction

Weighbridge Installation

Epoxy Grouted Rail Installation

Finished Project

Specifications subject to change without notice
DS-43-0102
Printed in U.S.A.
© 2002 Systems Associates, Inc.

SYSTEMS ASSOCIATES, INC. / 1932 Industrial Drive / Libertyville, Illinois 60048 / **(847) 367-6650** / Fax: (847) 367-6960
Visit our web site at SystemsAssoc.com or Email us at Sales@SystemsAssoc.com

systems
associates,
inc.

E-Mail: ltoroyan@fwenc.com

September 19, 2002

Foster Wheeler Environmental Corp.
5300 Broken Sound Blvd. Suite 110
Boca Raton, FL 33487

Attn: Lucine Toroyan, Coastal Engineer

Subject: NP1260 Two Draft Static Track Scale
EPA/Army Corps of Engineers - New Bedford, MA
SAI Project FWE-2090

Dear Lucine:

Per our 9-18-02 discussion, attached are .dwg files of our Drwgs. #1511325 and #1100833 for your reference. I think these should be of use to you for developing the foundation details for this peoject.

Regarding the anchor bolts, it is acceptable to use an epoxy type such as Hilti HVA adhesive anchors or equiv. There is, however, one note of caution. As noted on the drawing, the anchor bolts must be located within 1/8". It is critical that the foundation rebar be initially located so that it will not interfere with the subsequent anchor bolt installation.

If we can be of any further assistance, please contact Bill Barbera or myself.

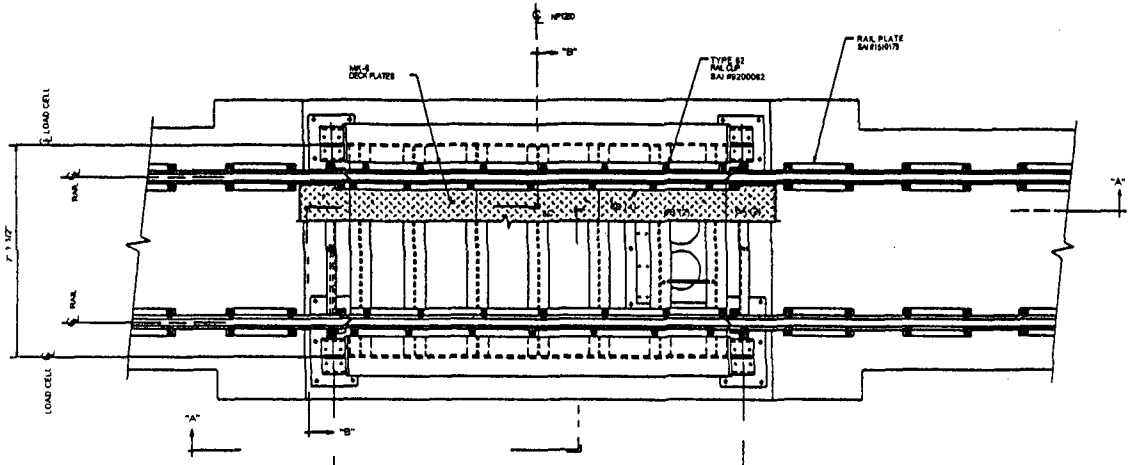
Sincerely,

SYSTEMS ASSOCIATES, Inc.

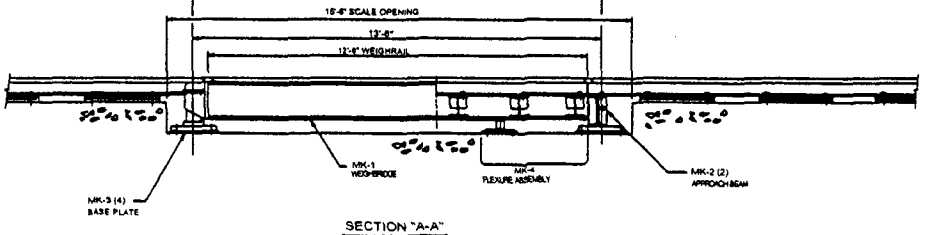
John Holleman

John Holleman
Manager, Structural Engineering
ims/ki1901fs

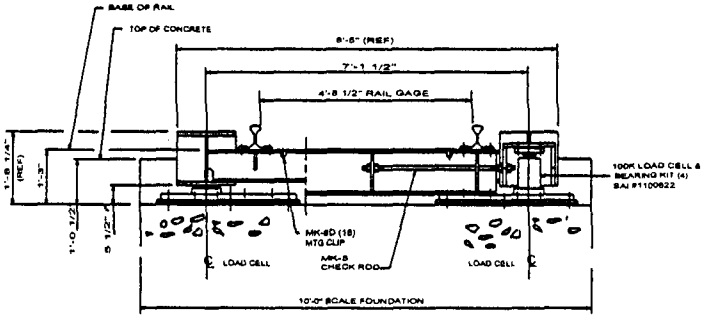
1932 Industrial Drive / Libertyville, Illinois 60048 / **(847) 367-6650** / Fax: (847) 367-6960
E-Mail: mail@systemsassoc.com



PLAN VIEW



SECTION "A-A"



SECTION "B-B"

REV	DESCRIPTION	DATE	BY

This document and any information or specifications contained herein are the property of Systems Associates, Incorporated and shall be kept confidential, shall not be reproduced, copied, or used as a basis for the manufacture or sales of apparatus or systems without expressively written authorization. This notice must be included on any reproductions of this drawing.

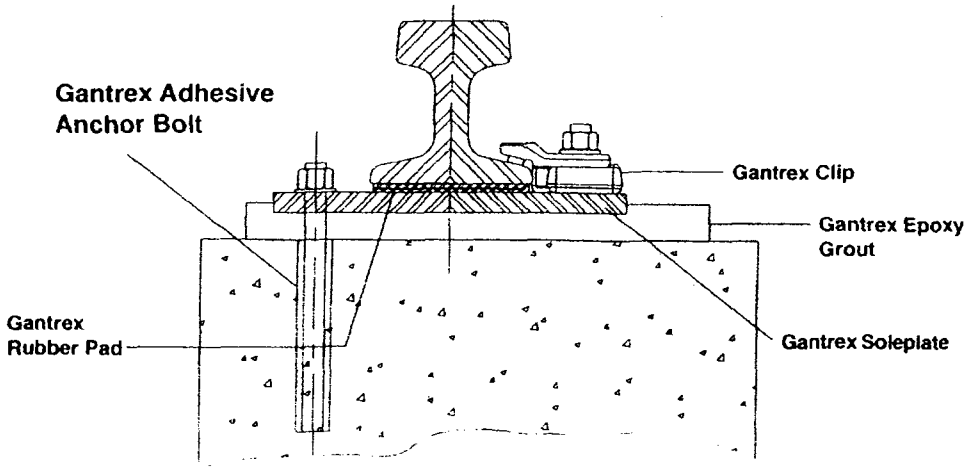
systems associates, incorporated
libertyville, illinois 60048

DRAWN BY: KAB		DATE: 5-19-98
SCALE: 1/2"=1'-0"	PROJECT:	REVISED:
NP1260 RAILROAD TRACK SCALE		
E-80/115# RE		DRAWING NUMBER 1510717

GANTREX®
A RAILWORKS COMPANY

Adhesive Anchor Bolts

For Crane Rail on Concrete Applications



INTRODUCTION

A Gantrex Anchor Bolt is a resin set anchor. It is installed by drilling a hole in the concrete deck, filling the hole with polyester resin, which acts as an adhesive, suspending a bolt in the resin and allowing the resin to cure, to complete the process. Unlike anchors using epoxy based resin, Gantrex anchors can be placed in temperatures as low as 10°F.

The bolt itself is an all-thread steel rod, complete with a nut and a washer. Bolts can be supplied in different diameters and lengths. The polyester-based resin supplied in US quart cans, can be poured directly from the container, into the hole.

MATERIALS

Anchor Bolt

Material:	A36: Fy (min) = 36,000 psi Ft (min) = 58,000 psi
	B7: Fy (min) = 105,000 psi Ft (min) = 125,000 psi
Finish:	Zinc plated or hot dipped galvanized.
Freight classification:	Class 50

Polyester-based resin

Packaging:	Supplied in US quart cans, four cans per carton.
Freight classification:	UN 1866, packing group III, Class 3

Catalyst

Packaging:	Supplied in pill bottle type containers, four per carton, packaged separately.
Freight classification:	UN 3102, packing group II, Class 5.2

PLACEMENT PROCEDURE

Holes are air-drilled in concrete deck, using a soleplate as template. The drilled holes are 1/8" greater in diameter, than the anchor bolt diameter. These holes are cleaned to remove dust and debris.

One container of catalyst is added to one can of polyester resin and mixed in the can for 60 seconds to 90 seconds. The mixture is poured into the hole, to about one third the depth. The anchor bolt is suspended from the soleplate, and placed in the resin in the hole. The resin cures and sets in about 1 hour. The anchor must not be disturbed during this time. Full cure occurs in 24 hours.

SUGGESTED EMBEDMENT

It is important that anchor bolts are embedded to a proper depth to achieve adequate strength. In 5 ksi concrete, for example, we suggest that A36 anchor bolts be embedded to at least 8 times their diameter (a 3/4" rod will require an embedded length of at least 6"). This is adequate to achieve enough bond with the concrete such that, in a pullout test, the anchor bolt will yield before the bond with the concrete. Similarly, the suggested embedment for B7 bolts is 12 times the bolt diameter.

ADHESIVE ANCHOR BOLTS

TECHNICAL INFORMATION

Gantrex Anchor Bolt Table

Gantrex Anchor Bolt Part Number *Notes (1, 2)*	Bolt Diameter (inches)	Hole Diameter (inches)	Bolt Length (inches)	Embed. Length (inches)	Rod Assy. Wt. (lbs.) A36 *Note (3)*	Rod Assy. Wt. (lbs.) B7 *Note (3)*	Resin Vol./Bolt (cu. ins.) *Note (4)*	Resin Weight (lbs.)	Anchor Bolts per can	Anchor Bolts / carton
AB 5/8 x 10-A36*	5/8	3/4	10	6	0.86	0.91	1.38	0.12	38	153
AB 5/8 x 12-A36*			12	8	1.01	1.05	1.85	0.16	29	115
AB 5/8 x 14-A36*			14	10	1.16	1.20	2.31	0.20	23	92
AB 3/4 x 10-A36*	3/4	7/8	10	6	1.16	1.24	1.94	0.16	27	109
AB 3/4 x 12-A36*			12	8	1.36	1.43	2.59	0.22	20	82
AB 3/4 x 14-A36*			14	10	1.56	1.63	3.23	0.27	16	66
AB 3/4 x 16-A36*			16	12	1.76	1.83	3.88	0.33	14	55
AB 7/8 x 12-A36*	7/8	1	12	8	1.92	2.03	3.07	0.26	17	69
AB 7/8 x 14-A36*			14	10	2.20	2.31	3.84	0.33	14	55
AB 7/8 x 16-A36*			16	12	2.48	2.59	4.61	0.39	12	46
AB 7/8 x 18-A36*			18	14	2.76	2.86	5.37	0.46	10	39
AB 1 x 12-A36*	1	1 1/8	12	8	2.54	2.68	3.72	0.32	14	57
AB 1 x 14-A36*			14	10	2.90	3.04	4.65	0.39	11	46
AB 1 x 16-A36*			16	12	3.26	3.40	5.58	0.47	9	38
AB 1 x 18-A36*			18	14	3.62	3.76	6.51	0.55	8	33
AB 1 1/4 x 14-A36*	1 1/4	1 3/8	14	10	4.73	4.97	6.03	0.51	9	35
AB 1 1/4 x 16-A36*			16	12	5.30	5.55	7.24	0.61	7	29
AB 11/4 x 18-A36*			18	14	5.88	6.12	8.45	0.72	6	25
AB 1 1/4 x 20-A36*			20	16	6.46	6.70	9.65	0.82	5	22

NOTES:

(1) Replace A-36 with B7 for high strength material.
(2) Suffix with 'Z' for Zinc plated or 'G' for hot dipped galvanized.
(3) Rod assembly consists of one rod + 1 nut + 1 washer.
(4) Resin volume shown includes 30% for waste.

HOW TO SPECIFY AND ORDER

1. To specify and order a Gantrex adhesive anchor bolt assembly, determine the correct diameter and length.
2. Determine correct part number from the above table and notes. For example, AB 1x14-A36G would be the part number for a 1" x 14" long, diameter bolt of A36 material, with one nut and one washer, all hot dipped galvanized.
3. If substrate temperature is likely to be below 45°F, at time of actual installation, please double the quantity of catalyst, at time of order placement.

While the steel hardware can be shipped at any time, due to the nature of the resin/catalyst system, it is recommended that the adhesive be shipped 3-4 weeks prior to actual installation.

GANTREX reserves the right to discontinue or change specifications at any time without prior notice and without incurring any obligation whatsoever.

Quality on Track®

PITTSBURGH *Corporate Headquarters* Sales/Warehouse Ph: (412) 655-1400 Fx: (412) 655-3814 • ATLANTA Ph: (770) 591-9010 Fx: (770) 591-9353 • CHICAGO Ph: (708) 361-3600 Fx: (708) 361-6439 • CLEVELAND Ph: (440) 543-7958 Fx: (440) 543-7963 • HALIFAX Ph: (902) 468-6689 Fx: (902) 468-6546

TORONTO Sales/Warehouse Ph: (905) 686-0560 Fx: (905) 686-0962 • HOUSTON Ph: (281) 893-0027 Fx: (281) 893-4512 • MONTREAL Ph: (450) 441-7043 Fx: (450) 441-0421 • NEW YORK Ph: (203) 849-9160 Fx: (203) 846-8228 • PHOENIX Ph: (928) 684-2815 Fx: (928) 684-2750 • VANCOUVER Ph: (604) 253-8400 Fx: (604) 253-2965

TOLL FREE: 800 2 GANTREX (800) 242-6873 — Web site: www.gantrex.com email: sales@gantrex.com

©GANTREX, 2001
PRINTED IN U.S.A.

sai DATA SHEET

Model 530
Digital Weight Indicator

SYSTEMS ASSOCIATES, INC. / 1932 Industrial Drive / Libertyville, Illinois 60048 / (847) 367-6650 / FAX: (847) 367-6960

DESCRIPTION

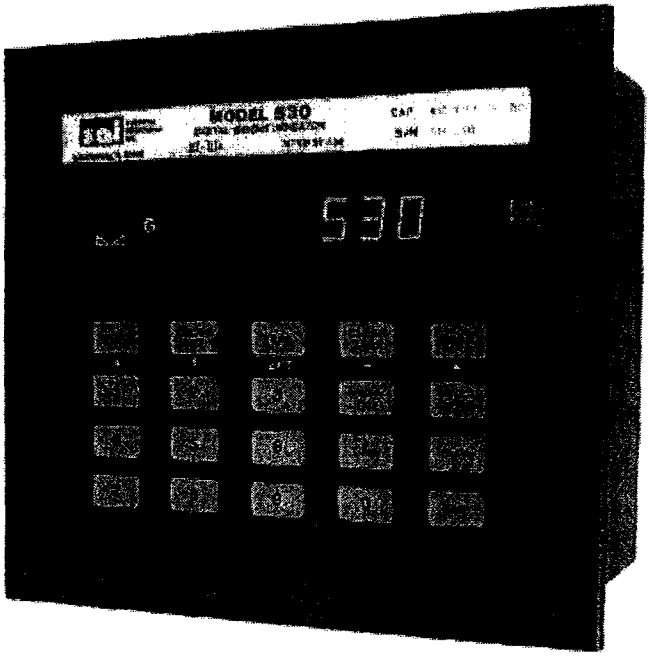
The Model 530 is a high performance digital weight indicator used in industrial weighing applications. This microprocessor based unit provides load cell excitation for up to eight 350 Ω load cells. Integral to the unit is a 20 bit A/D converter.

The front panel has 20 input keys to meet your scale system requirements. The Model 530 displays alpha numeric data on a 7-digit 16-segment blue-green vacuum fluorescent display. A bright red LED annunciator located on the front panel indicates when the digitizer is displaying a non-valid weight.

The Model 530 employs a simple menu driven procedure to set up and calibrate the indicator. The indicator prompts the user for parameter settings such as capacity, divisions, etc. These parameters can also be set via the serial interface port. Calibration is performed with only the front panel keys; no confusing dip switches or troublesome potentiometers.

The Model 530 includes two bi-directional RS-232 data ports including a standard 20 mA current loop output on the second port. RS-485 multi-drop and bi-directional 20 mA current loop drivers are available as an option.

A user adjustable three stage digital filter, display update rate, and serial output delays provide steady weights even with heavy vibrations.



FEATURES

- Menu-driven setup /calibration
- 25 conversions per second
- Compact size
- Meets NIST HB-44 requirements
- NTEP Certificate of Conformance #97-134
- Three stage digital filtering
- Serial communication
- Time and date
- Printer formatting
- 120 / 230 VAC power selections
- 12-28 VDC power option
- Splash proof front panel keypad
- Numeric keypad for setting tare and setpoint cutoffs
- Interface with up to eight 350 ohm load cells without external power supply

MODEL 530 - Digital Weight Indicator

SPECIFICATIONS

Specifications are applicable over the operating temperature range of -10° C to + 50° C

ANALOG

Full Scale Input Signal	4.5 mV/V (Includes Deadload Signal)
Internal Resolution	1,000,000 counts (A/D Converter Counts)
Display Resolution	1/60,000 counts
Conversion Rate	25 conversions/second
Digitizer Linearity	Within 0.01% of full scale
Stability of Zero	150 nV/°C. maximum
Stability of Span	3.5 ppm/°C. maximum
Common Mode Rejection	140 dB typical at 50-60 Hz
Normal Mode Rejection	90 dB typical at 50-60 Hz
Excitation Voltage	10 VDC, up to eight 350 Ω load cells
Linearization	10 selectable points

OPERATOR INTERFACE

0.55 inch, 16 segment vacuum, fluorescent display, 7 full digits, decimal point and comma available at each digit. Additional symbols for Automatic Tare, Manual Tare, Zero, Standstill, Minus, Net, and Gross. Display color is blue-green filtered to blue. Labels supplied for lb, kg, oz, g, and t.

SERIAL COMMUNICATIONS

Two standard communications ports allow RS-232 data exchange between the Model 530 and host computers, displays, and printers. All keyboard functions can be remotely activated by an external computer. Complete parameters setup, including calibration, allows a replacement digitizer to be set up and running fast.

ENVIRONMENTAL CONDITIONS

Operating Temperature	-10° C. to +40° C. Legal -10° C. to +50° C. Industrial
Storage Temperature	-10° C. to +70° C.
Humidity:	0 to 95% RH
Vibration:	Conforms to current OIML requirements

MECHANICAL

Width	7.94 inches
Height	7.94 inches
Depth	4.28 inches
Panel Cutout	7.32-7.36" square
Weight	4.4 lb. maximum
Mounting	Desk top or panel

POWER

AC Power	120 or 230 VAC
Frequency	48-62 Hz
Consumption	15 W maximum

OPTIONS

SETPOINT

8 DIGITAL INPUTS
Logic Low (Active)
0 - 1.5 VDC or ground
Logic High (Inactive)
+4 to +30 VDC or open

8 DIGITAL OUTPUTS
Logic Low (Active)
0 - +.8 VDC @300 mA
Logic High (Inactive)
external supply voltage

ANALOG OUTPUT

Voltage	0-10.5 VDC
Current	0 - 21 mA
Resolution	14 bits
Linearity	0.01%

SERIAL PORT
RS-485 Multidrop
20 mA Current Loop

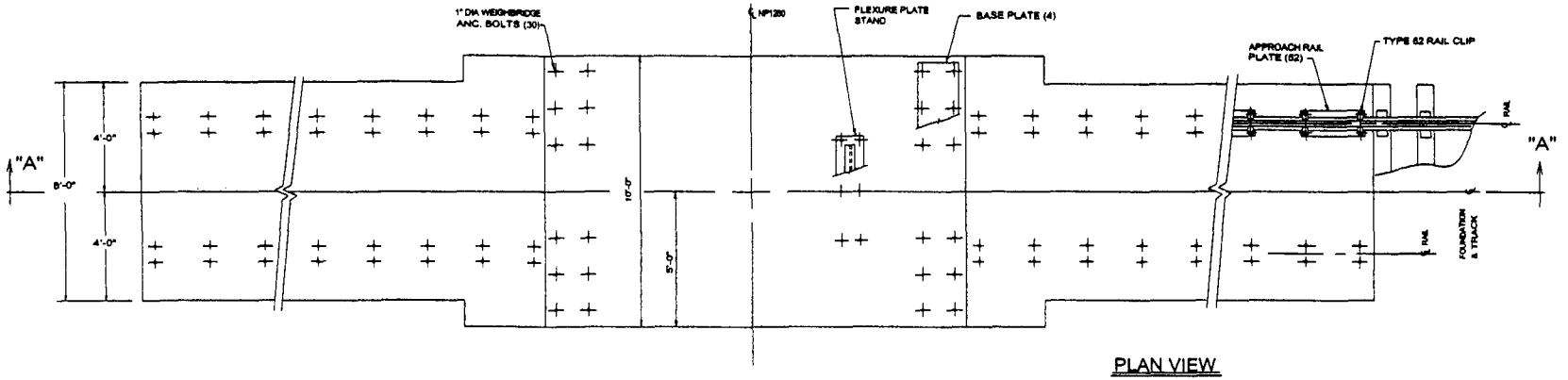
BCD
Remotely mounted module used to convert RS-232 serial port data to 7 BCD digits. BCD module is useful for interfacing to scoreboards and PLC's

ENCLOSURES
NEMA 12
NEMA 4
Stainless Steel

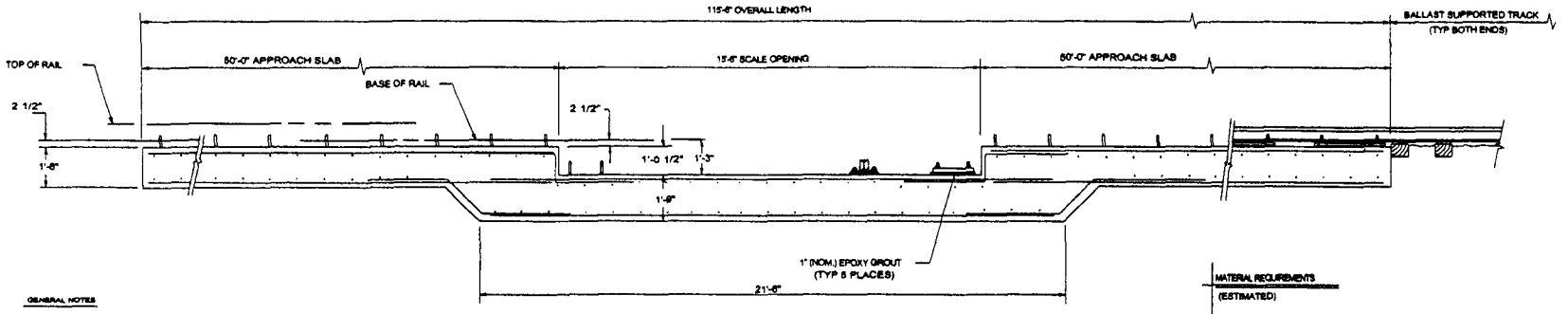
POWER
12-28 VDC 15 W Maximum

Specifications subject to change without notice
DS-60-0201
Printed in U.S.A.
© 2001 Systems Associates, Inc.

SYSTEMS ASSOCIATES, INC. / 1932 Industrial Drive / Libertyville, Illinois 60048 / **(847) 367-6650** / Fax: (847) 367-6960
Visit our web site at SystemsAssoc.com or Email us at Sales@SystemsAssoc.com



PLAN VIEW



SECTION "A-A"

GENERAL NOTES

1. ALL FOUNDATION MATERIALS AND CONSTRUCTION ARE TO BE IN COMPLIANCE WITH THE CURRENT EDITIONS OF THE AAR SCALE HANDBOOK AND CHAPTER 8, PART 1 OF THE A.R.E.M.A. "MANUAL FOR RAILWAY ENGINEERING".
2. THE FOUNDATION DETAILS AS SHOWN ON THIS DRAWING ARE BASED ON AN ALLOWABLE SOIL BEARING CAPACITY OF 4,000 PSF AT THE BASE OF THE CONCRETE.
3. A SOIL ANALYSIS OF THE INSTALLATION MUST BE COMPLETED SO AS TO DETERMINE THE ACTUAL SOIL BEARING CAPACITY. IF THE ANALYSIS REVEALS AN ACTUAL SOIL BEARING CAPACITY OF LESS THAN 4,000 PSF, AND IT CANNOT BE INCREASED TO 4,000 PSF BY DRAINAGE, ENGINEERED FILL OR OTHER MEANS, PILING WILL BE REQUIRED.
4. GENERAL FOUNDATION REQUIREMENTS
   A. THE FOUNDATION IS TO BE CONSTRUCTED SQUARE AND LEVEL IN A SINGLE MONOLITHIC POUR AS SHOWN.
   B. SUITABLE FORMWORK IS TO BE PROVIDED WHICH WILL MAINTAIN DIMENSIONAL INTEGRITY OF THE FOUNDATION DURING THE CONCRETE PLACEMENT AND CURING OPERATIONS.
5. REBAR PLACEMENT REQUIREMENTS
   A. MINIMUM BAR OVERLAP TO BE 2'-0" UNLESS SPECIFIED OTHERWISE.
   B. EMBEDMENT: 3" AGAINST EARTH OR FORMS
      2" AGAINST EXPOSED SURFACES
   C. IF REBAR INTERFERES WITH ANCHOR BOLT PLACEMENT, REBAR IS TO BE OFFSET.
6. ANCHOR BOLT PLACEMENT REQUIREMENTS
   A. ANCHOR BOLTS MUST BE LOCATED WITHIN +/- 1/8". IF REBAR INTERFERES WITH ANCHOR BOLT PLACEMENT, REBAR IS TO BE OFFSET.
   B. ANCHOR BOLTS ARE TO BE SECURELY HELD IN PLACE WITH SUITABLE TEMPLATES WHICH WILL PREVENT ANCHOR BOLT SHIFTING WHEN THE CONCRETE IS PLACED.
7. MATERIAL SPECIFICATIONS
   A. CONCRETE
      COMPRESSIVE STRENGTH OF 4,000 PSI AT 28 DAYS. MAXIMUM SIZE AGGREGATE TO BE 3/4" STONE. AIR ENTRAINED AND PLACED IN ACCORDANCE WITH ACI STD. 318-89.
   B. REBAR
      DEFORMED BILLET STEEL CONFORMING TO ASTM SPEC. A-615, GRADE 60.
   C. SUB-BASE (IF REQUIRED)
      FREE DRAINING GRANULAR MATERIAL. COMPACT TO 95% DRY DENSITY PER ASTM SPEC. D-1557.
   D. WEIGHBRIDGE GROUT (EPOXY TYPE)
      "CAULDITE 648" (MASTER BUILDERS, INC.), "FIVE STAR EPOXY" (FIVE STAR PRODUCTS), SPC-13-12 (DELTA PLASTICS) OR APPROVED EQUIVALENT.
   E. RAIL PLATE GROUT (NON-SHRINK CEMENT TYPE)
      "EMBECO 636" (MASTER BUILDERS, INC.), "FIVE STAR GROUT" (FIVE STAR PRODUCTS) OR APPROVED EQUIVALENT.
8. FINISHED GRADE IS TO SLOPE AWAY FROM THE FOUNDATION TO ASSURE POSITIVE SITE DRAINAGE.
9. THE 3" DIA PIPE SLEEVES ARE REQUIRED ONLY IF THE SCALE IS PROVIDED WITH A RAIL CAR IDENTIFICATION (RCI) SYSTEM.

MATERIAL REQUIREMENTS

(ESTIMATED)

EXCAVATION (TO BASE OF CONCRETE)	95 YD ^{3}
CONCRETE	70 YD ^{3}
REBAR (#5 & #8)	7300 LBS
EPOXY GROUT (WEIGHBRIDGE)	3 FT ^{3}
NON-SHRINK GROUT	25 FT ^{3}

REV	DESCRIPTION	DATE	BY

This document and any information or specifications contained herein are the property of Systems Associates, Incorporated and shall be kept confidential, shall not be reproduced, copied, or used as a basis for the manufacture or sales of apparatus or systems without expressively written authorization. This notice must be included on any reproductions of this drawing.

sai **systems associates, incorporated**
libertyville, illinois 60048

DRAWN BY: KAB		DATE: 7-27-95
SCALE: N.T.S.	PROJECT:	REVISED:
NP1260 FOUNDATION DETAILS		
2 DRAFT STATIC		DRAWING NUMBER 1511323

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Foundation Design

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. S-01 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____YES _____ NO

PREPARER J. Zhao

REVIEWED BY M. Hsieh DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Calculation Record

Client Name: USACE- New England District Page 1 of 118

Project Name: New Bedford Harbor – Wastewater Treatment Plant Project No.: 5197.1720.9302.00010

Calculation Title: Dewatering Facility Foundation Design

Calculation No./File No.: Rev. 1

Calculation Is: (check all that apply) ☒ Preliminary ☐ Final ☐ Nuclear Safety-Related

Objective Design reinforced foundation for dewatering building for both strength and service condition to resist all manufacture-specified equipment loading and other applicable loading.

Unverified Assumptions Requiring Subsequent Verification

No.	Assumption	Verified By	Date
1	No architectural drawings available at the time of calculation. Building loads need to be verified once the drawings and data become available.		

See Page 2 of this calculation for additional assumptions.

This Section Used for Computer Generated Calculations

Program Name/Number: PCA-Mats Version: 5.2

Evidence of or reference to computer program verification, if applicable:
It is unknown if the PCA-Mats V5.2 has been verified by FWENC QC procedure.

Bases or reference thereto supporting application of the computer program to the physical problem:

Review and Approval

Rev	Prepared By	Date	Verified By	Date	Approved By	Date
0	Jeff Zhao	1/28/02				
1	Jeff Zhao JZ	4/16/02				

Summary of Structural Calculations Rev. 1

The revised structural calculations (Rev. 1) take the following changes (since 90% submittal) into consideration.

1. Change of Load Condition: Added Hyster H700F fork truck, which is a controlling load in slab design of load-out area.
2. Change of Code Criteria: Per ACI 318 in floor slab design, instead of ACI 350. Only the sump bottom slab and walls are designed per ACI 350.
3. Change of Structural Dimensions: Move the N-S interior columns 15 ft towards west; shrink the rail track slab; and raise the sump bottom. See Page 5 for details.
4. Geotechnical Condition: Values of subgrade modulus have been clarified per Andrew Tognon's emails. See Page 9.
5. 100-yr Flood Elevation and Floor Elevations: Has been clarified. See Page 12.
6. New Item: Added the Support Building Foundation design. see p.6-8.

In addition, the Rev. 1 takes the 90% submittal comments into consideration.

As a result of the above diversions, Rev. 1 included the following major revisions accordingly.

1. Instead of designing a single, uniformly reinforced floor slab in process and load-out areas, the new design separated the two areas with an isolation joint. The slab thickness is 10" in process area and 12" in load-out area. Load-out slab is heavily reinforced to take the fork truck loading, while process slab is less reinforced. Tanks/ Equipment installation loads have been taken into consideration for the process area (HS20-44 truck). Twenty-ft wide aisle load pattern has also been included in the design of process area and load-out area to simulate the warehouse condition of the future marine terminal. The building sump is separated from the floor slab by isolation joint around its perimeter per ACI 360 requirement. The sump top and bottom slabs have been redone to reflect the load increase from 300 psf to 750 psf.
2. Reinforcement designs of process and load-out slabs only comply with ACI 318. Also have revised or deleted some ACI 350 complying details on the structural drawings.
3. Did not revise the mesh sizes of process area (Mat 1) and load-out area (Mat 2), as the 15' shifting has minor impact on moment outputs. However, the rail track slab (Mat 3) has been redone to reflect the significant reduction of the mat size. The raise of the sump bottom shortened the sump wall by 2'. No revise has been done regarding the sump wall as current condition becomes less critical.
4. Have adjusted the values of subgrade modulus in all major mat modeling. Subgrade modulus for sump bottom slab has been reduced from 80 kcf to 51 kcf.
5. Have re-examined the sump flotation safety to reflect the changes in 100-yr flood table, sump size, and the connection condition to the floor slab.
6. Have designed the support building foundation slab per 'Dewatering Facility Foundation Design Information" received on April 5, 2002.

Consideration of Joints

Since continuous trench drains are desirable, expansion joints were deleted from the floor slab. Detailed reasoning is on Page 10. Construction/ contraction joints are marked up on drawings with maximally 55' apart. PCA suggest 20 to 30 ft spacing of contraction joints for plain slabs of 10 in. thickness. With #5@12 EW for process area and #6@8EW for load-out area, 55' contraction spacing is reasonable.

ACI 302 recommended Isolation Joint at Columns (Fig. 3.2.5.1.a) is not applicable to the dewatering floor. The water-tightness is questionable for the fill around columns. Since the floor get wet quite often, Fig.3.2.5.1.b is not applicable neither. A ½" wide isolation joint (with waterstop) has been placed around the interior column pedestal. There shall be 2" grout between the column base plate and the top of the footing pedestal to keep the plates and bolts dry.

References:

- ACI 318-99/318R-99
- ACI 350R-89
- ACI 360R-92
- ASD 9th Edition
- Concrete Watertight Structures and Hazardous Liquid Containment (by Robert Hengst), ASCE Press, 1994.
- Faxes, emails, drawings, and correspondences from Boston, Boca Raton, and venders (inserted in the calculations).

Contents of Design Calculations:

1. New design information since 90% submittal (P. 4 ~ 14)
2. Process Area (Mat 1) (P. 15 ~ 30)
3. Load-out Area (Mat 2) (P. 31 ~ 60)
4. Rail Track Slab (Mat 3) (P. 61 ~ 75)
5. Building Sump (P. 76 ~ 116)
6. Support Building Foundation (P. 117 ~ 118)
7. Appendix: Design Data and References
8. Footings (in a separate calculation file)

New Design Information Since 90% Submittal

Load Criteria:

EQUIPMENT	LOAD (TONS)	LOCATION OF LOADING	DIMENSIONS	LOAD DISTRIBUTION
Plate & Frame Filter Presses (650 ft^3, 80 tons empty, 105 tons loaded)	105 tons	Process Area	60 ft x 13 ft (skid mounted)	2 – Longitudinal steel beams 60 ft long & 6 – cross beams 12 ft on center
Slurry Conditioning Tanks (20,000 gal frac tanks with slurry density of 70 lbs/ft^3)	94 tons/tank	Process Area	40 ft x 8 ft	Uniform over surface area (320 ft^2)
Slurry Equalization Tanks (2 – 64,000 gal tanks each with slurry density of 70 lbs/ft^3)	302 tons/tank	Process Area	36 ftx 30 ft (8 ft liquid level)	Uniform over surface area (1,080 ft^2)
Filter Cake Storage Container (Roll-off box with 17 yd^3 of filter cake with a density of 100 lbs/ft^3)	30 tons	Loadout Area	7ft x 24 ft	4 point loads on steel rollers
Front End Loader with 4 yd^3 bucket		Process and Loadout Area		xx tons/axle
Lift Truck (H700F Hyster Fork Truck)	Assuming a 35 ton live load: Total static load on front axle = 71 tons Total static load on rear axle = 59 tons	Loadout Area		Front axle wheel base = 104 inches Rear axle wheel base = 94 inches
Truck Loading (HS20-44)	36 tons	Process and Loadout Area		16 tons/axle
Future Use: Marine Cargo Terminal	Unknown	Process and Loadout Area	Unknown	750 psf EPA Direction. (Discrete loaded areas with aisle space)

Received @ 4/5/02 68.

5

In addition to the anticipated load table included above the following items also need to be taken into account for the revised structural calculation:

1. Loadout area will be widen from 75 feet to 90 feet by moving the process area internal wall 15 feet to the west. The building sump location should be moved accordingly. Depth of column footings in vicinty of sump also need to be re-evaluated (i.e., lowered).

2. The bottom of the main sump within the process area of the dewatering building is to be raised two (2) feet.

3. Column spacing is to remain as shown on the existing drawings with only changes due to moving the internal wall 15 feet to the west.

4. Curbing shown on Section E-E of Dwg # S-505 needs to be moved closer to rail tracks to facilitate loading of cars. Centerline of track to curbing can change from 19'11" to 8'-0".

5. We also need to revise the civil drawings to reflect the fact that there will be no tracks east of the dewatering building.

6. Incorporate floor drain piping based on layout developed by Joe Francis. We have a copy of these drawings both electronically and in the mail. Drawings will be redone to show new wall and sump location and readjust the floor drains. This will be done in Boston.

7. Foundation design should include utility trench for slurry/filtrate piping. Profile and cross section details are provided on C-112. Assume the concrete chamber box within building is 5 ft by 5 ft with a depth of 4 ft.

   - Drawing detail in Attachment A

8. Include slab and footings for support building.

   - Continuous footings
   - Attachment B has all loading details for slab and footings
   - Dimension of building in Attachment B

Code Criteria

1. Design the dewatering foundation slab to ACI 318 and the sump to ACI 350 per the NBH design team. AREMA manual says to design the rail on slab per ACI 318.

2. The AREMA section pertinent for rail loads are in Attachment C.

3. Also, in Attachment D is the MA Building Code Structural Section.

SUPPORT BUILDING STRUCTURAL INFO

Building Codes and References

The following publications or documents form a part of the basis of design for providing the design and construction of the structural elements for the dewatering support facility, consisting of:

Applicable Building or Design Codes and References:

- American Concrete Institute (ACI): ACI 318 – (1995) *Building Code Requirements for Structural Concrete.*
- American Society of Engineers (ASCE): ASCE 7 – (1995) *Minimum Design Loads for Buildings and Other Structures.*
- Commonwealth of Massachusetts, Board of Building Regulations and Standards: (1997 with all current amendments) *Massachusetts State Building Code.*
- Underwriters Laboratories (UL): UL 580 – (1997) *Uplift Resistance to Roof Assemblies.*

3.5.2 Building Description

The building for the Support Facility shall consist of a pre-engineered metal building with steel framing and metal roof and wall panels. The building provided shall be complete and weather-tight and suitable for the functional requirements indicated. The building plan dimensions shall be as provided by the building manufacturer's standard, but not less than the dimensions indicated on the Conceptual Layout Design Drawing (Appendix C), nor exceeding the indicated dimensions by more than the amount of the closest standard size thereto. The inside clear height between the finished floor and bottom of roof steel shall be a minimum of 10 feet.

The Support Facility building shall consist of vertical walls and a gable roof. The roof slope shall be a minimum of 1 to 12 (vertical to horizontal) to a maximum of 3 to 12. The building framing shall be rigid frame type providing a clear interior span.

3.5.3 Building Design Requirements

3.5.3.1 Design Loads

Loading combinations used shall be in accordance with the Massachusetts State Building Code or ASCE 7 or MBMA LRMBSM, as required.

The pre-engineered metal building shall be designed using the following minimum loads:

a) Dead Loads – Dead loads shall be determined from actual building components to be used.

b) Minimum Roof Live load – Use 16 pounds per square foot (psf).

c) Snow Loads – Compute and apply roof snow loads based on a flat (<30°) roof slope and the following parameters:

- Ground Snow Load, $P_g = 30$ psf
- Snow Exposure Factor, $C_e = 0.7$
- Importance Factor, I = 1.1

d) Wind Loads – Compute and apply wind pressures to building walls, roof and components based on following parameters:

- Basic Wind Speed, V = 90 mph
- Wind Exposure = C
- Importance Factor, I = 1.1

e) Seismic Loads – Compute and apply loads to building components as required to satisfy seismic requirements based on the following parameters:

- Effective Peak Velocity-Related Acceleration Coefficient, Av = 0.11
- Effective Peak Acceleration Coefficient, Aa = 0.11
- Seismic Hazard Exposure Group = I
- Seismic performance Category = C
- Site Soil Coefficient, S = 1.2
- Structural System – ordinary moment frame.

f) Collateral Loads – Include loads as required for HVAC equipment, mechanical equipment, fire protection system, or interior wall or ceiling finishes. A minimum of 5 psf shall be applied on framing systems for collateral loads.

3.5.3.2 Deflections

The building shall be designed to limit deflections to the maximum values indicated below, unless building finishes to be used require more restrictive deflection limits.

a) Structural Members – The maximum deflection of main framing members shall not exceed 1/240th of their respective spans.

b) Roof System – The maximum deflection due to the live roof loads for roof panels and purlins shall not exceed 1/180th of their respective spans, except that when interior finishes to be used require more restrictive deflection limits. Roof panels shall be provided to satisfy UL 580, Class 90. Maximum deflections of roof panels shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. In addition to the live loads indicated above, roof decking shall be designed for a 200-pound concentrated load at midspan.

c) Wall System – The maximum deflection due to wind on wall panels and girts shall be limited to 1/120th of their respective spans, except that when interior finishes to be used require more restrictive deflection limits.

3.5.3.3 Building Materials

The pre-engineered building framing system, wall and roof panels, and other components shall consist of the steel and/or aluminum materials. Roof insulation shall be R-38 and exterior walls shall be R-13.

3.5.4 Foundation Description

The building foundation shall consist of reinforced concrete frost walls and footings and column footings as required to support the pre-engineered building. The floor shall consist of a reinforced concrete slab on grade. A vapor barrier shall be placed under the floor slab, consisting of a 15-mil poly sheeting with edge laps and penetrations sealed. Insulation shall be provided on the exterior of the frost walls.

3.5.5 Foundation Design Requirements

3.5.5.1 Design Loads

The building foundation shall be designed using worst case bearing, uplift, overturning, or sliding forces determined by the building manufacturer. A minimum factor of safety of 1.5 shall be used for overturning, sliding and uplift. The floor slab shall be designed for a minimum 100 psf uniform load with a minimum slab thickness of 6 inches.

3.5.5.2 Soil Data

The allowable soil bearing capacity is expected to be on the order of 4,000 psf, the actual bearing capacity used for the foundation design shall be verified based on a soil boring advanced at the building location. The bottom of footing depth shall be a minimum of 48 inches below final grade for frost protection. Frost wall and column footings shall be constructed on undisturbed firm subgrade material exposed during foundation excavation. The floor slab shall be placed on 8 inches of compacted granular material or structural fill.

3.5.5.3 Foundation Materials

Cast-in-place concrete for the building foundation and floor slab shall be reinforced and have a 28-day compressive strength of 4,000 pounds per inch (psi).

Andrew Tognon

04/02/2002 09:07 AM

To: Jeff Zhao/Houston/FWENC@FWENC
cc: Mark Otten/Boston/FWENC@FWENC, Peter Dunlop/Langhorne/FWENC@FWENC
Subject: Subgrade Modulus

Jeff,

Table below give the geometry dependant subgrade modulus (Ks) for the slabs for the dewatering building

					Bearing Capacity(k_{si}) / Terzaghi
Slab	Calc ID	Width	Length	Original	k_s
		ft	ft	k/ft2	k/ft3
		1	1		192.00
Equipment/Process Area Slab	Mat 1	165	195	50	49
Loadout Area Slab	Mat 2	75	165	70	49
Rail Access Slab	Mat 3	30	150	40	51
Sump Slab	Sump	30	30		51

The Ks values recommended in the geotechnical report are adjusted for slab width to provide a constant winkler subgrade modulus required for the PCA-Mats problem. Mark and I have discussed the problem and based upon the input requirements for PCA-Mats recommend using a constant 50 kcf subgrade for all slabs greater than 30ft wide.... other methods were also evaluated but only changed the subgrade modulus slighty (60 kcf)

I also reviewed the previous PCA-Mats output using the original subgrade moduli (50 kcf, 70 ,kcf and 40 kcf). The settlements from the previous output given by PCA-Mats are low in comparison to some settlement estimates i have done. This is typical for the winkler type analyses using a constant subgrade modulus, and the PCA-Mats program should only be used for moment design and not to predict settlement, alternatively using the "additional nodal springs option" in PCA-Mats software may be used to refine the analyses to obtain a reasonable settlment profile. Although I don't believe this is necessary if we are using only the moment analyses for thickness design.
In any case, if not too time consuming, it would be good to compare the results of the Ks=50 kcf analyses to an additional one at Ks=25 kcf and Ks=100 kcf.

Let me know if you have any questions.

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Andrew Tognon, MESc
133 Federal St.
Boston, MA, 02110
Tel: (617) 457-8410
Fax: (617) 457-8498

Jeff Zhao

04/11/2002 04:24 PM

To: Lucine Toroyan/Boca Raton/FWENC@FWENC, James Brinkman/Boston/FWENC@FWENC
cc: Ming Hsieh/Livingston/FWENC@FWENC
Subject: Expansion Joints

I've discussed with Mike about the expansive joints on the dewatering slab. Mike thinks that, due to the hydration heat, the cast-in-place concrete will have at least a temperature of 70F, even if the ambient temperature is 50F (it is not allowed to cast the concrete below 45F). Since the slab is covered, assume a 100F maximum room temperature. For 205' long slab (loadout area), the expansion will be 205x12x30x0.00055/100 = 0.4". For 180' long slab (equipment area), the expansion will be 0.36".

So, 1/2" isolation joint around the slabs will be fine. Therefore, we don't need expansion joints. Please note that there is an isolation joint between the loadout area and the equipment area due to the different slab thickness and reinforcement. Please confirm again that there will be no traffic (especially the lift truck traffic) between these two area.

Lucy, I'll send you a fax showing the I.J. location. I'll send you the rest of markups of drawings (including the new supporting facility foundation sketches) tomorrow.

Regards,

Jeff Zhao, PE
Foster Wheeler Environmental Corp.
1001 South Dairy Ashford, Suite 210
Houston, TX 77077
Tel: 281-597-4829
Fax: 281-596-0308
Email: jzhao@fwenc.com

11

Lucine Toroyan

04/09/2002 02:24 PM

To: Jeff Zhao/Houston/FWENC@FWENC
cc: James Brinkman/Boston/FWENC@FWENC, Mark Otten/Boston/FWENC@FWENC
Subject: More Dewatering Info

Jeff,

Hot dipped galvanized for the steel inside the sump is fine as long as it has good corrosion resistant properties. This is up to you.

Don't worry about coating the pumps. For now, assume that they are self priming and sit on top of cover, but don't remove mounting location on bottom of sump just in case someone changes their mind about type of pump and location. Additional loading for pump on cover will not be restrictive to the design.

For the trench, Jim will send a hard copy of the drawing to both you and I tomorrow morning. The drawing will help us understand where the trench is entering the building and cutting through the perimeter foundation. We don't need to design the whole thing for now just how it affects/cuts-through our slab. Some of the information you were asking for such as loading condition on top of trench cover, pipe trench cover elevation, and length of pipe trench are not known right now. The profile and alignment have not been done yet.

Dimensions for the support facility are Length (N-S) is 88' - 6 3/4", Width (E-W) is 28' - 6 3/4", Height is 10', and concrete floor elevation is 9.5' NGVD. The SE end of the support facility matches up to the SW corner of the dewatering facility.

I hope this helps

Lucine Toroyan - Coastal Engineer
Foster Wheeler
5300 Broken Sound Blvd., Suite 110
Boca Raton, FL 33487
561-237-1853 Phone
561-237-1890 Fax

Lucine Toroyan
04/09/2002 12:48 PM

To: Jeff Zhao/Houston/FWENC@FWENC
cc: Andrew Tognon/Boston/FWENC@FWENC, Dan Maher/Boston/FWENC@FWENC, Mark Otten/Boston/FWENC@FWENC, James Brinkman/Boston/FWENC@FWENC
Subject: Re: Flood Plain Elevation

Jeff,

Jim and Dan confirmed floor elevations, and they are as follows:

9' NGVD 29 for process area, loadout area, and rail area
9.5' for the support facility attached to building

Lucine Toroyan - Coastal Engineer
Foster Wheeler
5300 Broken Sound Blvd., Suite 110
Boca Raton, FL 33487
561-237-1853 Phone
561-237-1890 Fax
Jeff Zhao

Jeff Zhao
04/09/2002 11:42 AM

To: Andrew Tognon/Boston/FWENC@FWENC
cc: Lucine Toroyan/Boca Raton/FWENC@FWENC, Dan Maher/Boston/FWENC@FWENC, Mark Otten/Boston/FWENC@FWENC
Subject: Re: Flood Plain Elevation

Please confirm that:
(1) the project elevation zero is equal to NGVD 29 zero.
(2) the floor general elevation is +10 ft at equipment & loading area.

Regards,

Jeff Zhao, PE
Foster Wheeler Environmental Corp.
1001 South Dairy Ashford, Suite 210
Houston, TX 77077
Tel: 281-597-4829
Fax: 281-596-0308
Email: jzhao@fwenc.com
Andrew Tognon

Andrew Tognon
03/27/2002 03:37 PM

To: Jeff Zhao/Houston/FWENC@FWENC
cc:
Subject: Flood Plain Elevation

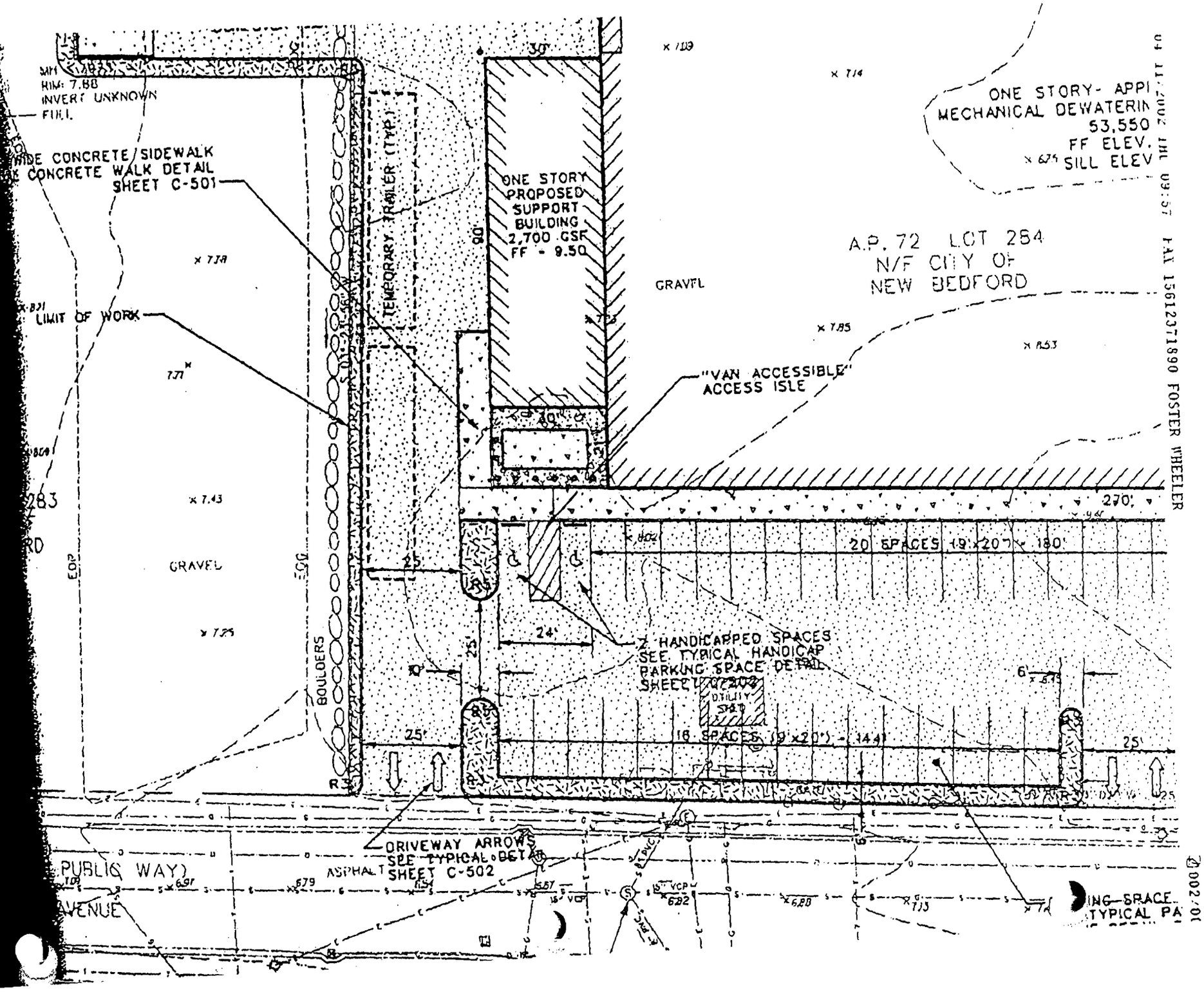
Jeff,
Spoke to Mark about the flood plain elevation it is 6 ft NGVD29
For a reference you can cite the Design Drawings - Sheet C-101 : Exisiting Conditions Plan
NOTE #4. THE SUBJECT PREMISES ARE LOCATED IN FLOOD ZONE "A" BEING ELEVATION 6.0

NGVD29 COMMUNITY NUMBER 255216 0009 B, REVISED JANUARY 05, 1984.

I didn't have a chance to ask about the subgrade modulus, and will keep you updated

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Andrew Tognon, MESc
Foster Wheeler Corp.
133 Federal St.
Boston, MA, 02110
Tel: (617) 457-8410
Fax: (617) 457-8498


RIM: 7.88
INVERT UNKNOWN
FILL
WIDE CONCRETE SIDEWALK
CONCRETE WALK DETAIL
SHEET C-501
LIMIT OF WORK
TEMPORARY TRAILER (TYP.)
ONE STORY
PROPOSED
SUPPORT
BUILDING
2,700 GSF
FF - 9.50
GRAVEL
A.P. 72 LOT 284
N/F CITY OF
NEW BEDFORD
ONE STORY- APPI
MECHANICAL DEWATERIN
53,550
FF ELEV.
SILL ELEV
"VAN ACCESSIBLE"
ACCESS ISLE
270'
20 SPACES (9'x20') = 180'
2 HANDICAPPED SPACES
SEE TYPICAL HANDICAP
PARKING SPACE DETAIL
SHEET C-502
16 SPACES (9'x20') = 144'
BOULDERS
DRIVEWAY ARROWS
SEE TYPICAL DETAIL
SHEET C-502
ASPHALT
PUBLIC WAY
AVENUE

Process Area (Mat 1)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JZ DATE 4/2/02 SHEET 15 OF

CHKD. BY DATE OFS NO. DEPT. NO.

CLIENT

PROJECT NEW BEDFORD – DEWATERING

SUBJECT LOADS AT EQUIPMENT AREA (MAT 1)

1. DEAD LOADS

(1) SLAB SELF WEIGHT (CASE A)

(2) PRESS:

1.75 KIP/LF ON TWO 60 FT SKID (LINE LOAD)
FOR PCA-MATS INPUT (ON A 5'×5' MESH)
1.75 × 5' = 8.75 KIP / NODE

(3) SLURRY CONDITIONING TANKS:
588 PSF, USE 600 PSF

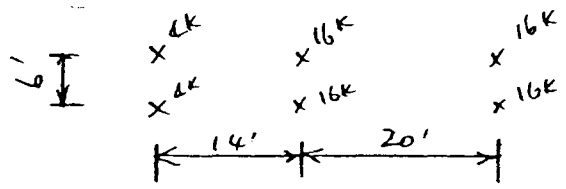
(4) SLURRY EQUALIZATION TANKS:
560 PSF, USE 600 PSF

CASE E

2. LIVE LOADS

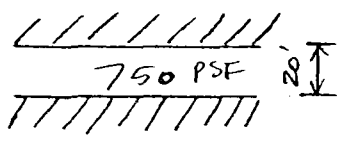
(1) 750 PSF DISTRIBUTION LOAD PER CITY REQUIREMENT.
– USED ONLY FOR SOIL PRESSURE CHECK.
(CASE B)

(2) CONSTRUCTION LOAD — DURING EQ INSTALLATION
USE HS20-44 TRUCK
(CASE C)

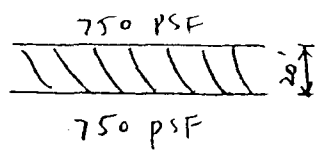


(3) 20' AISLE LOAD. (CASE D)

(a)



(b)



3. SEISMIC LOADS

PER BOSTON, THERE ARE NO ANCHOR BOLTS ON EQ BASES/SKIDS THEREFORE, ASSUME SEISMIC LOADING DOES NOT CONTROL.

LOAD COMBINATIONS:

1. DEWATERING USAGE

$S_1 = A + E$ $\quad U_1 = 1.4A + 1.4E$

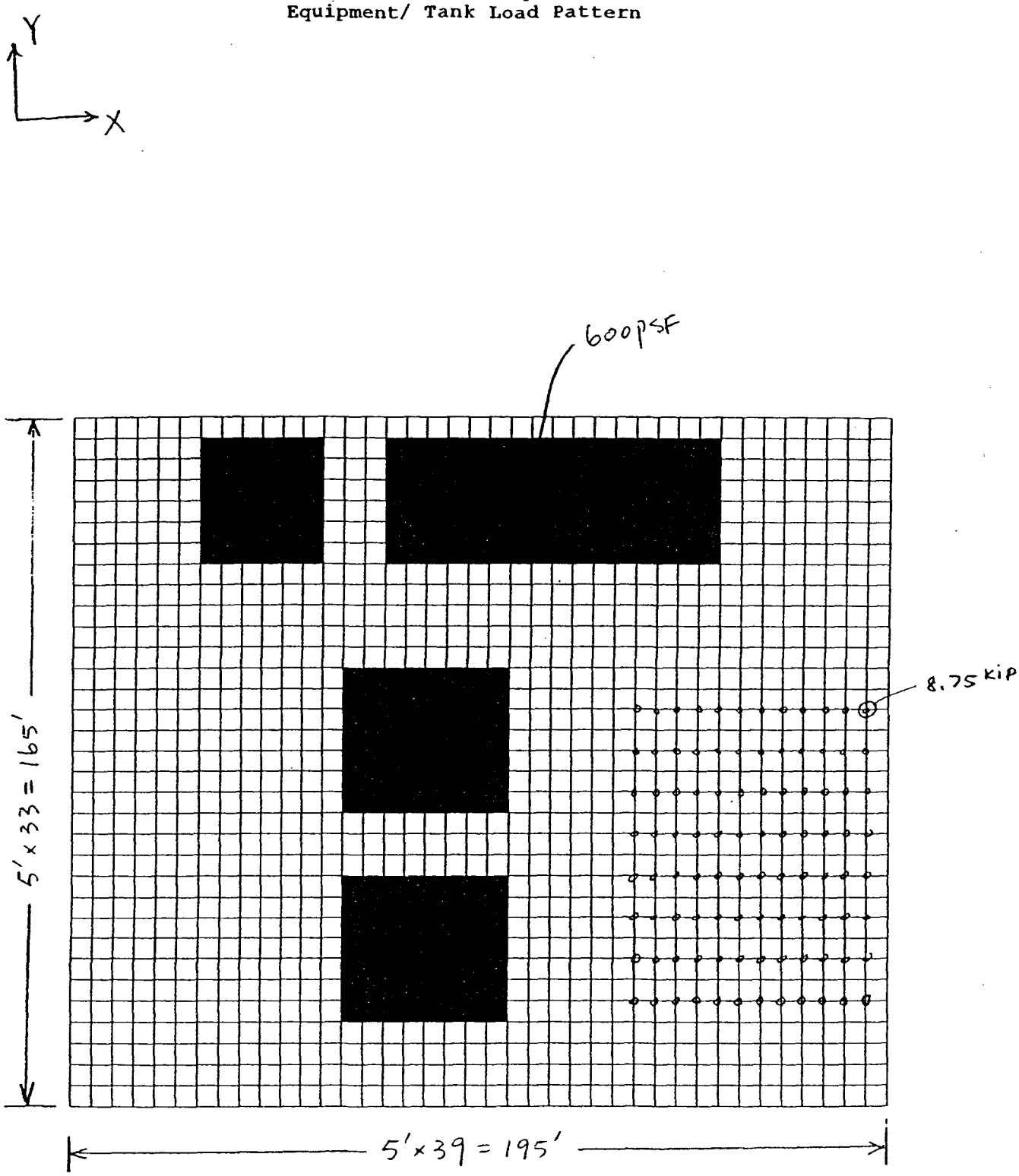
$S_2 = A + C$ $\quad U_2 = 1.4A + 1.7C$

2. FUTURE USE (MARINE CARGO TERMINAL)

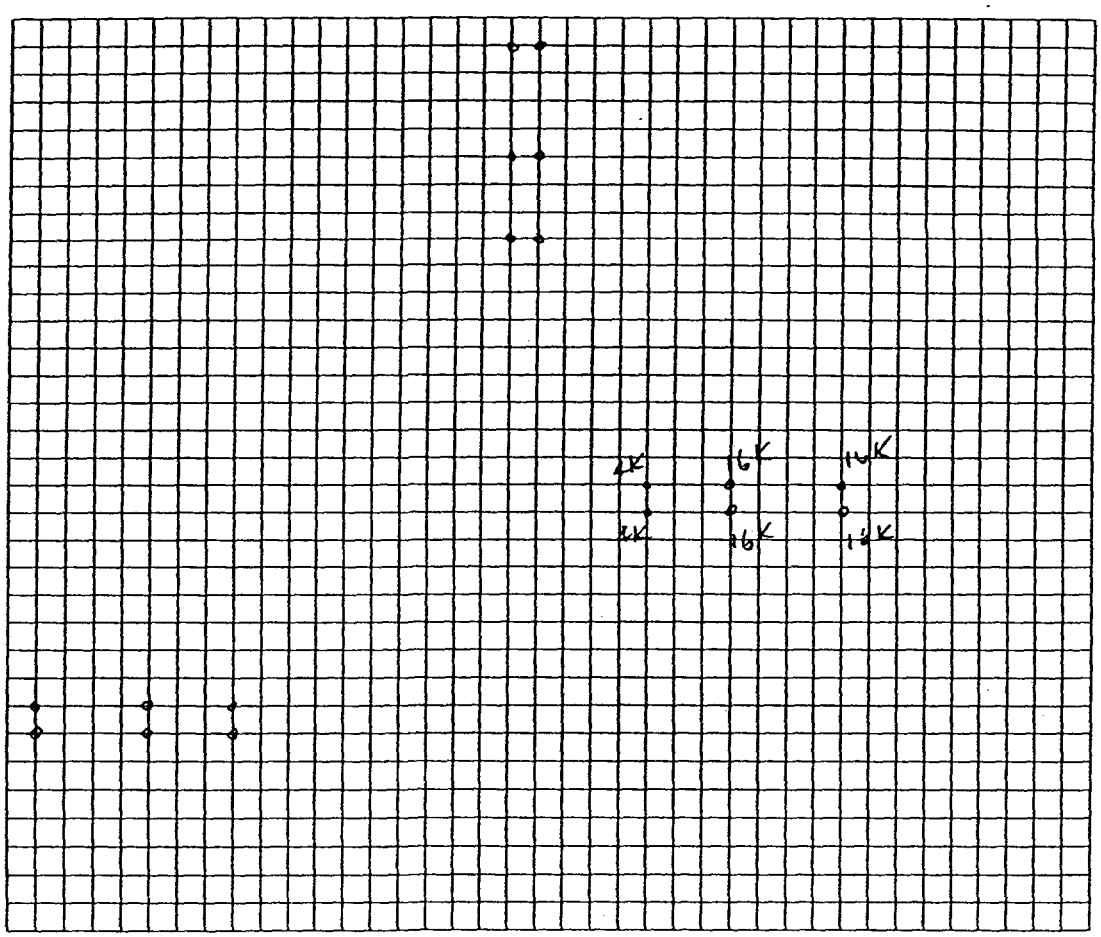
$S_3 = A + B$ $\quad U_3 = 1.4A + 1.7B$

$S_4 = A + D$ $\quad U_4 = 1.4A + 1.7D$

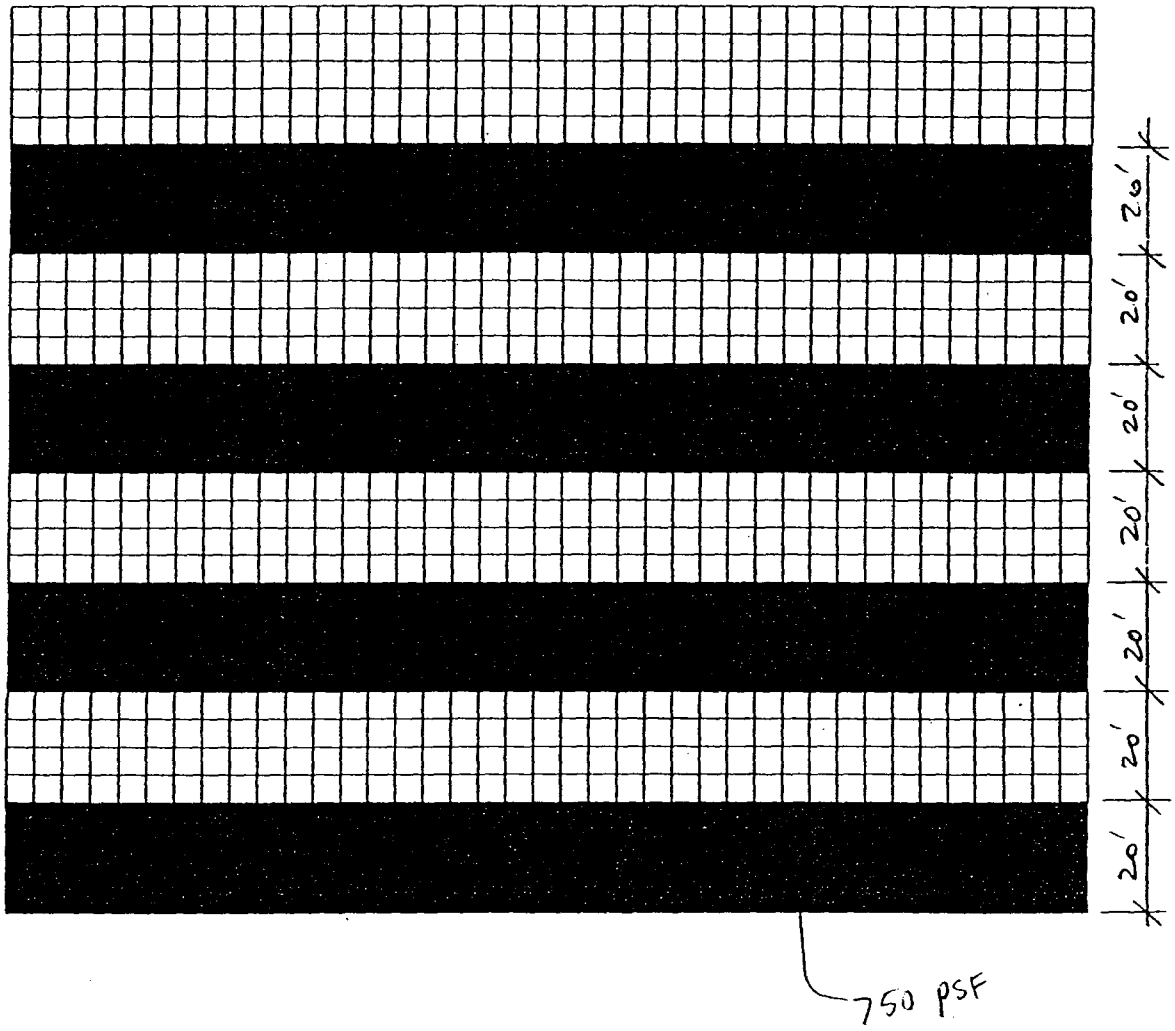
New Bedford - Dewatering Foundation 1
Equipment/ Tank Load Pattern



New Bedford - Dewatering Foundation 1
Construction Truck Load Pattern



New Bedford - Dewatering Foundation 1
Aisle Load Pattern



A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering Foundation 1
Engineer: JZ
File : C:\PROJECTS\NEWBED~1\DEWATER\100%SUB\MAT1%.MAT
Units : English Date : 01/04/02
Code : ACI 318-99 Time : 09:44:36

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 75.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 1360
Number of elements = 1287

A2 - THICKNESS DEFINITIONS:

Label	t (in)
thick1	10.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc-1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
soil-1	50	4

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel-1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP-1	2.7500	3.0000	2.7500	3.0000	0.1800 %

A9 - NODAL LOAD DEFINITIONS:

Label	Case	Pz (kip)	Mx (kip-ft)	My (kip-ft)
truck1	C	-4	0	0
truck2	C	-16	0	0
press	E	-8.75	0	0

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
dummy	A	-0.1
750psf	B	-750
aisle	D	-750
equip	E	-600

A11 - LOAD COMBINATIONS:

Self weight is included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	0.000	0.000	0.000	1.000	0.000	Ser.	Yes
S2	1.000	0.000	1.000	0.000	0.000	0.000	Ser.	Yes
S3	1.000	1.000	0.000	0.000	0.000	0.000	Ser.	Yes
S4	1.000	0.000	0.000	1.000	0.000	0.000	Ser.	Yes
U1	1.400	0.000	0.000	0.000	1.400	0.000	Ult.	Yes
U2	1.400	0.000	1.700	0.000	0.000	0.000	Ult.	Yes
U3	1.400	1.700	0.000	0.000	0.000	0.000	Ult.	Yes
U4	1.400	0.000	0.000	1.700	0.000	0.000	Ult.	Yes

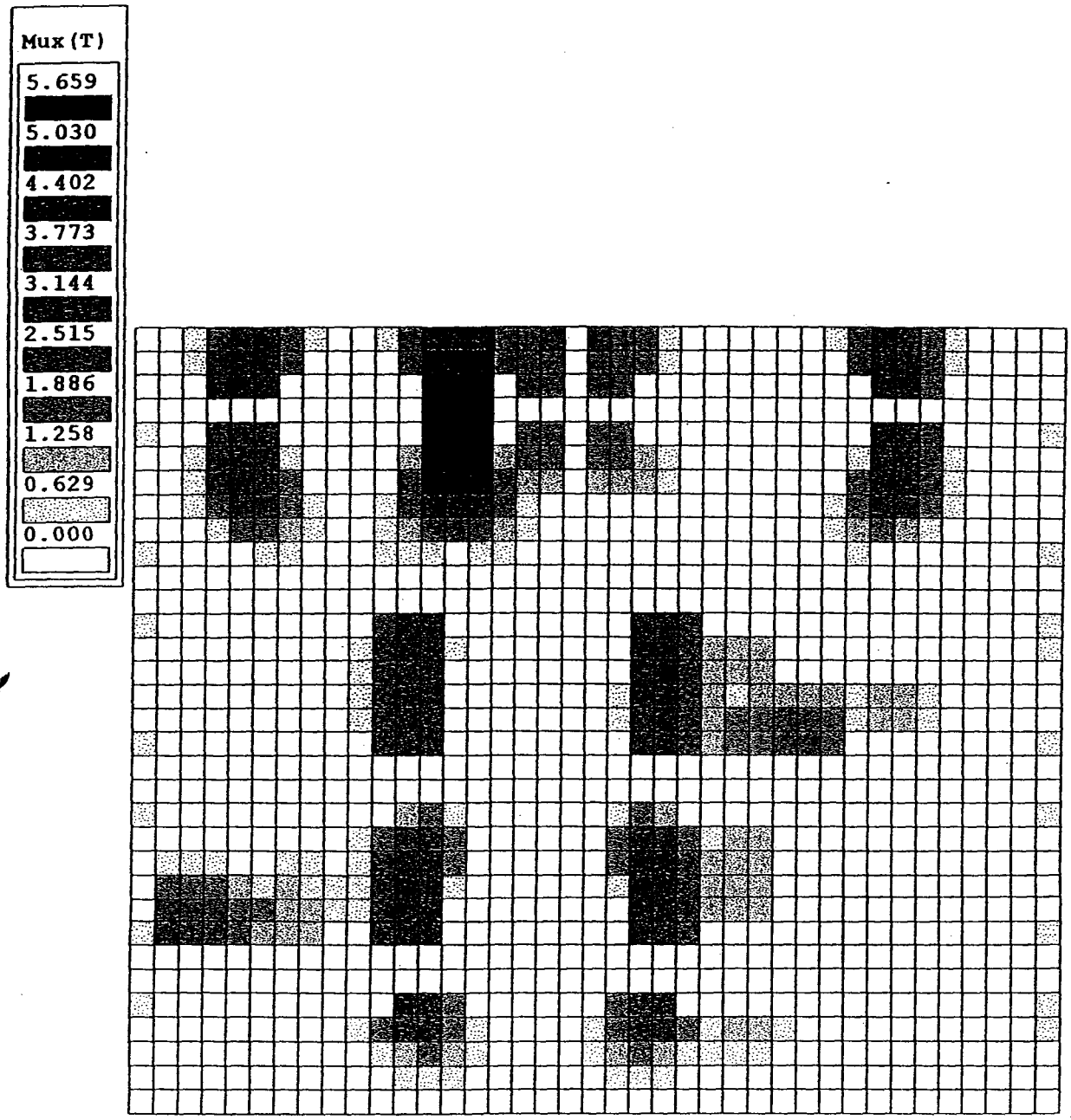
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	5	3	10
4	15	5	20	6	25
7	30	8	35	9	40
10	45	11	50	12	55
13	60	14	65	15	70
16	75	17	80	18	85
19	90	20	95	21	100
22	105	23	110	24	115
25	120	26	125	27	130
28	135	29	140	30	145
31	150	32	155	33	160
34	165	35	170	36	175
37	180	38	185	39	190
40	195				

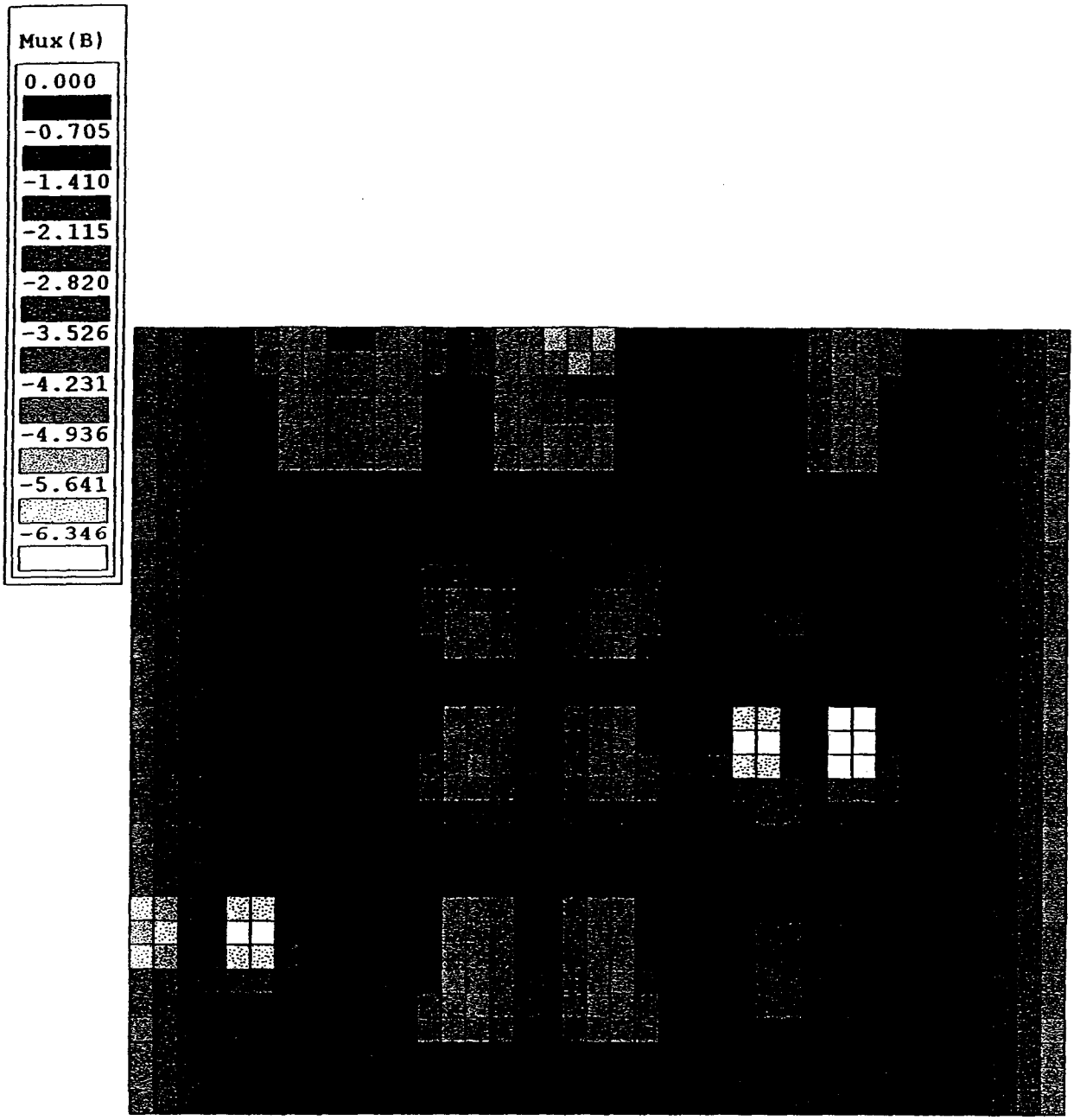
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	5	3	10
4	15	5	20	6	25
7	30	8	35	9	40
10	45	11	50	12	55
13	60	14	65	15	70
16	75	17	80	18	85
19	90	20	95	21	100
22	105	23	110	24	115
25	120	26	125	27	130
28	135	29	140	30	145
31	150	32	155	33	160
34	165				

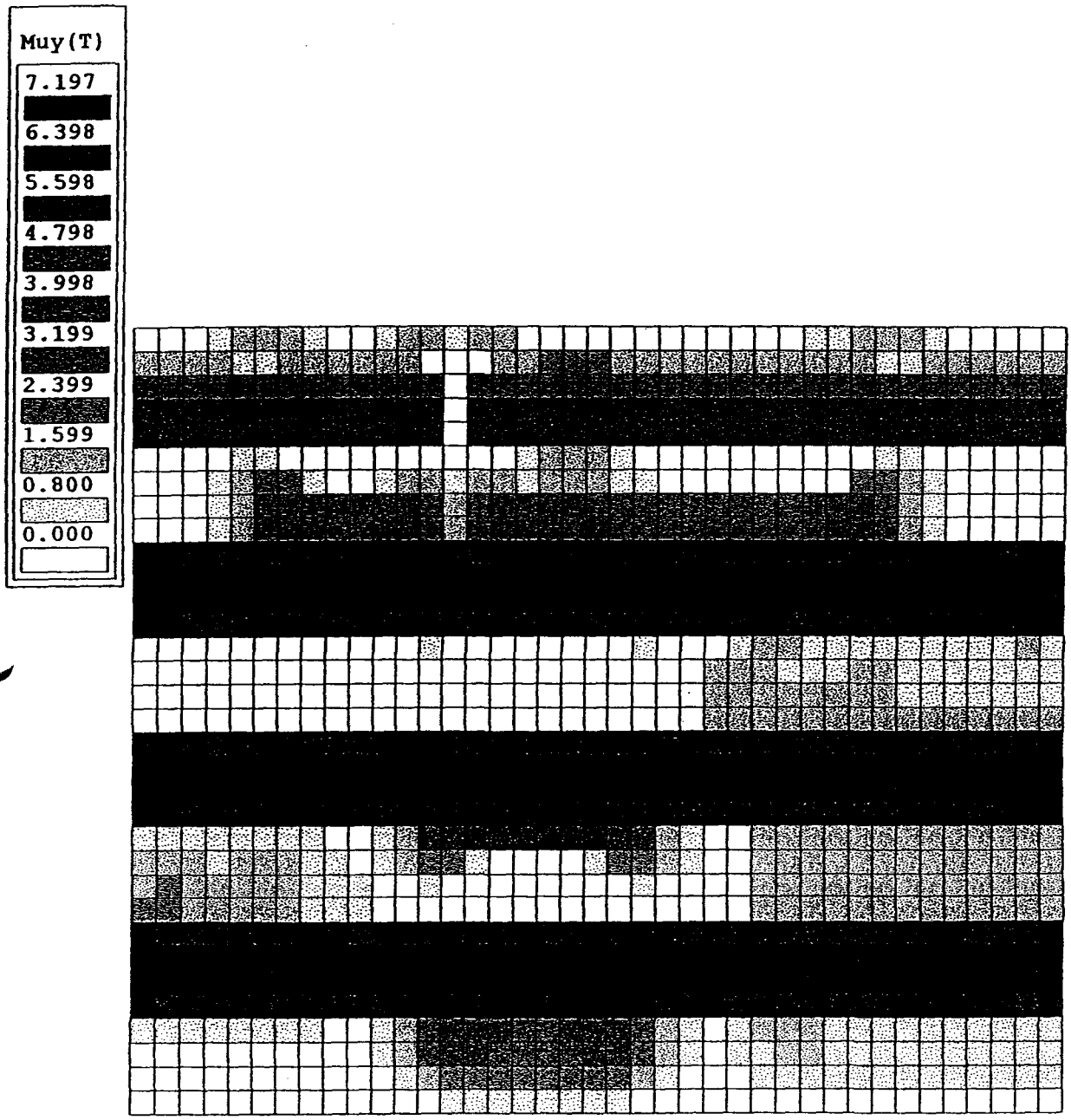
New Bedford - Dewatering Foundation 1
Maximum Moments (kip-ft/ft)



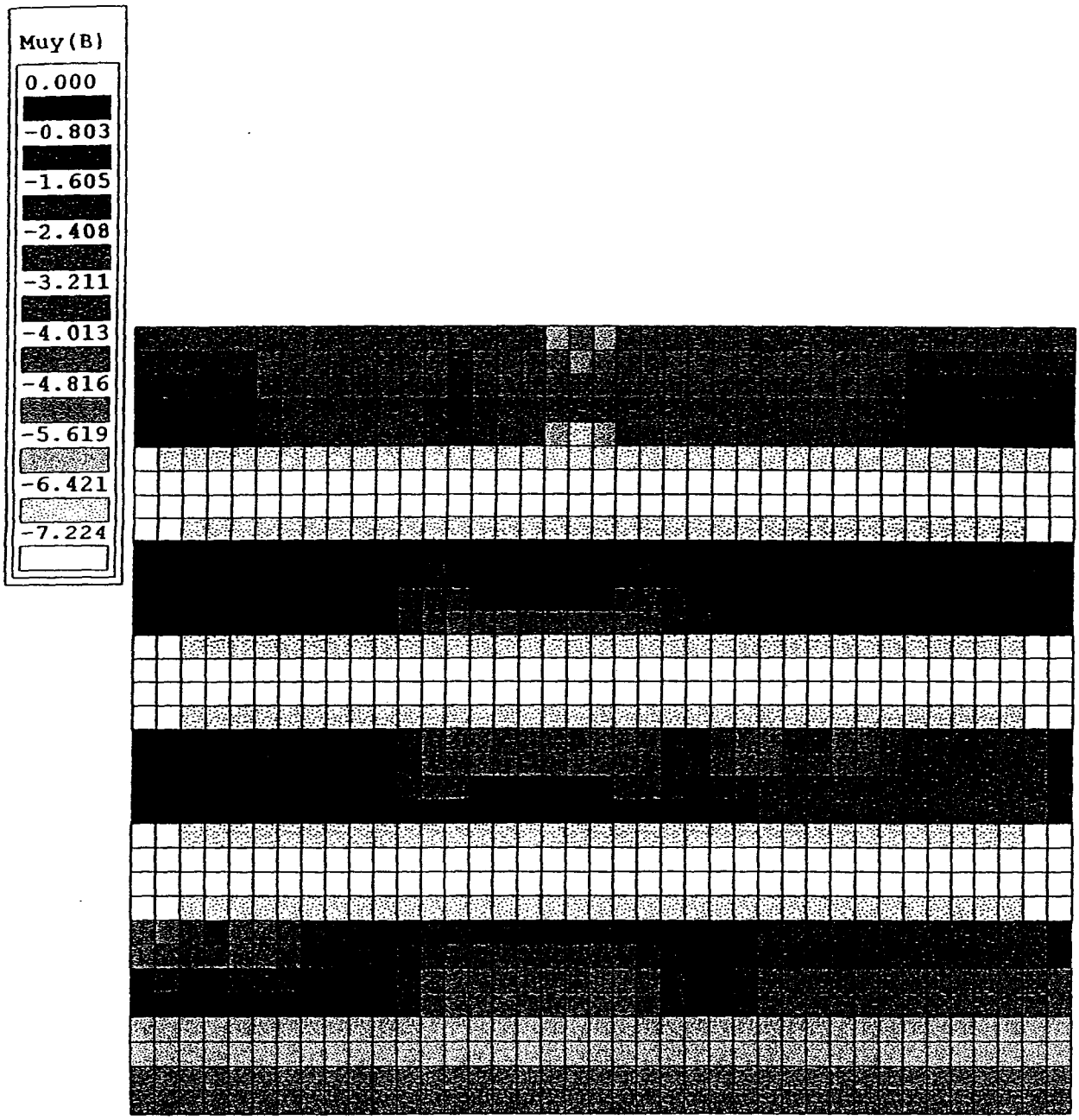
New Bedford - Dewatering Foundation 1
Maximum Moments (kip-ft/ft)



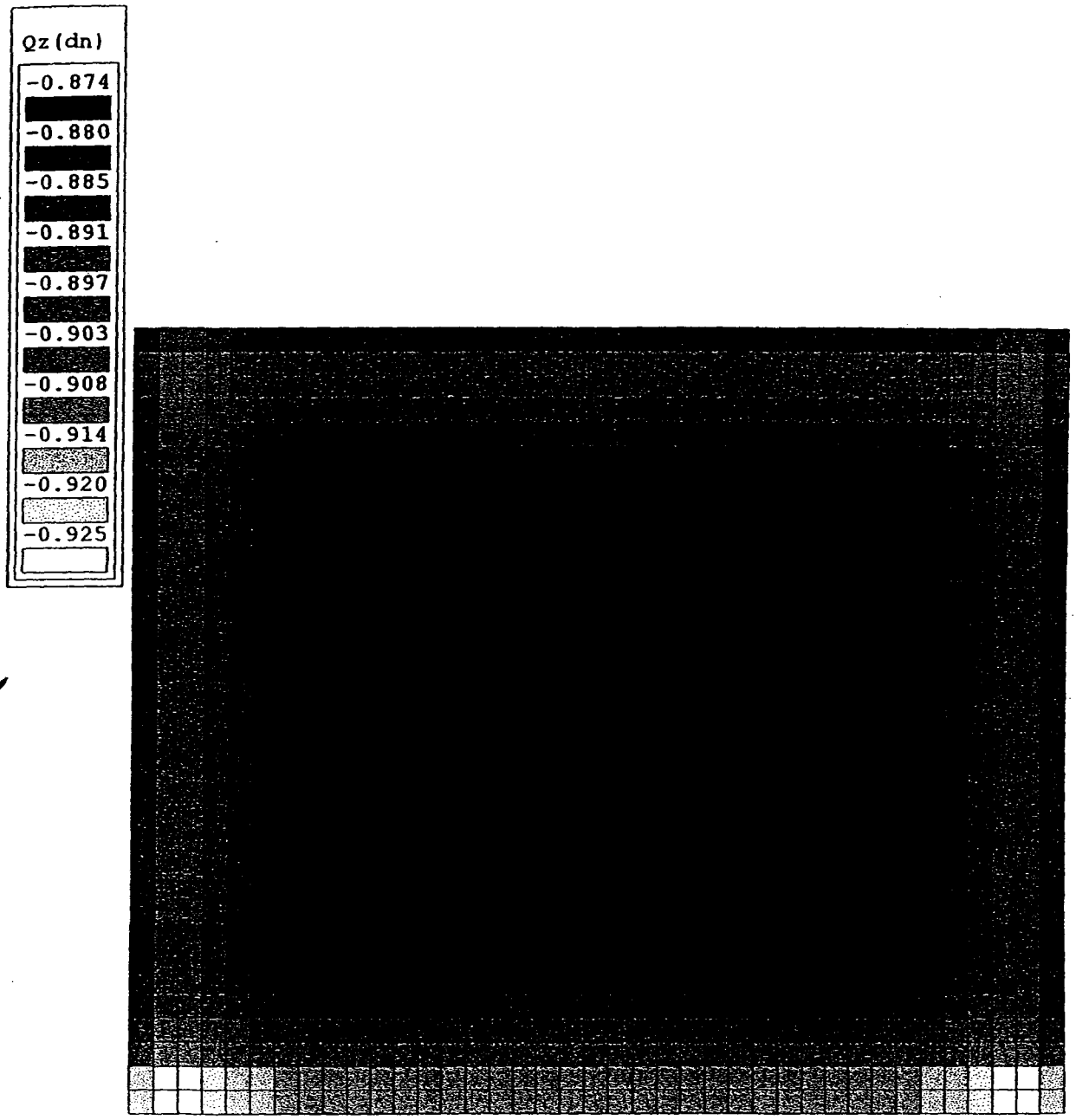
New Bedford - Dewatering Foundation 1
Maximum Moments (kip-ft/ft)



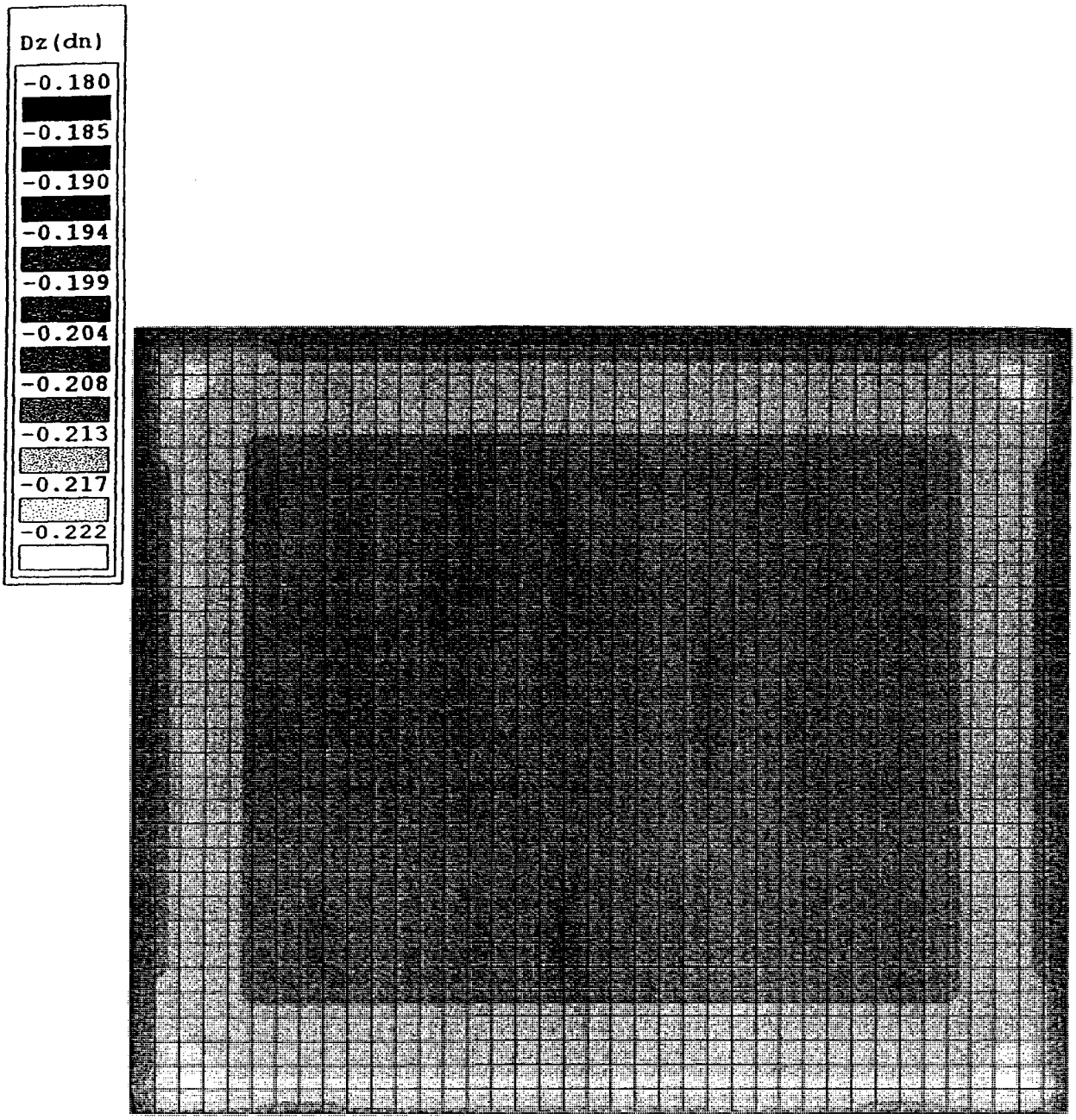
New Bedford - Dewatering Foundation 1
Maximum Moments (kip-ft/ft)



New Bedford - Dewatering Foundation 1
Pressure (ksf)



New Bedford - Dewatering Foundation 1
Displacement (in.)



FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	3-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Mat1	Date:	
	Mu.design	Page	of

Exposure: (●) Interior ( ) Exterior

Member: ( ) Beam (●) Slab

Bar Size: ( ) #3 ( ) #4 (●) #5 ( ) #6 ( ) #7 ( ) #8 ( ) #9 ( ) #10 ( ) #11 ( ) #14 ( ) #18

Stirrup Size: (●) None ( ) #3 ( ) #4 ( ) #5 ( ) #6 ( ) #7 ( ) #8 ( ) #9 ( ) #10 ( ) #11 ( ) #14 ( ) #18

Factored Moment =	7.3 kips*ft		
Average Load Factor =	1.55		
Service Moment =	57 kips*in		
Bar Spacing =	12 in		
Width, b =	12 in		
Slab Thickness=	10 in		
cover =	3.00 in	Bar Area =	0.31 in^2
f'c =	4000 psi	Bar Diameter =	0.625 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	6.6875 in
ϕ =	0.9	#Bars =	1
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.31 in^2

#5 @ 12 in. spacing

Moment Check

w =	0.04662		
ρ =	0.003108		
$A_{srequired}$ =	0.249415 in^2	ok	
β =	0.85		
ρ_b =	0.028507		
ρ_{max} =	0.02138		
A_{max} =	1.715753 in^2	ok	
(ACI 10.5.3) ρ_{min} =	0.003333		
A_{min} =	0.2675 in^2		
$4/3*A_{srequired}$ =	0.332553 in^2	ok	

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.3125 in	
A=	79.5 in^2	
NA =	1.472273 mm	
f_s =	29.42031 ksi	
z=	188.5768 kips/in	
Required =	155.5556 kips/in	no good

Bar spacing < two times the slab thickness

ACI-350 Check

Z =	115 kips/in		no good
fs =	29.42031 ksi		
Max Spacing =	9.090469 in		no good
Actual -> ρ =	0.003863		

$w = 0.85 - (SQRT(.7225-)(1.7*M_{factored}/(\phi*f'_c*b*d^2)))$

$\rho = w*f'_c/f_y$

$A_{srequired} = \rho*b*d$

$\beta = 0.85-0.05(f'c-4000)/1000$

$\rho_b = 0.85*(\beta*(f'c/fy)*(87/(87+fy))$

$\rho_{max} = 0.75*\rho_b$

$A_{max} = \rho_{max}*b*d$

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

$A_{min} = \rho_{min}*b*d$

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

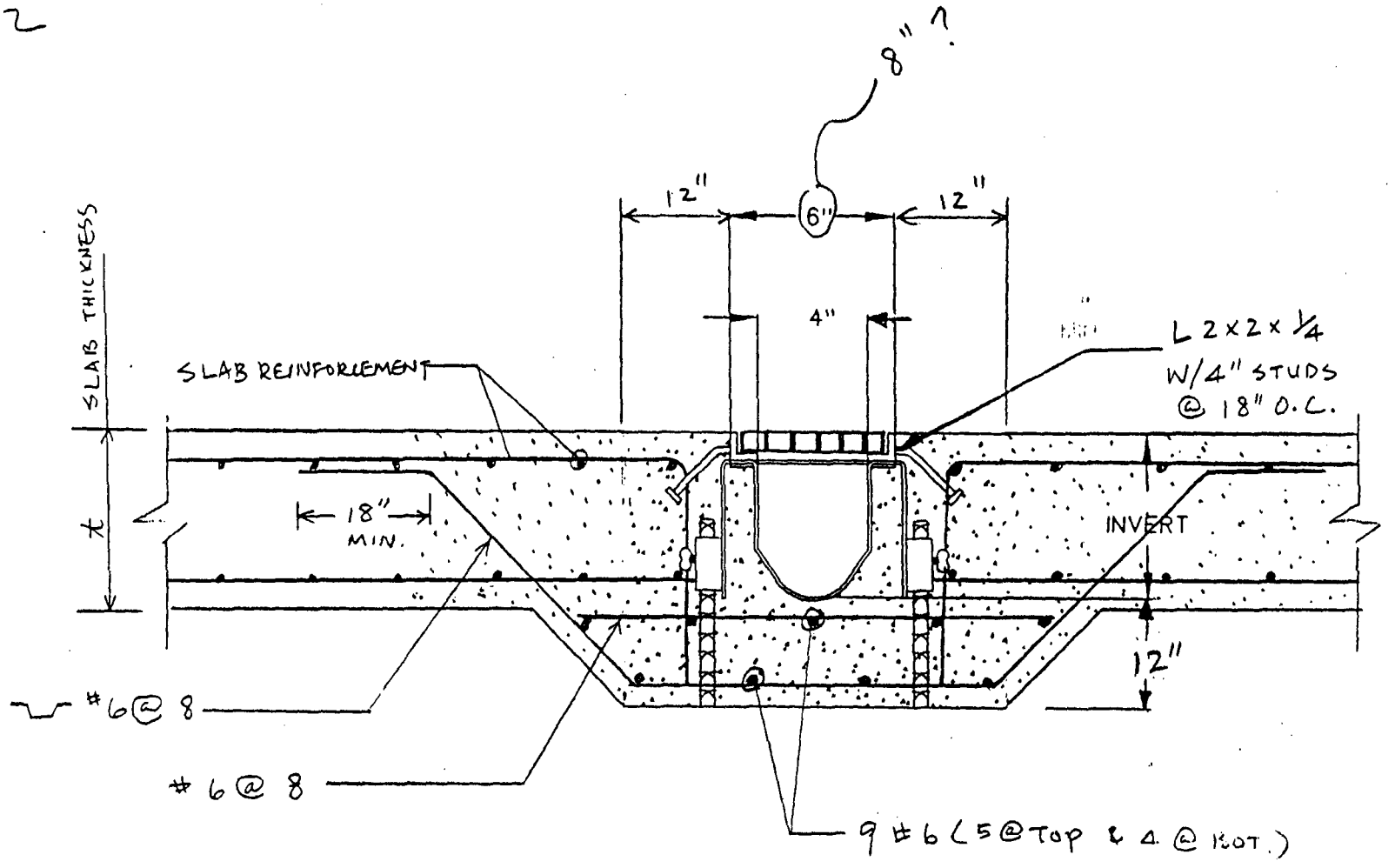
fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

fs*(dc*A)^(1/3) (ACI-318 10.6.4)

required = (175 or 145)*1.2/β

REPLACE J-J OF S-504 WITH THIS DETAIL

J.2 @ 4/9/02



TYPICAL REINFORCEMENT DETAIL AT FLOOR DRAIN

N.T.S.

30

Load-out Area (Mat 2)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JZ DATE 4/3/02 SHEET 31 OF

CHKD. BY DATE OFS NO. DEPT. NO.

CLIENT

PROJECT NEW BEDFORD - DEWATERING

SUBJECT LOADS AT LOADING AREA (MAT 2)

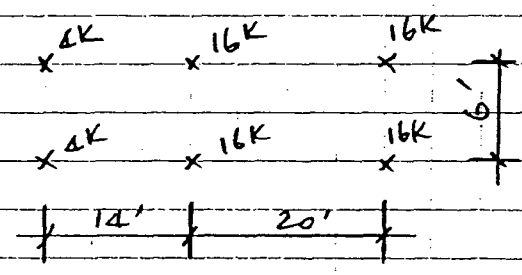
1. DEAD LOADS

(1) SLAB SELF WEIGHT (CASE A)

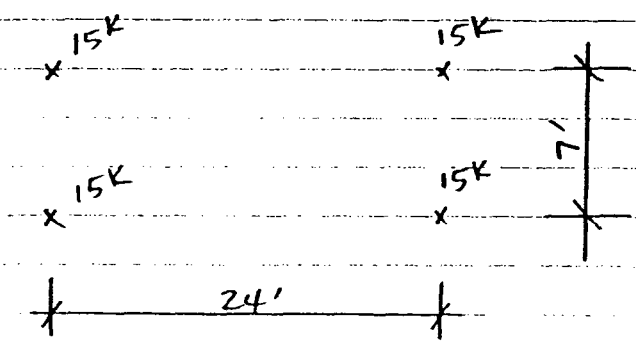
2. LIVE LOADS

DEWATERING OPERATION:

(1) HS 20-44 TRUCK (CASE B)



(2) FILTER CAKE STORAGE CONTAINER (30 ton) (CASE C)



(3) LIFT TRUCK - H700F HYSTER FORK TRUCK (CASE D)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

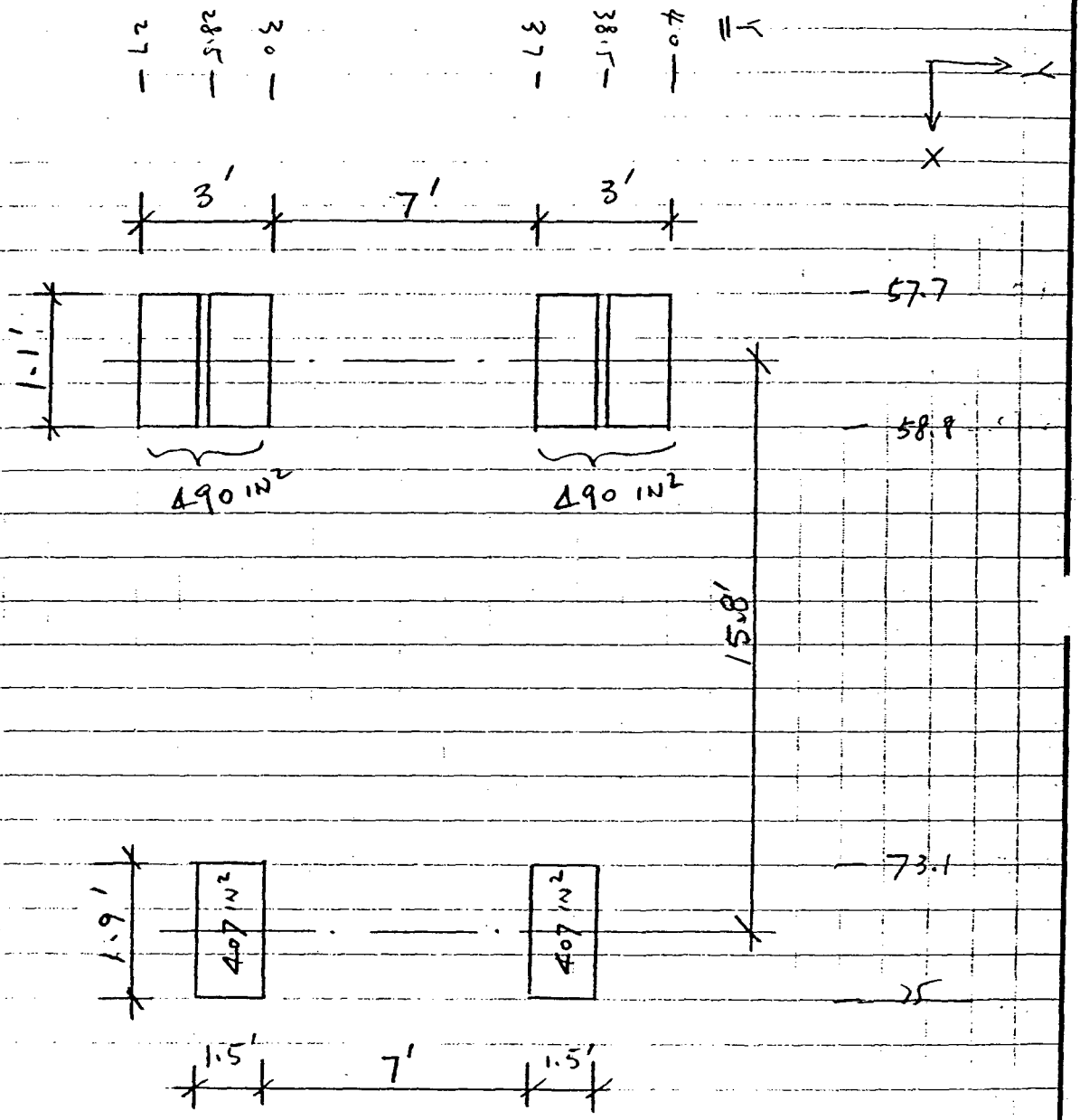
BY _____ DATE _____ SHEET 32 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT LOAD PATTERN OF H700F HYSTER FORK TRUCK



PER KEN MAKA OF HYSTER (815-468-2725), THE NEW GENERATION OF THE PNEUMATIC TIRE PRESSURE TO BE 140~145 PSI (USE 20880 PSF)

FRONT DUAL TIRES CONTACT AREA = $71^K / 145 psi$ = 490 IN^2

REAR TIRE CONTACT AREA = $59^K / 145 psi$ = 407 IN^2

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 33 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT _____

(4) FRONT END LOADER WITH 4 YD^3 BUCKET

DOES NOT CONTROL COMPARED WITH LIFT TRUCK

(5) FILTER CAKE STORAGE BINS (CASE E)

25 TONS STORAGE CAPACITY

ASSUME BIN SIZE 35' x 35' = 1225 SF

25 x 2000 / 1225 = 51 PSF

FUTURE USE. MARINE CARGO TERMINAL

(6) 20' AISLE LOAD (CASE F)

750 PSF

750 PSF

LOAD COMBINATIONS:

A) DEWATERING OPERATION

$S_1 = A + B$ $U_1 = 1.4A + 1.7B$

$S_2 = A + C$ $U_2 = 1.4A + 1.7C$

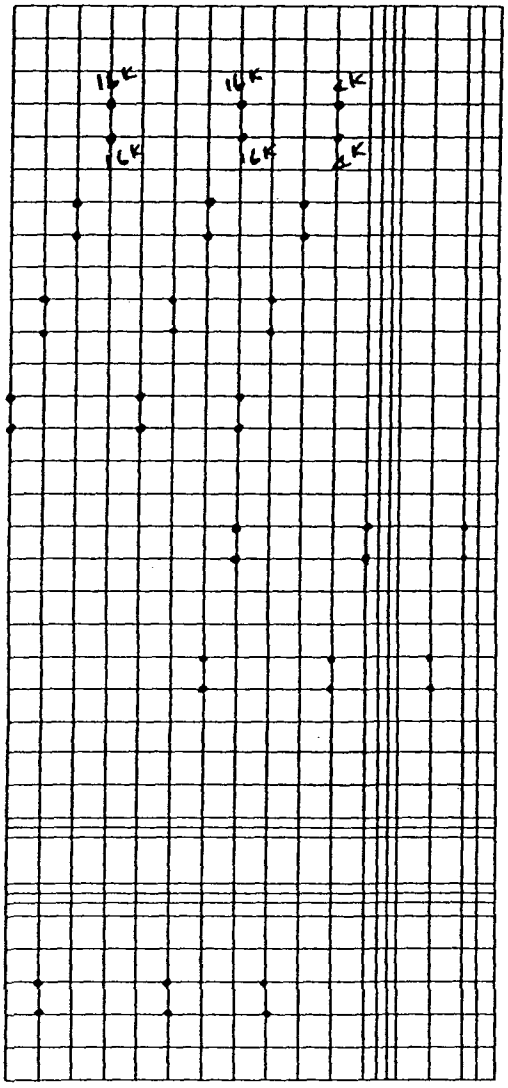
$S_3 = A + D$ $U_3 = 1.4A + 1.7D$

$S_4 = A + E$ $U_4 = 1.4A + 1.7E$

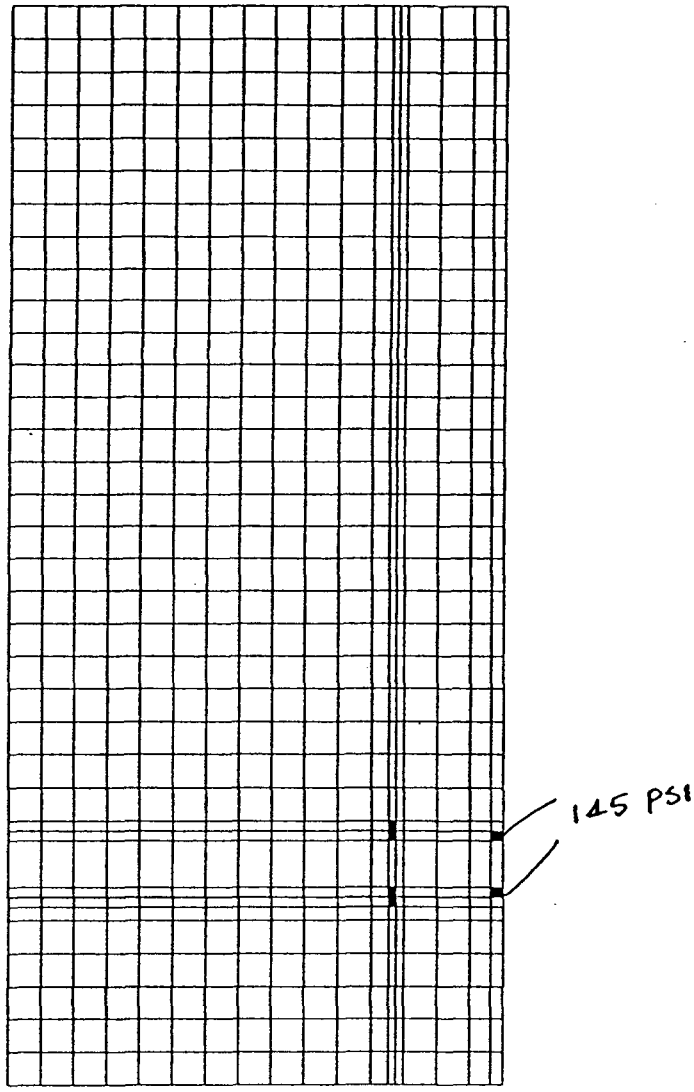
B) FUTURE USE - MARINE CARGO TERMINAL

$S_5 = A + F$ $U_5 = 1.4A + 1.7F$

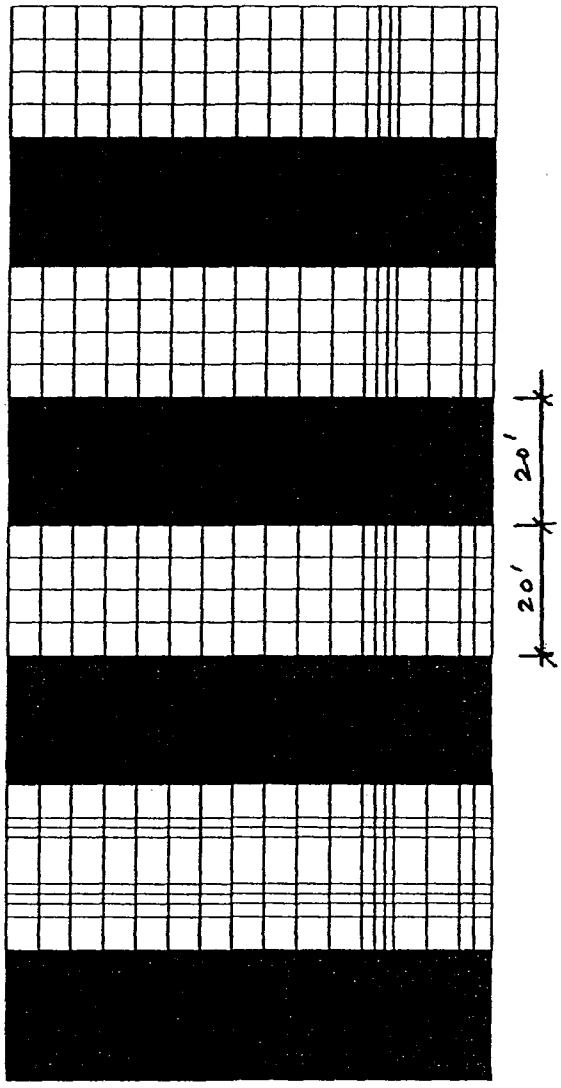
New Bedford - Dewatering Foundation 2
HS20-44 Truck Load Pattern



New Bedford - Dewatering Foundation 2
Lift Truck Load Pattern



New Bedford - Dewatering Foundation 2
Future Use - Aisle Load Pattern



A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering Foundation 2
Engineer: JZ
File : C:\PROJECTS\NEWBED~1\DEWATER\100%SUB\MAT2%.MAT
Units : English Date : 01/04/02
Code : ACI 318-99 Time : 10:46:47

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 75.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 703
Number of elements = 648

A2 - THICKNESS DEFINITIONS:

Label	t (in)
thick-1	12.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc-1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
soil-1	50	4

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel-1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP-1	2.7500	3.0000	2.7500	3.0000	0.1800 %

A9 - NODAL LOAD DEFINITIONS:

Label	Case	Pz (kip)	Mx (kip-ft)	My (kip-ft)
Truck-1	B	-4	0	0
Truck-2	B	-16	0	0
30tCont	C	-15	0	0

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
dummy	A	-0.1
liftT	D	-20880
cakebin	E	-51
aisle	F	-750

A11 - LOAD COMBINATIONS:

Self weight is included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	1.000	0.000	0.000	0.000	0.000	Ser.	Yes
S2	1.000	0.000	1.000	0.000	0.000	0.000	Ser.	Yes
S3	1.000	0.000	0.000	1.000	0.000	0.000	Ser.	Yes
S4	1.000	0.000	0.000	0.000	1.000	0.000	Ser.	Yes
S5	1.000	0.000	0.000	0.000	0.000	1.000	Ser.	Yes
U1	1.400	1.700	0.000	0.000	0.000	0.000	Ult.	Yes
U2	1.400	0.000	1.700	0.000	0.000	0.000	Ult.	Yes
U3	1.400	0.000	0.000	1.700	0.000	0.000	Ult.	Yes
U4	1.400	0.000	0.000	0.000	1.700	0.000	Ult.	Yes
U5	1.400	0.000	0.000	0.000	0.000	1.700	Ult.	Yes

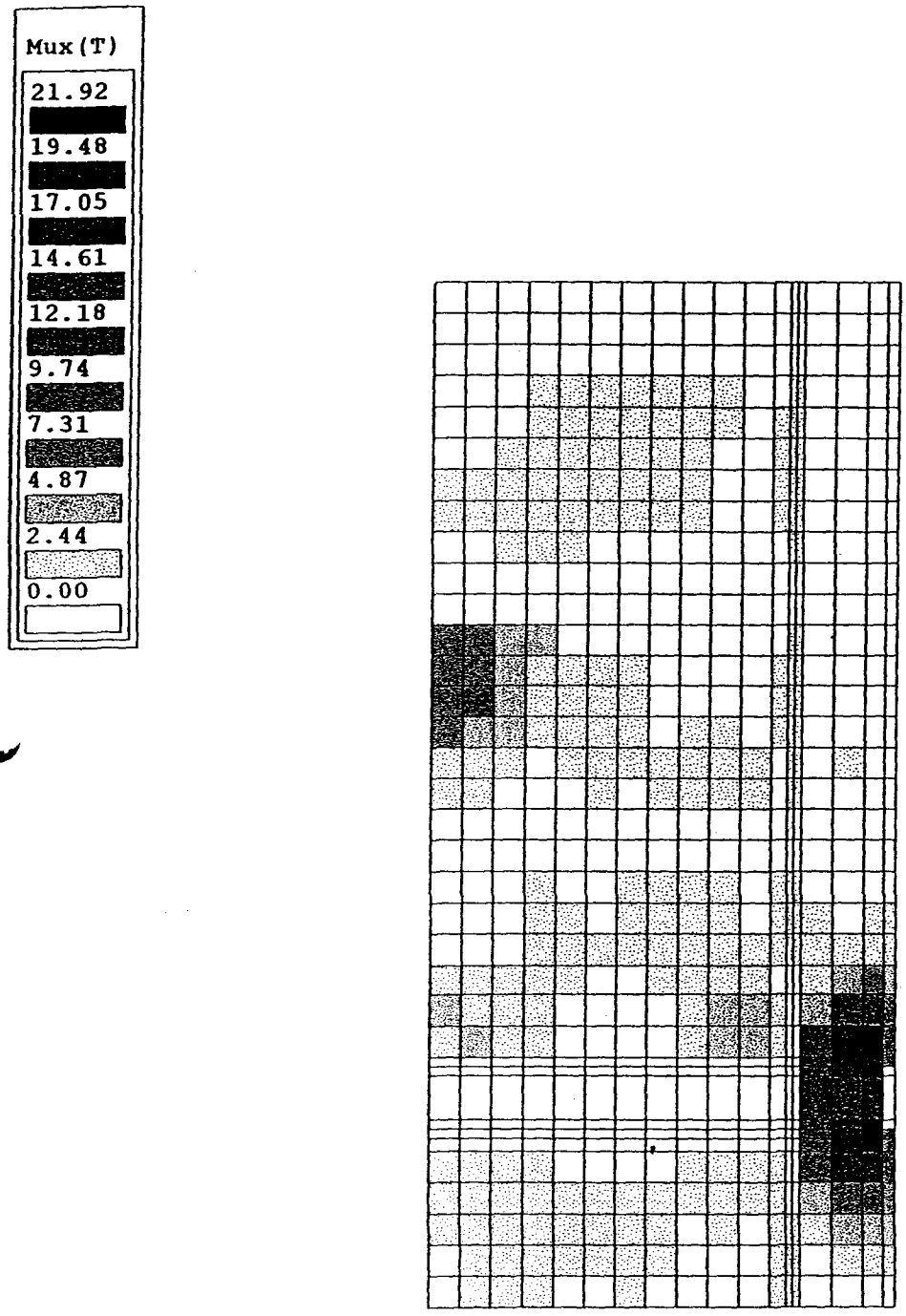
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	5	3	10
4	15	5	20	6	25
7	30	8	35	9	40
10	45	11	50	12	55
13	57.7	14	58.8	15	60
16	65	17	70	18	73.1
19	75				

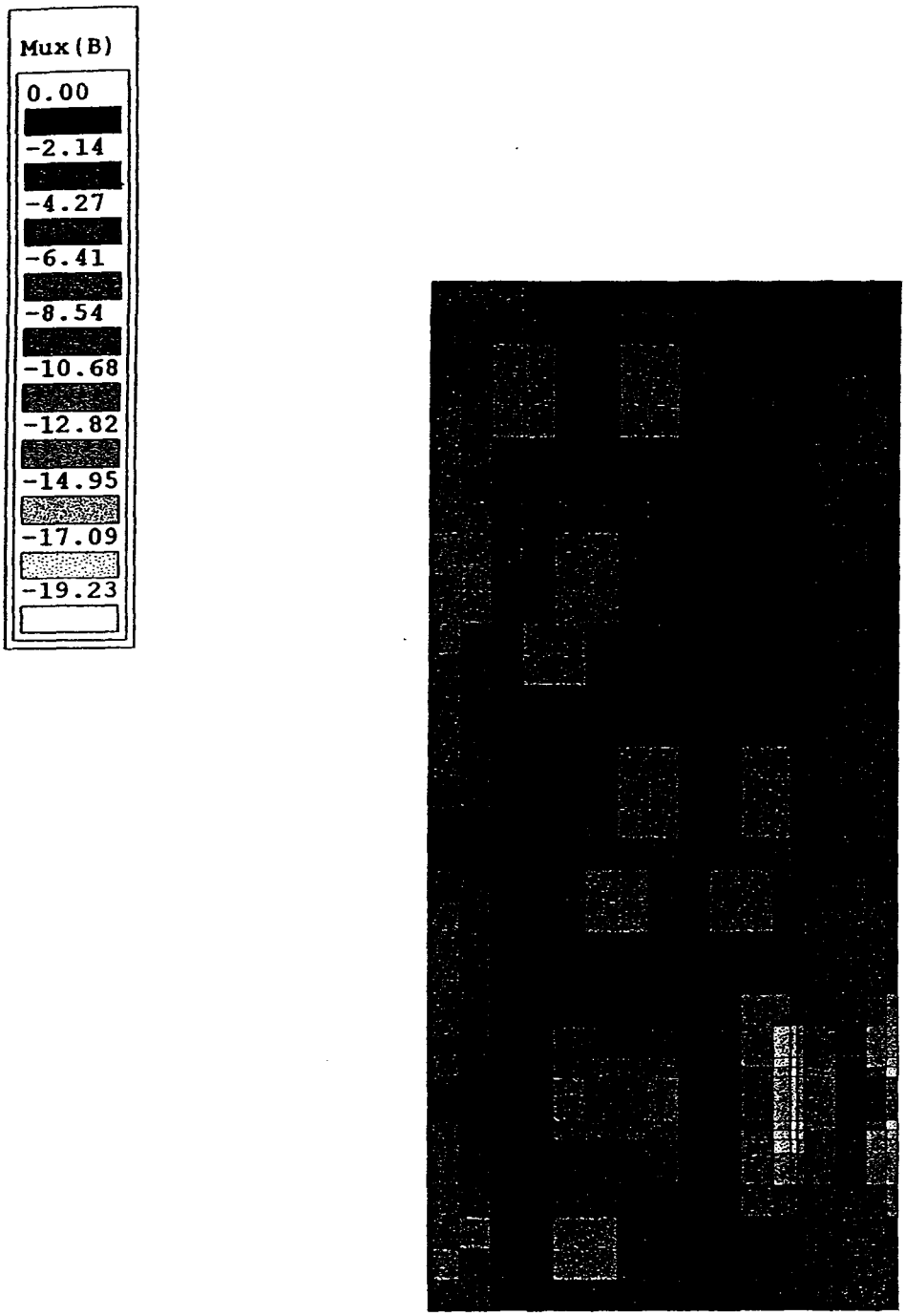
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	5	3	10
4	15	5	20	6	25
7	27	8	28.5	9	30
10	37	11	38.5	12	40
13	45	14	50	15	55
16	60	17	65	18	70
19	75	20	80	21	85
22	90	23	95	24	100
25	105	26	110	27	115
28	120	29	125	30	130
31	135	32	140	33	145
34	150	35	155	36	160
37	165				

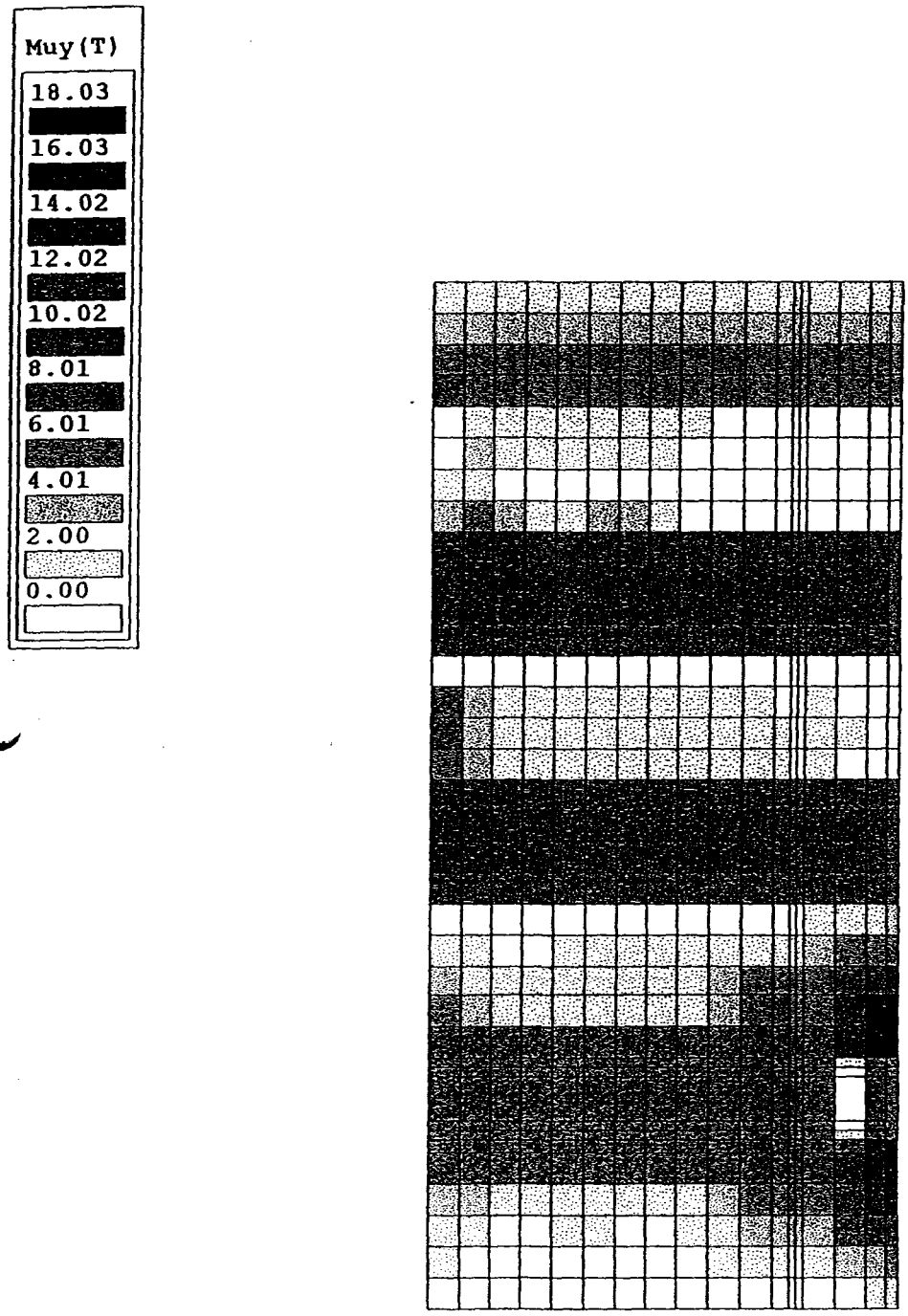
New Bedford - Dewatering Foundation 2
Maximum Moments (kip-ft/ft)



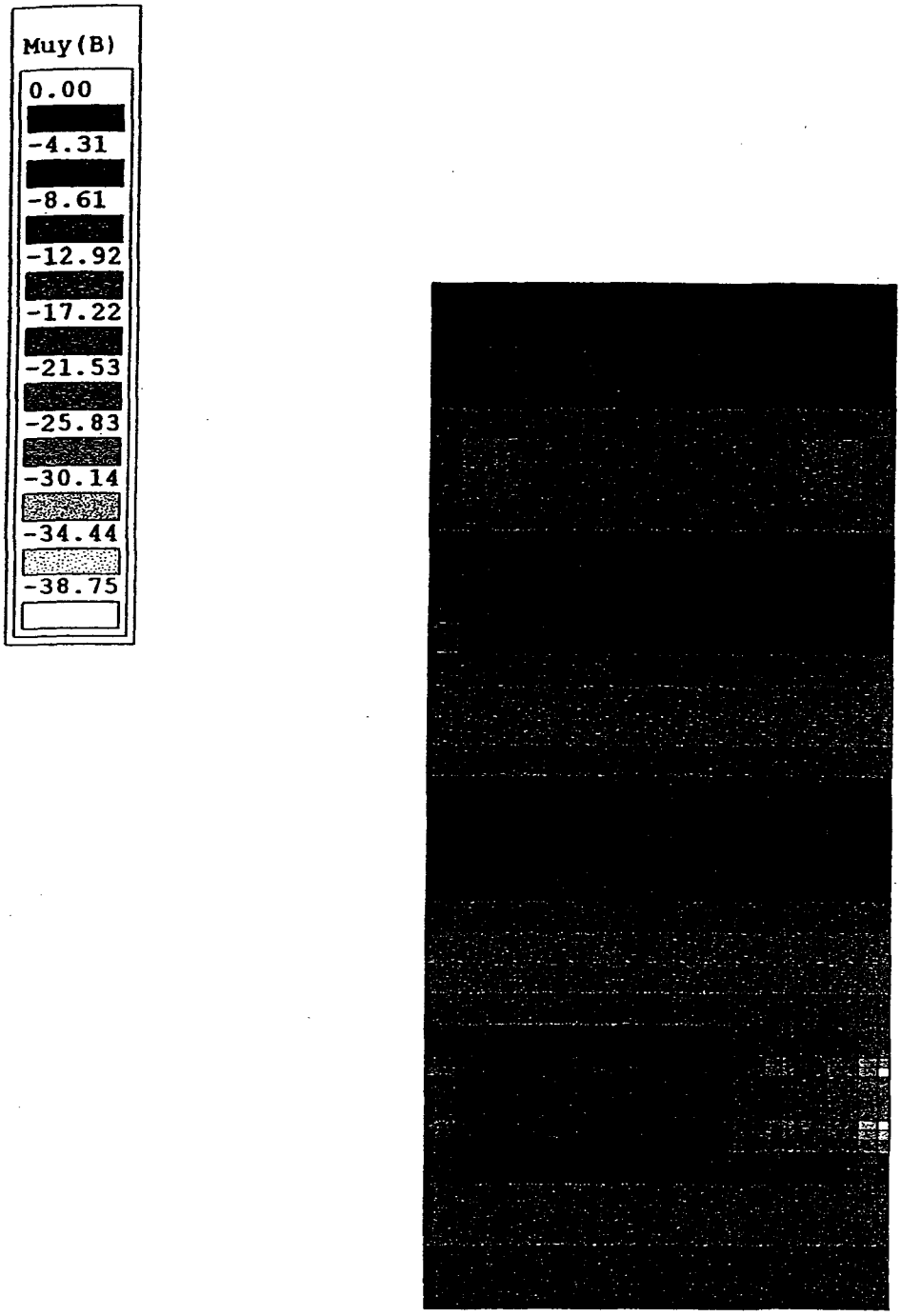
New Bedford - Dewatering Foundation 2
Maximum Moments (kip-ft/ft)



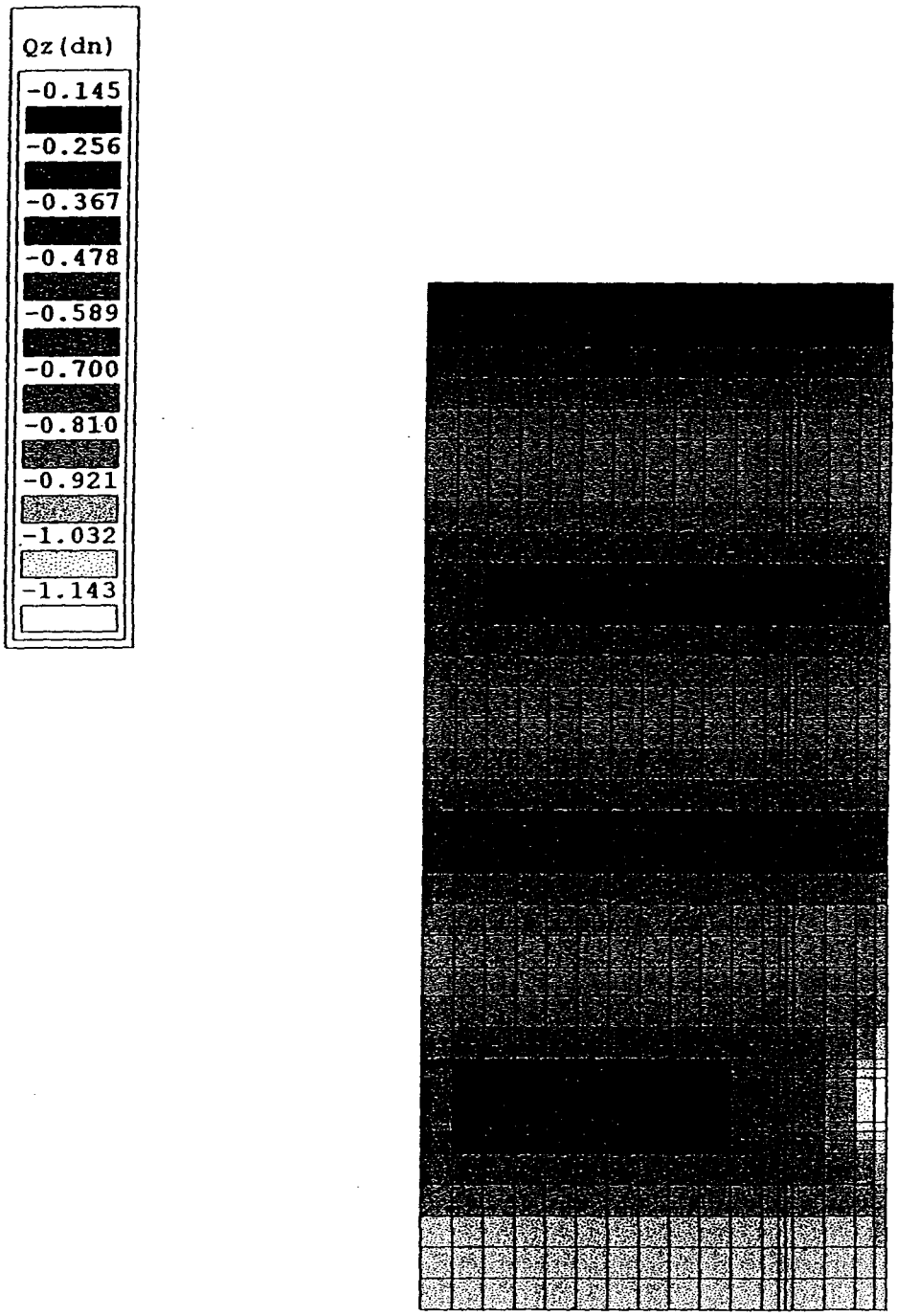
New Bedford - Dewatering Foundation 2
Maximum Moments (kip-ft/ft)



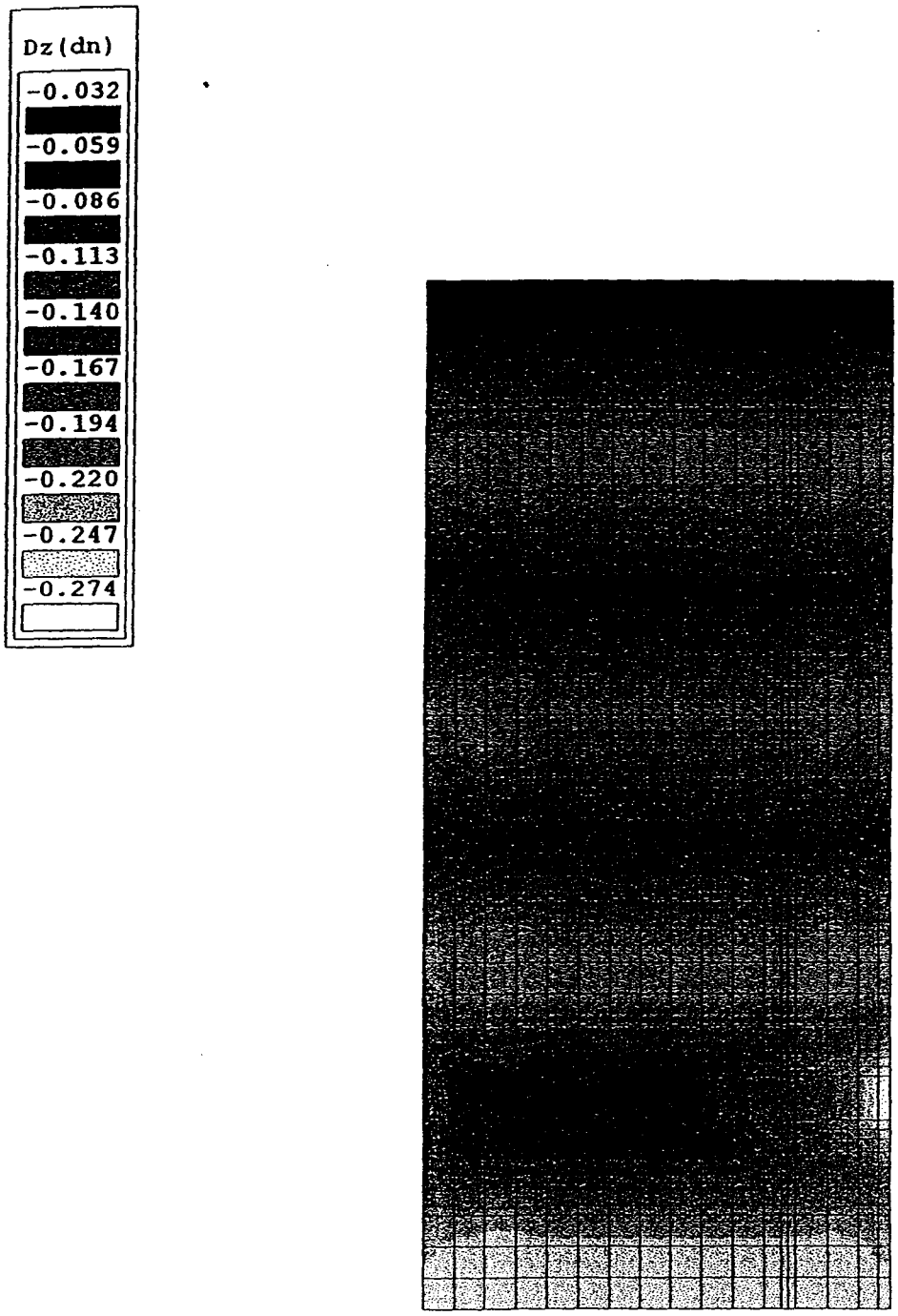
New Bedford - Dewatering Foundation 2
Maximum Moments (kip-ft/ft)



New Bedford - Dewatering Foundation 2
Pressure (ksf)



New Bedford - Dewatering Foundation 2
Displacement (in.)



FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	5-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Mat2	Date:	
	Mu.design (top)	Page	of

Exposure: ● Interior ○ Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	21.92 kips*ft		
Average Load Factor =	1.55		
Service Moment =	170 kips*in		
Bar Spacing =	10 in		
Width, b =	12 in		
Slab Thickness=	12 in		
cover =	2.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	9.625 in
ϕ =	0.9	#Bars =	1.2
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.528 in^2

#6 @ 10 in. spacing

Moment Check

	w =	0.068485	
	ρ =	0.004566	
	$A_{srequired}$ =	0.527333 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	2.469402 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.3850 in^2	
	$4/3*A_{srequired}$ =	0.703111 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	2.375 in	
A=	47.5 in^2	
NA =	2.280223 mm	
f_s =	36.2561 ksi	
z=	175.1863 kips/in	— N/A for two-way slab
Required =	155.5556 kips/in	~~no good~~

Bar spacing < two times the slab thickness , OK

ACI-350 Check

Z =	115 kips/in	no good
fs =	36.2561 ksi	
Max Spacing =	4.857188 in	no good
Actual -> ρ =	0.004571	

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f_c*b*d^2)))

ρ = w*f_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

ired = (175 or 145)*1.2/β

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	5-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Mat2	Date:	
	Mu.design (bottom)	Page	of

Exposure: ● Interior ○ Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	24 kips*ft		
Average Load Factor =	1.55		
Service Moment =	186 kips*in		
Bar Spacing =	8 in		
Width, b =	12 in		
Slab Thickness=	12 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	8.625 in
ϕ =	0.9	#Bars =	1.5
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.66 in^2

#6 @ 8 in. spacing

Moment Check

	w =	0.094917	
	ρ =	0.006328	
	$A_{srequired}$ =	0.654924 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	2.212841 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.3450 in^2	
	$4/3*A_{srequired}$ =	0.873232 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	54 in^2	
NA =	2.355392 mm	
f_s =	35.90939 ksi	
z=	203.5935 kips/in	N/A for two-way slab
Required =	155.5556 kips/in	~~no good~~

Bar spacing < two times the slab thickness, OK

ACI-350 Check

Z =	115 kips/in		no good
fs =	35.90939 ksi		
Max Spacing =	4.999241 in		no good
Actual -> ρ =	0.006377		

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

Purpose: Check slab shear resistance capacity per ACI 318, 11.12.2.1

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

Hyster H440-700F/FS Lift Truck Specifications and phone calls with Ken Maka and Ron Cowan.

B. Design Parameters

Tried slab thickness $t := 12 \cdot in$

28-day concrete compressive strength $f'_c := 4000 \cdot psi$

concrete cover $c := 3 \cdot in$

$d := t - c$

$d = 9\,in$

Wheel load $L := 71 \cdot k$

Tire pressure $p := 145 \cdot psi$

Tire contact width $C_1 := 36 \cdot in$

Tire contact length $C_2 := \frac{L}{p \cdot C_1}$ $C_2 = 13.6\,in$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$\beta_c := \max(\beta)$

$\beta_c = 2.647$

C. Wheel At Center of Slab

$$b_0 := 2 \cdot C_1 + 2 \cdot C_2 + 4 \cdot d$$

$$\alpha_s := 40$$

Slab shear strength

$$V_c := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right) \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \\ \left(2 + \alpha_s \cdot \frac{d}{b_0}\right) \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \\ 4 \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \end{bmatrix}$$

$$\phi V_n := 0.85 \cdot \min(V_c)$$

$$\phi V_n = 229.69\,k$$

D. Wheel At Edge of Slab

$$b_0 := C_1 + 2 \cdot C_2 + 2 \cdot d$$

$$\alpha_s := 30$$

Slab shear strength

$$V_c := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right) \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \\ \left(2 + \alpha_s \cdot \frac{d}{b_0}\right) \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \\ 4 \cdot \sqrt{4000} \cdot psi \cdot b_0 \cdot d \end{bmatrix}$$

$$\phi V_n := 0.85 \cdot \min(V_c)$$

$$\phi V_n = 137.95\,k$$ $> V_u = 1.7 \times 71^k$
$= 120.7^k$

E. Wheel At Corner of Slab

$$b_0 := C_1 + C_2 + d$$

$$\alpha_s := 20$$

Slab shear strength

$$V_c := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot b_0\cdot d \\ \left(2 + \alpha_s\cdot\frac{d}{b_0}\right)\cdot\sqrt{4000}\cdot psi\cdot b_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot b_0\cdot d \end{bmatrix}$$

$$\phi V_n := 0.85\cdot\min(V_c)$$

$\phi V_n = 99.56k$ < $V_u = 120.7^k$

HOWEVER, WHEEL AT CORNER OF BUILDING IS VERY RARE.

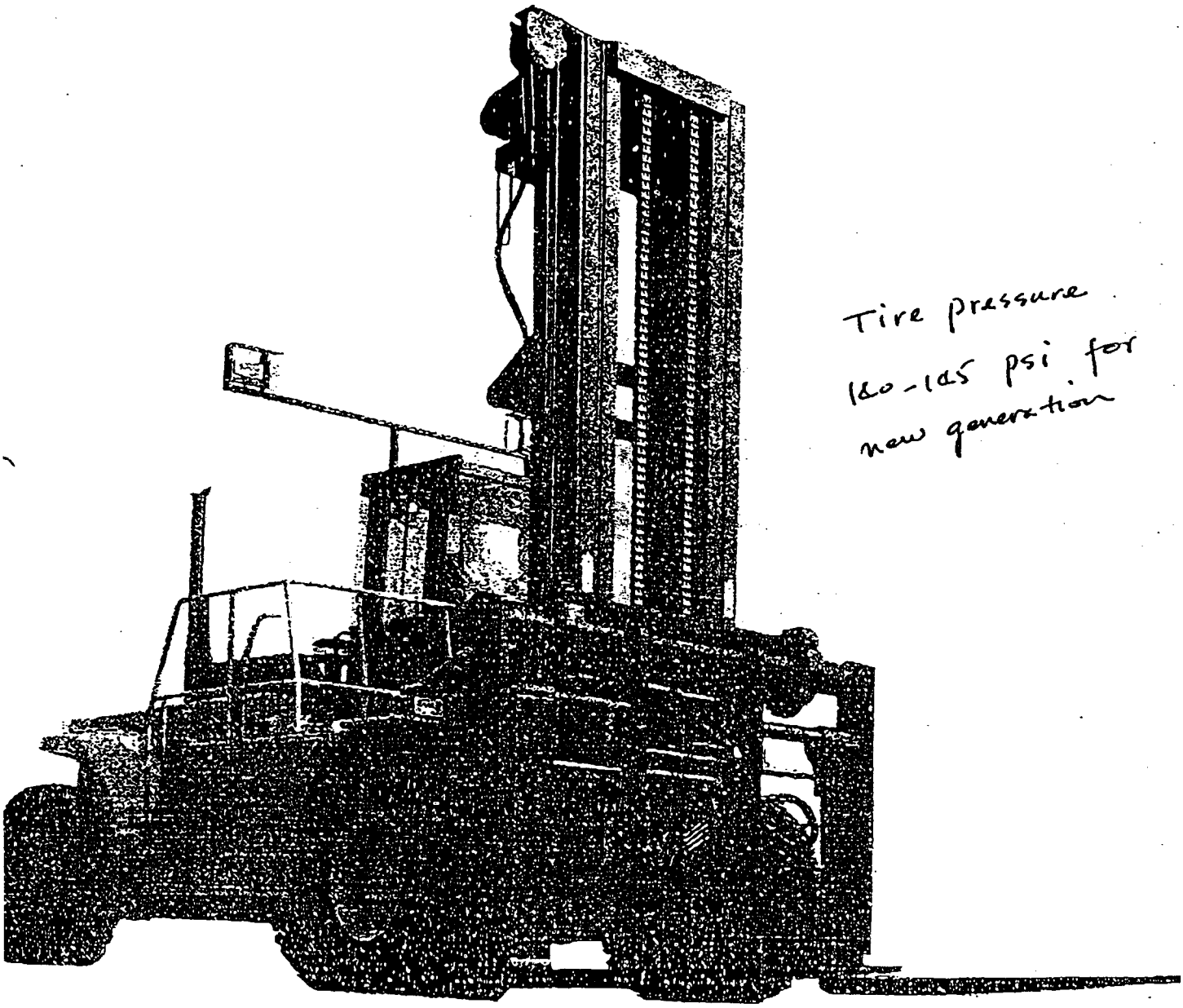
WHEEL AT EDGE IS REALISTIC SITUATION SUCH AS AT FLOOR DRAINS.

SO, t = 12" IS ACCEPTABLE.

52

H440-700F/FS Lift Truck Technical Guide

HYSTER



Tire pressure
160-165 psi for
new generation

Post-it® Fax Note 7671	Date 4-4-02	# of pages ▶
To JEFF LHAH	From KEN MAKA	
Co./Dept.	Co. HYSTER Co	
Phone #	Phone # 704 756-9948	
Fax # 281-596-0308	Fax # 815-468-2723	

Hyster Company
ISO 9002
World Class

Standard Features and Options

CITY

Model H440FS: 44,000 lbs. (20,000 kg) at 36.0 (900 mm)

Model H550FS: 55,000 lbs. (25,000 kg) at 36.0 (900 mm)

Model H550F: 55,000 lbs. (25,000 kg) at 48.0 (1,200 mm)

Model H620FS: 62,000 lbs. (28,000 kg) at 36.0 (900 mm)

Model H620F: 62,000 lbs. (28,000 kg) at 48.0 (1,200 mm)

Model H650F: 65,000 lbs. (30,000 kg) at 48.0 (1,200 mm)

Model H700FS: 70,000 lbs. (32,000 kg) at 36.0 (900 mm)

Model H700F: 70,000 lbs. (32,000 kg) at 48.0 (1,200 mm)

Rated capacities for *H440-550F/FS* trucks include being equipped with a two-stage VISTA mast to 124.5 (3,165 mm) maximum fork height; 114.0 (2,900 mm) standard carriage with 72.0 - 96.0 (1,830 to 2,440 mm) long forks as required; diesel engine and Powershift transmission.

The *H620-700F/FS* trucks are equipped with a 124.0 (3,150 mm) standard carriage with 90.0 - 96.0 (2,290 to 2,440 mm) long forks as required; diesel engine and Powershift transmission.

STANDARD EQUIPMENT

H440-550F/FS trucks include the following features as standard equipment. H440FS truck has 136.0 (3,455 mm) wheelbase; H550FS truck has 144.0 (3,660 mm) wheelbase; H550F has 176.0 (4,320 mm) wheelbase. Each truck has Cummins 6CT8.3 diesel engine; 2-stage VISTA mast with 124.5 (3,165 mm) maximum fork height; 114.0 (2,900 mm) standard carriage with fork positioners; 72.0 (1,830 mm) long forks (H440-550FS); 96.0 (2,440) long forks (H550F); 6 degrees forward, 10 degrees back tilt; suspension seat with folding armrests; adjustable hydraulic control console; tilt steering pod with soft-touch steering wheel; overhead guard; light group; powershift transmission; 4-function hydraulic valve; operator restraint system; side view mirrors; horn; reverse audible alarm; operating manual; and UL Classification D.

H620-700F/FS trucks include the following features as standard equipment. H620/700FS truck has 155.0 (3,940 mm) wheelbase; H620F truck has 170.0 (4,320 mm) wheelbase; H650/700F has 190.0 (4,830 mm) wheelbase. Each truck has Cummins 6CT8.3 diesel engine; 2-stage VISTA mast with 124.5 (3,165 mm) maximum fork height; 124.0 (3,150 mm) standard carriage with fork positioners; 72.0 (1,830mm) long forks (H620/700FS); 96.0 (2,440 mm) long forks (H620/700F); 6 degrees forward, 10 degrees back tilt; suspension seat with folding armrests; adjustable hydraulic control console; tilt steering pod with soft-touch steering wheel; overhead guard; light group; powershift transmission; 4-function hydraulic valve; operator restraint system; side view mirrors; horn; reverse audible alarm; operating manual; and UL Classification D.

Optional equipment includes 14.00 x 24, x 28 ply off-road tires (H440FS); two-door cab; lifting eyes; tilt indicator; light groups; integral sideshift; pin-type forks; empty container handling forks; 20-40 container handling attachment; low- and high-mount fork packages; and twistlocks.

ENGINES

Each truck is equipped with the 4-cycle, in-line, 6-cylinder Cummins 6CT8.3 turbocharged diesel engine for heavy-duty applications. Standard items include 506.6 cu.in. (8,300 cu. cm) displacement; 4.50 (114 mm) bore; 5.30 (135 mm) stroke; 24-volt electrical system; 50-amp, heavy-duty alternator with integral regulator and dust-proof starter; two cartridge-type oil filters; mechanical fuel pump; heavy-duty dry-type air cleaner with centrifugal pre-cleaner and outside, high-level air intake; restriction indicator; and overhead exhaust. Maximum torque is 567 ft.lbs. (770 N-m) at 1,500 RPM. Mechanical governor governs speed at 2,500 RPM.

14.9PSI cooling system includes heavy-duty radiator, thermostat and bypass; and puller-type fan. Large heat exchanger cools transmission oil.

MASTS

VISTA masts provide good visibility. Welded mast channels and formed cross-members provide durable weldments. Six standard masts for the H440-550F/FS trucks and six for the H620-700F/FS trucks provide versatility to match applications.

CARRIAGE

Pin-type carriage with fork positioners provides durability. Optional pin-type sideshift with integral carriage and fork positioners adds versatility. Overall width:

H440-550F/FS 114.0 (2,900 mm)

H620-700F/FS 124.0 (3,150 mm)

FORKS

H440-550F/FS

4.50 x 8.00 x 72.0

(115 x 205 x 1,830 mm) or

4.00 x 11.00 x 96.0

(102 x 280 x 2,440 mm)

H620-700F/FS

4.10 x 11.80 x 96.0

(105 x 300 x 2,440 mm) or

4.50 x 12.00 x 72.0 to 96.0

(115 x 305 x 1,830 to 2,440 mm)

Inside to inside, minimum fork spacing for the H440-550F/FS with the standard or sideshift carriage is 39.8 (1,010 mm) and 37.0 (940 mm) for the H620-700F/FS.

Maximum, outside to outside distance for the H440-550F/FS with standard or sideshift carriage is 108.3 (2,750 mm) and 117.7 (2,990 mm) for the H620-700F/FS.

TRANSMISSION

Three-speed powershift transmission and torque converter produce smooth shifting, precise inching, fast acceleration, and withstands rugged duty cycles. Gull-wing hood provides easy access to check transmission oil.

BRAKES

Non-asbestos brakes are standard equipment. Service brakes consist of hydraulic disc wheel brakes and disc brake on the drive line. Spring-actuated drive-line park brake applies automatically when pressure falls below 1,200 PSI.

STEERING SYSTEM

Fully-hydrostatic power steering provides fast, low-effort maneuvering. Equal-area, double-ended cylinder makes for a balanced steering system, with an equal number of lock-to-lock turns in both directions. Steering cylinder is transverse mounted in one-piece welded axle frame. Wheel spindles and hubs are mounted on pre-lubed and sealed, tapered roller bearings for reduced maintenance.

HYDRAULIC SYSTEM

Hydraulic system operates at 2,500 PSI (17,250 kPa). Restriction indicators signal when filters need replacement. 25-micron hydraulic filters are easily accessed. Two gear-type mechanical pumps provide 108 GPM maximum output. Flow amplifier saves energy by diverting only the required amount of oil for steering. Automatic, two-speed system increases lift speed in no-load situations.

Special attachments, equipment or accessories not listed above may be available through SPED for specific application requirements.

Hyster Company
P.O. Box 847
Danville, Illinois 61832-0847

PRODUCTIVITY THAT ENDURES

Hyster, , MONOTROL, and VISTA are registered trademarks of Hyster Company. Challenger and XL_2 are trademarks of Hyster Company. Hyster products are subject to change without notice.

SAFE OPERATORS... BUCKLE UP

Hyster Company uses recycled paper for all its literature.

862815

12/97 Litho in U.S.A.

H440-700F/FS Mast Dimensions

H440-550F/FS MAST DIMENSIONS						in. mm				
Maximum Fork Height ⇧ (Top of Forks)		Overall Lowered Height		Overall Extended Height Without Load Backrest Extension		* Free-Lift (TOF) Without Load Skirst Extnts.	Total Weight of Standard Truck H440FS lb. (kg)	H550FS lb. (kg)	*H550F* lb. (kg)
2-STAGE VISTA MAST									
124.5	3 162	155.0	3 937	215.0	5 461	0	65,558 (29 732)	71,758 (32 543)	71,918 (32 616)
172.5	4 382	179.0	4 547	263.0	6 680	0	66,903 (30 341)	73,103 (33 153)	73,263 (33 226)
196.5	4 991	181.0	4 851	287.0	7 280	0	67,157 (30 457)	73,357 (33 268)	73,517 (33 341)
220.5	5 600	203.0	5 156	311.0	7 889	0	68,071 (30 871)	74,271 (33 683)	74,431 (33 756)
244.5	6 210	215.0	5 461	335.0	8 509	0	68,562 (31 096)	74,762 (33 908)	74,922 (33 980)
364.5	9 258	275.0	6 985	455.0	11 557	0	71,332 (32 360)	77,532 (35 162)	77,692 (35 235)

⇧ Mast lift heights over 196.5 (4 991mm) maximum fork height require reduced capacity and restricted back tilt.

H620-700F/FS MAST DIMENSIONS						in. mm					
Maximum Fork Height ⇧ (Top of Forks)		Overall Lowered Height		Overall Extended Height Without Load Backrest Extension		* Free-Lift (TOF) Without Load Skirst Extnts.	Total Weight of Standard Truck H620FS lb. (kg)	H700FS lb. (kg)	*H620F* lb. (kg)	*H650F* lb. (kg)	*H700F* lb. (kg)
2-STAGE VISTA MAST											
124.5	3 162	168.5	4 277	228.0	5 600	0	87,919 (39 879)	88,529 (40 156)	87,814 (39 825)	86,529 (39 242)	89,669 (40 666)
172.5	4 382	192.5	4 887	276.5	7 020	0	88,278 (40 498)	89,888 (40 773)	89,174 (40 442)	87,889 (39 859)	91,029 (41 283)
220.5	5 600	216.5	5 496	324.0	8 848	0	90,838 (41 196)	91,448 (41 473)	90,734 (41 148)	89,449 (40 566)	92,589 (41 990)
268.5	6 820	240.5	6 106	372.0	9 458	0	92,125 (41 787)	82,735 (42 064)	92,470 (41 937)	91,185 (41 354)	94,325 (42 778)
364.5	9,258	288.5	7,345	468.0	11,896	0	94,851 (43 024)	95,461 (43 300)	94,746 (42 969)	93,461 (42 386)	96,601 (43 810)
388.5	9 868	300.5	7 640	492.5	12 506	0	95,446 (43 294)	96,056 (43 570)	95,341 (43 238)	94,056 (42 656)	97,196 (44 080)

⇧ Mast lift heights over 196.5 (4 991mm) maximum fork height require reduced capacity and restricted back tilt.

HYSTER

H650-700F Lift Truck Specifications

GENERAL	1	Manufacturer		Hyster Company	Hyster Company	
	2	Model		H650F	H700F	
	3	Capacity, rated	lb. (kg)	65,000 (30 000)	70,000 (32 000)	
	4	Load Center	in. (mm)	48.0 (1 200)	48.0 (1 200)	
	5	Power type		Diesel	Diesel	
	6	Operator type		Sit	Sit	
	7	Tire type, front / rear		Pneumatic / Pneumatic	Pneumatic / Pneumatic	
	8	Wheels, front / rear	(X=drive)	4X / 2	4X / 2	
DIMENSIONS	10	2-Stg.VISTA mast (Ton of Forks)	in. (mm)	124.5 (3 163)	124.5 (3 163)	
	11	Forks, length / width / thickness	in. (mm)	96.0 x 12.0 x 4.5 (2 438 x 305 x 114)	96.0 x 12.0 x 4.5 (2 438 x 305 x 114)	
	12	Tilt angle, standard mast, forward / rearward	in. (mm)	6 / 10	6 / 10	
	13	Length to face of forks	in. (mm)	273.1 (6 937)	281.6 (7 153)	
	14	Width, standard tires	in. (mm)	133.0 (3 380)	133.0 (3 380)	
	15	Height, standard mast lowered	in. (mm)	168.5 (4 280)	168.5 (4 280)	
	16	Height, standard mast extended, without LSF	in. (mm)	228.2 (5 798)	228.2 (5 798)	
	17	Turning radius, minimum outside	in. (mm)	264.4 (6 716)	268.4 (6 817)	
	18	Length, cntr drive axle to face of forks	in. (mm)	42.1 (1 069)	42.1 (1 069)	
		Length, cntr drive axle to face of forks w/s.s.	in. (mm)	45.6 (1 160)	45.6 (1 160)	
	19	Aisle width, (add load length for 90 degree stack)	in. (mm)	306.5 (7 785)	310.5 (7 890)	
	20	Equal intersecting right angle aisle	in. (mm)	221.8 (5 634)	225.8 (5 735)	
PERFORMANCE +	21	Stability, (comply with ANSI)*		YES	YES	
	22	Travel speed, maximum forward (powershift)	mph (km/hr.)	16.3 (26.2)	16.3 (26.2)	
	23	Lift speed, standard mast, NL / RL	ft/min. (m/s)	106.0 (0.54) / 45.0 (0.23)	106.0 (0.54) / 45.0 (0.23)	
	24	Lowering, standard mast, NL / RL	ft/min. (m/s)	65.0 (0.33) / 94.0 (0.48)	65.0 (0.33) / 96.0 (0.49)	
	25	Drawbar pull, powershift xmsn, max / 1 mph	lb. (kN)	42,500 (189)	42,450 (188)	
	26	Gradeability, powershift xsmn, 1 mph NL / RL	Percent	36 / 30	33 / 28	
	28	Total approximate weight, standard equipped truck	lb. (kg)	86,530 (39 242)	89,670 (40 661)	
	29	Axle loading, static-RL front / rear	lb. (kg)	136,180 (61 760) / 15,350 (6 961)	141,865 (64 338) / 17,805 (8 074)	
WHEELS & TIRES	31	Number of tires, front / rear		4 / 2	4 / 2	
	32	Tire size, drive tires (front)		16.00 x 25 - 24 Ply	16.00 x 25 - 28 Ply	
	33	Tire size, steer tires (rear)		16.00 x 25 - 24 Ply	16.00 x 25 - 28 Ply	
	34	Wheelbase, center of steer to center of drive axle	in. (mm)	190.0 (4 826)	190.0 (4 826)	
	35	Tread, center to center of tires, steer / drive	in. (mm)	116.0 (2 950) / 93.0 (2 362)	116.0 (2 950) / 93.0 (2 362)	
	36	Ground clearance, lowest point-NL	in. (mm)	15.0 (381)	15.0 (381)	
	37	Ground clearance, center of wheelbase-NL	in. (mm)	22.0 (559)	22.0 (559)	
	38	Brakes, method of control, service / parking		Hydraulic / Hydraulic	Hydraulic / Hydraulic	
	39	Brakes, method of operation, service / parking		Foot / Hand	Foot / Hand	
DRIVETRAIN	41	Battery, volts / cold cranking amps	V / amps	24 / 660	24 / 660	
	42	Engine, make-model		Cummins 6CT8.3	Cummins 6CT8.3	
	43	Output per SAE standards	hp (kW)	215 (160)	215 (160)	
	44	Governed speed, NL	RPM	2500	2500	
	45	Cycle / number of cylinders / displacement	cu.in. (cm3)	4 / 6 / 504.5 (8 267)	4 / 6 / 504.5 (8 267)	
	46	Clutch type, powershift		Torque Converter	Torque Converter	
	47	Gear change type, powershift		Hand Lever	Hand Lever	
	48	Number of speeds, forward / reverse		3 / 3	3 / 3	
	49	Transmission type		Powershift	Powershift	
	51	Relief pressure for attachments	psi (kPa)	3,200 (22 050)	3,200 (22 050)	

* **CERTIFICATION:** These Hyster lift trucks meet design specifications of Part II ANSI B56.1-1988, as required by OSHA Section 1910.178 (a) (2) and with Part III ANSI B56.1-Revision in effect at the time of manufacture. Certification of compliance with the applicable ANSI standards appears on the lift truck's nameplate which is affixed to truck when shipped complete from the factory.

+ Performance specifications are for truck equipped as described under Standard Equipment on the back of this Technical Guide. Performance specifications are affected by the condition of the vehicle and how it is equipped, as well as the nature and condition of the operating environment. If these specifications are critical, the proposed application should be discussed with your dealer.

Optional cab and forks are shown in the front cover photograph.

HYSTER

H550-620F Lift Truck Specifications

GENERAL	1	Manufacturer		Hyster Company	Hyster Company	
	2	Model		H550F	H620F	
	3	Capacity, rated	lb. (kg)	55,000 (25 000)	62,000 (28 000)	
	4	Load Center	in. (mm)	48.0 (1 200)	48.0 (1 200)	
	5	Power type		Diesel	Diesel	
	6	Operator type		Sit	Sit	
	7	Tire type, front / rear		Pneumatic / Pneumatic	Pneumatic / Pneumatic	
	8	Wheels, front / rear	(X=drive)	4X / 2	4X / 2	
DIMENSIONS	10	2-Stg.VISTA mast (Top of Forks)	in. (mm)	124.5 (3 163)	124.5 (3 163)	
	11	Forks, length / width / thickness	in. (mm)	96.0 x 8.0 x 4.5 (2 438 x 203 x 114)	96.0 x 12.0 x 4.5 (2 438 x 305 x 114)	
	12	Tilt angle, standard mast, forward / rearward	in. (mm)	6 / 10	6 / 10	
	13	Length to face of forks	in. (mm)	252.1 (6 403)	261.6 (6 645)	
	14	Width, standard tires	in. (mm)	120.0 (3 040)	133.0 (3 380)	
	15	Height, standard mast lowered	in. (mm)	155.0 (3 937)	168.5 (4 280)	
	16	Height, standard mast extended, without LBE	in. (mm)	215.0 (5 460)	228.2 (5 793)	
	17	Turning radius, minimum outside	in. (mm)	241.3 (6 129)	245.3 (6 231)	
	18	Length, cntr drive axle to face of forks	in. (mm)	41.1 (1 045)	42.1 (1 069)	
		Length, cntr drive axle to face of forks w/s.s.	in. (mm)	43.6 (1 110)	45.6 (1 160)	
	19	Aisle width, (add load length for 90 degree stack)	in. (mm)	282.3 (7 170)	294.7 (7 555)	
	20	Equal intersecting right angle aisle	in. (mm)	203.7 (5 174)	214.2 (5 440)	
PERFORMANCE †	21	Stability, (comply with ANSI)*		YES	YES	
	22	Travel speed, maximum forward (powershift)	mph (km/hr.)	18.4 (29.6)	16.3 (26.2)	
	23	Lift speed, standard mast, NL / RL	ft/min. (m/s)	131.0 (0.67) / 61.0 (0.31)	106.0 (0.54) / 45.0 (0.23)	
	24	Lowering, standard mast, NL / RL	ft/min. (m/s)	45.0 (0.23) / 96.0 (0.49)	65.0 (0.33) / 90.0 (0.46)	
	25	Drawbar pull, powershift xmsn, 1 mph	lb. (kN)	37,550 (167)	42,480 (188)	
	26	Gradeability, powershift xsmn, 1 mph NL / RL	Percent	31 / 31	33 / 30	
WT	28	Total approximate weight, standard equipped truck	lb. (kg)	72,230 (32 757)	87,810 (39 823)	
	29	Axle loading, static-RL front / rear	lb. (kg)	113,130 (51 306) / 14,100 (6 395)	133,130 (60 376) / 16,685 (7 567)	
WHEELS & TIRES	31	Number of tires, front / rear		4 / 2	4 / 2	
	32	Tire size, drive tires (front)		14.00 x 24 - 28 Ply	16.00 x 25 - 24 Ply	
	33	Tire size, steer tires (rear)		14.00 x 24 - 28 Ply	16.00 x 25 - 24 Ply	
	34	Wheelbase, center of steer to center of drive axle	in. (mm)	170.0 (4 320)	170.0 (4 320)	
	35	Tread, center to center of tires, steer / drive	in. (mm)	104.0 (2 640) / 93.0 (2 362)	116.0 (2 950) / 93.0 (2 362)	
	36	Ground clearance, lowest point-NL	in. (mm)	13.5 (343)	15.0 (381)	
	37	Ground clearance, center of wheelbase-NL	in. (mm)	20.5 (520)	22.0 (559)	
	38	Brakes, method of control, service / parking		Hydraulic / Hydraulic	Hydraulic / Hydraulic	
	39	Brakes, method of operation, service / parking		Foot / Hand	Foot / Hand	
DRIVETRAIN	41	Battery, volts / cold cranking amps	V / amps	24 / 660	24 / 660	
	42	Engine, make-model		Cummins 6CT8.3	Cummins 6CT8.3	
	43	Output per SAE standards	hp (kW)	215 (160)	215 (160)	
	44	Governed speed, NL	RPM	2500	2500	
	45	Cycle / number of cylinders / displacement	cu.in. (cm3)	4 / 6 / 504.5 (8 267)	4 / 6 / 504.5 (8 267)	
	46	Clutch type, powershift		Torque Converter	Torque Converter	
	47	Gear change type, powershift		Hand Lever	Hand Lever	
	48	Number of speeds, forward / reverse		3 / 3	3 / 3	
	49	Transmission type		Powershift	Powershift	
	51	Relief pressure for attachments	psi (kPa)	3,200 (22 050)	3,200 (22 050)	

* **CERTIFICATION:** These Hyster lift trucks meet design specifications of Part II ANSI B56.1-1969, as required by OSHA Section 1910.178 (a) (2) and with Part III ANSI B56.1-Revision in effect at the time of manufacture. Certification of compliance with the applicable ANSI standards appears on the lift truck's nameplate which is affixed to truck when shipped complete from the factory.

† **NOTE:** Performance specifications are for truck equipped as described under Standard Equipment on the back of this Technical Guide. Performance specifications are affected by the condition of the vehicle and how it is equipped, as well as the nature and condition of the operating environment. If these specifications are critical, the proposed application should be discussed with your dealer.

Optional cab and lights are shown in the front cover photograph.

HYSTER

H440-550FS Lift Truck Specifications

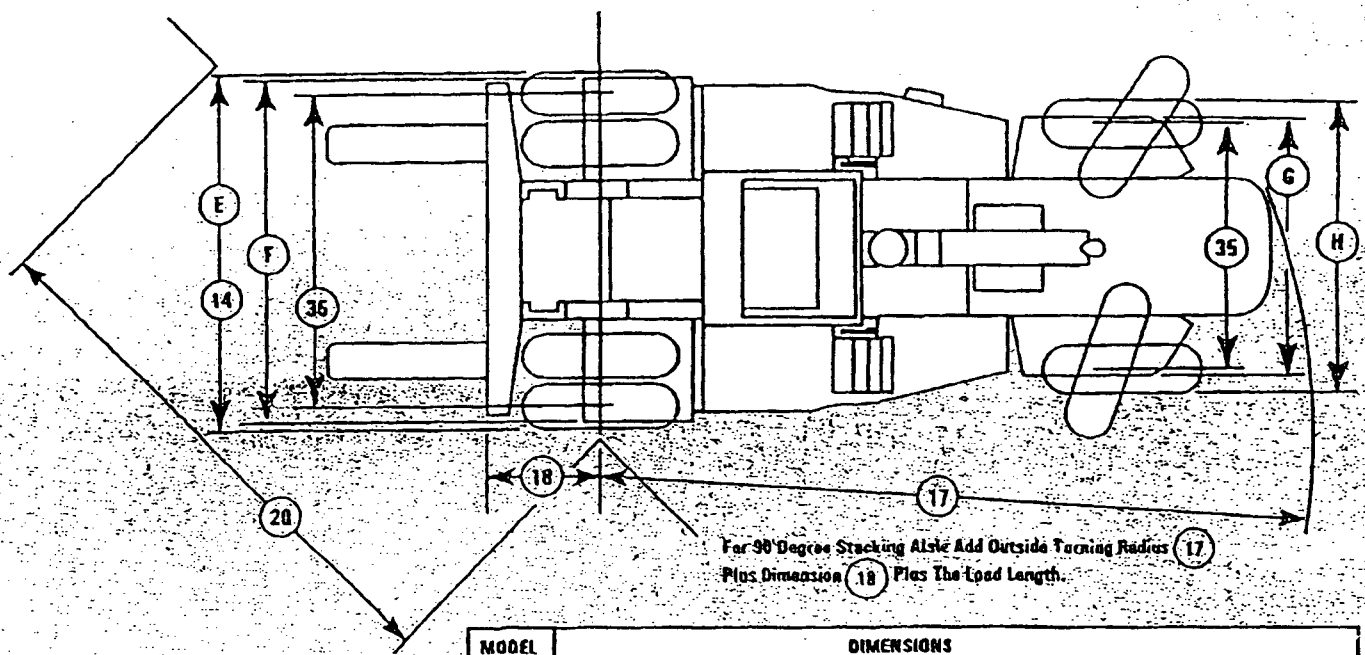
GENERAL	1	Manufacturer		Hyster Company	Hyster Company	
	2	Model		H440FS	H550FS	
	3	Capacity, rated	lb. (kg)	44,000 (20 000)	55,000 (25 000)	
	4	Load Center	in. (mm)	36.0 (900)	36.0 (900)	
	5	Power type		Diesel	Diesel	
	6	Operator type		Sit	Sit	
	7	Tire type, front / rear		Pneumatic / Pneumatic	Pneumatic / Pneumatic	
	8	Wheels, front / rear	(X=drive)	4X / 2	4X / 2	
DIMENSIONS	10	2-Stg.VISTA mast (Top of Forks)	in. (mm)	124.5 (3 163)	124.5 (3 163)	
	11	Forks, length / width / thickness	in. (mm)	72.0 x 8.0 x 4.5 (1 830 x 203 x 114)	72.0 x 8.0 x 4.5 (1 830 x 203 x 114)	
	12	Tilt angle, standard mast, forward / rearward	in. (mm)	6 / 10	6 / 10	
	13	Length to face of forks	in. (mm)	218.1 (5 540)	226.1 (6 629)	
	14	Width, standard tires	in. (mm)	120.0 (3 040)	120.0 (3 040)	
	15	Height, standard mast lowered	in. (mm)	155.0 (3 937)	155.0 (3 937)	
	16	Height, standard mast extended, without LBE	in. (mm)	215.0 (5 460)	215.0 (5 460)	
	17	Turning radius, minimum outside	in. (mm)	202.0 (5 130)	211.2 (5 365)	
	18	Length, cntr drive axle to face of forks	in. (mm)	41.1 (1 045)	41.1 (1 045)	
		Length, cntr drive axle to face of forks w/s.s.	in. (mm)	43.6 (1 110)	43.6 (1 110)	
	19	Aisle width, (add load length for 90 degree stack)	in. (mm)	243.1 (6 175)	252.3 (6 408)	
	20	Equal intersecting right angle aisle	in. (mm)	183.9 (4 671)	188.5 (4 788)	
PERFORMANCE †	21	Stability, (comply with ANSI)*		YES	YES	
	22	Travel speed, maximum forward (powershift)	mph (km/hr.)	18.0 (29.0)	18.0 (29.0)	
	23	Lift speed, standard mast, NL / RL	ft/min. (m/s)	131.0 (0.67) / 61.0 (0.31)	131.0 (0.67) / 61.0 (0.31)	
	24	Lowering, standard mast, NL / RL	ft/min. (m/s)	45.0 (0.23) / 89.0 (0.45)	45.0 (0.23) / 96.0 (0.49)	
	25	Drawbar pull, powershift xmsn, 1 mph	lb. (kN)	37,660 (167)	37,550 (167)	
	26	Gradeability, powershift xsmn, 1 mph NL / RL	Percent	31 / 36	29 / 31	
WT	28	Total approximate weight, standard equipped truck	lb. (kg)	65,560 (29 733)	71,760 (32 544)	
	29	Axle loading, static-RL front / rear	lb. (kg)	96,840 (43 918) / 12,721 (5 769)	112,330 (50 943) / 14,430 (6 544)	
WHEELS & TIRES	31	Number of tires, front / rear		4 / 2	4 / 2	
	32	Tire size, drive tires (front)		14.00 x 24 - 20 Ply	14.00 x 24 - 28 Ply	
	33	Tire size, steer tires (rear)		14.00 x 24 - 20 Ply	14.00 x 24 - 28 Ply	
	34	Wheelbase, center of steer to center of drive axle	in. (mm)	136.0 (3 455)	144.0 (3 660)	
	35	Tread, center to center of tires, steer / drive	in. (mm)	104.0 (2 640) / 94.0 (2 390)	104.0 (2 640) / 94.0 (2 390)	
	36	Ground clearance, lowest point-NL	in. (mm)	13.5 (343)	13.5 (343)	
	37	Ground clearance, center of wheelbase-NL	in. (mm)	20.5 (520)	20.5 (520)	
	38	Brakes, method of control, service / parking		Hydraulic / Hydraulic	Hydraulic / Hydraulic	
	39	Brakes, method of operation, service / parking		Foot / Hand	Foot / Hand	
DRIVETRAIN	41	Battery, volts / cold cranking amps	V / amps	24 / 660	24 / 660	
	42	Engine, make-model		Cummins 6CT8.3	Cummins 6CT8.3	
	43	Output per SAE standards	hp (kW)	215 (160)	215 (160)	
	44	Governed speed, NL	RPM	2500	2500	
	45	Cycle / number of cylinders / displacement	cu.in. (cm3)	4 / 6 / 504.5 (8 267)	4 / 6 / 504.5 (8 267)	
	46	Clutch type, powershift		Torque Converter	Torque Converter	
	47	Gear change type, powershift		Hand Lever	Hand Lever	
	48	Number of speeds, forward / reverse		3 / 3	3 / 3	
	49	Transmission type		Powershift	Powershift	
	51	Relief pressure for attachments	psi (kPa)	3,200 (22 050)	3,200 (22 050)	

* **CERTIFICATION:** These Hyster lift trucks meet design specifications of Part II ANSI B56.1-1969, as required by OSHA Section 1910.178 (a) (2) and with Part III ANSI B56.1-Revision in effect at the time of manufacture. Certification of compliance with the applicable ANSI standards appears on the lift truck's nameplate which is affixed to truck when shipped complete from the factory.

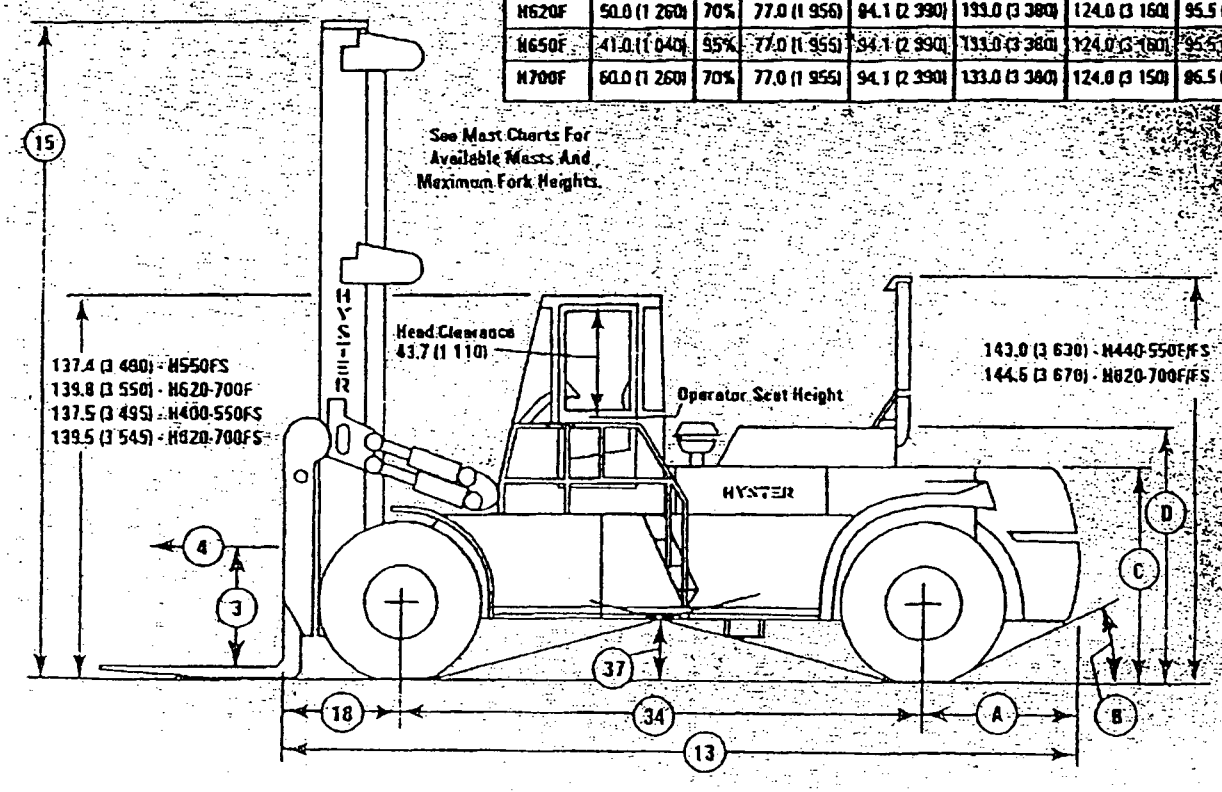
† **NOTE:** Performance specifications are for truck equipped as described under Standard Equipment on the back of this Technical Guide. Performance specifications are affected by the tion of the vehicle and how it is equipped, as well as the nature and condition of the operating environment. If these specifications are critical, the proposed application should be ussed with your dealer.

Optional cab and lights are shown in the front cover photograph.

H440-700F/FS Lift Truck Specifications



MODEL	DIMENSIONS							
	A	B	C	D	E	F	G	H
H440FS	41.0 (1 040)	80%	75.5 (1 920)	92.7 (2 355)	120.0 (3 040)	110.0 (2 795)	95.5 (2 425)	108.8 (2 765)
H550FS	41.0 (1 040)	80%	75.5 (1 920)	92.7 (2 355)	120.0 (3 040)	110.0 (2 795)	95.5 (2 425)	108.8 (2 765)
H620FS	50.0 (1 260)	70%	77.0 (1 955)	94.1 (2 390)	133.0 (3 380)	124.0 (3 150)	95.5 (2 425)	109.8 (2 790)
H700FS	50.0 (1 260)	70%	77.0 (1 955)	94.1 (2 390)	133.0 (3 380)	124.0 (3 150)	95.5 (2 425)	109.8 (2 790)
H550F	41.0 (1 040)	84%	75.5 (1 920)	92.7 (2 355)	120.0 (3 040)	110.0 (2 795)	95.5 (2 425)	108.8 (2 765)
H620F	50.0 (1 260)	70%	77.0 (1 955)	94.1 (2 390)	133.0 (3 380)	124.0 (3 150)	95.5 (2 425)	109.8 (2 790)
H650F	41.0 (1 040)	95%	77.0 (1 955)	94.1 (2 390)	133.0 (3 380)	124.0 (3 150)	95.5 (2 425)	109.8 (2 790)
H700F	50.0 (1 260)	70%	77.0 (1 955)	94.1 (2 390)	133.0 (3 380)	124.0 (3 150)	95.5 (2 425)	109.8 (2 790)



Circled numbers correspond to the line numbers on the tabulated charts inside the Technical Guide.
Figures are in inches/pounds (metric equivalent).

H650-700F Lift Truck Specifications

GENERAL	2	Model		H650F	H700F
	4	Load Center	in. (mm)	48.0 (1 200)	48.0 (1 200)
	6	Operator type		Sit	Sit
	8	Wheels, front / rear	(X=drive)	4X / 2	4X / 2
DIMENSIONS	11	Forks, length / width / thickness	in. (mm)	96.0 x 12.0 x 4.5 (2 438 x 305 x 114)	96.0 x 12.0 x 4.5 (2 438 x 305 x 114)
	13	Length to face of forks	in. (mm)	273.1 (6 937)	281.6 (7 153)
	15	Height, standard mast lowered	in. (mm)	168.5 (4 280)	168.5 (4 280)
	17	Turning radius, minimum outside	in. (mm)	264.4 (6 716)	268.4 (6 817)
		Length, cntr drive axle to face of forks w/s.s.	in. (mm)	45.6 (1 160)	45.6 (1 160)
	20	Equal intersecting right angle aisle	in. (mm)	221.8 (5 634)	225.8 (5 735)
PERFORMANCE †	22	Travel speed, maximum forward (powershift)	mph (km/hr.)	16.3 (26.2)	16.3 (26.2)
	24	Lowering, standard mast, NL / RL	ft/min. (m/s)	65.0 (0.33) / 94.0 (0.48)	65.0 (0.33) / 96.0 (0.49)
	26	Gradeability, powershift xsmn, 1 mph NL / RL	Percent	36 / 30	33 / 28
	29	Axle loading, static-RL front / rear	lb. (kg)	136,180 (61 760) / 15,350 (6 961)	141,865 (64 338) / 17,805 (8 074)
WHEELS & TIRES	32	Tire size, drive tires (front)		16.00 x 25 - 24 Ply	16.00 x 25 - 28 Ply
	34	Wheelbase, center of steer to center of drive axle	in. (mm)	190.0 (4 826)	190.0 (4 826)
	36	Ground clearance, lowest point-NL	in. (mm)	15.0 (381)	15.0 (381)
	38	Brakes, method of control, service / parking		Hydraulic / Hydraulic	Hydraulic / Hydraulic
DRIVETRAIN	41	Battery, volts / cold cranking amps	V / amps	24 / 660	24 / 660
	43	Output per SAE standards	hp (kW)	215 (160)	215 (160)
	45	Cycle / number of cylinders / displacement	cu.in. (cm3)	4 / 6 / 504.5 (8 267)	4 / 6 / 504.5 (8 267)
	47	Gear change type, powershift		Hand Lever	Hand Lever
	49	Transmission type		Powershift	Powershift

* CERTIFICATION: These Hyster lift trucks meet design specifications of Part II ANSI B56.1-1988, as required by OSHA Section 1910.178 (a) (2) and with Part III ANSI B58.1-Revision in effect at the time of manufacture. Certification of compliance with the applicable ANSI standards appears on the lift truck's nameplate which is affixed to truck when shipped complete from the factory.

† Performance specifications are for truck equipped as described under Standard Equipment on the back of this Technical Guide. Performance specifications are affected by the [illegible] of the vehicle and how it is equipped, as well as the nature and condition of the operating environment. If these specifications are critical, the proposed application should be discussed with your dealer.

Optional cab and lights are shown in the front cover photograph.

H440-700F/FS Mast Dimensions

H440-550F/FS MAST DIMENSIONS in. mm

Maximum Fork Height ⇧ (Top of Forks)		Overall Lowered Height		Overall Extended Height Without Load Backrest Extension		* Free-Lift (TOF) Without Load Bkrst.Extstn.	Total Weight of Standard Truck H440FS lb. (kg)	H550FS lb. (kg)	*H550F* lb. (kg)
2-STAGE VISTA MAST									
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
172.5	4 382	179.0	4 547	263.0	6 680	0	66,903 (30 341)	73,103 (33 153)	73,263 (33 226)
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
220.5	5 600	203.0	5 156	311.0	7 899	0	68,071 (30 871)	74,271 (33 683)	74,431 (33 756)
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
364.5	9 258	275.0	6 985	455.0	11 557	0	71,332 (32 350)	77,532 (35 162)	77,692 (35 235)

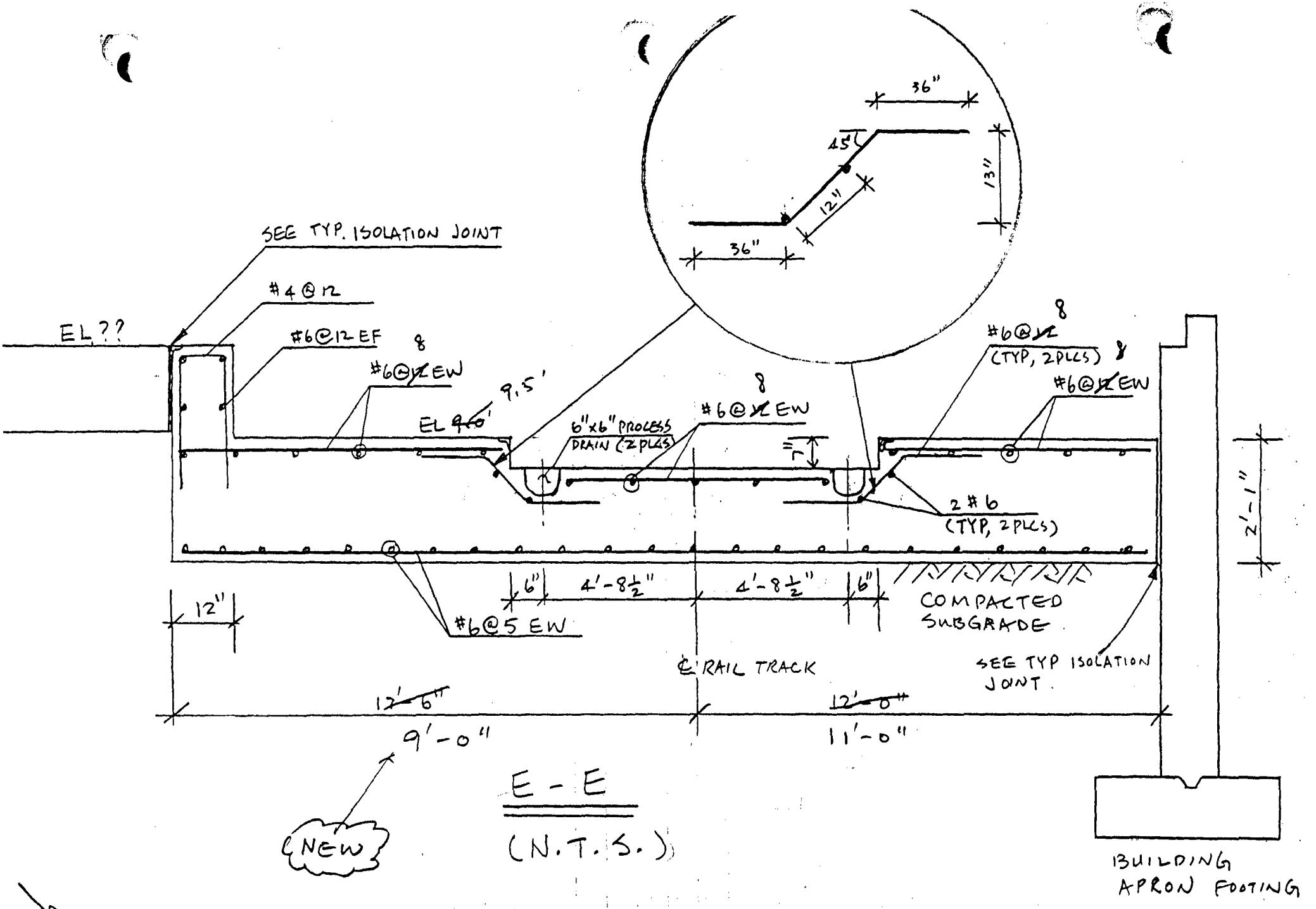
⇧ Mast lift heights over 196.5 (4 991mm) maximum fork height require reduced capacity and restricted back tilt.

H620-700F/FS MAST DIMENSIONS in. mm

Maximum Fork Height ⇧ (Top of Forks)		Overall Lowered Height		Overall Extended Height Without Load Backrest Extension		* Free-Lift (TOF) Without Load Bkrst.Extstn.	Total Weight of Standard Truck H620FS lb. (kg)	H700FS lb. (kg)	*H620F* lb. (kg)	*H650F* lb. (kg)	*H700F* lb. (kg)
2-STAGE VISTA MAST											
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
172.5	4 382	182.5	4 887	276.5	7 020	0	89,270 (40 496)	89,880 (40 773)	88,174 (40 442)	87,888 (39 859)	91,028 (41 283)
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
268.5	6 820	240.5	6 106	372.0	9 458	0	92,126 (41 787)	92,735 (42 064)	92,470 (41 937)	91,185 (41 354)	94,325 (42 778)
[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
388.5	9 868	300.5	7 640	492.5	12 508	0	95,446 (43 294)	96,056 (43 570)	95,341 (43 239)	94,056 (42 656)	97,196 (44 080)

⇧ Mast lift heights over 196.5 (4 991mm) maximum fork height require reduced capacity and restricted back tilt.

Rail Track Slab (Mat 3)


36"
45°
13"
12"
36"
SEE TYP. ISOLATION JOINT
#4 @ 12
EL ??
#6@12 EF
8
#6@~~12~~ EW
9.5'
EL ~~9.0~~'
6"x6" PROCESS DRAIN (2 PLCS)
8
#6@~~12~~ EW
r
8
#6@~~12~~
(TYP, 2 PLCS)
8
#6@~~12~~ EW
2 #6
(TYP, 2 PLCS)
2'-1"
12"
6"
4'-8½"
4'-8½"
6"
#6@5 EW
COMPACTED SUBGRADE
℄ RAIL TRACK
SEE TYP ISOLATION JOINT
~~12'-6"~~
9'-0"
~~12'-0"~~
11'-0"
NEW
BUILDING APRON FOOTING

E - E

(N.T.S.)

DEWATERING END - RAIL TRACK SLAB

1) DEAD LOAD (CASE A)

* SELF WEIGHT

* RAIL + TIE WEIGHT

RAIL: 119 LB/YD = 0.04 K/FT

TIE: 7"×9"×8.5'×0.15 = 0.56 K/TIE @ 24" SPACING

USE 2' SPACING MESH.

ASSIGN 0.04×2 + 0.56/2 = 0.36 K/NOTE NOTE LOAD

2) LIVE LOAD

* WHEEL LOAD FROM RAIL CAR (CASE B)
PER LUCY'S CALCS, THE GONDOLA HAS 2 AXIES SPACED @ 43'-4", EACH AXIE HAS 4 WHEELS WITH A WHEEL LOAD OF 33.25 K (SEE ATTACHMENT)

* 750 PSF LIVE LOAD (CASE C)

LOAD COMBINATION

SERVICE: $S_1 = A + B$

$S_2 = A + C$

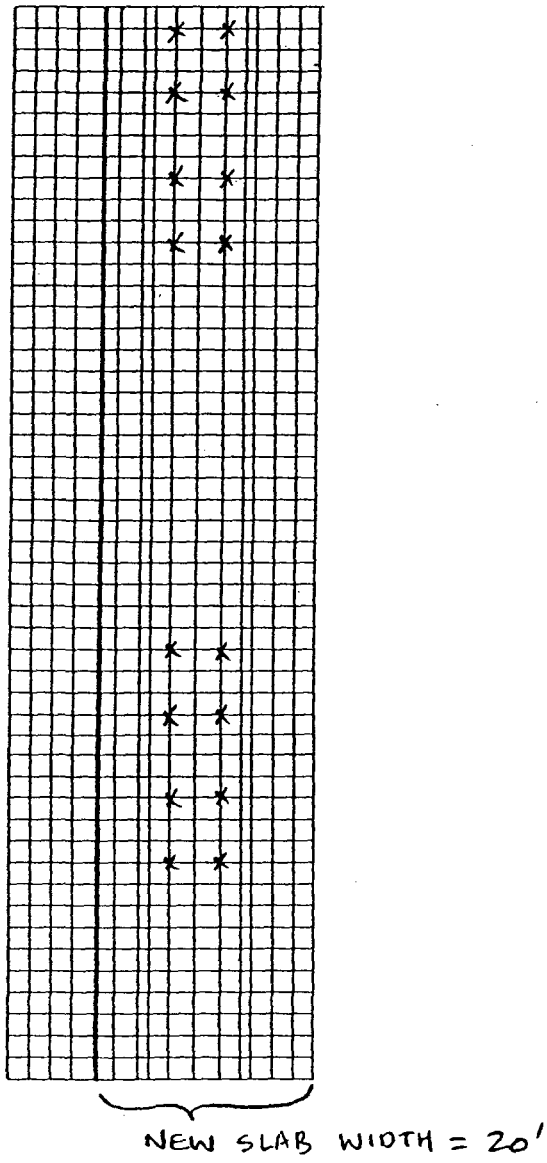
$S_3 = A + B + C$

ULTIMATE: $U_1 = 1.4A + 1.7B$

$U_2 = 1.4A + 1.7C$

$U_3 = 1.4A + 1.7B + 1.7C$

New Bedford - Dewatering - rail track fnd.
Rail Car Wheel Locations



A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering - rail track fnd.
Engineer: JZ
File : C:\PROJECTS\NEWBED~1\DEWATER\100%SUB\RAIL%.MAT
Units : English Date : 01/23/02
Code : ACI 318-99 Time : 09:55:12

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 75.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 612
Number of elements = 550

A2 - THICKNESS DEFINITIONS:

Label	t (in)	Label	t (in)
thick1	18.00	thick2	25.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
soil1	51	4

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP1	2.7500	3.0000	2.7500	3.0000	0.1800 %

A9 - NODAL LOAD DEFINITIONS:

Label	Case	Pz (kip)	Mx (kip-ft)	My (kip-ft)
rail+tie	A	-0.36	0	0
wheel	B	-33.25	0	0

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
LL	C	-750

A11 - LOAD COMBINATIONS:

Self weight is included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	1.000	0.000	0.000	0.000	0.000	Ser.	Yes
S2	1.000	0.000	1.000	0.000	0.000	0.000	Ser.	Yes
S3	1.000	1.000	1.000	0.000	0.000	0.000	Ser.	Yes
U1	1.400	1.700	0.000	0.000	0.000	0.000	Ult.	Yes
U2	1.400	0.000	1.700	0.000	0.000	0.000	Ult.	Yes
U3	1.400	1.700	1.700	0.000	0.000	0.000	Ult.	Yes

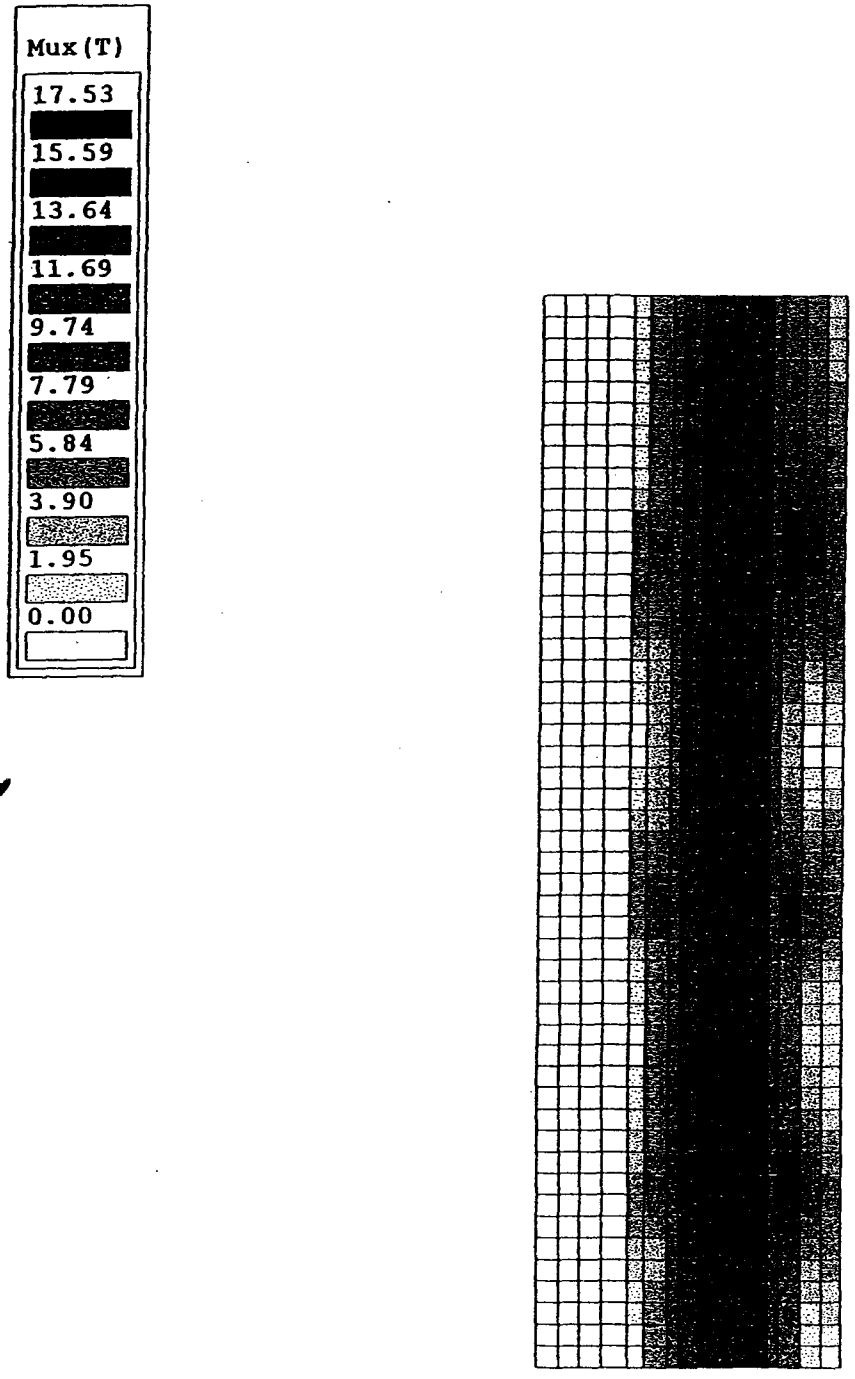
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2	3	4
4	6	5	8.5	6	10
7	12.25	8	13.25	9	15.15
10	17.5	11	19.85	12	21.75
13	22.75	14	24.75	15	26.75
16	28.5				

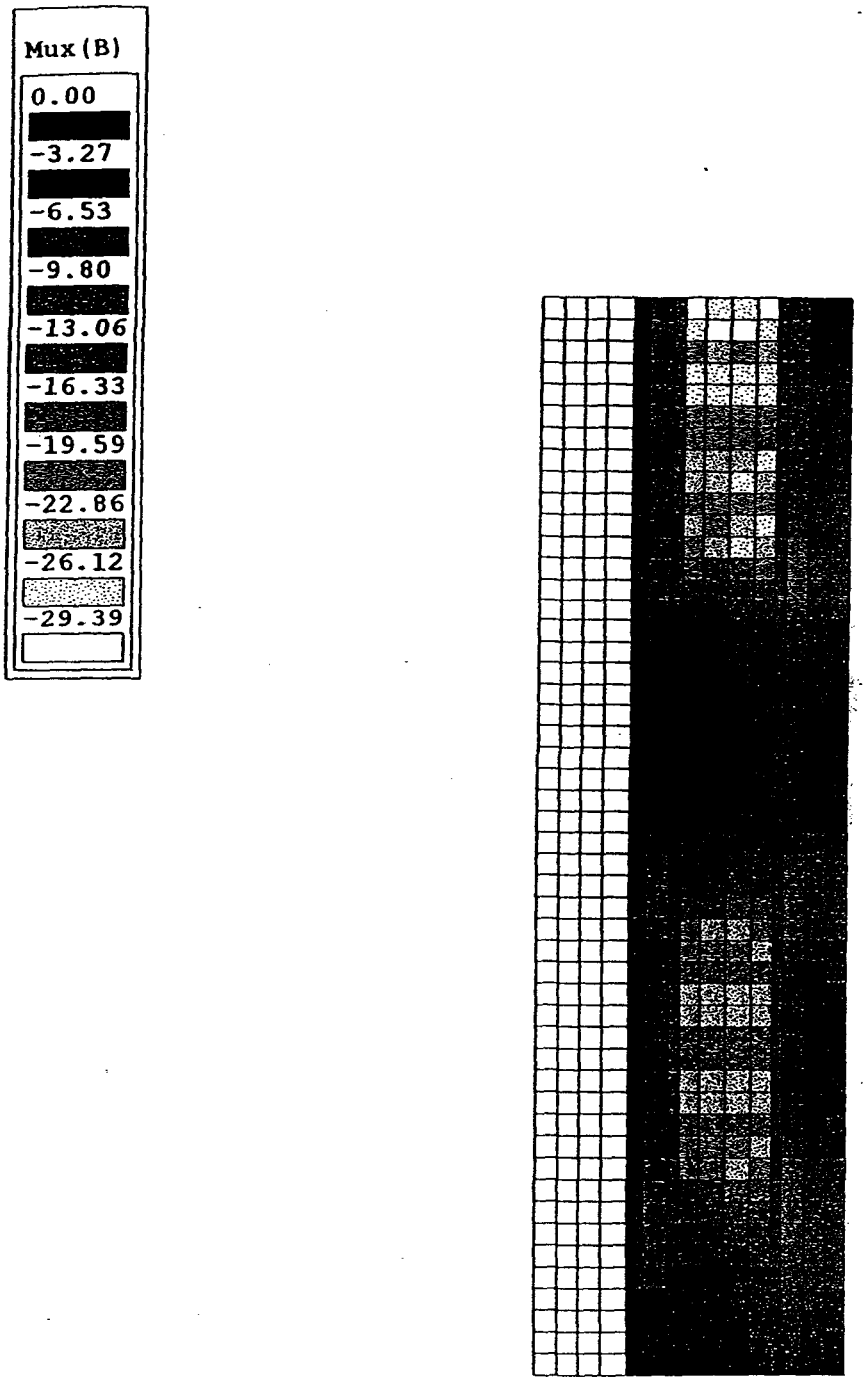
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2	3	4
4	6	5	8	6	10
7	12	8	14	9	16
10	18	11	20	12	22
13	24	14	26	15	28
16	30	17	32	18	34
19	36	20	38	21	40
22	42	23	44	24	46
25	48	26	50	27	52
28	54	29	56	30	58
31	60	32	62	33	64
34	66	35	68	36	70
37	72	38	74	39	76
40	78	41	80	42	82
43	84	44	86	45	88
46	90	47	92	48	94
49	96	50	98	51	100

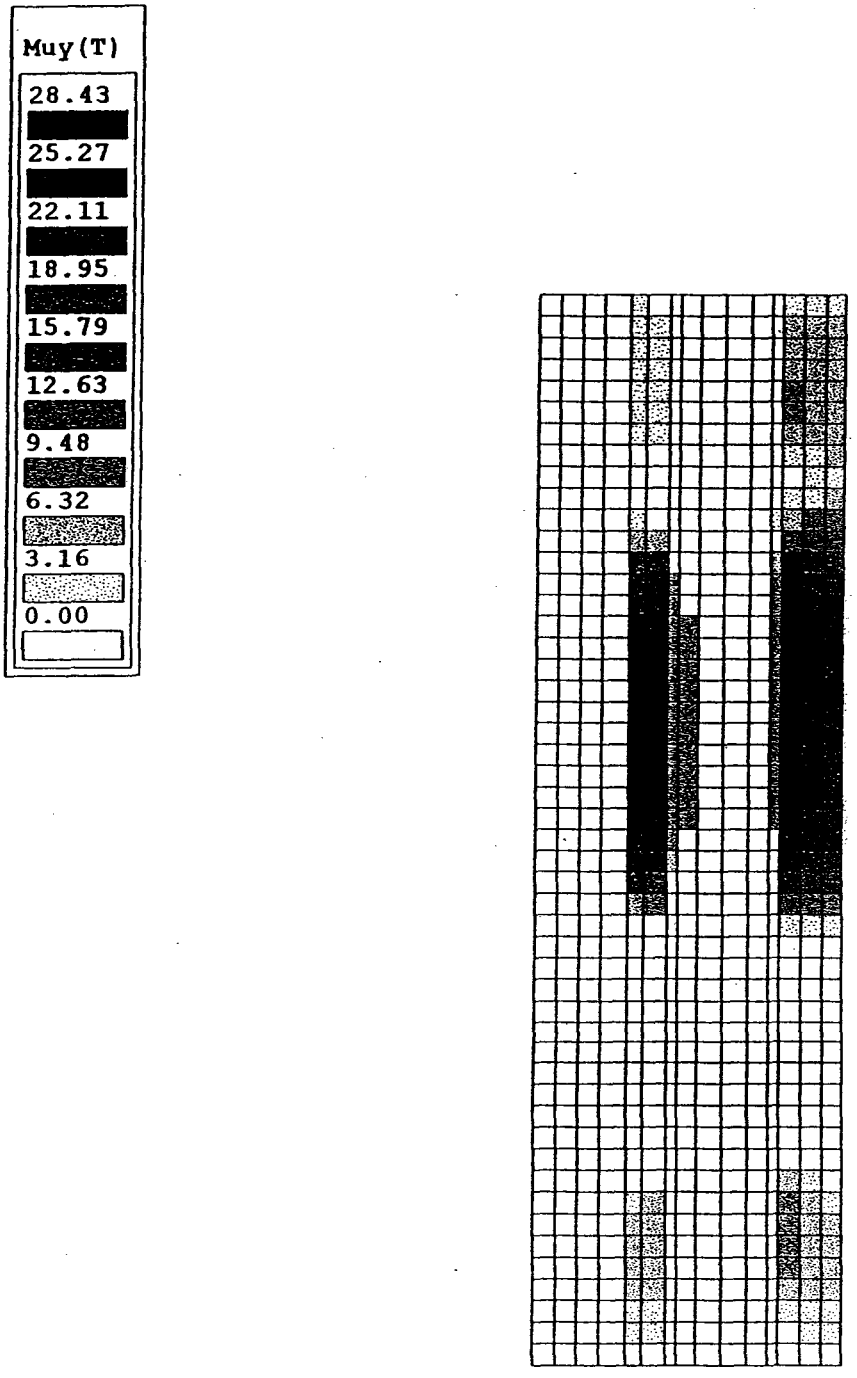
New Bedford - Dewatering - rail track fnd.
Maximum Moment (kip-ft/ft)



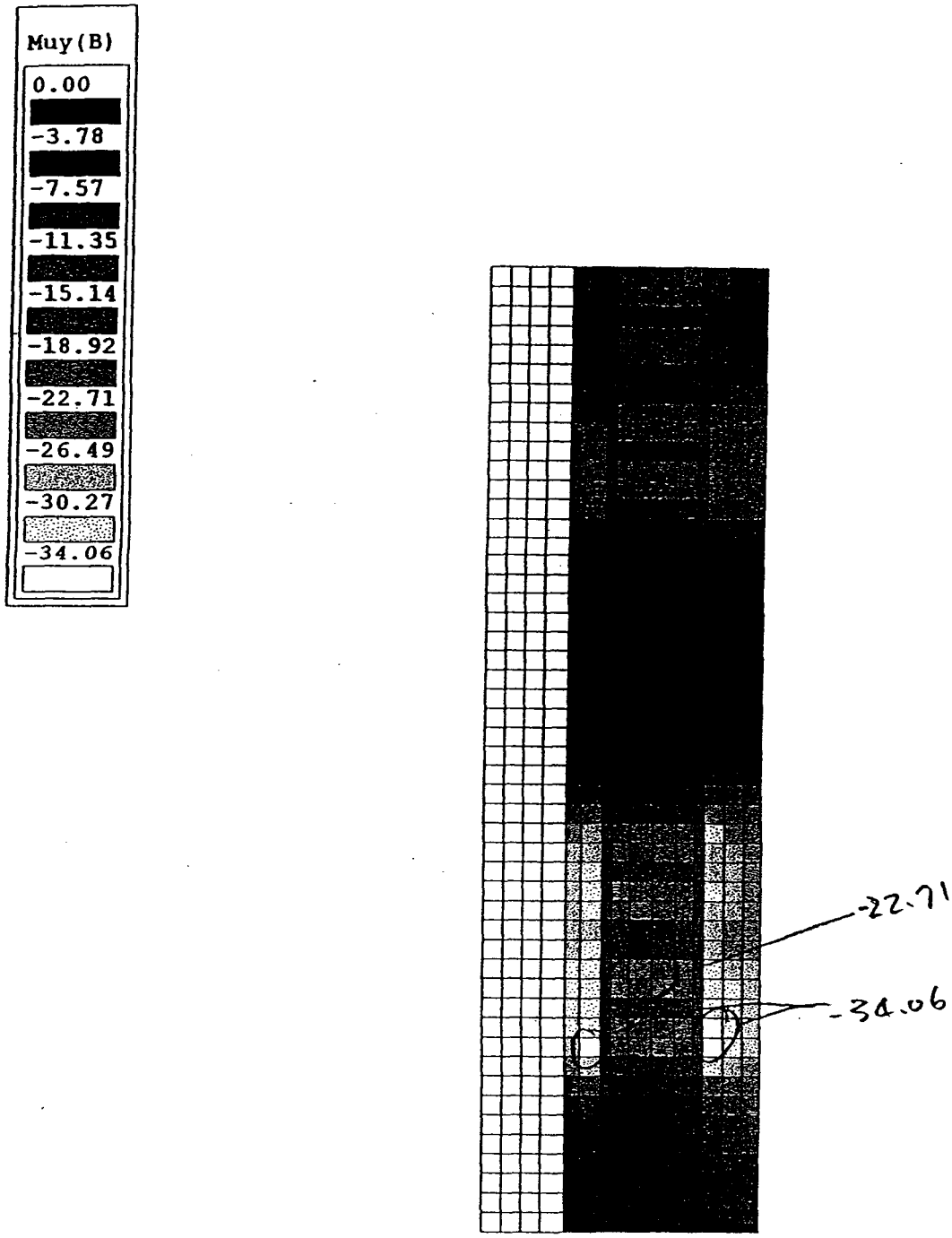
New Bedford - Dewatering - rail track fnd.
Maximum Moment (kip-ft/ft)



New Bedford - Dewatering - rail track fnd.
Maximum Moment (kip-ft/ft)

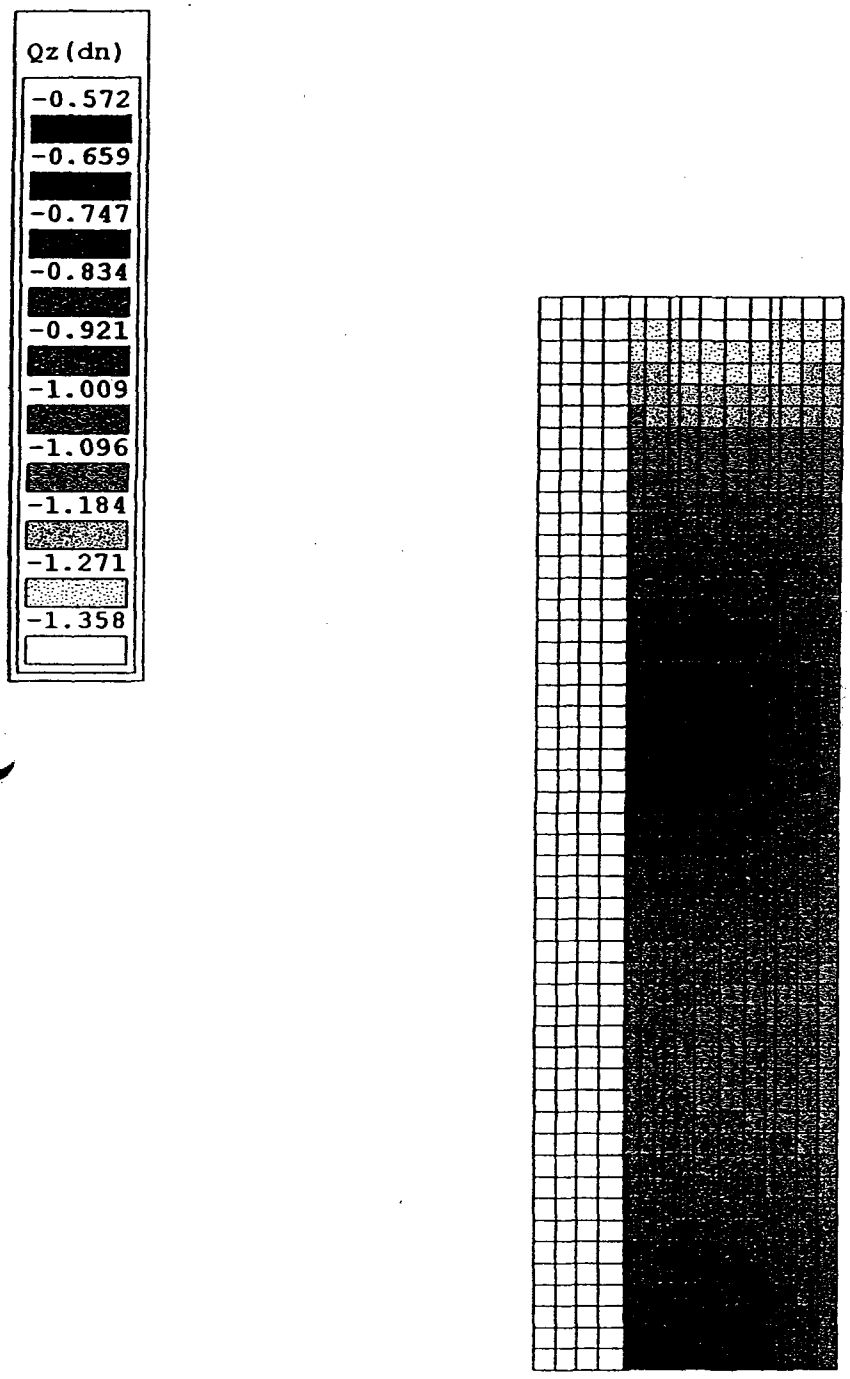


New Bedford - Dewatering - rail track fnd.
Maximum Moment (kip-ft/ft)

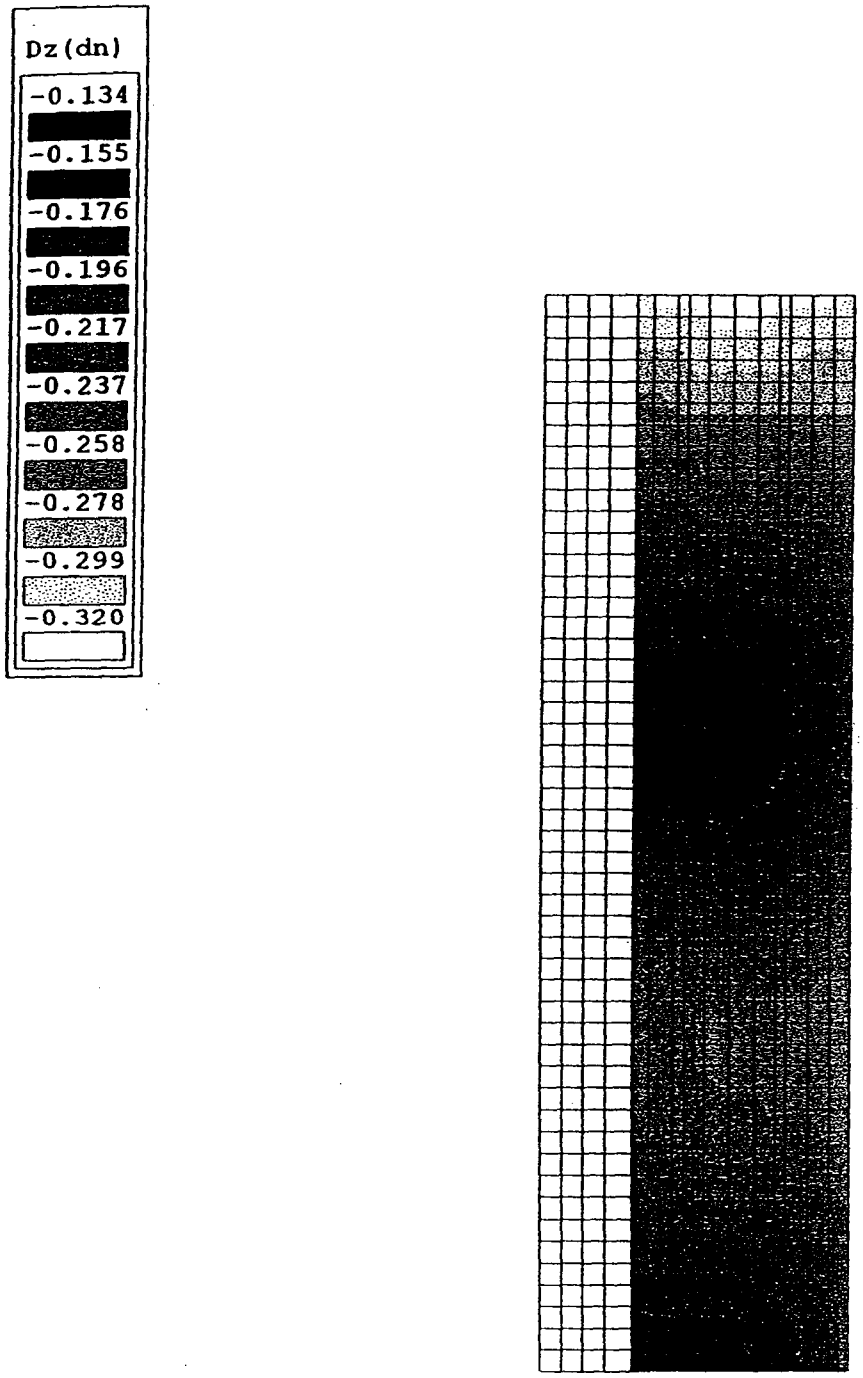


THERE ARE NO SIGNIFICANT CHANGES COMPARED WITH 90% DESIGN MOMENT OUTPUTS. THEREFOR, NO REVISE ON REINFORCEMENT DESIGN.

New Bedford - Dewatering - rail track fnd.
Pressure (ksf)



New Bedford - Dewatering - rail track fnd.
Displacement (in.)



FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	25-Jan-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - rail slab	Date:	
	Mux(T)	Page	of

Exposure: O Interior ● Exterior

Member: O Beam ● Slab

Bar Size: O #3 O #4 O #5 ● #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Stirrup Size: ● None O #3 O #4 O #5 O #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Factored Moment =	31 kips*ft		
Average Load Factor =	1.55		
Service Moment =	240 kips*in		
Bar Spacing =	8 in		
Width, b =	12 in		
Slab Thickness=	18 in		
cover =	2.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	15.625 in
ϕ =	0.9	#Bars =	1.5
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.66 in^2

#6 @ 8 in. spacing

Moment Check

w =	0.036035		
ρ =	0.002402		
$A_{srequired}$ =	0.450437 in^2	ok	
β =	0.85		
ρ_b =	0.028507		
ρ_{max} =	0.02138		
A_{max} =	4.008769 in^2	ok	
(ACI 10.5.3) ρ_{min} =	0.003333		
A_{min} =	0.6250 in^2		
$4/3*A_{srequired}$ =	0.600582 in^2	ok	

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	2.375 in	
A=	38 in^2	
NA =	3.302161 mm	
f_s =	25.03645 ksi	
z=	112.3022 kips/in	
Required =	128.8889 kips/in	ok

ACI-350 Check

Z =	115 kips/in	ok
fs =	25.03645 ksi	
Max Spacing =	12 in	ok
Actual -> ρ =	0.00352	

$w = 0.85 - (SQRT(.7225-)(1.7*M_{factored}/(\phi*f'_c*b*d^2)))$

$\rho = w*f'_c/f_y$

$A_{srequired} = \rho*b*d$

$\beta = 0.85-0.05(f'c-4000)/1000$

$\rho_b = 0.85*(\beta*(f'c/fy)*(87/(87+fy))$

$\rho_{max} = 0.75*\rho_b$

$A_{max} = \rho_{max}*b*d$

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

$A_{min} = \rho_{min}*b*d$

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	25-Jan-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - rail slab	Date:	
	Muy(T)	Page	of

Exposure: O Interior ● Exterior

Member: O Beam ● Slab

Bar Size: O #3 O #4 O #5 ● #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Stirrup Size: ● None O #3 O #4 O #5 O #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Factored Moment =	37 kips*ft		
Average Load Factor =	1.55		
Service Moment =	286 kips*in		
Bar Spacing =	8 in		
Width, b =	12 in		
Slab Thickness=	25 in		
cover =	2.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	22.625 in
ϕ =	0.9	#Bars =	1.5
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.66 in^2

#6 @ 8 in. spacing

Moment Check

	w =	0.020321	
	ρ =	0.001355	
	$A_{srequired}$ =	0.36781 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	5.804698 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.9050 in^2	
	$4/3*A_{srequired}$ =	0.490413 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	2.375 in	
A=	38 in^2	
NA =	4.053805 mm	
f_s =	20.40157 ksi	
z=	91.51228 kips/in	
Required =	128.8889 kips/in	ok

ACI-350 Check

Z =	115 kips/in	ok
fs =	20.40157 ksi	
Max Spacing =	12 in	ok
Actual -> ρ =	0.002431	

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	25-Jan-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - rail slab	Date:	
	Mux(B), Muy(B)	Page	of

Exposure: ○ Interior ● Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	43 kips*ft		
Average Load Factor =	1.55		
Service Moment =	333 kips*in		
Bar Spacing =	5 in		
Width, b =	12 in		
Slab Thickness=	18 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	14.625 in
ϕ =	0.9	#Bars =	2.4
Normal/Severe exposure (0/1) =	0	A_{steel}=	1.056 in^2

#6 @ 5 in. spacing

Moment Check

	w =	0.05781	
	ρ =	0.003854	
	$A_{srequired}$ =	0.676372 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	3.752208 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.5850 in^2	
	$4/3*A_{srequired}$ =	0.901829 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	33.75 in^2	
NA =	3.897242 mm	
f_s =	23.65685 ksi	
z=	114.6761 kips/in	
Required =	128.8889 kips/in	ok

ACI-350 Check

Z =	115 kips/in	ok
fs =	23.65685 ksi	
Max Spacing =	12 in	ok
Actual -> ρ =	0.006017	

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

Building Sump

1. DEAD LOADS (CASE A)

(1) SLAB SELF:

(2) FLOOR DOOR: ASSIGN $-0.5^K \times 9 = -4.5^K$ TOTAL ON EACH OPENING (i.e. -0.5^K ON EACH NODE)

2. LIVE LOADS

(1) 750 PSF DISTRIBUTION LOAD – ENTIRE SLAB

(2) 750 PSF ON FLOOR DOOR:

$750 \times (5' \times 5') = 18,750$ LB

$18.75^K / 9 = 2.08^K$ / NODE

(CASE B)

(3) H20-44 TRUCK (CASE C)

ASSUME THE TRUCK ACCIDENTALLY BACK UP ON TOP OF THE SLAB – TWO 16^K WHEEL LOADS SPACE AT ~ 6'

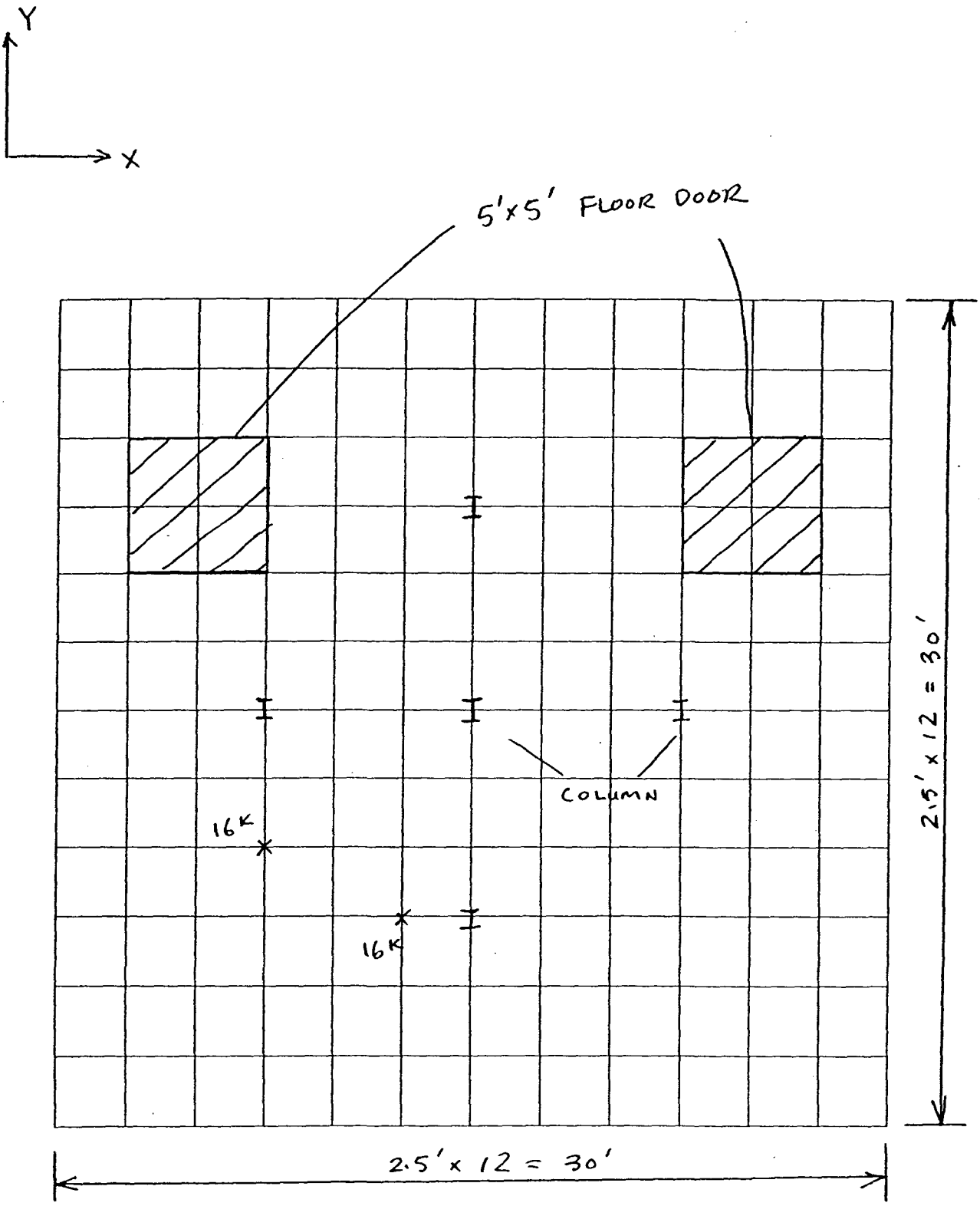
LOAD COMBINATION:

SERVICE: $S_1 = A + B$ ULTIMATE: $U_1 = 1.4A + 1.7B$

$S_2 = A + C$ $U_2 = 1.4A + 1.7C$

SET D_Z RESTRAINTS AT SLAB EDGE NODES TO SIMULATE THE WALL-SUPPORT. ASSIGN VERY SOFT DUMMY SOIL ($K_s = 0.0001$ KCF, $Q_a = 0.1$ KSF) UNDERNEATH THE SLAB TO SIMULATE SUSPENSION CONDITION. AT EVERY COLUMN LOCATION, SET $D_Z = 0$, TOO.

New Bedford - Dewatering Fnd. - sump top
Slab Mesh



A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering Fnd. - sump top
Engineer: JZ
File : C:\PROJECTS\NEWBED~1\DEWATER\100%SUB\SUMPTOP%.MAT
Units : English Date : 01/11/02
Code : ACI 318-99 Time : 09:46:13

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 75.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 167
Number of elements = 136

A2 - THICKNESS DEFINITIONS:

Label	t (in)
thick-1	12.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc-1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
fake	0.0001	0.1

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel-1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP	2.7500	3.0000	2.7500	3.0000	0.1800 %

A8 - SLAVED NODES GROUP DEFINITIONS:

Label	DOF	Label	DOF
wallRx	Rx	wallRy	Ry

A9 - NODAL LOAD DEFINITIONS:

Label	Case	Pz (kip)	Mx (kip-ft)	My (kip-ft)
fldoor	A	-0.5	0	0
fldoor	B	-2.08	0	0
H20	C	-16	0	0

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
live	B	-750

A11 - LOAD COMBINATIONS:

Self weight is included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	1.000	0.000	0.000	0.000	0.000	Ser.	Yes
S2	1.000	0.000	1.000	0.000	0.000	0.000	Ser.	Yes
U1	1.400	1.700	0.000	0.000	0.000	0.000	Ult.	Yes
U2	1.400	0.000	1.700	0.000	0.000	0.000	Ult.	Yes

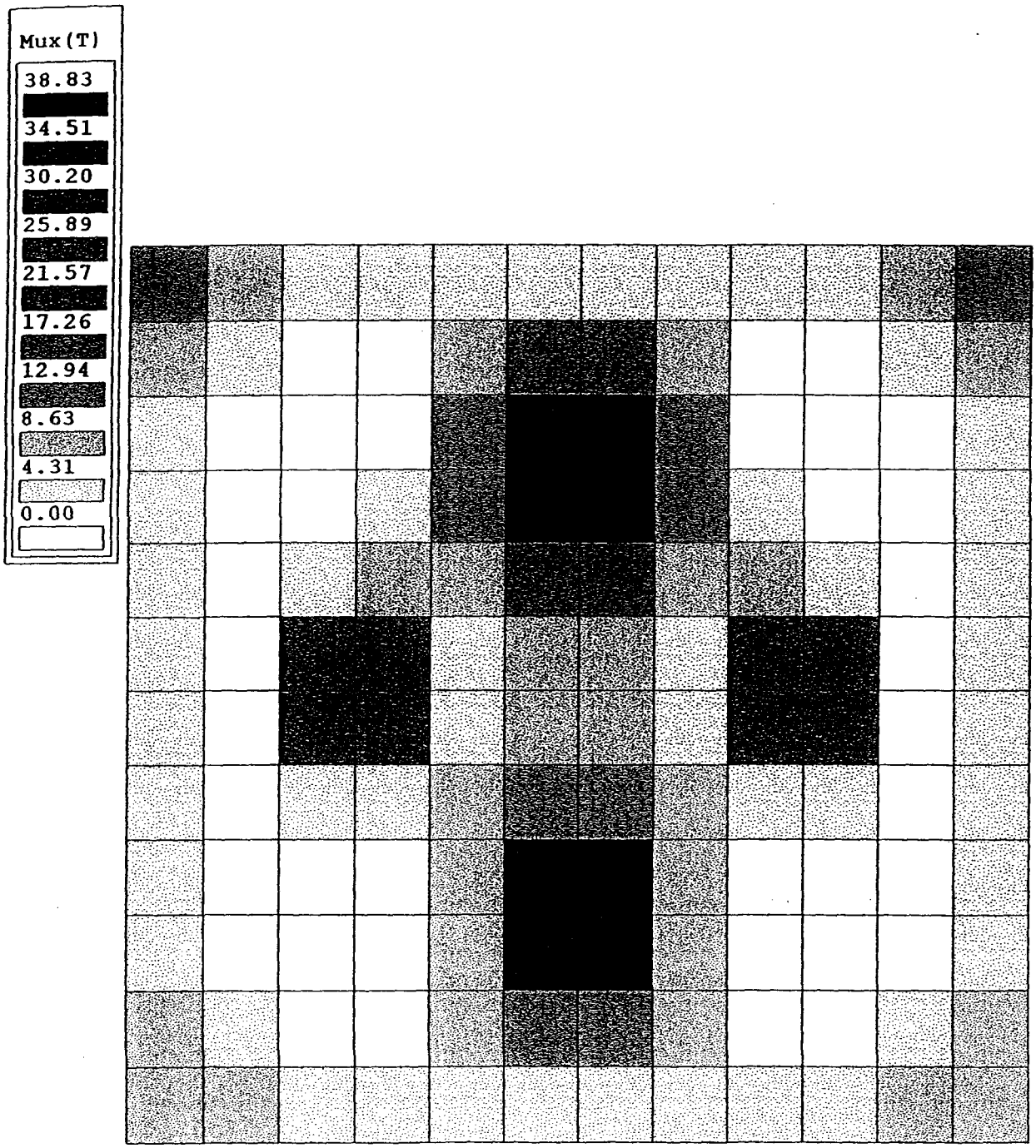
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2.5	3	5
4	7.5	5	10	6	12.5
7	15	8	17.5	9	20
10	22.5	11	25	12	27.5
13	30				

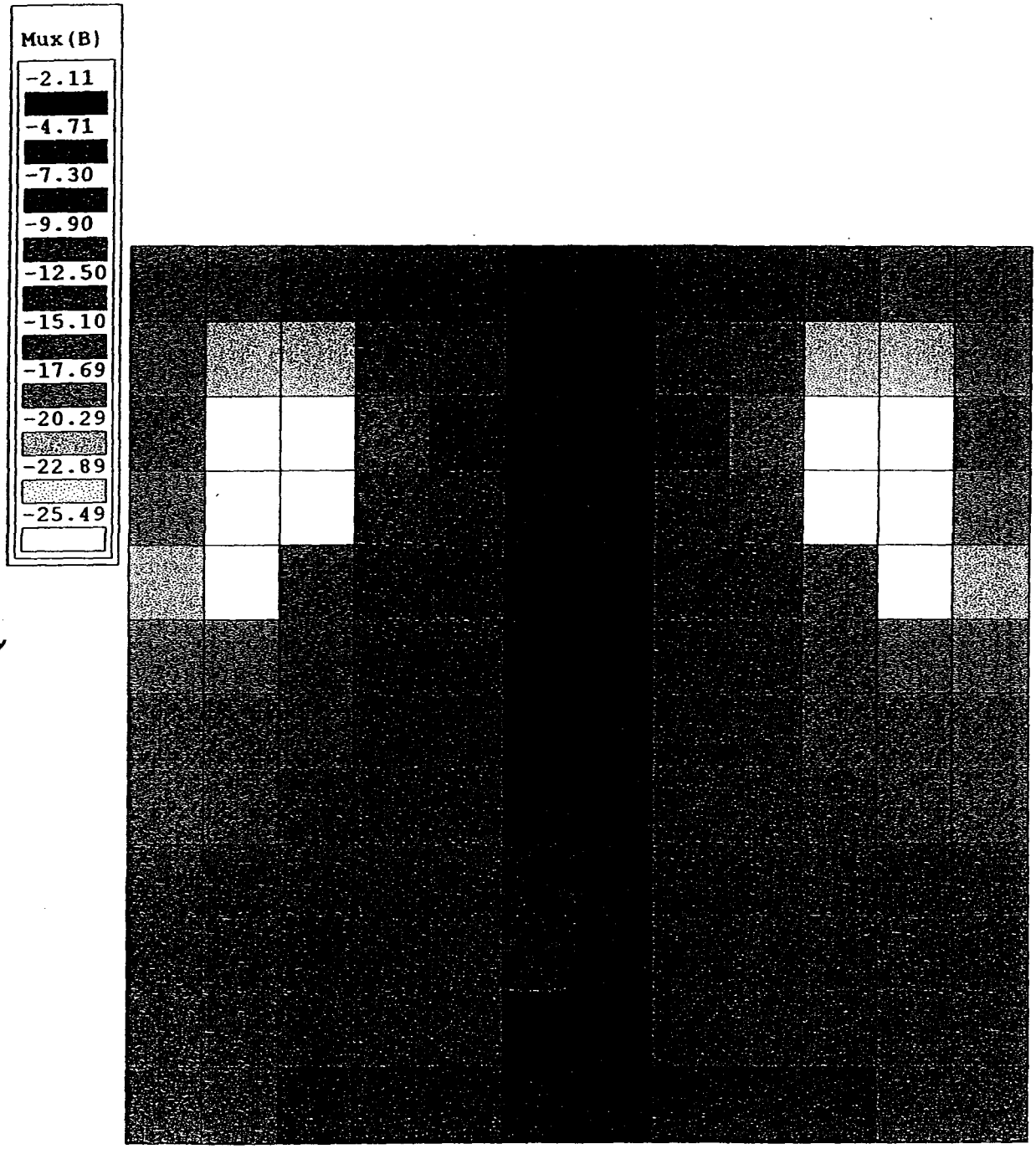
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2.5	3	5
4	7.5	5	10	6	12.5
7	15	8	17.5	9	20
10	22.5	11	25	12	27.5
13	30				

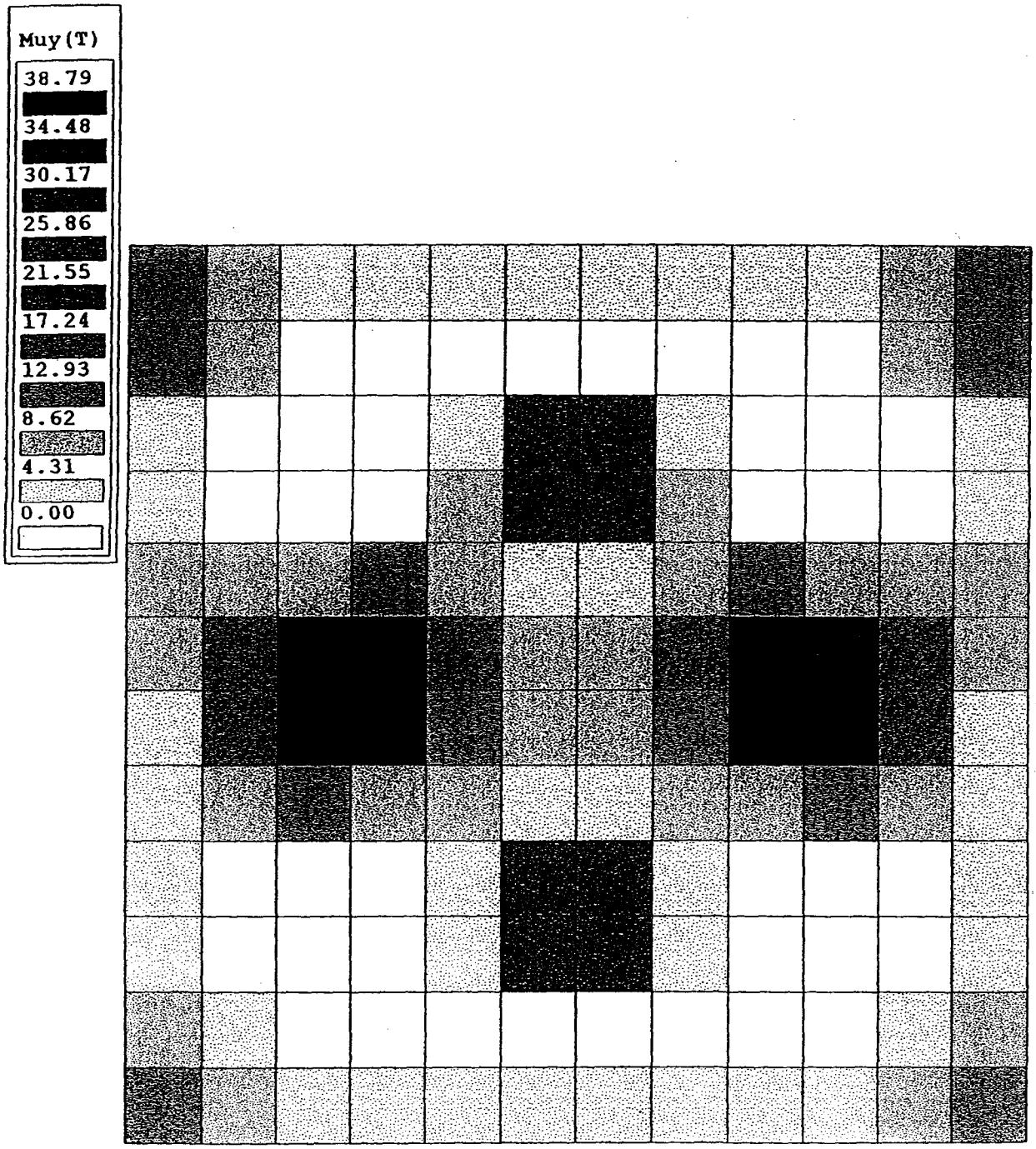
New Bedford - Dewatering Fnd. - sump top
Maximum Moment (kip-ft/ft)



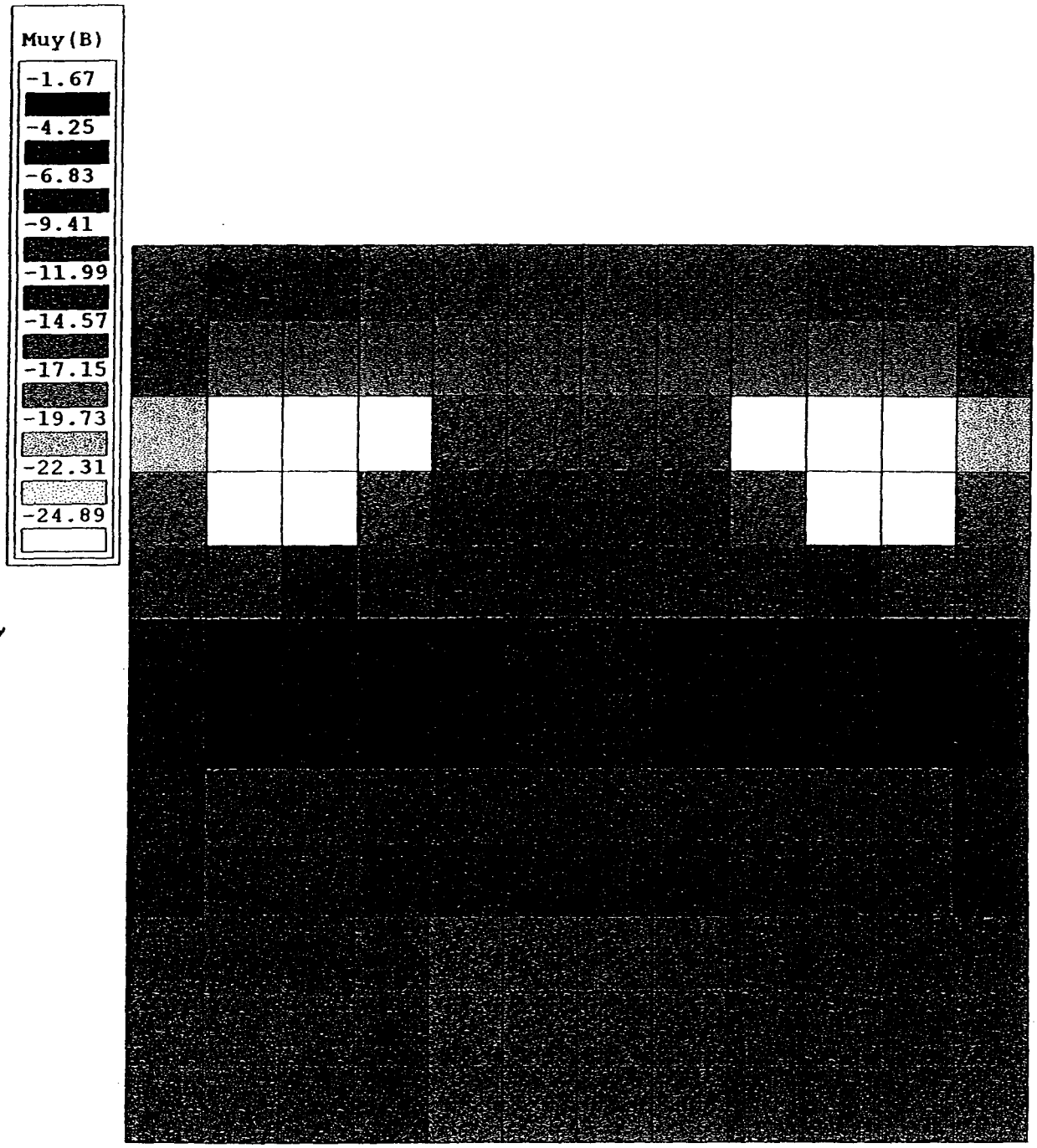
New Bedford - Dewatering Fnd. - sump top
Maximum Moment (kip-ft/ft)



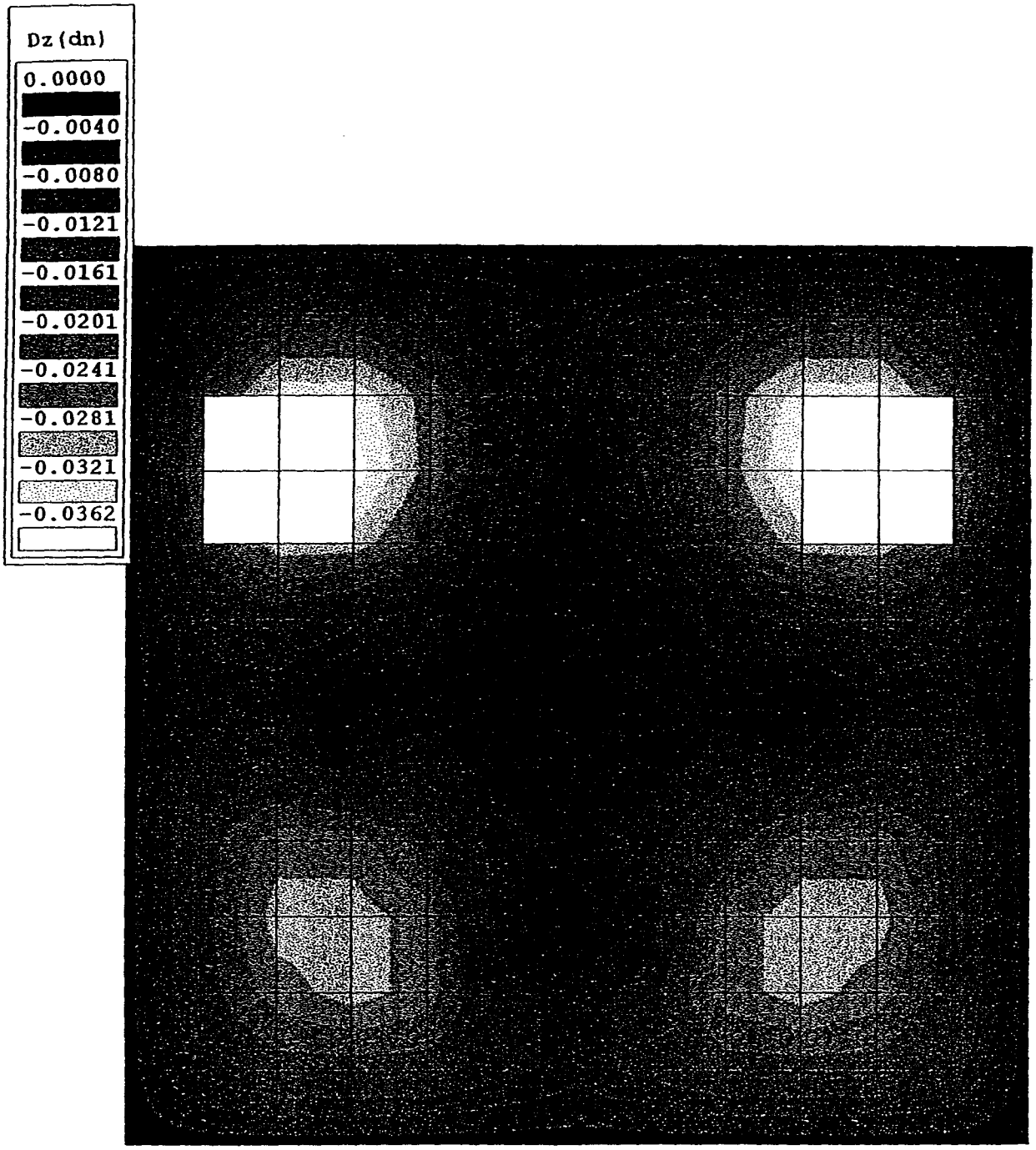
New Bedford - Dewatering Fnd. - sump top
Maximum Moment (kip-ft/ft)



New Bedford - Dewatering Fnd. - sump top
Maximum Moment (kip-ft/ft)



New Bedford - Dewatering Fnd. - sump top
Displacement (in.)



FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	9-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - sump top slab	Date:	
	Mu.design	Page	of

Exposure: ● Interior ○ Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	39 kips*ft		
Average Load Factor =	1.55		
Service Moment =	302 kips*in		
Bar Spacing =	5 in		
Width, b =	12 in		
Slab Thickness=	12 in		
cover =	2.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	9.625 in
ϕ =	0.9	#Bars =	2.4
Normal/Severe exposure (0/1) =	0	A_{steel}=	1.056 in^2

#6 @ 5 in. spacing

Moment Check

	w =	0.126327	
	ρ =	0.008422	
	$A_{srequired}$ =	0.972715 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	2.469402 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.3850 in^2	
	$4/3*A_{srequired}$ =	1.296954 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	2.375 in	
A=	23.75 in^2	
NA =	3.050861 mm	
f_s =	33.21587 ksi	
z=	127.3859 kips/in	
Required =	155.5556 kips/in	ok

Bar spacing < two times the slab thickness

ACI-350 Check

	Z =	115 kips/in	no good
	fs =	33.21587 ksi	
	Max Spacing =	6.316715 in	ok
Actual ->	ρ =	0.009143	

$w = 0.85 - (SQRT(.7225-)(1.7*M_{factored}/(\phi*f'_c*b*d^2)))$

$\rho = w*f'_c/f_y$

$A_{srequired} = \rho*b*d$

$\beta = 0.85-0.05(f'c-4000)/1000$

$\rho_b = 0.85*(\beta*(f'c/fy)*(87/(87+fy))$

$\rho_{max} = 0.75*\rho_b$

$A_{max} = \rho_{max}*b*d$

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

$A_{min} = \rho_{min}*b*d$

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

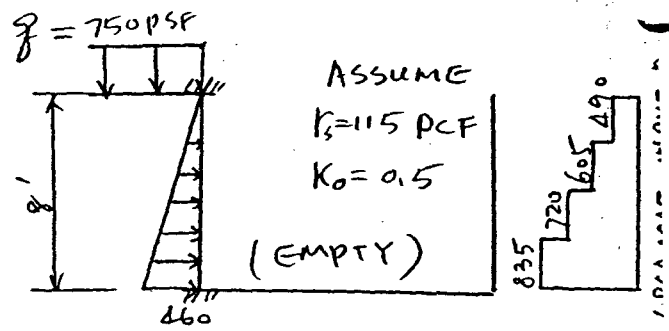
fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

quired = (175 or 145)*1.2/β

SUMP - WALL SLAB

1) SOIL LOAD (CASE A)



$K_o \gamma_s h = 0.5 \times 115 \times 8'$

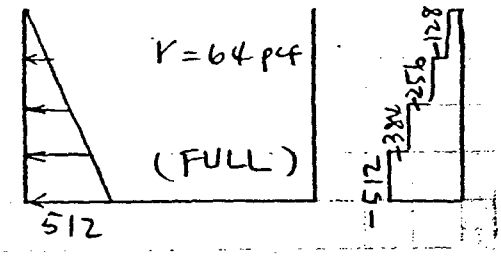
$= 460$ PSF

$K_o \cdot q = 0.5 \times 750$

$= 375$ PSF

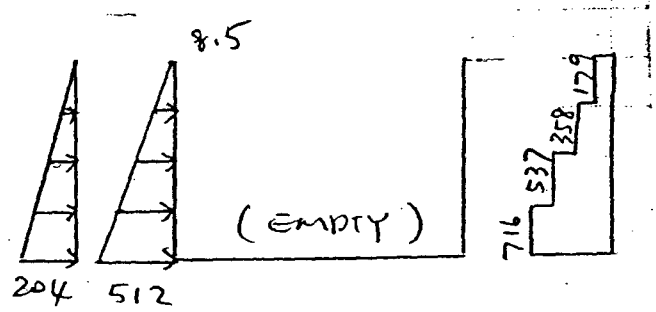
460
+) 375
835 PSF

2) LIQUID IN SUMP (CASE B)



$\gamma h = 64 \times 8 = 512$ PSF

3) 100 YR FLOOD (CASE C)



PER NICK'S EMAIL, USE
8.5' FLOOD EL.
PER, JOE'S EMAIL, USE
9.5' FLOOR EL.
CONSIDER 12" FLOOR SLAB

SOIL PRESSURE:

$K_o(\gamma_s - \gamma)h$

$= 0.5(115-64) \cdot 8$

$= 204$ PSF

USE PCAMATS. MODEL THE SLAB AS EDGE SUPPORTED SLAB.

LOAD COMBINATION:

SERVICE: $S_1 = A + B + C$

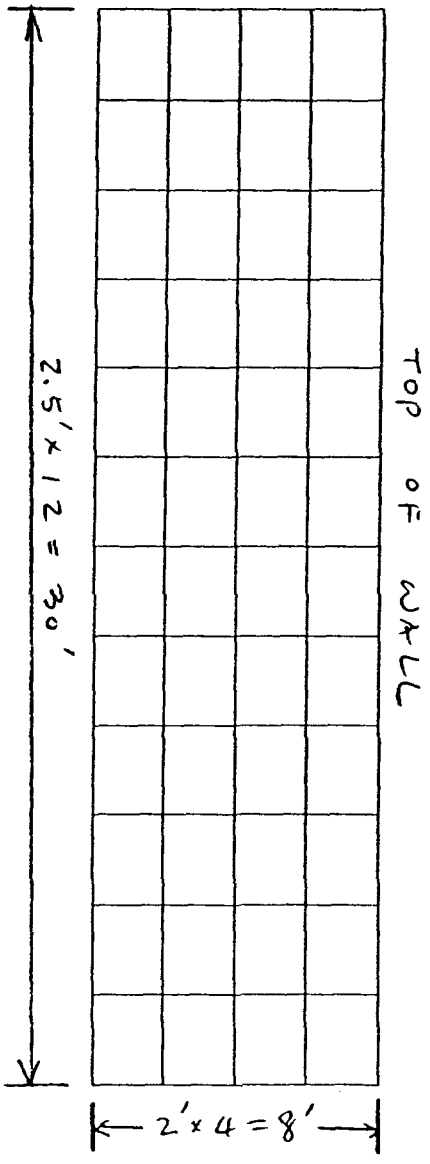
ULTIMATE: $U_1 = 1.7\,A$

$U_2 = 1.7\,B$

$U_3 = 1.7\,C$

~~64~~

New Bedford - Dewatering Fnd. -sump wall
Sump Wall Mesh



```
oooooooo      oooooo      ooooo
oooooooo    oooooooo    ooooooo
oo    oo    oo    oo    oo   oo
oo    oo    oo          oo   oo
oooooooo    oo          ooooooo   ooooo
ooooooo     oo    oo    ooooooo   ooooo
oo          oooooooo    oo   oo
oo           oooooo     oo   oo

oo      oo                    o
ooo    ooo                   oo
oooo  oooo      ooooo        oo        ooooo
oo oooo oo     o    oo       oo       oo    o
oo  oo  oo      oooooo     oooooo     oo
oo      oo     oo   oo       oo        ooooo
oo      oo     oo   oo       oo            oo
oo      oo     oo   oo       oo  o    o    oo
oo      oo      ooooo o      ooo      ooooo  (TM)
```

==========

PCA-Mats (tm) - A Computer Program for:
Finite Element Analysis of Slabs, Mats and Combined Footings

==========

Copyright 1988-1995, Portland Cement Association
All rights reserved

Licensee stated above acknowledges that Portland Cement Association (PCA) is not and cannot be responsible for either the accuracy or adequacy of the material supplied as input for processing by the PCA-Mats computer program. Furthermore, PCA neither makes any warranty expressed nor implied with respect to the correctness of the output prepared by the PCA-Mats program. Although PCA has endeavored to produce PCA-Mats error free the program is not and cannot be certified infallible. The final and only responsibility for analysis, design and engineering documents is the licensees. Accordingly, PCA disclaims all responsibility in contract, negligence or other tort for any analysis, design or engineering documents prepared in connection with the use of the PCA-Mats program.

A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering Fnd. -sump wall
Engineer: JZ
File : C:\PROJECTS\NEWBED-1\DEWATER\SUMP-WAL.MAT
Units : English Date : 01/15/02
Code : ACI 318-99 Time : 09:47:47

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 25.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 65
Number of elements = 48

A2 - THICKNESS DEFINITIONS:

Label	t (in)
thick-1	12.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc-1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
dummy	0.0001	0.1

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel-1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP-1	2.7500	3.0000	2.7500	3.0000	0.1800 %

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
soil-1	A	835
soil-2	A	720
soil-3	A	605
soil-4	A	490
L-1	B	-512
L-2	B	-384
L-3	B	-256
L-4	B	-128
Flood-1	C	716
Flood-2	C	537
Flood-3	C	358
Flood-4	C	179

A11 - LOAD COMBINATIONS:

Self weight is not included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	1.000	1.000	0.000	0.000	0.000	Ser.	Yes
U1	1.700	0.000	0.000	0.000	0.000	0.000	Ult.	Yes
U2	0.000	1.700	0.000	0.000	0.000	0.000	Ult.	Yes
U3	0.000	0.000	1.700	0.000	0.000	0.000	Ult.	Yes

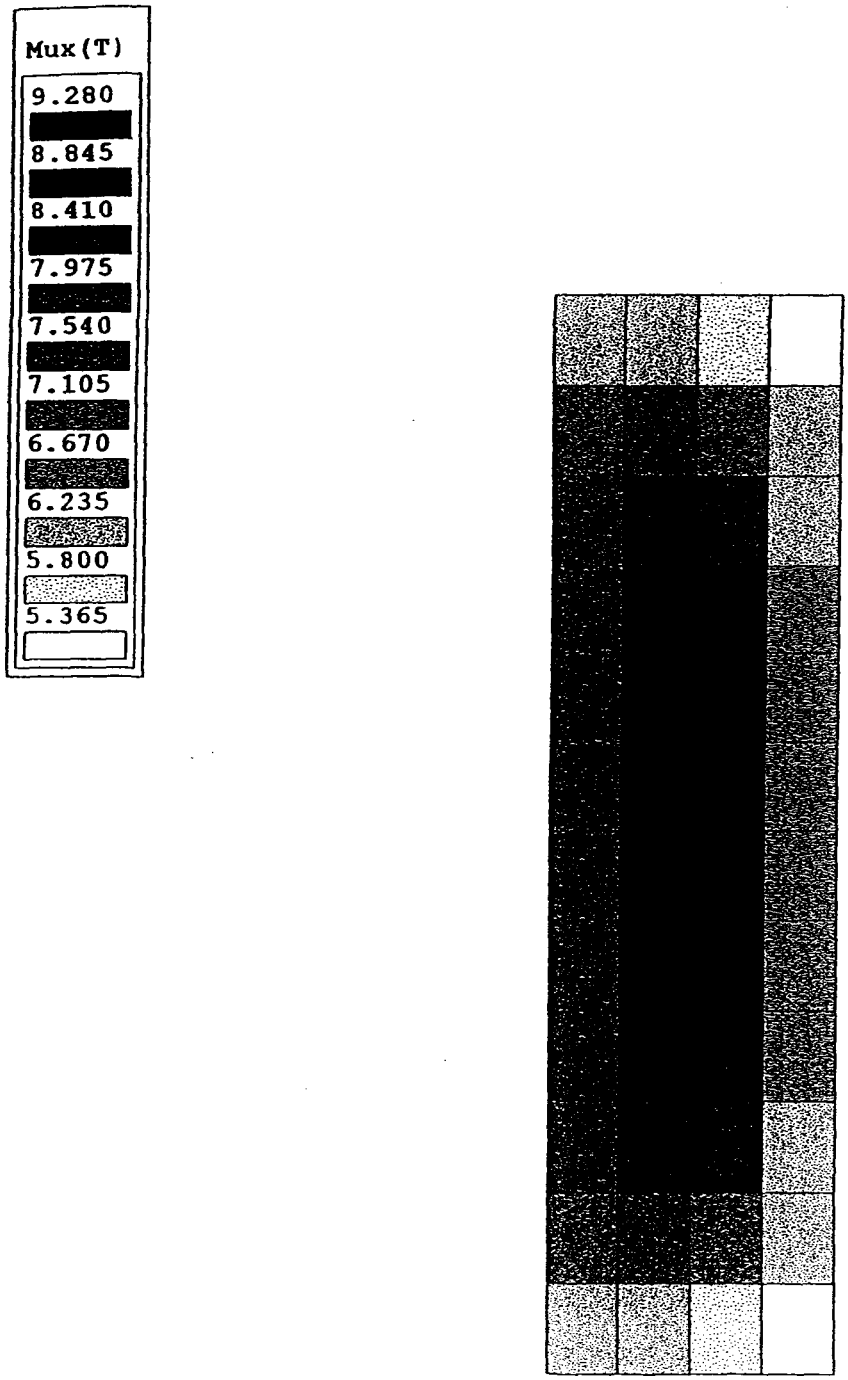
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2	3	4
4	6	5	8		

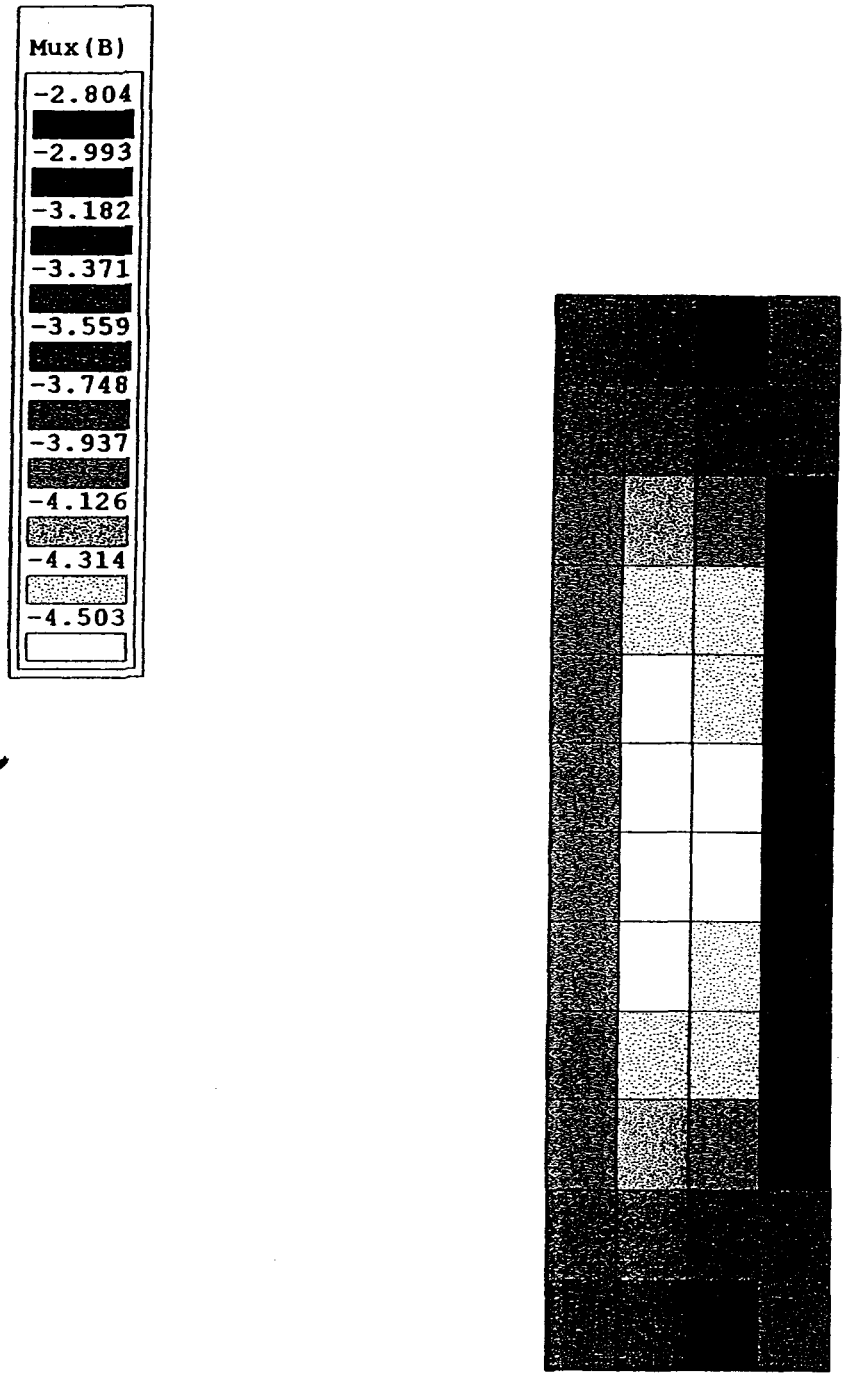
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	0	2	2.5	3	5
4	7.5	5	10	6	12.5
7	15	8	17.5	9	20
10	22.5	11	25	12	27.5
13	30				

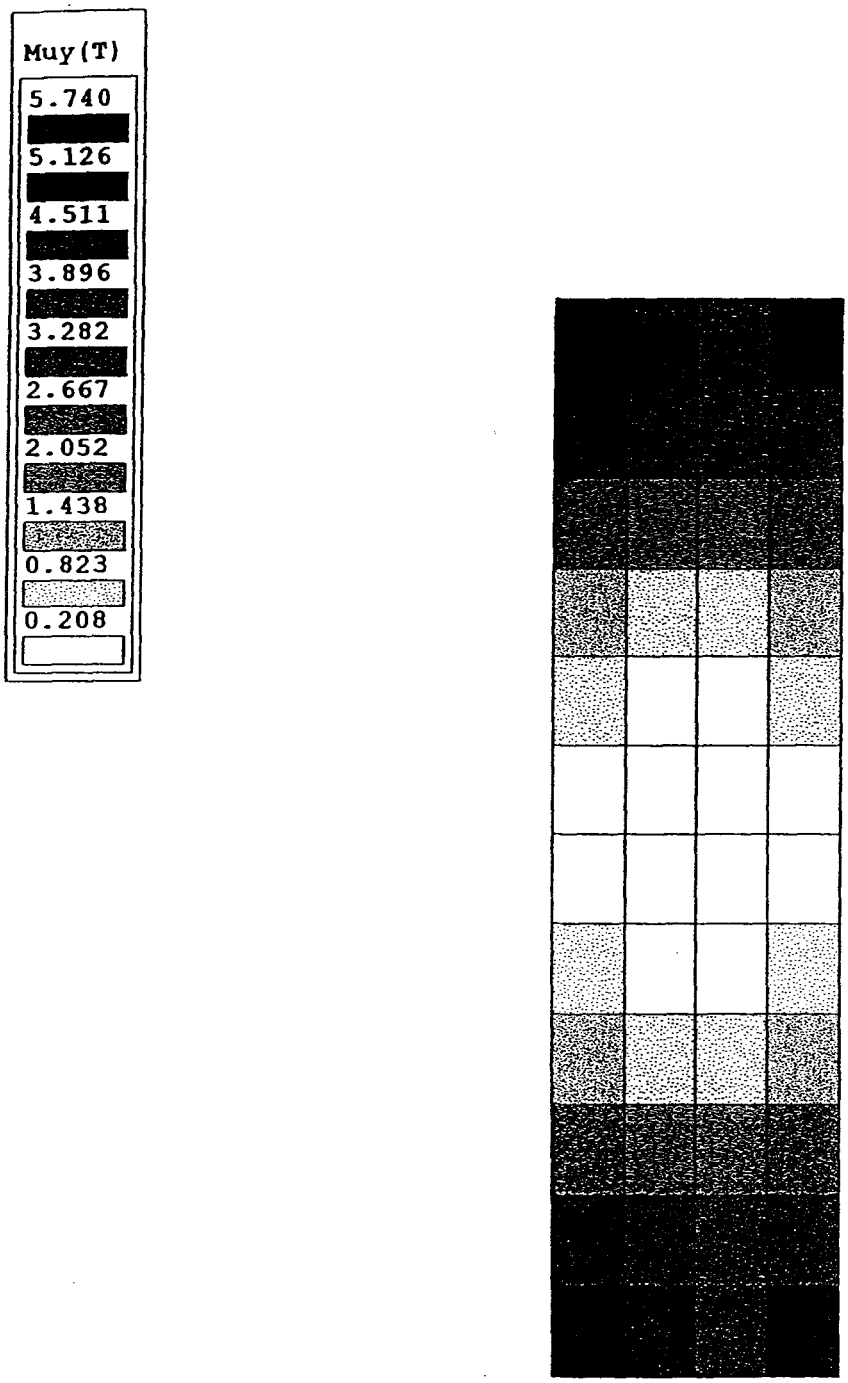
New Bedford - Dewatering Fnd. -sump wall
Maximum Moment (kip-ft/ft)



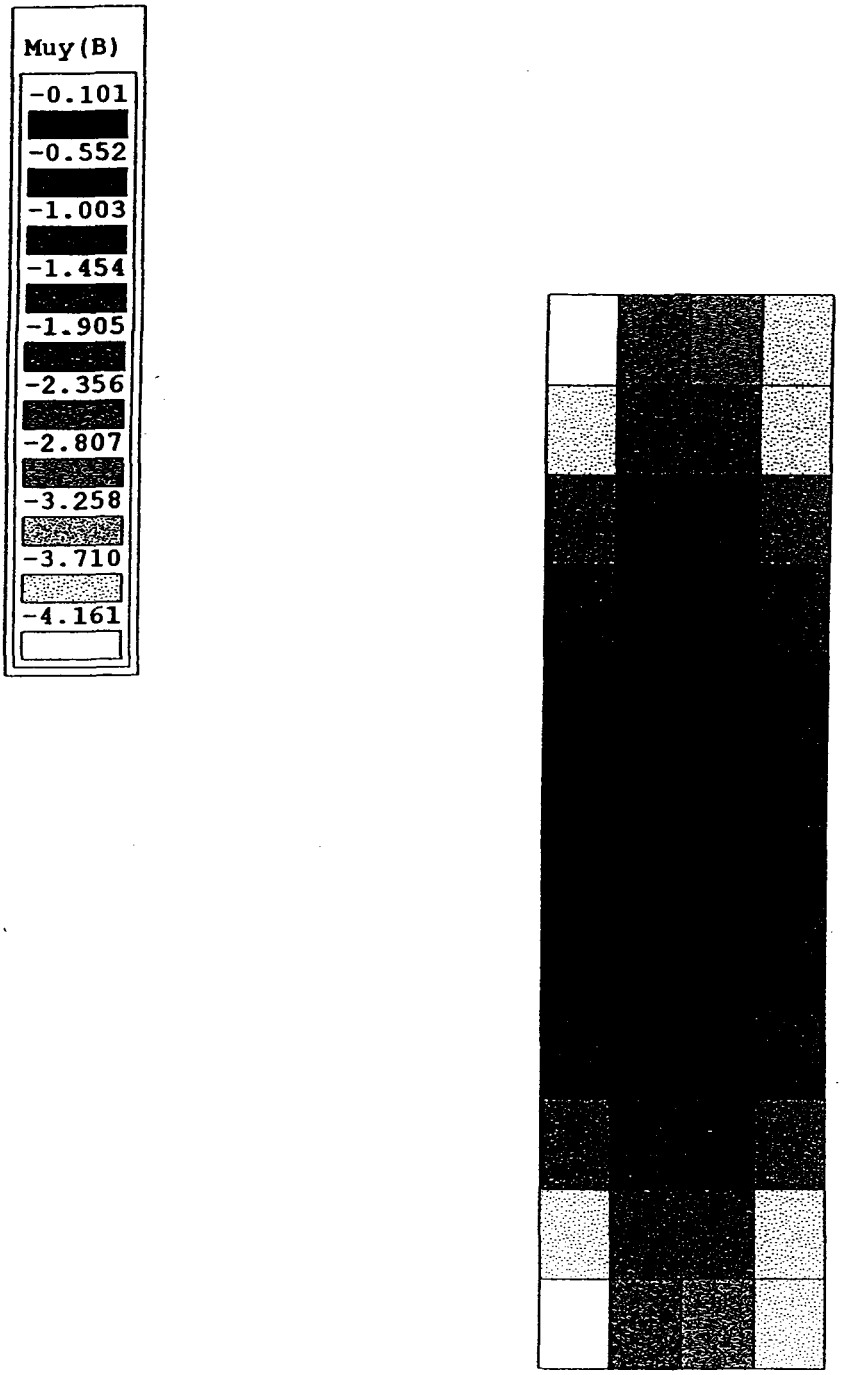
New Bedford - Dewatering Fnd. -sump wall
Maximum Moment (kip-ft/ft)



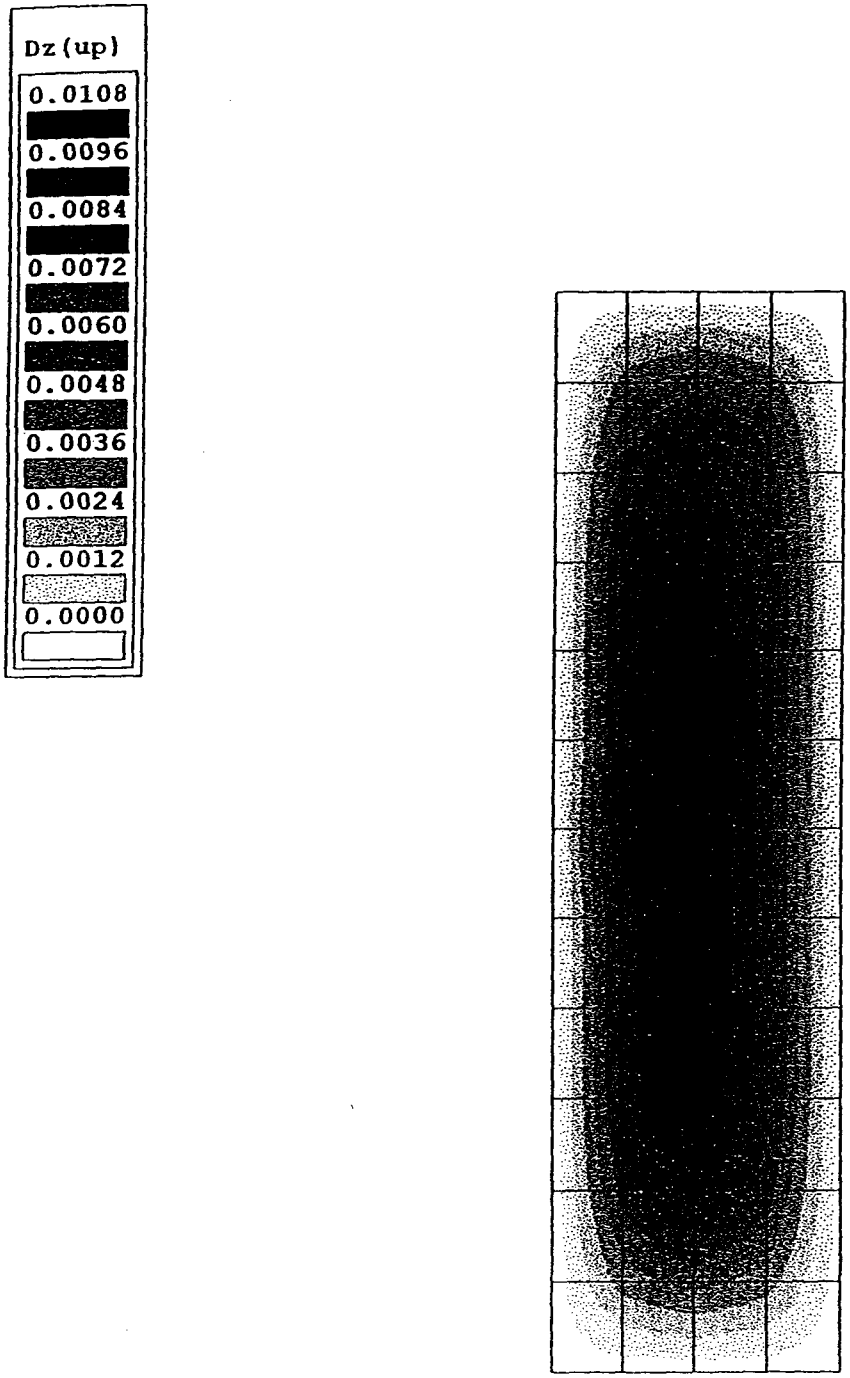
New Bedford - Dewatering Fnd. -sump wall
Maximum Moment (kip-ft/ft)



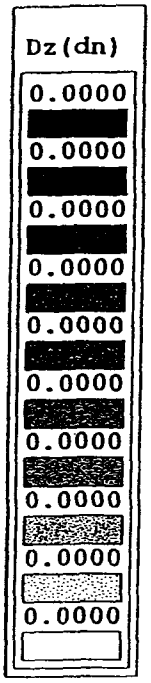
New Bedford - Dewatering Fnd. -sump wall
Maximum Moment (kip-ft/ft)

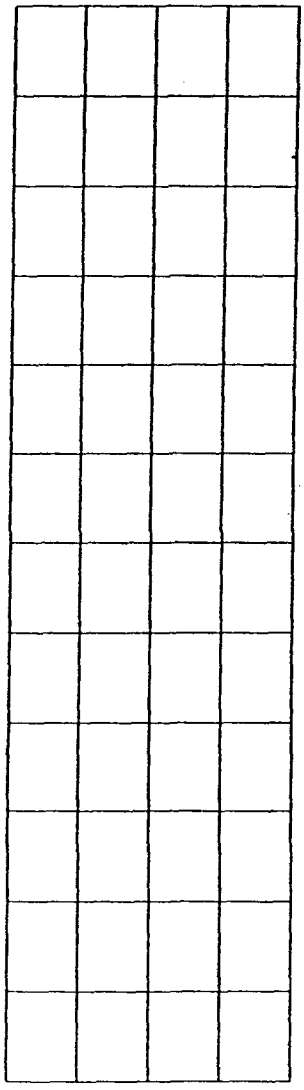


New Bedford - Dewatering Fnd. -sump wall
Displacement (in.)



New Bedford - Dewatering Fnd. -sump wall
Displacement (in.)





FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	16-Jan-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Sump Wall	Date:	
	Mux	Page	of

Exposure: ○ Interior ● Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	9.5 kips*ft		
Average Load Factor =	1.55		
Service Moment =	74 kips*in		
Bar Spacing =	10 in		
Width, b =	12 in		
Slab Thickness=	12 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	8.625 in
ϕ =	0.9	#Bars =	1.2
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.528 in^2

#6 @ 10 in. spacing

Moment Check

	w =	0.036246	
	ρ =	0.002416	
	$A_{srequired}$ =	0.250099 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	2.212841 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.3450 in^2	
	$4/3*A_{srequired}$ =	0.333465 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	67.5 in^2	
NA =	2.142239 mm	
f_s =	17.60809 ksi	
z=	107.5403 kips/in	
Required =	128.8889 kips/in	ok

ACI-350 Check

	Z =	115 kips/in	ok
	fs =	17.60809 ksi	
	Max Spacing =	12 in	ok
Actual ->	ρ =	0.005101	

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	16-Jan-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Sump Wall	Date:	
	Muy	Page	of

Exposure: O Interior ● Exterior

Member: O Beam ● Slab

Bar Size: O #3 O #4 O #5 ● #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Stirrup Size: ● None O #3 O #4 O #5 O #6 O #7 O #8 O #9 O #10 O #11 O #14 O #18

Factored Moment =	6 kips*ft		
Average Load Factor =	1.55		
Service Moment =	46 kips*in		
Bar Spacing =	12 in		
Width, b =	12 in		
Slab Thickness=	12 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	8.625 in
ϕ =	0.9	#Bars =	1
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.44 in^2

#6 @ 12 in. spacing

Moment Check

	w =	0.022708	
	ρ =	0.001514	
	$A_{srequired}$ =	0.156682 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	2.212841 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	0.3450 in^2	
	$4/3*A_{srequired}$ =	0.20891 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	81 in^2	
NA =	1.979919 mm	
f_s =	13.25442 ksi	
z=	86.02284 kips/in	
Required =	128.8889 kips/in	ok

ACI-350 Check

Z =	115 kips/in		ok
fs =	13.25442 ksi		
Max Spacing =	12 in		ok
Actual -> ρ =	0.004251		

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'c*b*d^2)))

ρ = w*f'c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY JZ DATE 4/15/02 SHEET 10 OF ____

CHKD. BY ____ DATE ____ OFS NO. ____ DEPT. NO. ____

CLIENT ____

PROJECT NEW BEDFORD - DEWATERING FACILITY FOUNDATION

SUBJECT BUILDING SUMP - BOTTOM SLAB

1. DEAD LOADS (CASE A)

(1) SLAB SELFWEIGHT: USE 18" THICKNESS (PER 100 yr FLOTATION CHECK, SEE FOLLOWING)

(2) SUMP WALL + TOP SLAB:

WALL: $31' \times 4 \times 6' \times 1' \times 0.15 = 112^K$

TOP SLAB: $32' \times 32' \times 1 \times 0.15 = 154^K$

INSTALL 5 INNER COLUMNS. ASSUME EACH COL TAKES $(112^K + 154^K)/(5+6) = 24.2^K$

EACH EDGE NODE TAKES (2.5' MESH):

$$\frac{(112+154) - 24.2 \times 5}{12 \times 2 + 13 \times 2} = 2.9^K$$

W14x90 COL WEIGHT: $90 \times 6' = 0.54^K$/COL

$$\begin{array}{r} 24.2^K \\ +)\ 0.54^K \\ \hline 24.7^K/\text{COL} \end{array}$$

2. LIVE LOADS

(1) 750 PSF LIVE LOAD TRANSFER FROM TOP (CASE B)

$0.75 \times 32' \times 32' = 768^K$

EACH COLUMN TAKES: $768/(5+6) = 69.8^K$

EACH EDGE NODE TAKES: $(768 - 69.8 \times 5)/(12 \times 2 + 13 \times 2) = 8.4^K$

(2) LIQUID (CASE C)

(a) PRESSURE ON TOP, ASSUME 64 LB/CF LIQUID DENSITY

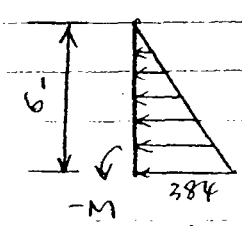
$64 \times 6' = 384$ PSF

(b) BENDING MOMENT ON SLAB EDGE

$-M = 0.5 \times 0.384 \times 6' \times \frac{6'}{3}$

$= -2.3^{K\text{-}FT}/FT$

$-2.3 \times 2.5' = -5.8$ K-FT/NODE



rh=

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 102 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT BUILDING SUMP – BOTTOM SLAB

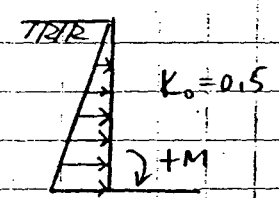
(C) EARTH PRESSURE (CASE D)

USE THE MOMENTS FROM THE SUMP WALL DESIGN

PER MUX(T) OUTPUT, FACTORED MAX. MOMENTS AT TOE OF THE SUMP WALL IS LESS THAN 8 KIP-FT/FT

$8/1.7 = 4.7$ K-FT/FT (UN-FACTORED)

$4.7 \times 2.5' = 11.8$ K-FT/NODE



(d) 100 yr - FLOOD (CASE E)

FLOOR EL = +9', BOTTOM EL = 9'-1'-6'-1.5' = +0.5'

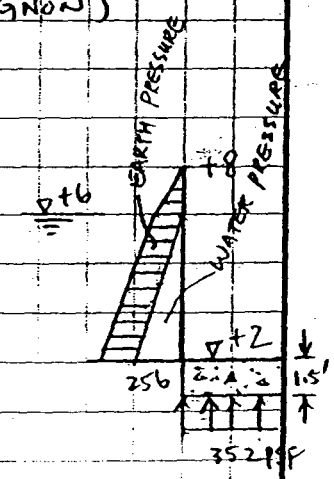
100 yr FLOOD = +6' (PER ANDREW TOGNONI)

* WATERHEAD $h = +6' - (+0.5') = 5.5'$

$p = rh = 64 \times 5.5' = 352$ PSF

* BENDING MOMENT ON SLAB EDGE

SINCE SIDE PRESSURE MAKES THE BOT. SLAB LESS CRITICAL, IT'S NOT INCLUDED.



LOAD COMBINATIONS

SERVICE:

$S_1 = A + D$ (EMPTY)

$S_2 = A + B + D$ (EMPTY)

$S_3 = A + B + C$ (FULL)

$S_4 = A + E$ (EMPTY + FLOOD)

ULTIMATE:

$U_1 = 1.4A + 1.7D$

$U_2 = 1.4A + 1.7B + 1.7D$

$U_3 = 1.4A + 1.7B + 1.7C$

$U_4 = 1.4A + 1.7E$

$U_5 = 0.9A + 1.7D$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 103 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

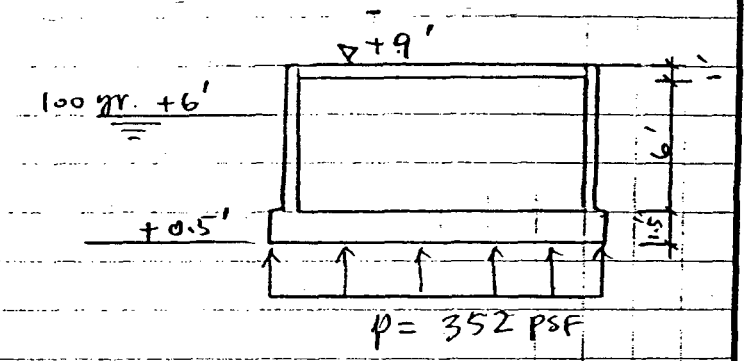
SUBJECT BUILDING SUMP – 100 yr FLOOD CHECK

THICKNESS OF

TOP SLAB = 12"

BOTTOM SLAB = 18"

WALL = 12"



$p = \gamma h$

$= 64 \times (6 - 0.5)$

$= 352$ PSF

(SEE ATTACHED EMAIL FOR THE ORIGINATION OF 100 yr. FLOOD ELEVATION)

SUMP BOTTOM AREA:

$(30' + 1' \times 2 + 0.5' \times 2)^2 = 1089$ SF

$1089 \times 352 \doteq 383^K$ ← FLOTATION FORCE ON SUMP

(1) SELF WEIGHT OF

BOTTOM SLAB: $1089 \times 1.5' \times 0.15 = 245^K$

TOP SLAB: $(30' + 1' \times 2)^2 \times 0.15 = 154^K$

WALLS: $(31' \times 4 \times 6' \times 1') \times 0.15 = 112^K$

$\Sigma = 511^K$

(2) SUBMERGED SOIL WEIGHT ON LIP OF BOTTOM SLAB

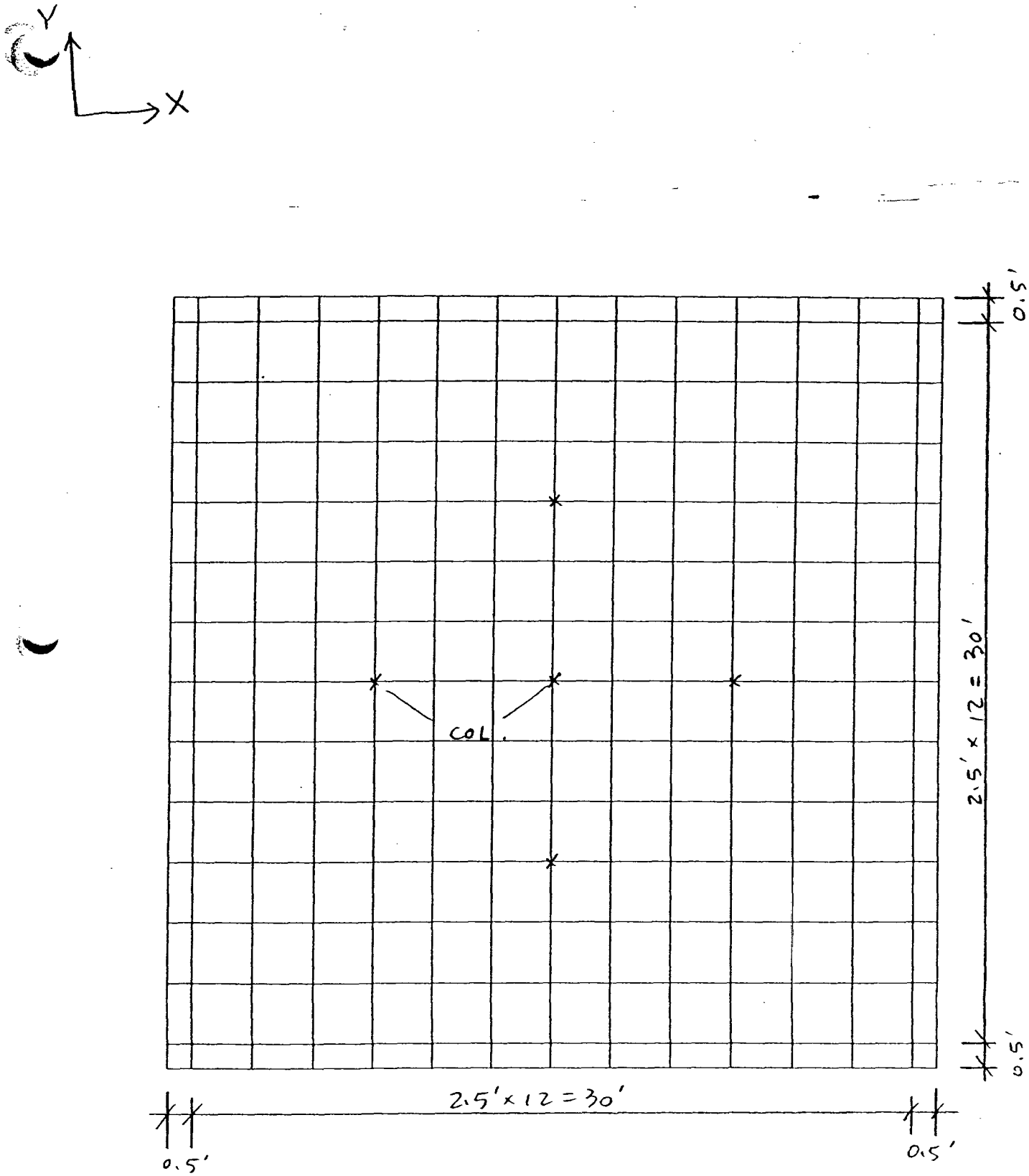
$30' \times 4 \times 0.5' \times (9' - 0.5' - 1.5')\,(115 - 64)/1000 = 21^K$

$(1) + (2) = 511 + 21 = 532^K$

SAFETY FACTOR $= 532^K / 383^K = 1.39$

SINCE SOIL FRICTION HAS NOT BEEN ACCOUNTED, THIS SF SHOULD BE OK.

New Bedford - Dewatering Fnd. - sump bottom
Mesh



A1 - GENERAL INFORMATION:

Project : New Bedford - Dewatering Fnd. - sump bottom
Engineer: JZ
File : C:\PROJECTS\NEWBED~1\DEWATER\100%SUB\SUMPBOT%.MAT
Units : English Date : 01/11/02
Code : ACI 318-99 Time : 09:46:13

Maximum number of iterations = 10
Maximum allowed displacement = 1 in
Minimum contact area allowed = 75.00 %
Displacement limit for uplift = 0 in
Reinforcement is based on maximum moment within an element.

Number of nodes = 225
Number of elements = 196

A2 - THICKNESS DEFINITIONS:

Label	t (in)
thick-1	18.00

A3 - CONCRETE DEFINITIONS:

Label	f'c (ksi)	Wc (pcf)	Ec (ksi)	v
conc-1	4	150	3834.3	0.000

A4 - SOIL DEFINITIONS:

Label	Ks (kcf)	Qa (ksf)
soil-1	51	4

A5 - REINFORCING STEEL DEFINITIONS:

Label	Fy (ksi)	Es (ksi)
steel-1	60	29000

A6 - DESIGN PARAMETERS DEFINITIONS:

Label	Top-X (in)	Top-Y (in)	Bot-X (in)	Bot-Y (in)	Min Reinf
DP	2.7500	3.0000	2.7500	3.0000	0.1800 %

A8 - SLAVED NODES GROUP DEFINITIONS:

Label	DOF	Label	DOF
wallRx	Rx	wallRy	Ry

A9 - NODAL LOAD DEFINITIONS:

Label	Case	Pz (kip)	Mx (kip-ft)	My (kip-ft)
wall+top	A	-2.9	0	0
column	A	-24.7	0	0
edge	B	-8.4	0	0
col	B	-69.8	0	0
-Mx	C	0	-5.8	0
+Mx	C	0	5.8	0
-My	C	0	0	-5.8
+My	C	0	0	5.8
-Mx	D	0	-11.8	0
+Mx	D	0	11.8	0
-My	D	0	0	-11.8
+My	D	0	0	11.8

A10 - SURFACE LOAD DEFINITIONS:

Label	Case	Wz (psf)
liquid	C	-384
flood	E	352

A11 - LOAD COMBINATIONS:

Self weight is included under Case A.

Ld Combo	Case A	Case B	Case C	Case D	Case E	Case F	Type	Save?
S1	1.000	0.000	0.000	1.000	0.000	0.000	Ser.	Yes
S2	1.000	1.000	0.000	1.000	0.000	0.000	Ser.	Yes
S3	1.000	1.000	1.000	0.000	0.000	0.000	Ser.	Yes
S4	1.000	0.000	0.000	0.000	1.000	0.000	Ser.	Yes
U1	1.400	0.000	0.000	1.700	0.000	0.000	Ult.	Yes
U2	1.400	1.700	0.000	1.700	0.000	0.000	Ult.	Yes
U3	1.400	1.700	1.700	0.000	0.000	0.000	Ult.	Yes
U4	1.400	0.000	0.000	0.000	1.700	0.000	Ult.	Yes
U5	0.900	0.000	0.000	1.700	0.000	0.000	Ult.	Yes

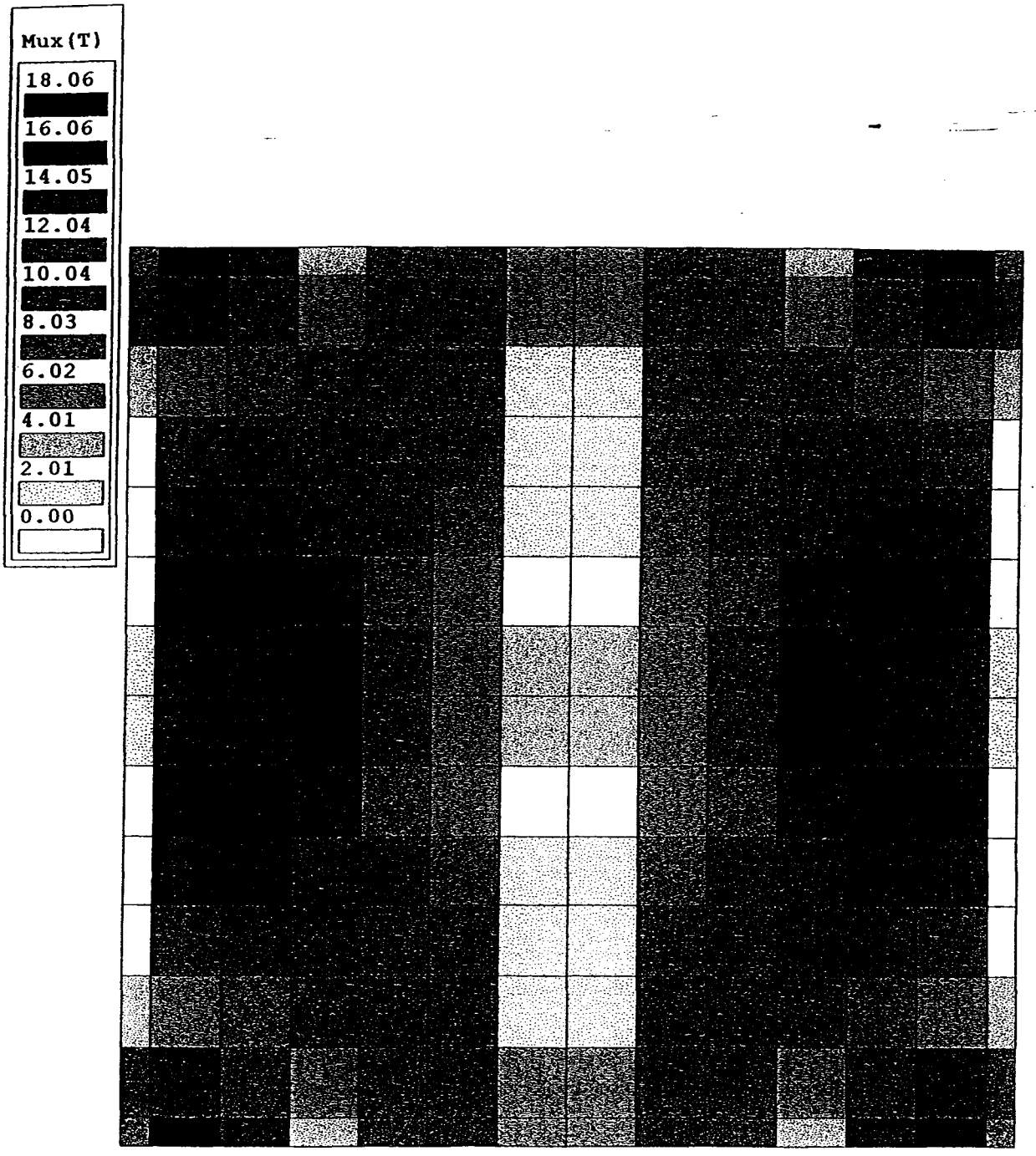
A12 - X-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	-1	2	0	3	2.5
4	5	5	7.5	6	10
7	12.5	8	15	9	17.5
10	20	11	22.5	12	25
13	27.5	14	30	15	31

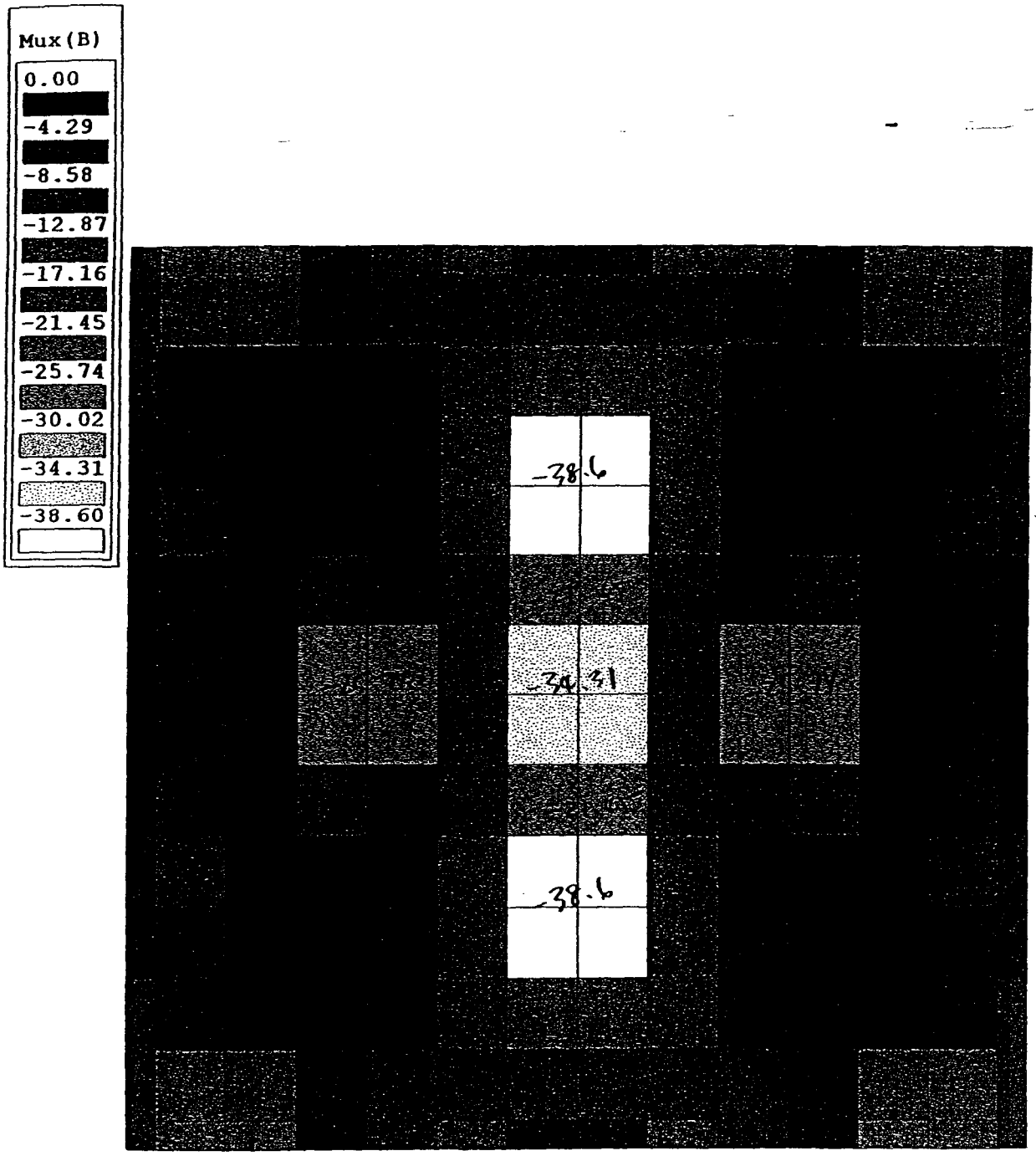
A13 - Y-GRID LINE DEFINITIONS:

No.	Coord. (ft)	No.	Coord. (ft)	No.	Coord. (ft)
1	-1	2	0	3	2.5
4	5	5	7.5	6	10
7	12.5	8	15	9	17.5
10	20	11	22.5	12	25
13	27.5	14	30	15	31

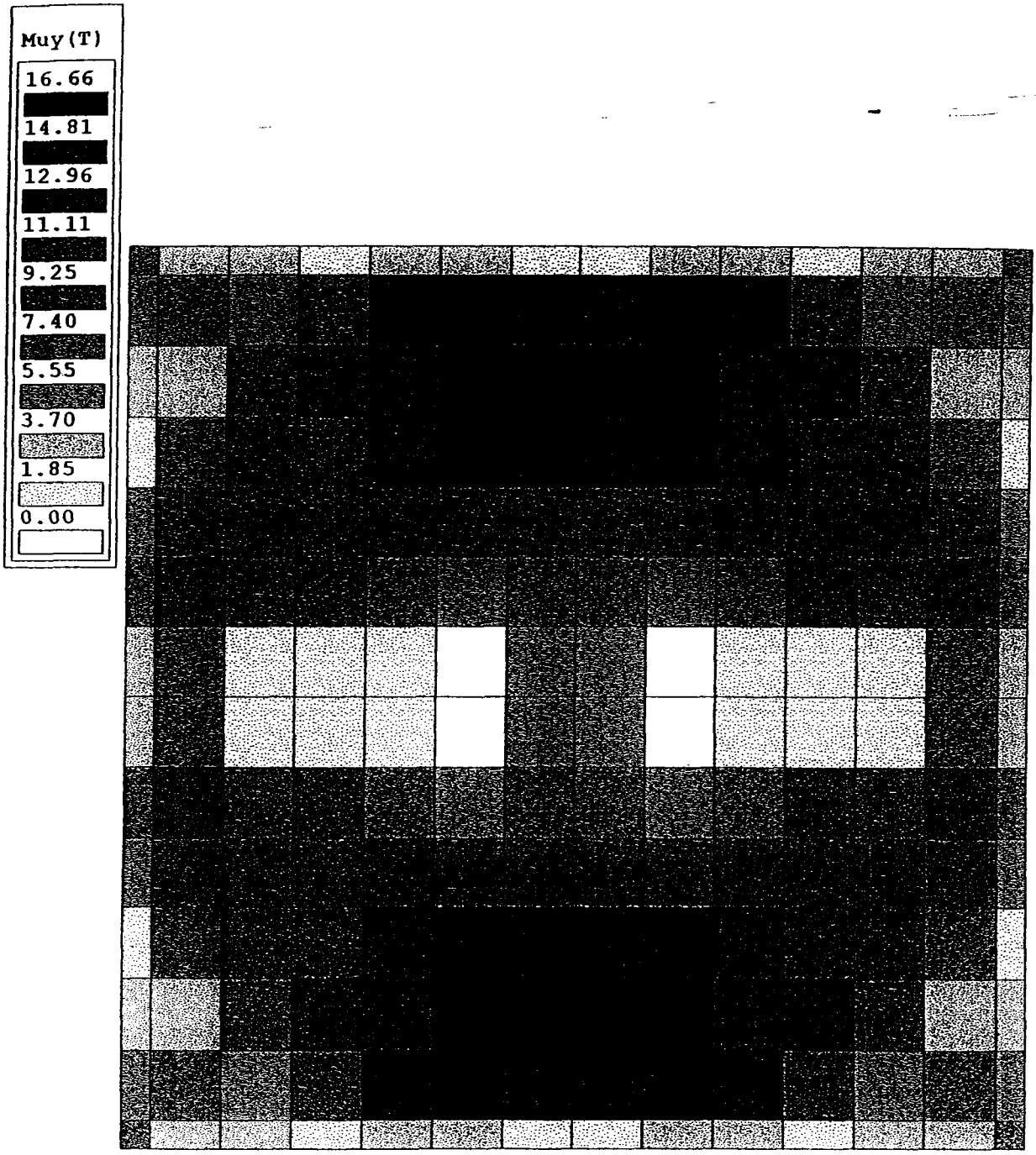
New Bedford - Dewatering Fnd. - sump bottom
Maximum Moment (kip-ft/ft)



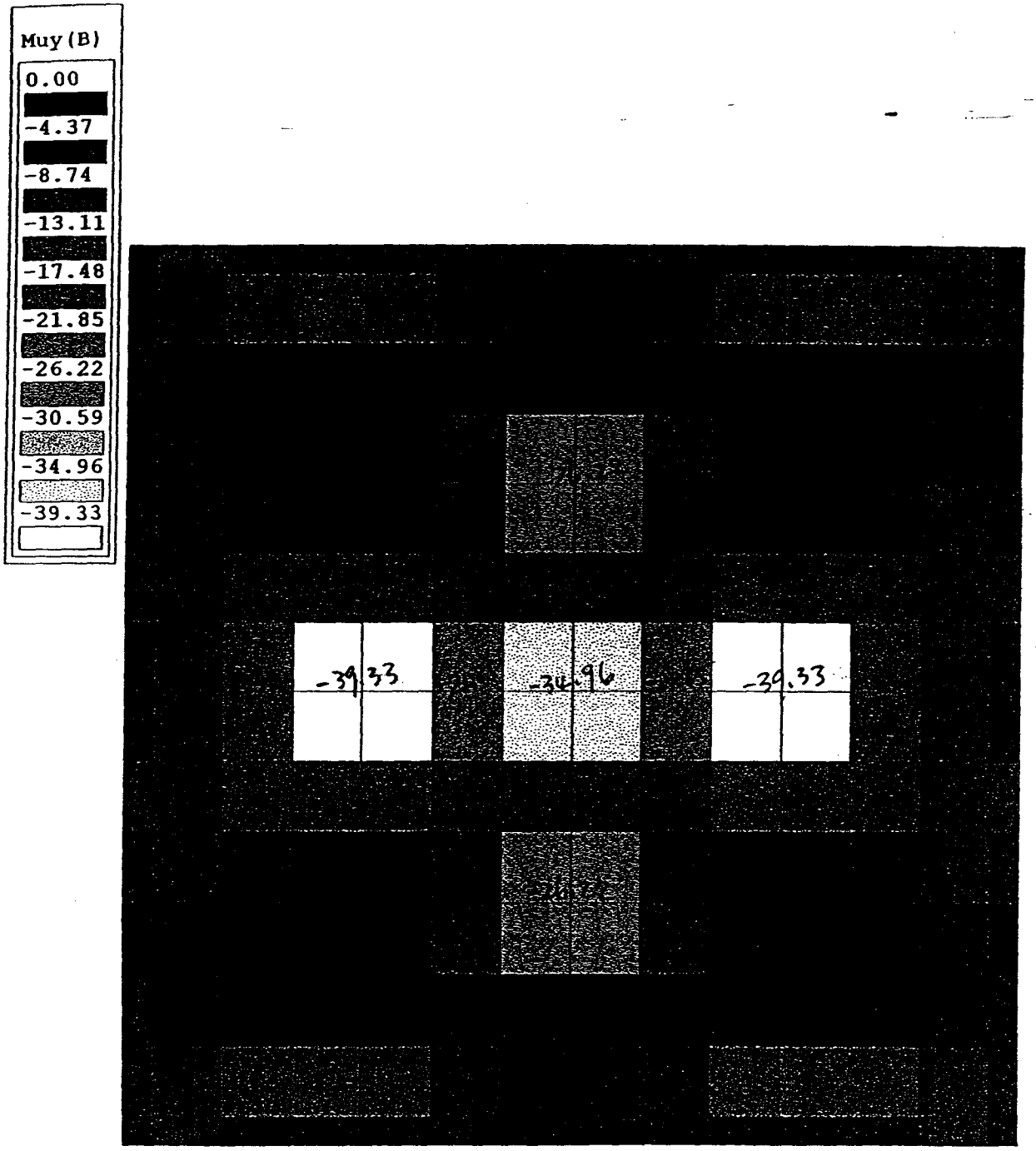
New Bedford - Dewatering Fnd. - sump bottom
Maximum Moment (kip-ft/ft)



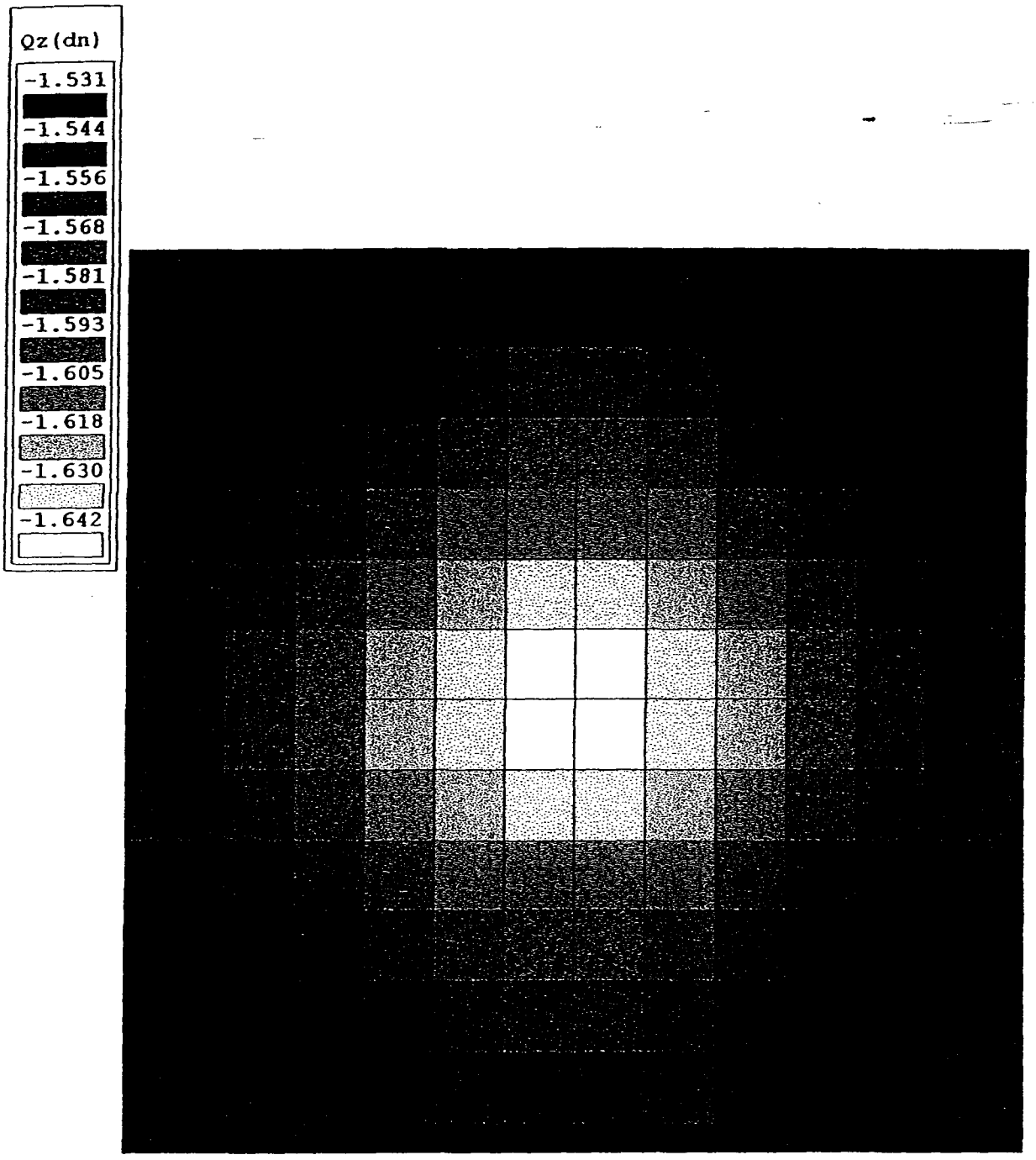
New Bedford - Dewatering Fnd. - sump bottom
Maximum Moment (kip-ft/ft)



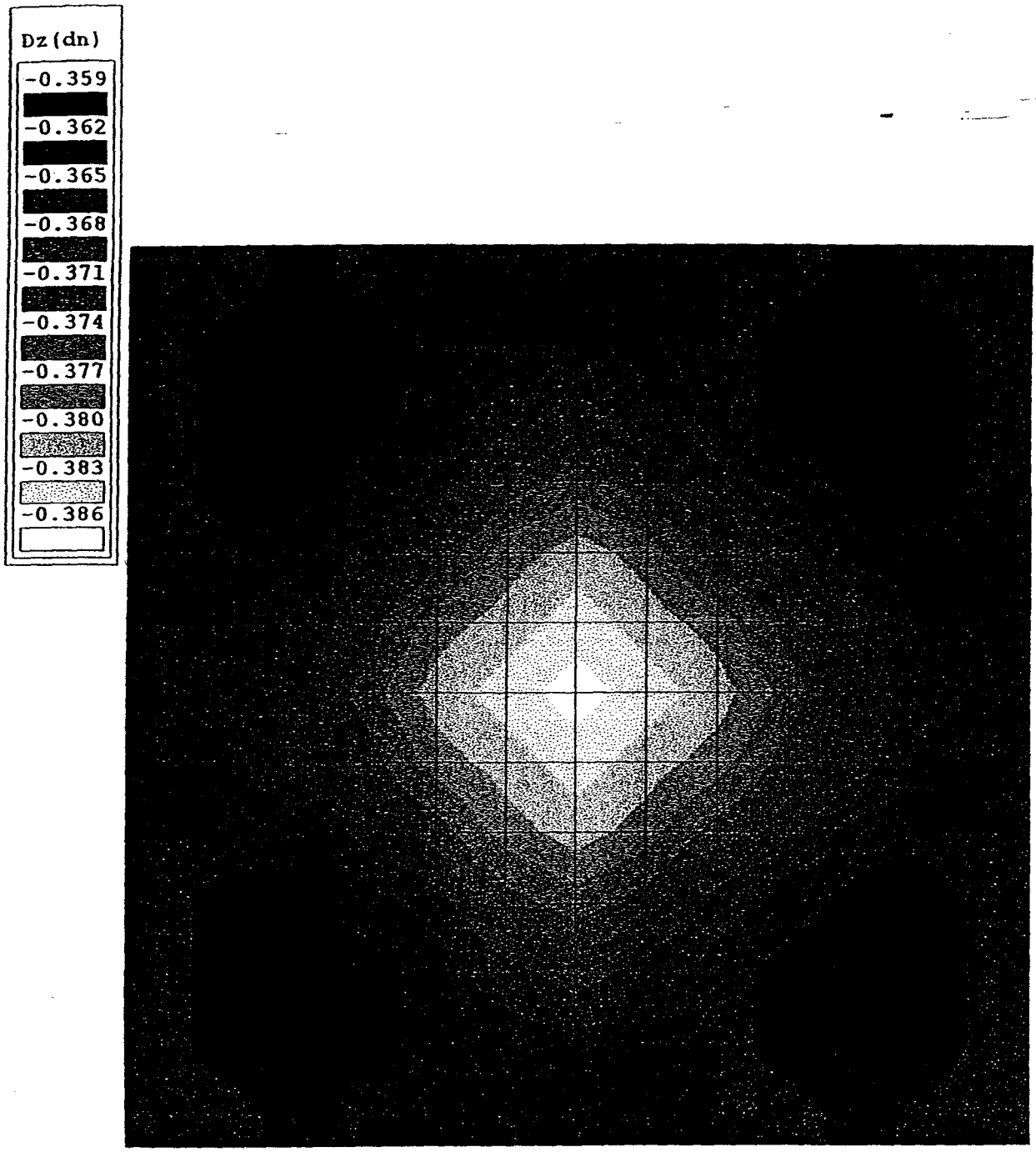
New Bedford - Dewatering Fnd. - sump bottom
Maximum Moment (kip-ft/ft)



New Bedford - Dewatering Fnd. - sump bottom
Pressure (ksf)



New Bedford - Dewatering Fnd. - sump bottom
Displacement (in.)



* FROM M_{ux} (BOT) & M_{uy} (BOT) CONTOURS, THERE ARE SOME "HOT" SPOTS AT THE LOCATION OF COLUMNS.
* CONSIDERING THE COLUMN LOADS WILL BE DISTRIBUTED BY BASE PLATES, INSTEAD OF POINT CONTACTS, USE THE 2ND HIGHEST MOMENT, i.e. ≈ 26 K-FT/FT, IS REASONABLE. SEE NEXT PAGE FOR REINFOREMENT DESIGN. $1.3 \times 26 \doteq 34$ K-FT/FT
* FOR CONSTRUCTION CONVENIENCE AND AVOIDING MISTAKE, USE #6 @ 6" EW, TOP & BOTTOM.

SHEAR CHECK

SLAB THICKNESS $t = 18''$

COL. BASE PLATE SIZE : $C_1 \times C_2 = 18'' \times 18''$

$f_c' = 4000$ PSI , $\beta_c = 1$, $\phi = 0.85$

CONCRETE COVER $c = 3''$

$d = t - c = 15''$

FOR PUNCHING SHEAR :

$b_o = 2C_1 + 2C_2 + 4d$ $\alpha_s = 40$

$= 2 \times 18 + 2 \times 18 + 4 \times 15$

$= 132''$

$$\phi V_n = 0.85 \times \text{MIN.} \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right) \cdot \sqrt{4000} \cdot b_o \cdot d \\ \left(2 + \alpha_s \frac{d}{b_o}\right) \sqrt{4000} \cdot b_o \cdot d \\ 4 \cdot \sqrt{4000} \cdot b_o \cdot d \end{bmatrix} = 426^K$$

$1.3 V_u = 1.3 \times 1.7 \times 69.8^K = 154^K$

$\phi V_n > 1.3 V_u$ OK.

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	15-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - sump bottom slab	Date:	
	Mu(B)	Page	of

Exposure: ● Interior ○ Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	34 kips*ft		
Average Load Factor =	1.55		
Service Moment =	263 kips*in		
Bar Spacing =	6 in		
Width, b =	12 in		
Slab Thickness=	18 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	14.625 in
ϕ =	0.9	#Bars =	2
Normal/Severe exposure (0/1) =	0	A_{steel}=	0.88 in^2

#6 @ 6 in. spacing

Moment Check

w =	0.045366		
ρ =	0.003024		
$A_{srequired}$ =	0.530784 in^2	ok	
β =	0.85		
ρ_b =	0.028507		
ρ_{max} =	0.02138		
A_{max} =	3.752208 in^2	ok	
(ACI 10.5.3) ρ_{min} =	0.003333		
A_{min} =	0.5850 in^2		
$4/3*A_{srequired}$ =	0.707712 in^2	ok	

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	40.5 in^2	
NA =	3.605698 mm	
f_s =	22.28399 ksi	
z=	114.7896 kips/in	
Required =	155.5556 kips/in	ok

ACI-350 Check

Z =	115 kips/in	ok	
fs =	22.28399 ksi		
Max Spacing =	12 in	ok	
Actual -> ρ =	0.005014		

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f_c*b*d^2)))

ρ = w*f_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

SUMP INNER COLUMN DESIGN

PER SUMP BOTTOM SLAB DESIGN, AXIS LOAD ON EACH COLUMN:

DEAD $26.2^k \times 1.4 = 36.7^k$

LIVE $26.2^k \times 1.7 = 44.5^k$

81.2^k

COL. EFFECTIVE LENGTH 8'

TRY W14×90 (F_y=36 KSI)

FOR KL= 8', GOOD FOR $536^k >> 81.2^k$

OK

Support Building Foundation

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY IZ DATE 4/16/02 SHEET 117 OF

CHKD. BY DATE OFS NO. DEPT. NO.

CLIENT

PROJECT NEW BEDFORD - DEWATERING

SUBJECT SUPPOR BUILDING FND. - FLOOR SLAB

PER "DEWATERING FACILITY FOUNDATION DESIGN INFORMATION" RECEIVED ON 2/5/02, THE BUILDING FOUNDATION SHALL CONSIST OF REINFORCED CONCRETE FROST WALLS & COLUMN FOOTINGS AS REQUIRED TO SUPPORT THE PRE-ENGINEERED BUILDING. THE FLOOR SHALL CONSIST OF A REINFORCED CONCRETE SLAB ON GRADE. (3.5.4)

THE FLOOR SLAB SHALL BE DESIGNED FOR A MIN. 100 PSF UNIFORM LOAD WITH A MIN. SLAB THICKNESS OF 6 INCHES. (3.5.5.1)

SINCE THERE ARE NO SIGNIFICANT CONCENTRATED LOADS AND DISTRIBUTION LOADS ON THIS FLOOR, DESIGN THE SLAB AS ACI 360 TYPE B SLAB (i.e. SLAB REINFORCED FOR SHRINKAGE AND TEMPERATURE ONLY)

TRY 8" SLAB THICKNESS, $f_c' = 4000$ PSI

$f_r = 7.5\sqrt{f_c'} = 474$ PSI

PER TABLE A1.4.1 (PCA METHOD), FOR SUBGRADE MODULUS $k = 50$ PCI (86 KCF) AND CONCRETE FLEXURAL STRENGTH $f_r = 550$ PSI, 8" SLAB CAN TAKE 680 PSF ALLOWABLE LOAD.
EXTRAPULATING FOR $K = 50$ KCF & $f_r = 474$ PSI 8" SLAB CAN TAKE AT LEAST 300 PSF LOAD, > 100 PSF - OK

DETERMIN SHRINKAGE & TEMPERATURE REINFOREMENT PER "SUBGRADE DRAG EQUATION" $A_s = \frac{FLw}{2f_s}$ (6.3, ACI 360)

WHERE

A_s = CROSS-SECTIONAL AREA IN SQ. IN OF STEEL PER LINEAL FT.

f_s = ALLOWABLE STRESS IN THE REINFORCEMENT. USE 30,000 PSI (2/3 to 3/4 of the yield point)

F = THE FRICTION FACTOR. USE 1.5.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 118 OF _____

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT _____

SUBJECT _____

L = DISTANCE IN FT BETWEEN JOINTS.
USE $28'-6\frac{3}{4}'' \doteq 28.6'$

W = DEAD WEIGHT OF THE SLAB, PSF, USUALLY ASSUMED TO BE 12.5 PSF PER IN. OF THICKNESS
$12.5 \times 8'' = 100$ PSF

SO, $A_s = (1.5 \times 28.6 \times 100)/(2 \times 30{,}000)$

$= 0.072\ IN^2/LF$

USE #4 @ 12" EW, $A_s = 0.2\ IN^2/LF > 0.072\ IN^2/LF$

PLACE THE REBAR MESH AT TOP HALF OF THE SLAB THICKNESS. – 2" TOP COVER

Appendix

Design Data and References

FOSTER WHEELER ENVIRONMENTAL CORPORATION
133 Federal Street 6th Floor • Boston, Massachusetts 02110
Phone: 617-457-8200 Fax: 617-457-8499/8409

CONFIDENTIAL

To: Lucy Torgyan / Jeff Zhao From: Joe Francis

Fax: 561-237-1890 / 281-596-0308 Page: 3 (incl. cover)

☐ Urgent ☐ For Your Information ☐ For Review ☐ Please Comment ☐ Please Reply

Message:

Elevation showing clear height required for overhead bridge crane.

Plan view is based on 2 overhead cranes on the same rail. This setup will require a 30 ft span north of the tracks and south of the filter presses. There should be enough space south of the presses but north of the rr tracks could be a problem.

If we can't find 30' ft north of the tracks, then we can use only one crane design. With 1 crane still possible to do the required loading but we lose redundancy should crane fail.

We offer a full range of environmental consulting, engineering, and remediation services to Industry and Government. These services include:

Hazardous Waste Services

- Risk-Based Management Services
- Assessments and Investigations
- Remedial Design
- Remediation
- Operations and Maintenance
- Hazardous and Nuclear Waste Management

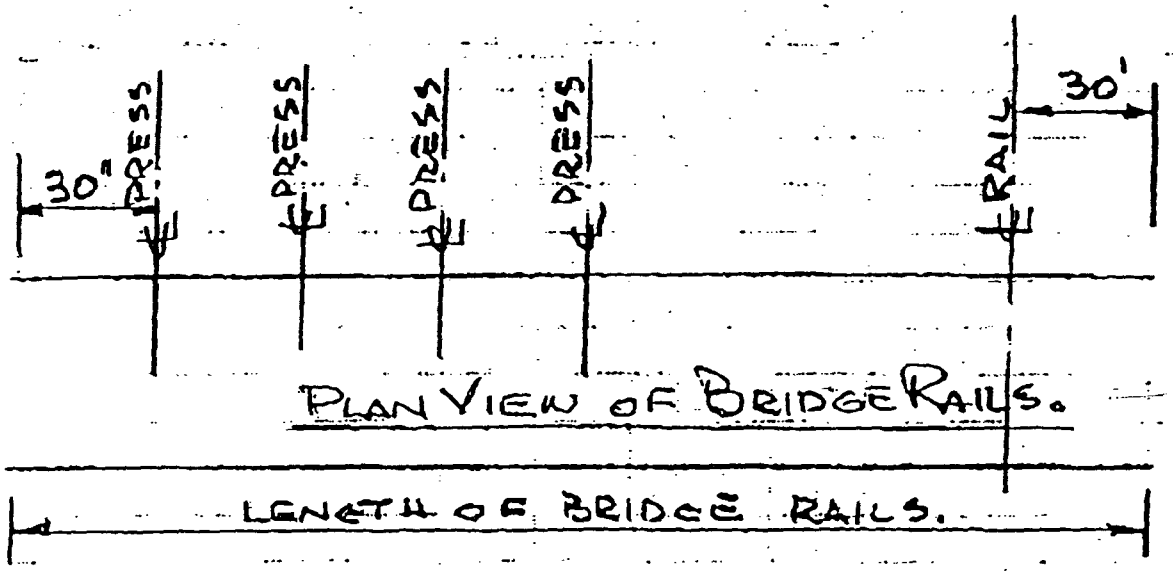
Consulting and Engineering Services

- Regulatory Compliance and Permitting
- Natural Resource Management
- Air, Water and Wastewater Engineering
- Ecological/Geoscience Services
- Economic, Social and Cultural Services
- Occupational Safety and Health

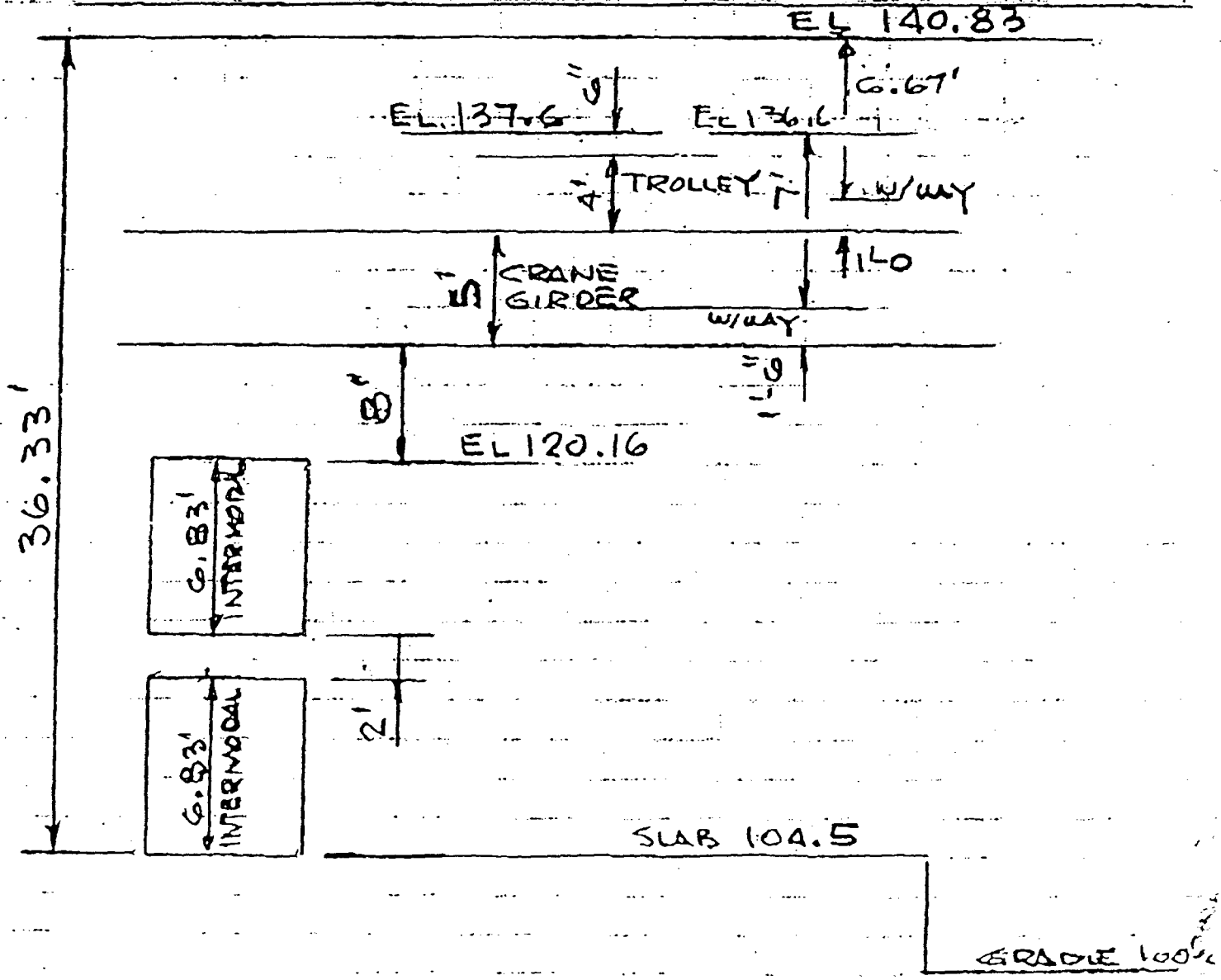
Our mission is to conduct a global business directed toward cleaning up and protecting the environment while facilitating economic growth, and to do so in a safe, compliant, cost-effective manner. Of paramount importance to us is providing Client Service Quality® which translates to responsiveness and best value.

If you do not receive all pages of this facsimile transmittal, please notify sender immediately.

The information contained in this facsimile message is privileged and confidential information intended only for the use of the individual or entity named above. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution or copy of this communication is strictly prohibited. If you have received this communication in error, please immediately notify us by telephone and return the original message to us at the above address via the U.S. Postal Service. Thank you.



ELEVATION SHOWING CLEAR HEIGHT REQ'D.



RECEIVED 1/3/2002

FOSTER WHEELER USA CORPORATION

TO:	J. FRANCIS	DATE:	1/3/02
COMPANY:	FWENC	FROM:	R. LEE MERVILLE
		COMPANY:	FW USA
TEL NO:		FAX NO:	(908) 730- 5169
FAX NO:	617-457-8498	NO. PAGES:	2 (INCL COVER)
CC:			

NOTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

SUBJECT: HEIGHT CLEARANCE, BRIDGE RAIL PLANVIEW,

THE COLUMN LOADS FROM BRIDGE CRANE AND SUPPORT BEAMS W/RAILS WILL BE, 110 KIPS (110,000 LBS) PER COLUMN ON 24' CENTERS.

NOTE THAT THE BUILDING SHOULD BE BRACED TO WITHSTAND THE STARTING AND BRAKING FORCES GENERATED BY THE CRANE ON THE SUPPORT BEAMS AND RAILS.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

FAX MEMORANDUM

From: Lucy

Phone Number: 561-237-1853

To: Jeff

Fax Number: 281-596-0308

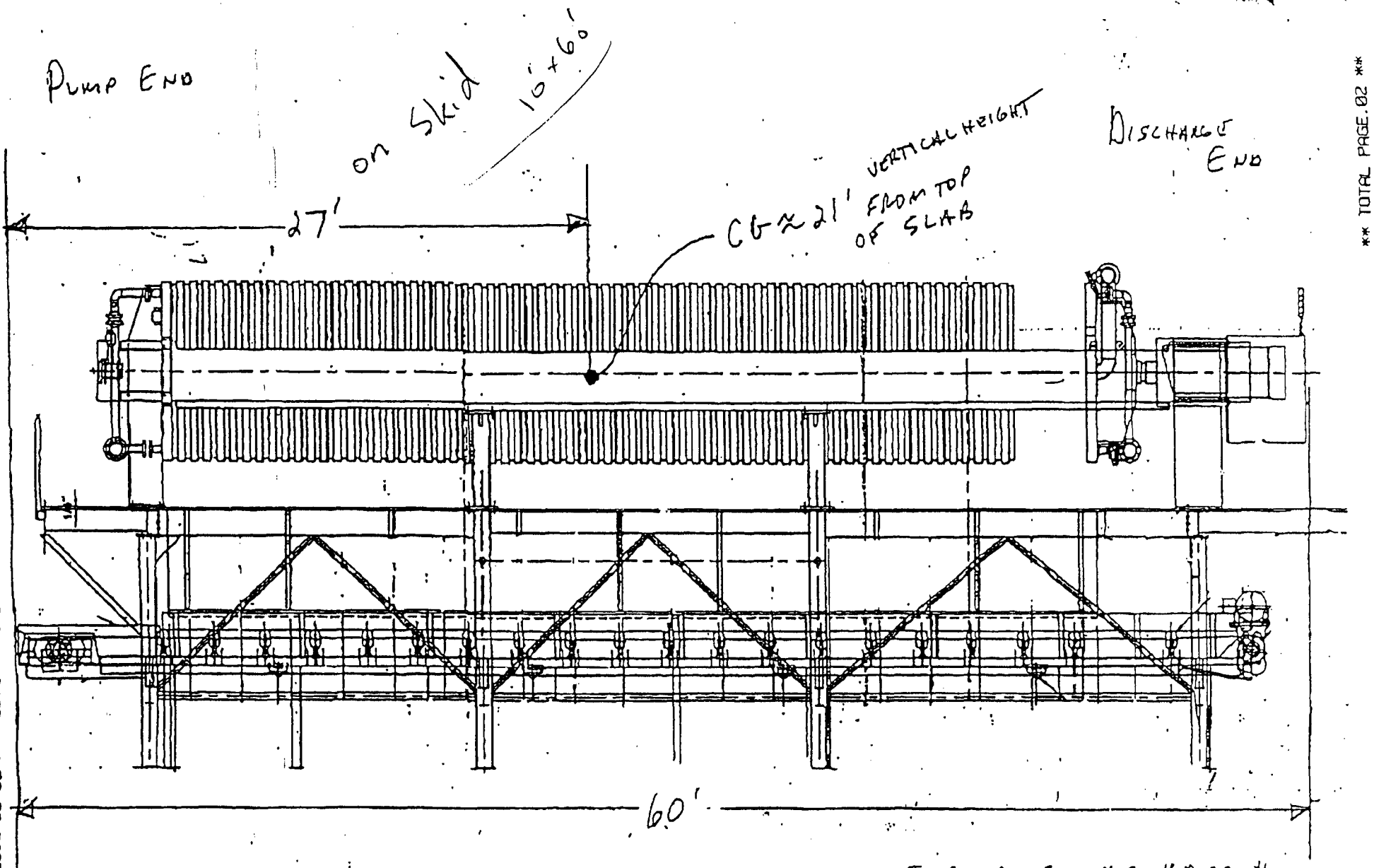
Number of Pages: 2

Subject:

Date: 1/4/02

Text:

5300 Broken Sound Blvd., Suite 110
Boca Raton, FL 33487-3509
Tel. 561-237-1888 Fax. 561-237-1890



1" ≈ 6'

WEIGHT OF PRESS + STAND = 160,000#
APPROX 700 CF SLUDGE CAKE = 50,000#
(2) ROLL-OFFS UNDER (EMPTY) = 20,000#
CAKE WEIGHT IN (2) ROLLOFFS = 100,000#

FOSTER WHEELER ENVIRONMENTAL CORPORATION
133 Federal Street 6th Floor • Boston, Massachusetts 02110
Phone: 617-457-8200 Fax: 617-457-8498/8499

CONFIDENTIAL

To: Mandy Loeffler **From:** Joe Francis

Fax: 281 596-0308 **Page:** 17 (incl. cover)

☐ Urgent ☐ For Your Information ☐ For Review ☐ Please Comment ☐ Please Reply

Message: Misc Building / Crane / Foundation info.

Please pass along to Jeff as well.

Once you've had a chance to review this info give me a call to discuss.

Thanks Joe

We offer a full range of environmental consulting, engineering, and remediation services to Industry and Government. These services include:

Hazardous Waste Services

- Risk-Based Management Services
- Assessments and Investigations
- Remedial Design
- Remediation
- Operations and Maintenance
- Hazardous and Nuclear Waste Management

Consulting and Engineering Services

- Regulatory Compliance and Permitting
- Natural Resource Management
- Air, Water and Wastewater Engineering
- Ecological/Geoscience Services
- Economic, Social and Cultural Services
- Occupational Safety and Health

Our mission is to conduct a global business directed toward cleaning up and protecting the environment while facilitating economic growth, and to do so in a safe, compliant, cost-effective manner. Of paramount importance to us is providing Client Service Quality® which translates to responsiveness and best value.

If you do not receive all pages of this facsimile transmittal, please notify sender immediately.

The information contained in this facsimile message is privileged and confidential information intended only for the use of the individual or entity named above. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution or copy of this communication is strictly prohibited. If you have received this communication in error, please immediately notify us by telephone and return the original message to us at the above address via the U.S. Postal Service. Thank you.

FOSTER WHEELER USA CORPORATION

TO:	J. FRANCIS	DATE:	1/3/02
COMPANY:	FWENG	FROM:	R. LEE MERVILLE
		COMPANY:	FW USA
TEL NO:		FAX NO:	(908) 730- 5169
FAX NO:	617-457-8498	NO. PAGES:	2 (INCL COVER)
CC:			

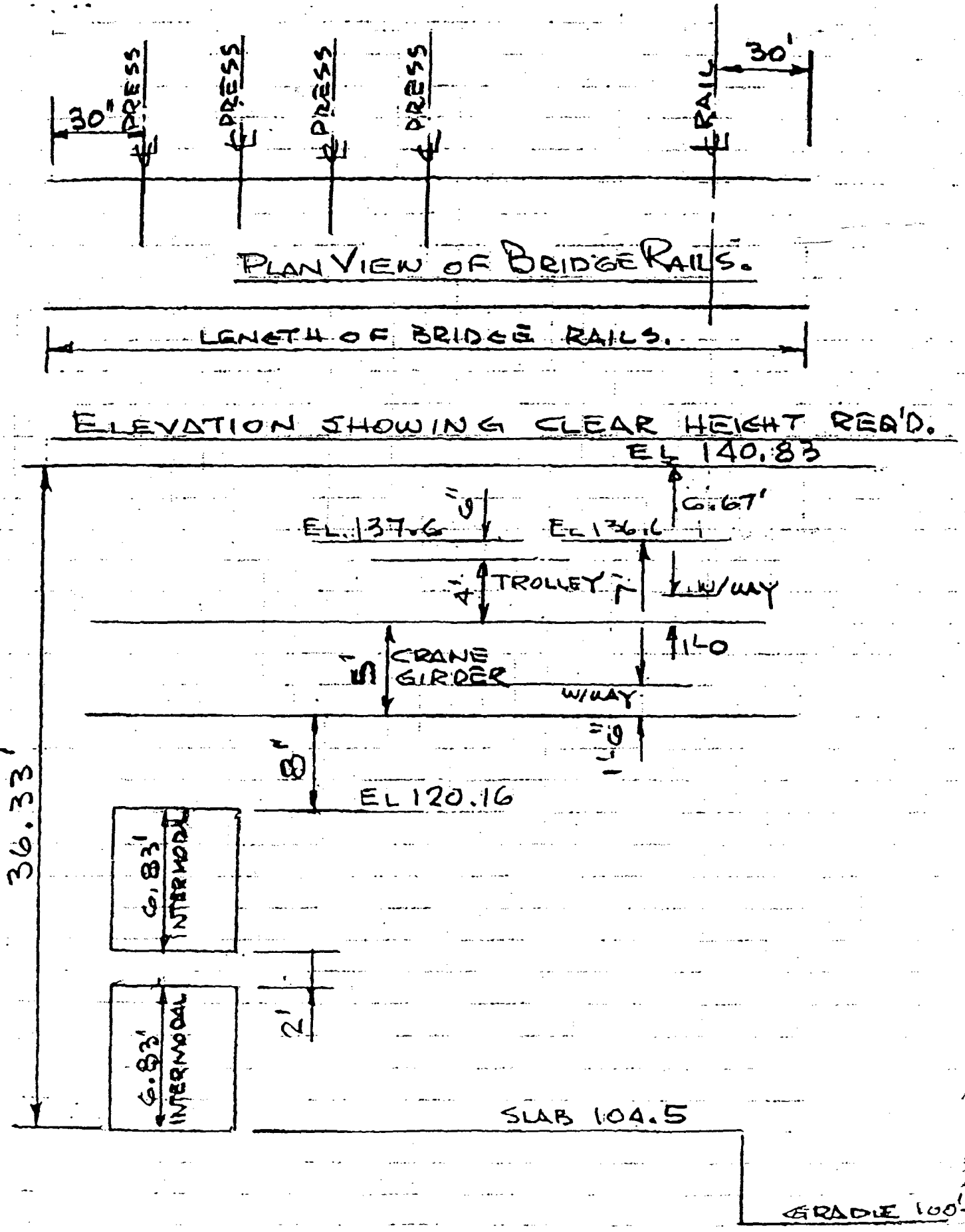
NOTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

SUBJECT: HEIGHT CLEARANCE, BRIDGE RAIL PLANVIEW,

THE COLUMN LOADS FROM BRIDGE CRANE AND SUPPORT BEAMS W/RAILS WILL BE, 110 KIPS (110,000 LBS) PER COLUMN ON 24' CENTERS.

NOTE THAT THE BUILDING SHOULD BE BRACED TO WITHSTAND THE STARTING AND BRAKING FORCES GENERATED BY THE CRANE ON THE SUPPORT BEAMS AND RAILS.


30"
PRESS
PRESS
PRESS
PRESS
RAIL
30'
PLAN VIEW OF BRIDGE RAILS.
LENGTH OF BRIDGE RAILS.
ELEVATION SHOWING CLEAR HEIGHT REQ'D.
EL 140.83
6.67'
EL 137.6
EL 136.6
TROLLEY
W/WAY
1'-0
CRANE GIRDER
W/WAY
8'
EL 120.16
36.33'
6.83' INTERMODAL
2'
6.83' INTERMODAL
SLAB 104.5
GRADE 100'-0

FOSTER WHEELER USA CORPORATION

TO:	R. OTOSKI	DATE:	1/8/02
COMPANY:	FWENG	FROM:	R. LEE MERVILLE
		COMPANY:	FW USA
TEL NO:		FAX NO:	(908) 730- 5160
FAX NO:	617-457-8498	NO. PAGES:	5 (INCL COVER)
CC:			

NOTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

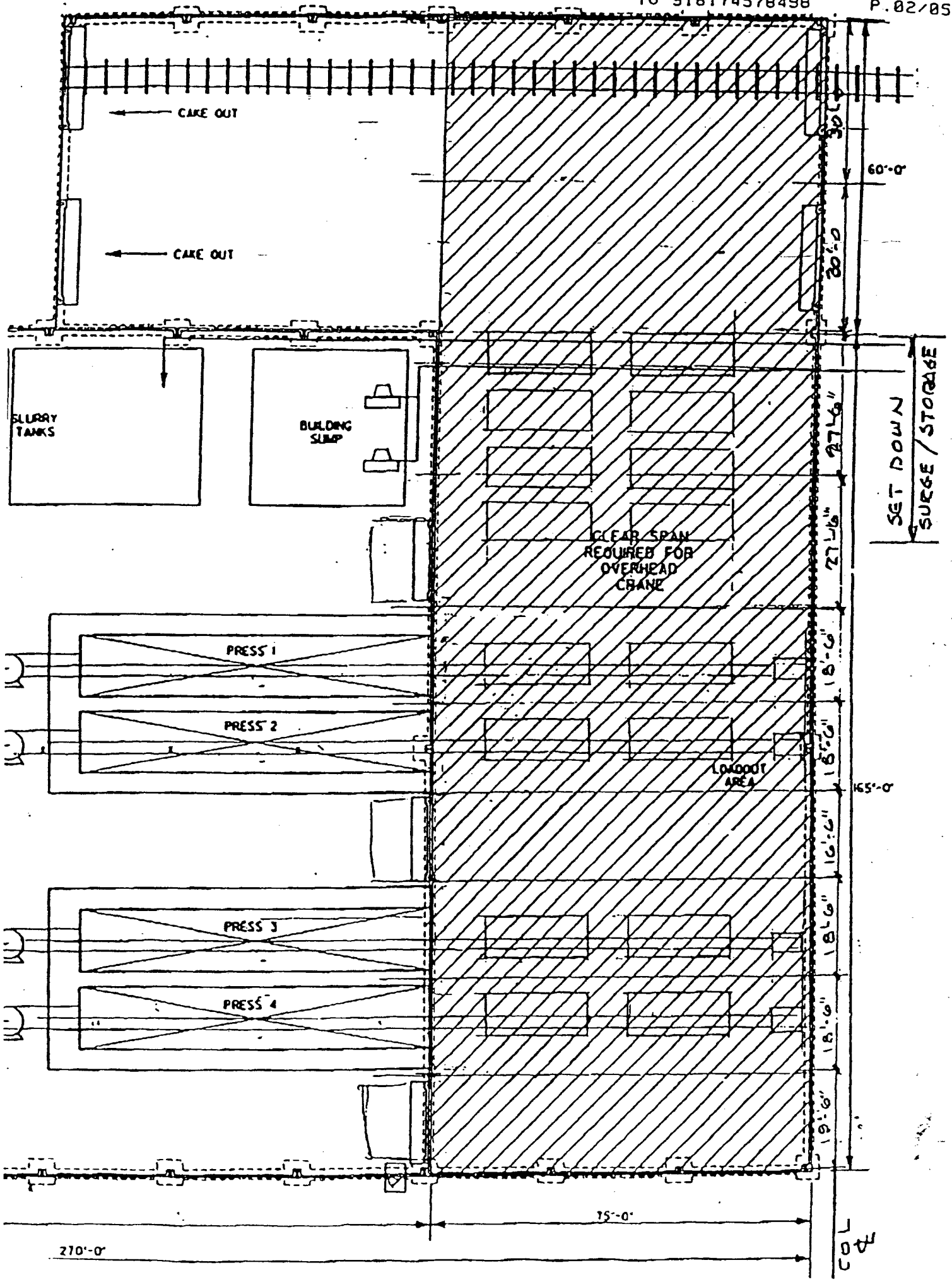
SUBJECT: BLDG LAYOUT / FLOOR / COL CENTERS.

ATTACHED IS BLDG LAYOUT/W COLUMN CENTERS, DUMP BOXES, CABLE HAUL SYSTEMS, ETC.

AMERICAN CRANE BUDGET QUOTATION
- CRANE
- CABLE HAUL

ROLLER USED UNDER PROPOSED DUMP BOXES
- THEY MUST BE MADE TO SWING UP FOR BOXES GOING TO SURGE/STORAGE TO ALLOW MORE BEARING AREA ON CONCRETE SLAB.

Lee


CAKE OUT
CAKE OUT
SLURRY TANKS
BUILDING SUMP
CLEAR SPAN REQUIRED FOR OVERHEAD CRANE
PRESS 1
PRESS 2
PRESS 3
PRESS 4
LOADOUT AREA
SET DOWN
SURGE / STORAGE
30'
60'-0"
30'-0"
27'-6"
27'-6"
18'-6"
18'-6"
16'-6"
18'-6"
18'-6"
19'-6"
165'-0"
75'-0"
270'-0"
COL

FOSTER WHEELER ENVIRONMENTAL CORPORATION
133 Federal Street 6th Floor • Boston, Massachusetts 02110
Phone: 617-457-8200 Fax: 617-457-8498/8409

CONFIDENTIAL

To: Mandy Loeffler From: Joe Francis

Fax: 281 596-0308 Page: 17 (Incl. cover)

☐ Urgent ☐ For Your Information ☐ For Review ☐ Please Comment ☐ Please Reply

Message: Misc Building / Crane / Foundation info.

Please pass along to Jeff as well.

Once you've had a chance to review this info give me a call to discuss.

Thanks Joe

We offer a full range of environmental consulting, engineering, and remediation services to Industry and Government. These services include:

Hazardous Waste Services

- Risk-Based Management Services
- Assessments and Investigations
- Remedial Design
- Remediation
- Operations and Maintenance
- Hazardous and Nuclear Waste Management

Consulting and Engineering Services

- Regulatory Compliance and Permitting
- Natural Resource Management
- Air, Water and Wastewater Engineering
- Ecological/Geoscience Services
- Economic, Social and Cultural Services
- Occupational Safety and Health

Our mission is to conduct a global business directed toward cleaning up and protecting the environment while facilitating economic growth, and to do so in a safe, compliant, cost-effective manner. Of paramount importance to us is providing Client Service Quality® which translates to responsiveness and best value.

If you do not receive all pages of this facsimile transmittal, please notify sender immediately.

The information contained in this facsimile message is privileged and confidential information intended only for the use of the individual or entity named above. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution or copy of this communication is strictly prohibited. If you have received this communication in error, please immediately notify us by telephone and return the original message to us at the above address via the U.S. Postal Service. Thank you.

FOSTER WHEELER USA CORPORATION

TO:	J. FRANCIS	DATE:	1/3/02
COMPANY:	FWENC	FROM:	R. LEE MERVILLE
		COMPANY:	FW USA
TEL NO:		FAX NO:	(908) 730- 5169
FAX NO:	617-457-8498	NO. PAGES:	2 (INCL COVER)
CC:			

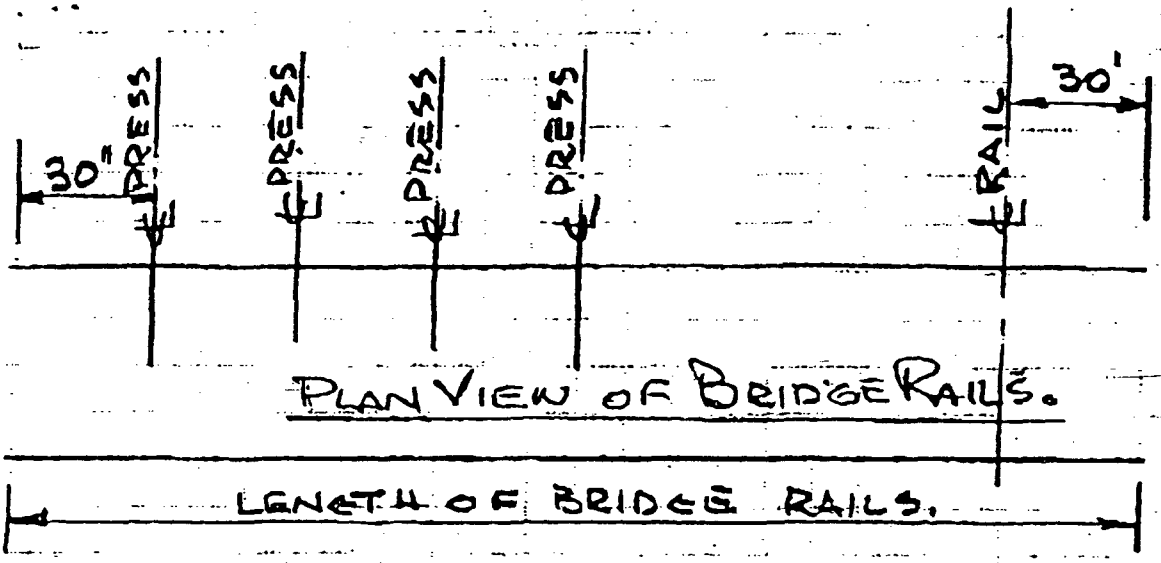
NOTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

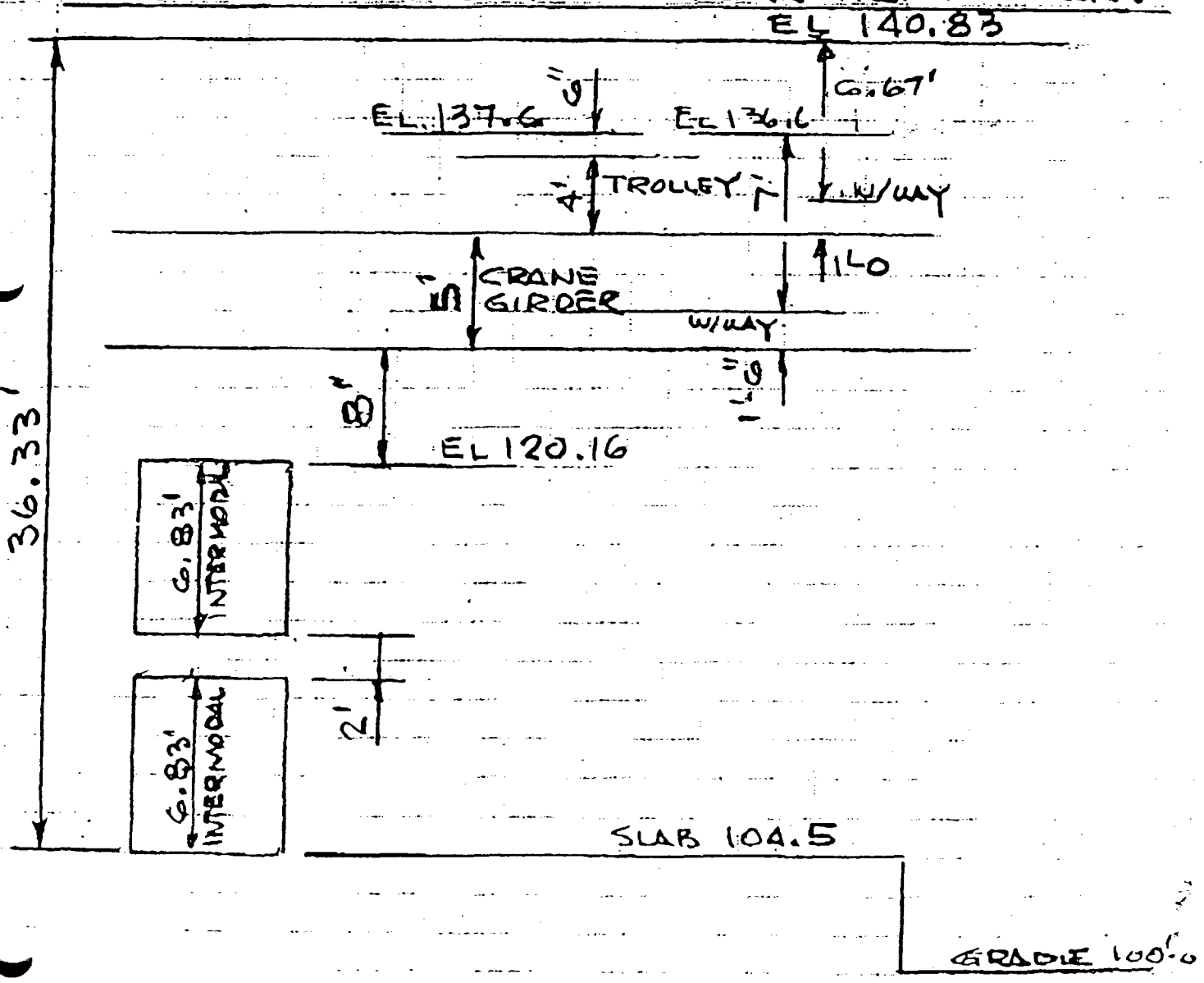
SUBJECT: HEIGHT CLEARANCE, BRIDGE RAIL PLANVIEW,

THE COLUMN LOADS FROM BRIDGE CRANE AND SUPPORT BEAMS W/RAILS WILL BE, 110 KIPS (110,000 LBS) PER COLUMN ON 24' CENTERS.

NOTE THAT THE BUILDING SHOULD BE BRACED TO WITHSTAND THE STARTING AND BRAKING FORCES GENERATED BY THE CRANE ON THE SUPPORT BEAMS AND RAILS.



ELEVATION SHOWING CLEAR HEIGHT REQ'D.



FOSTER WHEELER USA CORPORATION

O:	R. OTOSKI	DATE:	1/8/02
OMPANY:	FWENC	FROM:	R. LEE MERVILLE
		COMPANY:	FW USA
EL NO:		FAX NO:	(908) 730- 5168
AX NO:	617-457-8498	NO. PAGES:	5 (INCL COVER)
C:			

OTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

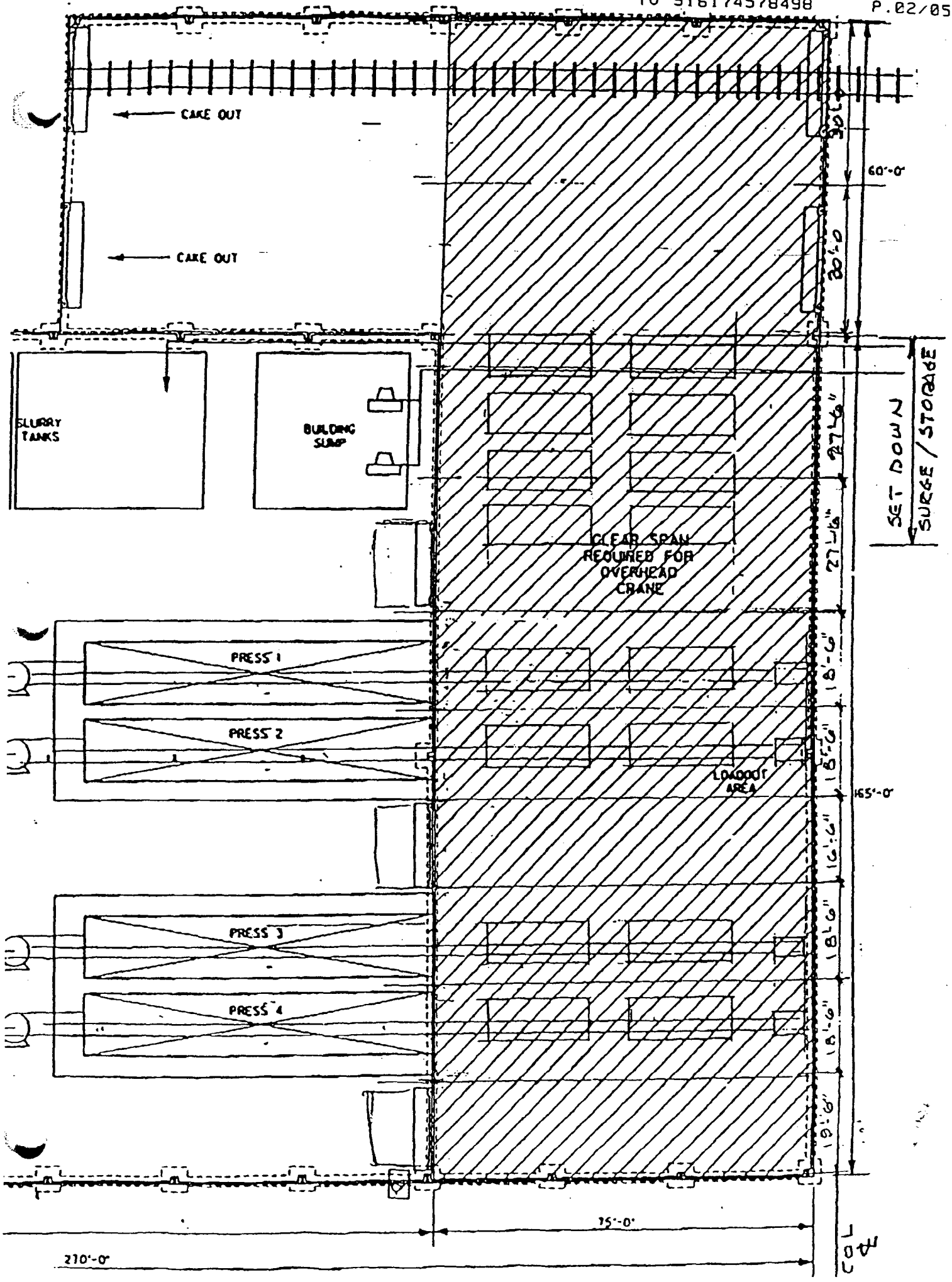
UBJECT: BLDG LAYOUT / FLOOR / COL CENTERS.

ATTACHED IS BLDG LAYOUT / W COLUMN CENTERS, DUMP BOXES, CABLE HAUL SYSTEMS, ETC.

AMERICAN CRANE BUDGET QUOTATION
- CRANE
- CABLE HAUL

ROLLER USED UNDER PROPOSED DUMP BOXES
- THEY MUST BE MADE TO SWING UP FOR BOXES GOING TO JUDGE / STORAGE TO ALLOW MORE BEARING AREA ON CONCRETE SLAB.

Lee


CAKE OUT
CAKE OUT
SLURRY TANKS
BUILDING SUMP
CLEAR SPAN REQUIRED FOR OVERHEAD CRANE
PRESS 1
PRESS 2
PRESS 3
PRESS 4
LOADOUT AREA
SET DOWN
SURGE / STORAGE
60'-0"
30'-0
30'-0
27'-6"
27'-6"
18'-6"
18'-6"
16'-6"
18'-6"
18'-6"
165'-0"
75'-0"
210'-0"

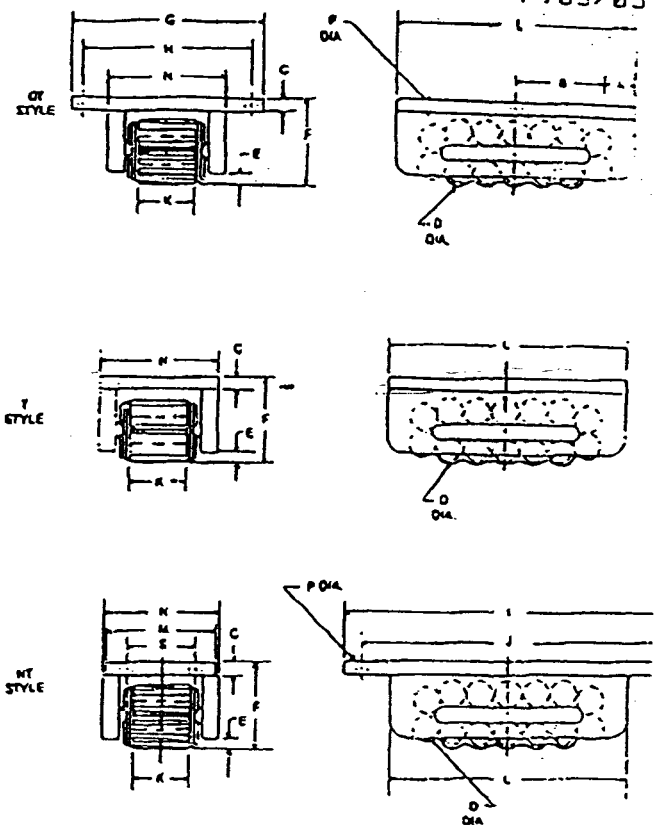
• INDIVIDUAL ROLLERS .75-75 TONS

T Style NT Style OT Style

A variety of top plate styles, exceptionally strong materials of construction, and a wide range of modification possibilities make OT, T, and NT Rollers the true OEM leaders of the Hilman line! Rollers in this series are built for long life and a wide range of operating conditions.

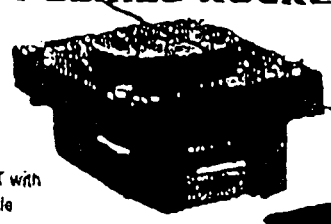
For basic linear motion, these rollers are used as bearing slides, conveyors, guides, casters or dollies. Typical applications include the straight motion required for thermal expansion under a furnace or heat exchanger, as slides under nuclear shield doors, upside down as a conveyor in heavy die handling carts, in concrete forming for the casting and curing process as well in the launching of heavy segments, attached to a cradle for the launching of huge ships, or as a heavy duty wheel-like device to mobilize grandstand seats.

The OT type has an oversized top, the T type has a flush top, and the NT type has a long narrow top. The top plates add extra strength to the frame and variety to mounting capabilities, making one type ideal for cavity mount, bolt-on or weld mount. OT and NT Rollers are available with standard top plate sizes and mounting hole patterns, which can be modified to customer specifications. Hilman Elastomeric Preload Pads are available in either fabric impregnated or neoprene form for each roller model.

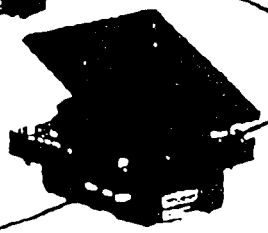


PRODUCT NUMBERS OT STYLE	NT STYLE	T STYLE	CAPACITY (TONS)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	S	CONTACT ROLLS	LBS / KG OT	NT
				DIMENSIONS (INCHES / MM)																		
.75-OT	.75-NT	.75-T	.75	3/4	2-1/2	3/8	11/16	3/8	3-1/8	7	5-1/2	8	7-1/4	2	6-1/2	3-1/2	3-5/8	5/16	2	6	12	12
				19	64	10	17	10	79	178	140	203	184	51	165	89	92	8	51		5	5
1T	1-NT	1-T	1	1	2-1/2	3/8	11/16	3/8	2-3/8	6	4-3/4	8	7	2	6	3-1/2	3-9/16	9/16	1-7/8	6	13	12
				25	64	10	17	10	60	152	121	203	178	51	152	89	91	14	48		6	
2.5-OT	2.5-NT	2.5-T	2.5	3/4	2-1/2	3/8	15/16	3/8	3-5/8	7	5-1/2	9-1/2	8	2-7/16	6-1/2	4	4-1/8	9/16	2	4	21	1
				19	64	10	24	10	92	178	140	241	203	62	165	102	105	14	51		10	9
5-OT	5-NT	5-T	5	3/4	3-1/4	3/8	15/16	7/16	3-1/8	8	6-3/4	11-3/4	10-1/8	2-7/16	8	4-1/2	4-7/16	9/16	3	5	22	21
				19	83	10	24	11	79	203	171	298	257	62	203	114	113	14	76		10	10
8-OT	8-NT	8-T	8	3/4	3-1/4	3/8	15/16	7/16	3-1/8	8	6-3/4	11-3/4	10-1/8	3-5/16	8	5	5-5/16	9/16	3	5	25	23
				19	83	10	24	11	79	203	171	298	257	84	203	127	135	14	76		11	10
15-OT	15-NT	15-T	15	1-5/8	3-11/16	5/8	1-3/16	1/2	3-7/8	10	8-1/2	14-3/4	12-11/16	2-3/4	10-5/8	5	5-3/16	11/16	2-5/16	5	46	44
				41	94	16	30	13	98	254	216	375	322	70	270	127	132	17	59		21	20
20-OT	20-NT	20-T	20	1-5/8	3-11/16	5/8	1-3/16	1/2	3-7/8	10	8-1/2	14-3/4	12-11/16	4	10-5/8	6-1/2	6-7/16	11/16	3-1/2	5	49	49
				41	94	16	30	13	98	254	216	375	322	102	270	165	164	17	89		22	22
37.5-OT	37.5-NT	37.5-T	37.5	2	5-1/2	3/4	1-5/8	5/8	5-1/2	12	10-1/2	21	18-3/4	3-1/2	15	7	7-1/4	13/16	4-1/4	6	121	114
				51	140	19	41	16	140	305	267	533	476	89	381	178	184	21	108		55	52
50-OT	50-NT	50-T	50	3-3/4	5-1/2	3/4	1-5/8	5/8	5-1/2	12	10-1/2	21	18-3/4	3-1/2	18-1/2	7	7-1/4	13/16	4-1/4	8	147	142
				95	140	19	41	16	140	305	267	533	476	89	470	178	184	21	108		67	64
75-OT	75-NT	75-T	75	1-1/4	9-1/4	1	1-15/16	1/2	6-3/4	14	11-1/2	27	24	3-5/8	21	7-1/2	7-3/8	1-1/16	5	7	241	227
				32	235	25	49	13	171	356	292	686	610	92	533	191	187	27	127		109	103

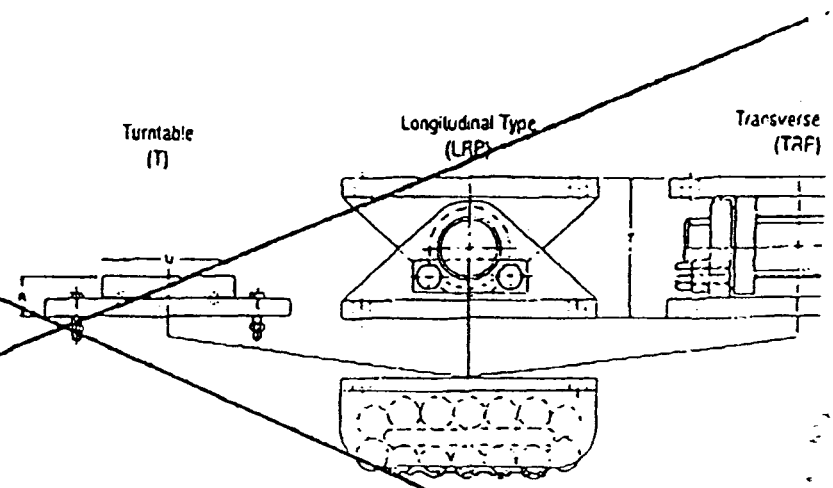
• OT, NT SERIES TURNTABLES
• OT SERIES ROCKER TOPS



37.5-OT with Turntable



15-OT with LRP



urntables are available for OT and NT Series rollers in capacities from 5 ns to 75 tons. Turntables bolt to the base roller unit and allow the roller to rivel or provide some freedom of lateral motion in Accu-Roll applications ere tracks aren't perfectly parallel. Connection hardware is included.

ansverse (TRP) and Longitudinal (LRP) Rocker tops for the OT Series

PRODUCT NUMBERS TURNTABLES / ROCKERS T-OT	T-NT	LRP	TRP	FITS ROLLER MODEL	DIMENSIONS IN (MM) A	U				WEIG TURNTABLES LBS. KGS
T-5-OT	T-5-NT	5-LRP	5-TRP	5-OT/NT	1-1/2 38	6	152	4-3/8	111	15 7
T-8-OT	T-8-NT	8-LRP	8-TRP	8-OT/NT	1-1/2 38	6	152	4-3/8	111	16 [illegible]

531 Old Swede Road
Douglassville, PA 19518
Phone: 610-385-6061
Fax: 610-385-3191

American Crane & Equipment CO

Fax

To:	Foster Wheeler – Lee Merville	**From:**	Paul Smyk
Fax:	908-730-5169	**Date:**	January 7, 2002
Phone:		**Pages:**	2
Re:	New Bedford Crane	**CC:**	

☐ **Urgent** ☑ **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle**

•Comments:

We have developed a preliminary quotation for the New Bedford Crane, and the car puller. Also, I have increased the weights slightly as a result of further investigation, and compromising on a 75 ft. span. I think you will probably still be ok regarding the column loads. Pricing is based on the following:

ITEM #1 Container Crane

Capacity: 30 tons at nameplate (below grapple)

Design Capacity: 40 tons

Rating: CMAA Class E

Span: 75 Ft.

Lift: Approx 26 ft. on drums

Power Supply: 460-3-60 AC

Hoist Speed: 18 FPM Variable

Trolley Speed: 100 FPM Variable

Bridge Speed: 150 FPM Variable

Operator's Controls: Enclosed cab w/ AC and Heat

Back-up Controls: Remote Radio System

Trolley Weight: 16,000 lbs

Bridge Weight: 50,000 lbs

Wheel Load: 30,000 lbs using 8 wheels, 15 inch diameter

Full length walkway on bridge and trolley

Cranelights: (4) 400 W HPSV mounted on walkway

Lift points: 2 included for interface with BROMMA container grab

Crane Price.....$525,000 EACH

Container Grapple Price.....$150,000 EACH

Price includes runway rail and electrification for (2) cranes on same runway.

ITEM #2 Cable Haul System

Capacity: 10,718 lbs

Centerline to Centerline of System: 152'-0" (Drum to Tension Sheave)

Operator's Controls: Console with pushbuttons

System Price.....$90,000 EACH

Prices do not included installation

Prices are FOB, Douglassville, PA

Delivery is approximately 20-22 weeks ARO

FOSTER WHEELER USA CORPORATION

O: R. OTOSKI
COMPANY: EWENC
TEL NO:
FAX NO: 617-457-8498
CC: JOE FRANCIS,

DATE: 1/4/02
FROM: R. LEE MERVILLE
COMPANY: FW USA
FAX NO: (908) 730- 5169
NO. PAGES: 5 (INCL COVER)

NOTE: Please call sender a (908) 730- 5156 if you do not receive all pages indicated above.

MESSAGE

SUBJECT: COST STUDY INTERMODAL VS GONDOLA.

THIS IS AN EYE OPENER - READ COMMENT AND ORDER THE GONDOLA'S.

THE LAST PAGE IS A CROSS-SECTION OF A TYPICAL SOLE PLATE THAT THE CONTAINERS UNDER THE PRESSES ROLL ON.

Alan

INTERMODAL LINER CONSUMPTION.

48 CONTAINERS PER DAY.
DOUBLE LINERS = 96 LINERS/DAY
@ 40 LB EACH
20T TRAILER W/HOLD 1000 LINERS
1000 LINERS ÷ 96 = 10.4 DAYS.
USE 8MIL CLEAR & 6MIL BLACK = 59.00/CONTAINER.
59 x 48 = 3312.00/DAY.

INTERMODAL COVER & BUNGEE CONSUMPTION
48 COVERS PER DAY
14 BUNGEES/COVER
48 COVERS @ 50.00 = 2400.00/DAY

48 x 14 = 672 BUGEES @ .50 = 336.00/DAY.

CONSUMABLES DAILY.

LINERS	3312
COVERS	2400
BUNGEES	336
	6048

LABOR
39.3 + 25.68 = 64.98
65 x 50 = 3250

6048 + 3250 = 9298 M$L

GONDOLA SHIPMENT 12 CARS DAILY

CONSUMABLES DAILY

LINERS	3000
COVERS	2400
BUNGEES	1200
	6600

LABOR
(1.5 + 17.67 + .75) 12
47.04 H/H @ 50.00 = 2352
+ 9 HRS @ 50.00 = 450 M$L
6600 + 2352 + 450 = 9402

Δ FOR OPERATIONS - LINERS, COVERS, BUNGEES AND LABOR.

GONDOLA	9402
INTERMODAL	9298
	104.00

Δ FOR LINERS, TARPS AND LABOR DAILY, MAT'L LOADED TO RR.

* OTHER COSTS TO BE CONSIDERED:
COST OF INTERMODALS.
COST OF INTERMODAL DUNNAGE & FASTENINGS.
COST OF TRANSFER/DUMP BOXES
COST Δ FOR 35T VS 28T CRANE.

COST OF INTERMODALS

RENTAL OF 1100 UNITS @ 9.00/DAY/UNIT

DAILY COST 9900.00
DAILY MAINT 1687.00
11587

OWN 1100 INTERMODALS - PRORATE LIFE @ 7.5 YEARS

1100 x 7000 = 7,700,000 ÷ 7.5 = 1,026,667 /YEAR
616,000 /YR MAINT
1,642,667 /YR
÷ 300
5475.00/DAY.

EST. DUNNAGE & FASTENING
PER DAY (12 CARS)

BLOCKING = 60.00/CAR
8 H/DOWNS = 400.00/CAR } 460.00/CAR
+ 4 H/H = 200.00 } 660.00/CAR x 12 = 7920.00/DAY

COST OF TRANSFER / DUMP BOXES

PRORATE LIFE ON 7.5 YEARS.

OWN 24 UNITS

24 x 112500 = 2700,000 ÷ 7.5 = 360.000
21,6000. MAINT
576000. /YR
÷ 300
1920.00 DAY

Δ COST OF CRANE 28T TO 35T

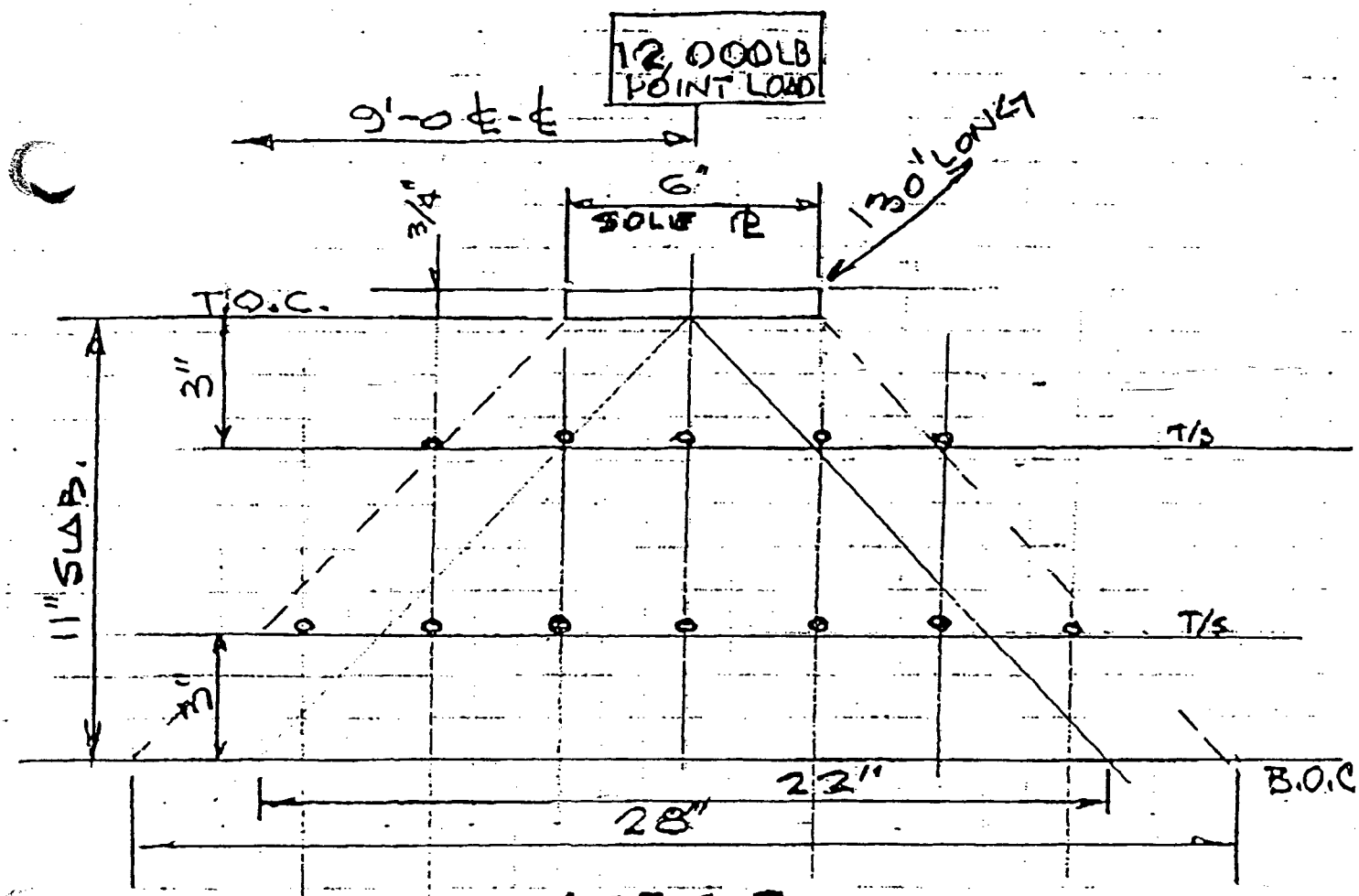
PRORATE ON 7.5 YR

EST 125,000.00 ÷ 7.5 = 16667 /YR
10000 /ANNUALIZED MAINT
26667
÷ 300
89.00/DAY.

COST SUMMARY - INTERMODAL CONTAINERS VS GONDOLA'S.

	INTERMODAL	GONDOLA.
DAILY LINERS, LABOR, COVERS, BUNGEES	9298	9402
INTERMODALS, OWNED, PER DAY	5475	
DUNNAGE, BLOCKING, FASTENING	7920	
TRANSFER DUMP BOXES / DAY		1920
Δ COST of 28T TO 35T CRANE		89
DAILY TOTAL	22693	11411

THIS SHOWS A DAILY ADDITIONAL COST OF 11,282.00 FOR THE USE OF INTERMODALS OWNED BY THE PROCESSOR OR A DIRECT COST OF 13.59 PER C.Y.



12,000 LB ON 4.27 S.F.

12,000 ÷ 3.6 = 2810 LB/S.F. AT BOTTOM OF 11" SLAB.

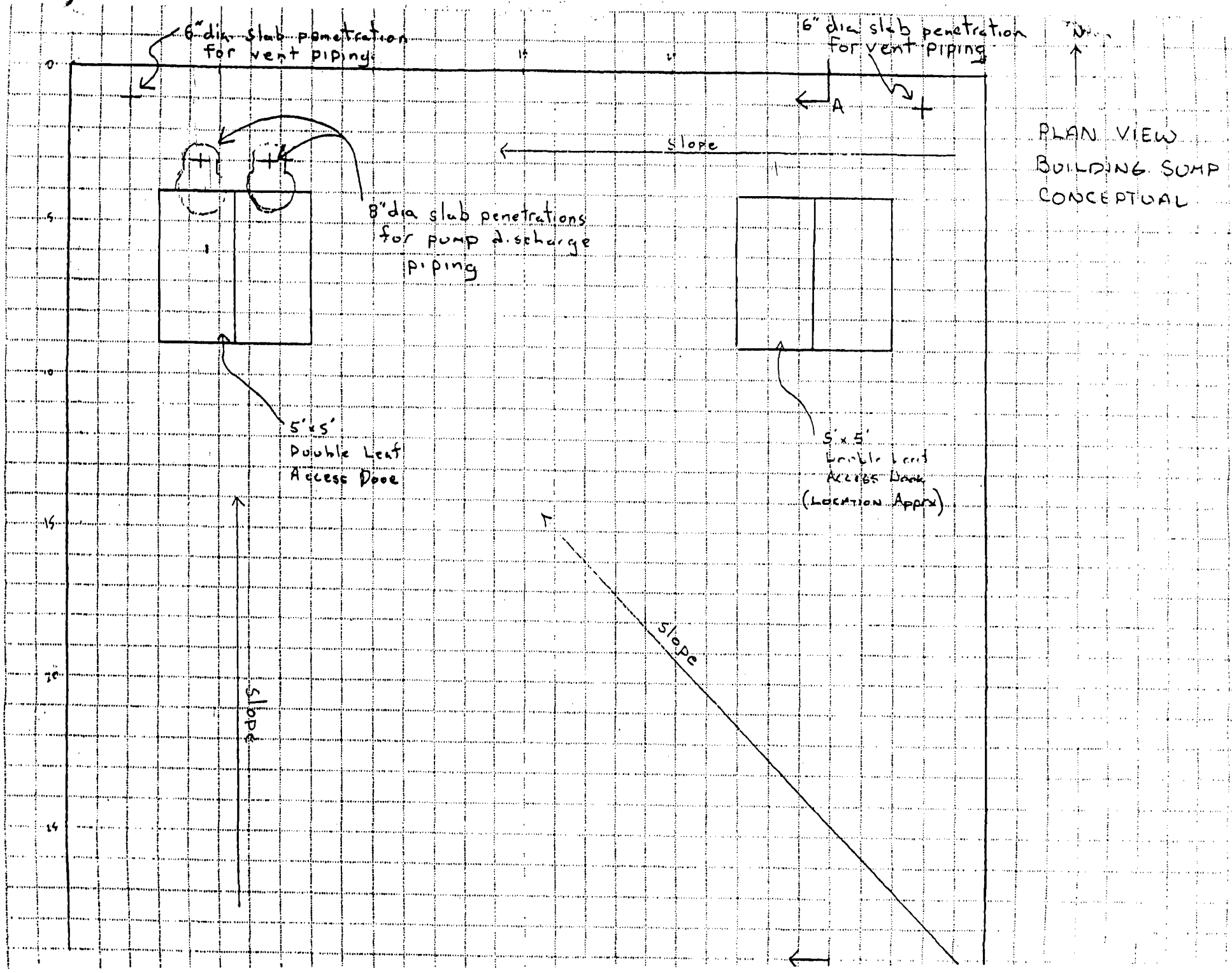
2 SOLE PLATES REQUIRED UNDER EACH FILTER PRESS.

12,000 lb ÷ 2 =

20~30 t container

SOLE PLATE CROSS SECTION

100 lb/CF

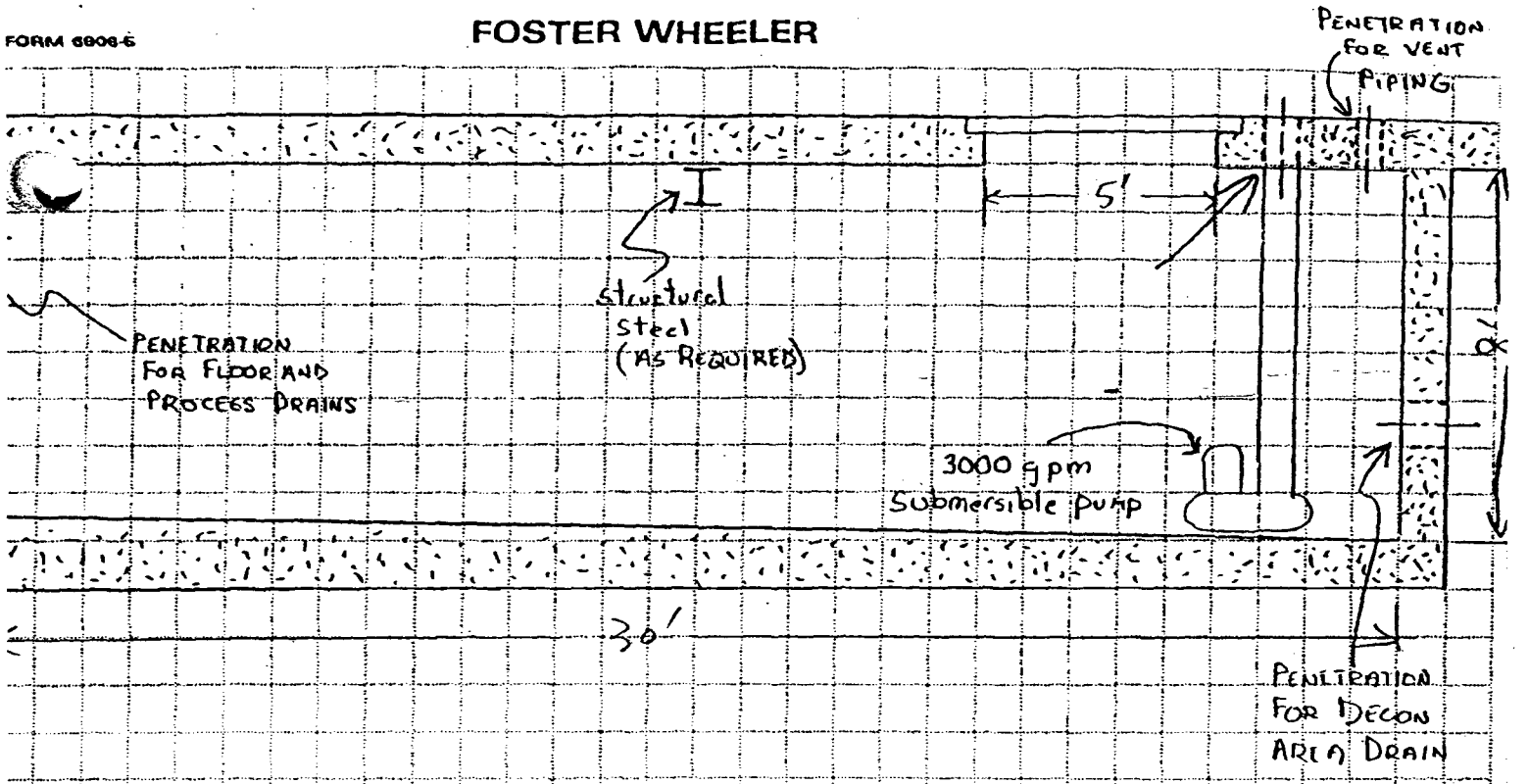


FOSTER WHEELER

FORM 6806-5

FORM 6906-6

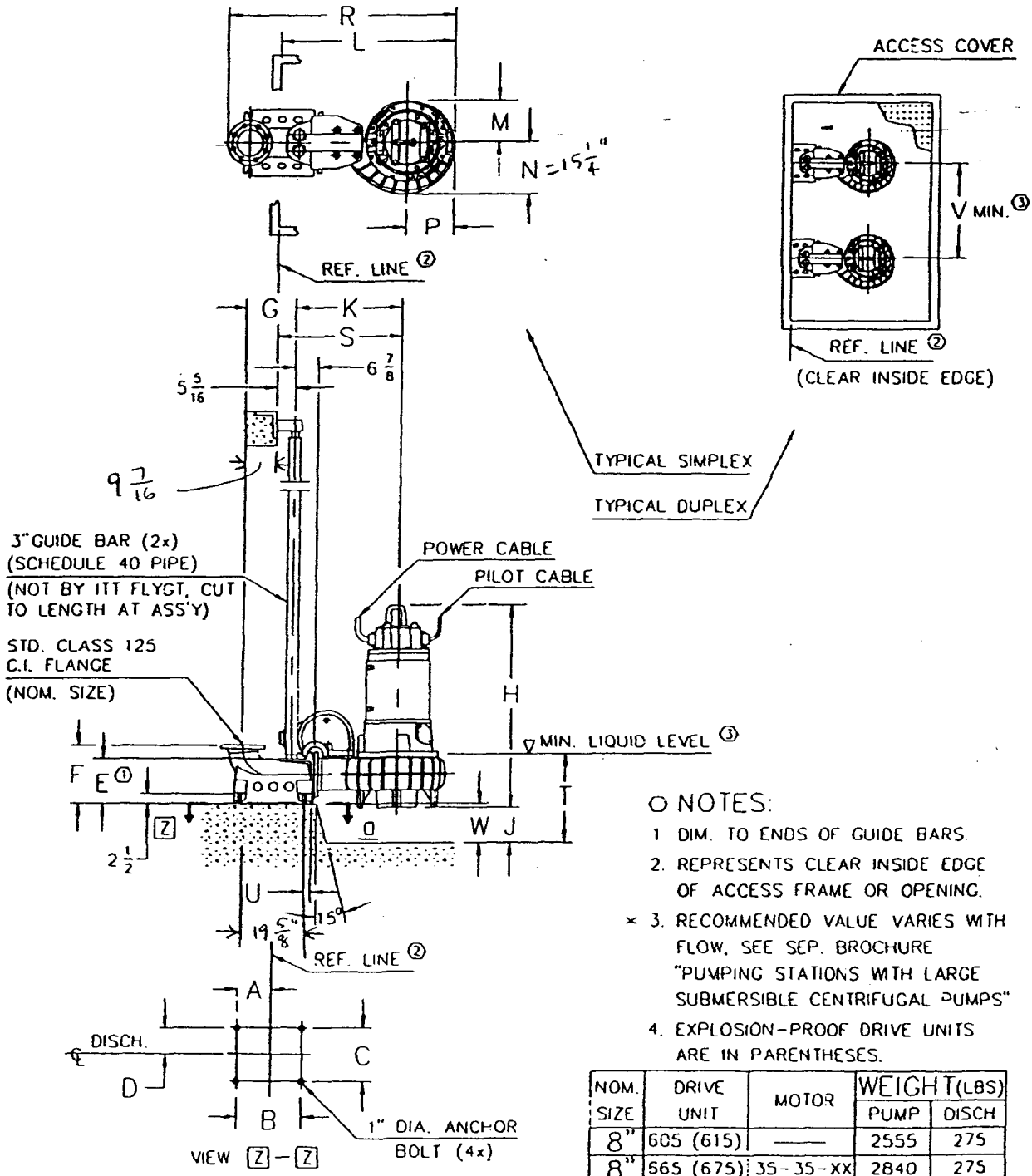
FOSTER WHEELER



BUILDING SUMP - CONCEPTUAL
SECTION A
1 inch = 4 feet

CP-3231 (600 Series Drives)

Section 4		OUTLINE DIMENSIONS	Issued: 10/96	Supersedes:



NOTES:

1. DIM. TO ENDS OF GUIDE BARS.
2. REPRESENTS CLEAR INSIDE EDGE OF ACCESS FRAME OR OPENING.
3. × RECOMMENDED VALUE VARIES WITH FLOW, SEE SEP. BROCHURE "PUMPING STATIONS WITH LARGE SUBMERSIBLE CENTRIFUGAL PUMPS"
4. EXPLOSION-PROOF DRIVE UNITS ARE IN PARENTHESES.

NOM. SIZE	DRIVE UNIT	MOTOR	WEIGHT (LBS) PUMP	WEIGHT (LBS) DISCH
8"	605 (615)	——	2555	275
8"	665 (675)	35-35-XX	2840	275
8"	665 (675)	35-45-XX	2905	275

ALL DIMENSIONS IN INCHES

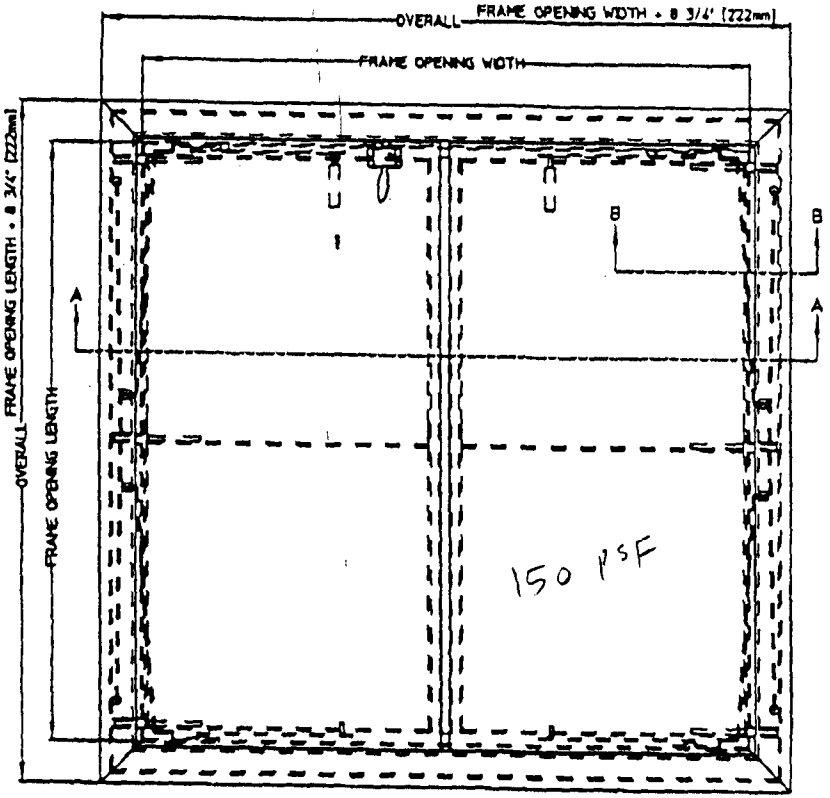
DIMENSIONAL CHART

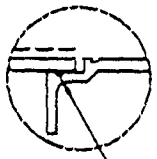
NOM. SIZE	DRIVE UNIT	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W
8"	605 (615)	9 7/8	19 3/4	15 3/4	7 7/8	13 1/2	17 3/4	14 3/4	61	10 3/4	32	51 1/4	12 3/4	15 1/4	14	67 1/2	37 1/4	*	2	*	12
8"	665 (675)	9 7/8	19 3/4	15 3/4	7 7/8	13 1/2	17 3/4	14 3/4	67 3/4	10 3/4	32	51 1/4	12 3/4	15 1/4	14	67 1/2	37 1/4	*	2	*	12

Type KD Floor Door

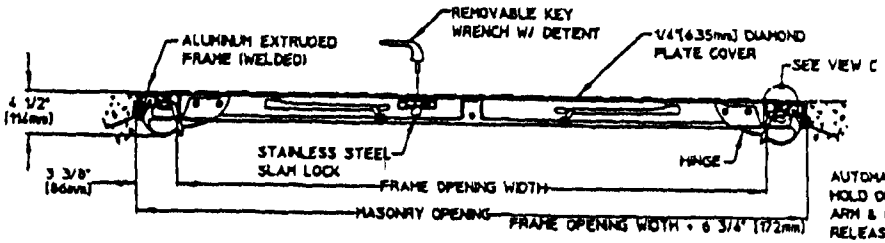
DOUBLE LEAF ALUMINUM DIAMOND PATTERN PLATE

Reinforced for 150 lbs. per square foot (or 732 kg. per square meter) live load

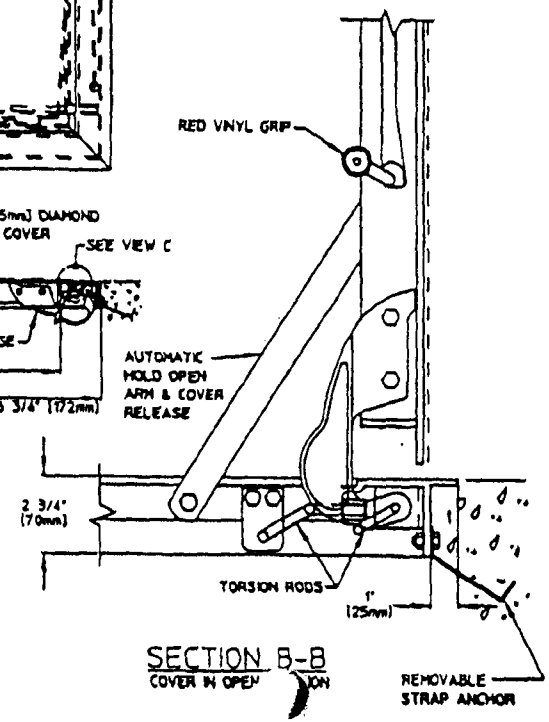




VIEW C



SECTION A-A



SECTION B-B
COVER IN OPEN POSITION

General Contractor, Please Note:

1. Be careful not to rack or twist frame when setting unit. Block up and shim the frame if necessary to be sure covers rest evenly on frame all around.

Factory Finish: Aluminum - mill finish with bituminous paint on surfaces to be in contact with concrete.
Hardware - zinc plated steel - chromate sealed

Manufacturers of Doors for Special Services
THE BILCO COMPANY
New Haven, Connecticut 06505

QUAN-TITY	TYPE	FRAME OPENING WIDTH x LENGTH
☐	KD-2	4'-0" x 4'-0" (1220M x 1220M)
☐	KD-3	4'-0" x 6'-0" (1220M x 1830M)
☐	KD-4	5'-0" x 5'-0" (1525M x 1525M)

ARCH'T OR ENG'R _____
PURCHASE ORDER _____ DATE _____
PROJECT _____
GEN'L CONTRACTOR _____
PURCHASER _____
BILCO REPRESENTATIVE _____
DWG. NO. _____ DATE _____

This drawing is the property of The Bilco Company and incorporates specifications and patented designs in which The Bilco Company has proprietary rights and, accordingly, is not to be reproduced without the express written consent of The Bilco Company.

© 1990-91 THE BILCO COMPANY

FOSTER WHEELER ENVIRONMENTAL CORPORATION

FAX MEMORANDUM

From: Lucine **Phone Number:** 561-237-1853

To: Jeff Zhao **Fax Number:** 281-596-0308

Number of Pages:

Subject: Drains Example

Date: 1/18/02

Jeff,

Our email is temporarily down. I spoke w/ Joe and he should be able to send something out on Monday afternoon. I am still trying to track Markdown to get final answers.

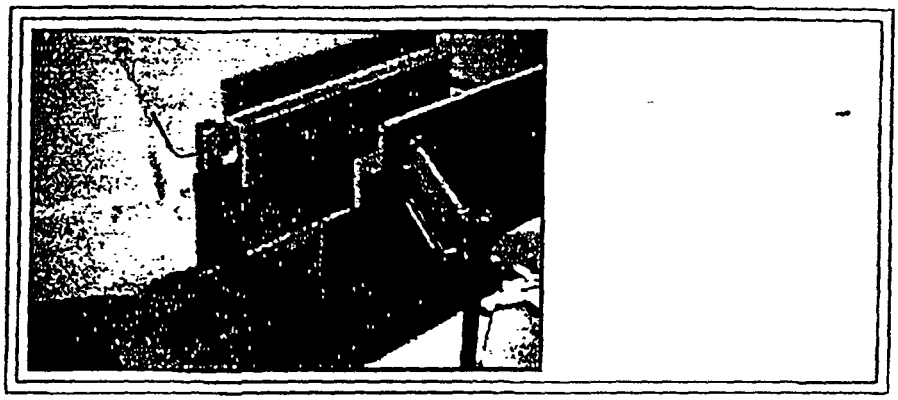
Thanks,

Lucine

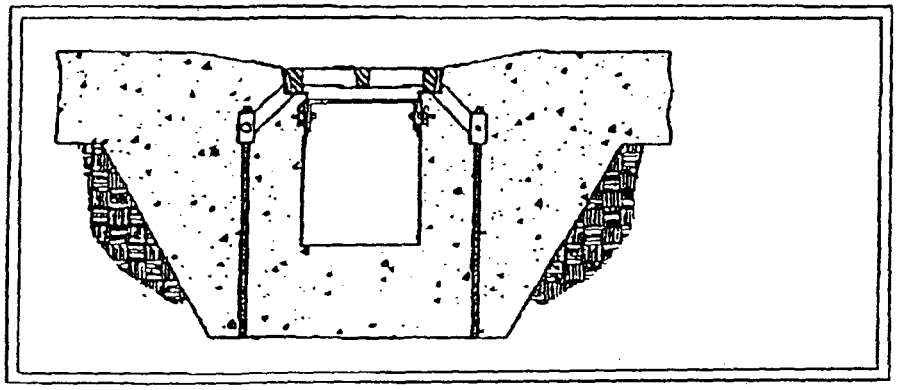
5300 Broken Sound Blvd., Suite 110
Boca Raton, FL 33487-3509
Tel. 561-237-1888 Fax. 561-237-1890

MultiDrain™ Patent # 5000621

The trench forming system for projects requiring lined trenches.



MultiDrain is a trench forming system with a leave-in-place form liner, Z frame and other patented features. The Frames and Channels may be manufactured in Galvanized Steel (typical) or Stainless Steel. Trench covers are available in a wide variety of materials and load capacities. Grates are available in gray cast iron (typical), ductile iron, painted steel, galvanized steel, stainless steel, aluminum and fiberglass. Load capacities from pedestrian traffic to commercial and military aircraft. System sizes available from 4" to 24" wide and deep. MultiDrain is versatility!



[Home] [Free Info] [EconoDrain] [Specifications] [EZ Form]
[Aviation Series] [Catch Basins] [MultiDrain] [E-Z Frame] [E-mail]

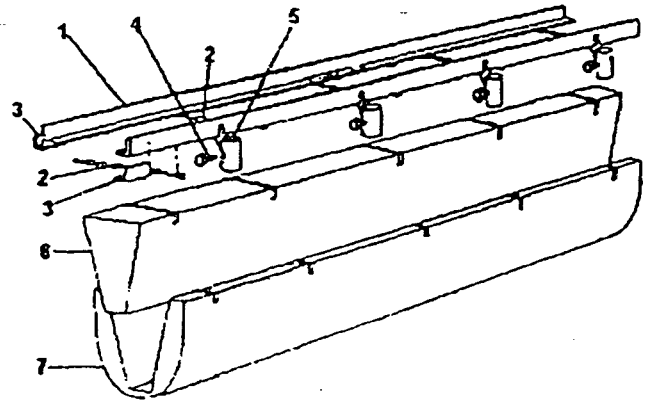
MultiDrain *Systems*
Atlanta, Ga.
Phone: 1-800-433-1119
Fax: 1-800-731-9636

Copyright 2000 by MultiDrain *Systems*

EconoDrain™

Precise trench forming made simple and affordable.

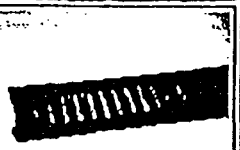
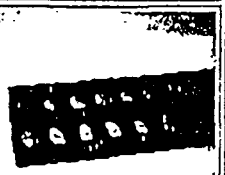
Patent # 4993878

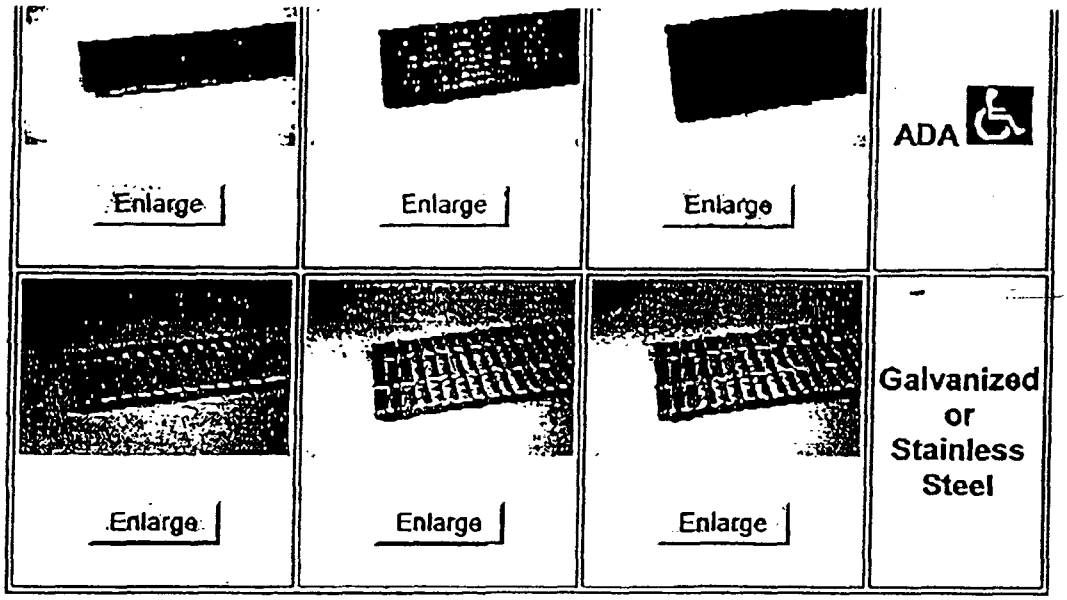


1. **Frame Assembly**
2. **Spacer Rod**
3. **Alignment Tab**
4. **Hex Bolt**
5. **Anchor Stand**
6. **Expanded Polystyrene (EPS) Form-** Center Wedge
7. **Expanded Polystyrene (EPS) Form-** Outer Section

EconoDrain provides versatile and durable surface drainage for a wide variety of applications. Available with standard .50% slope, neutral or special slopes. Designed to run further with continuous slope than other forming systems, without costly optional components. Gratings available for light to extra heavy loads. Standard EconoDrain widths of 4", 8" and 12" are available. For other widths see the EZ Form system.

Grates

Series 4	Series 8	Series 12	
 Enlarge	 Enlarge	Enlarge	Gray Iron (Standard) or Ductile Iron



Available Gratings:

- Gray Cast Iron (Standard)
- Ductile Cast Iron
- Galvanized Steel
- Stainless Steel
- Fiberglass
- Cast Aluminum

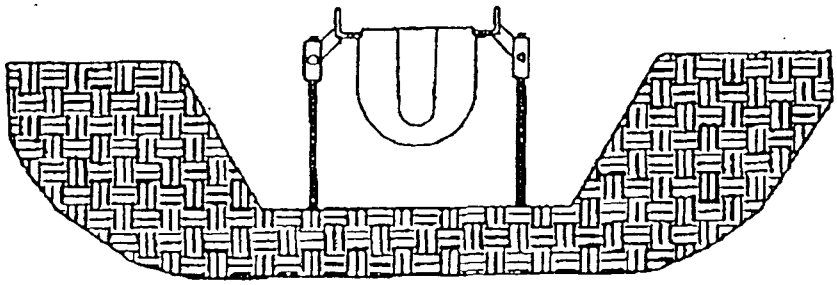
Available Frames:

- Coated Steel
- Galvanized Steel (Hot-dipped)
- Stainless Steel

Easy Installation

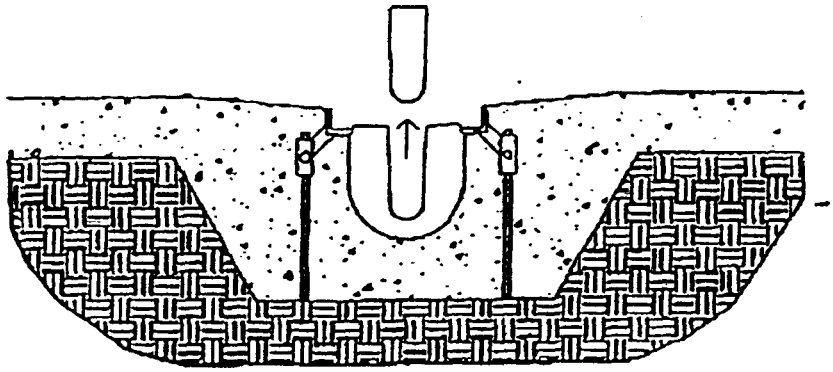
If pictures don't completely load, click "refresh" or "reload"

Mount system on rebar driven into the ground. Level and tighten. Place concrete.

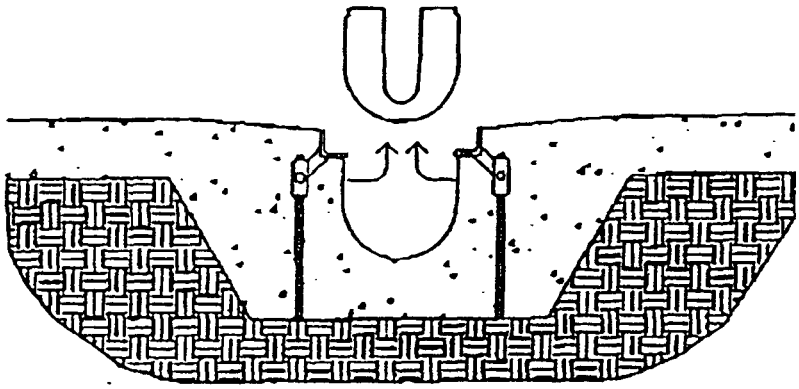


Cut and remove 1/4" rods welded between frames.Remove center form

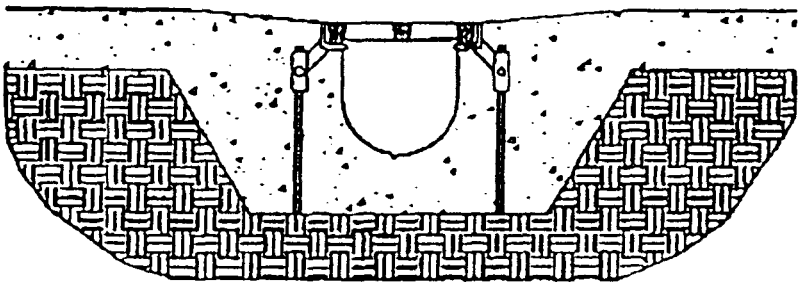
wedge.



Remove outer form. Clean debris from frameseat.



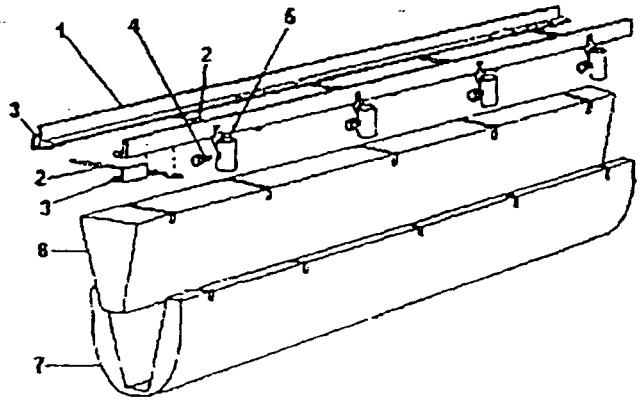
Install Covers.



EconoDrain™

Precise trench forming made simple and affordable.

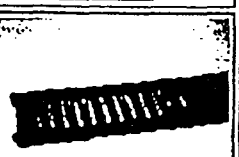
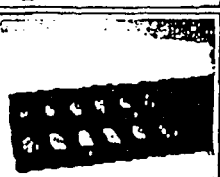
Patent # 4993878

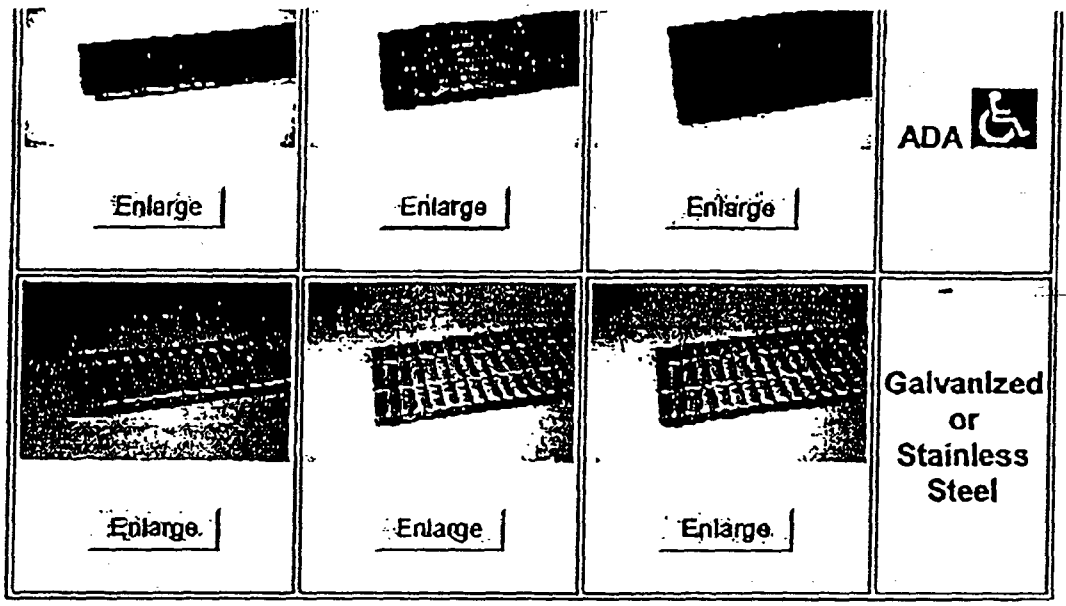


1. **Frame Assembly**
2. **Spacer Rod**
3. **Alignment Tab**
4. **Hex Bolt**
5. **Anchor Stand**
6. **Expanded Polystyrene (EPS) Form-** Center Wedge
7. **Expanded Polystyrene (EPS) Form-** Outer Section

EconoDrain provides versatile and durable surface drainage for a wide variety of applications. Available with standard .50% slope, neutral or special slopes. Designed to run further with continuous slope than other forming systems, without costly optional components. Gratings available for light to extra heavy loads. Standard EconoDrain widths of 4", 8" and 12" are available. For other widths see the EZ Form system.

Grates

Series 4	Series 8	Series 12	
 Enlarge	 Enlarge	Enlarge	Gray Iron (Standard) or Ductile Iron



Available Gratings:

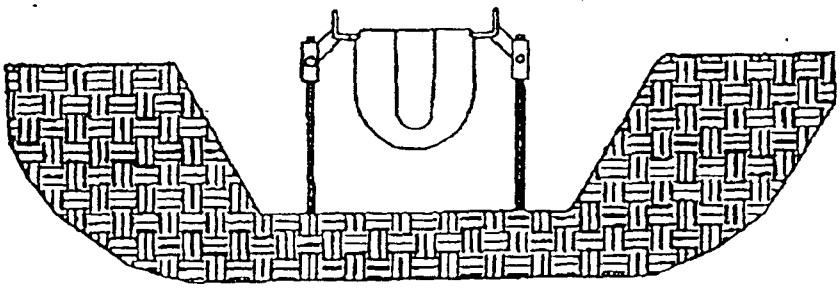
- Gray Cast Iron (Standard)
- Ductile Cast Iron
- Galvanized Steel
- Stainless Steel
- Fiberglass
- Cast Aluminum

Available Frames:

- Coated Steel
- Galvanized Steel (Hot-dipped)
- Stainless Steel

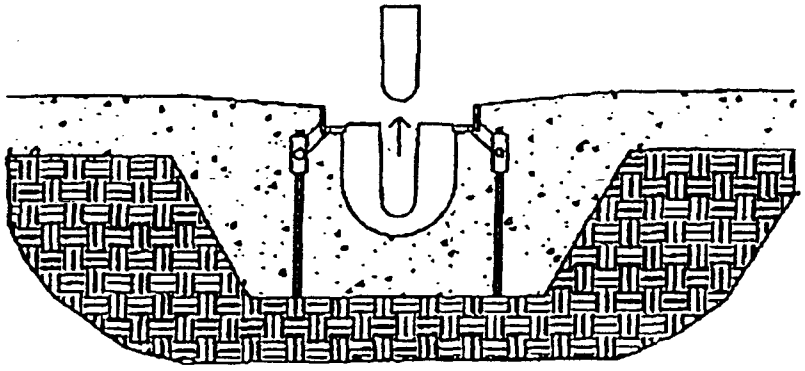
Easy Installation If pictures don't completely load, click "refresh" or "reload"

Mount system on rebar driven into the ground. Level and tighten. Place concrete.

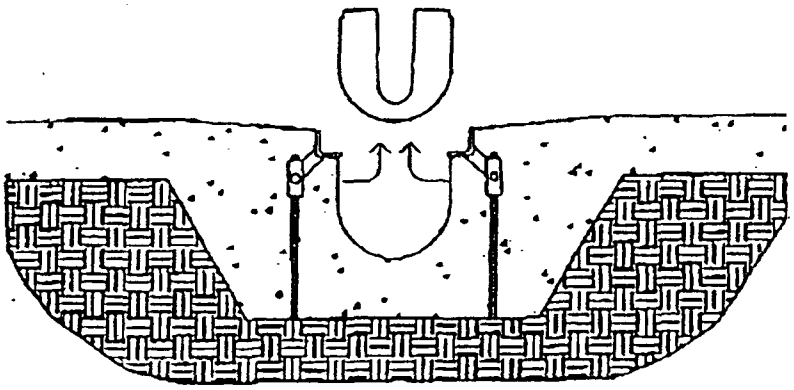


Cut and remove 1/4" rods welded between frames.Remove center form

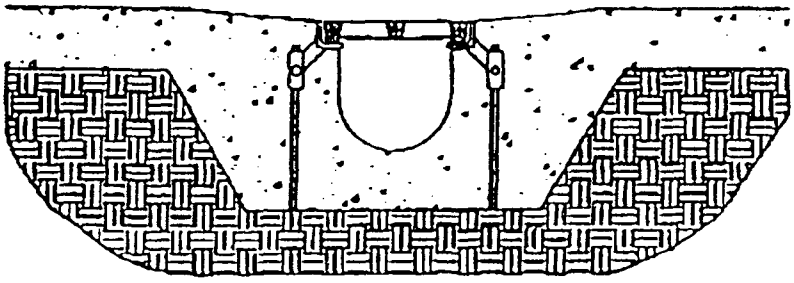
wedge.



Remove outer form. Clean debris from frameseat.



Install Covers.



Trench Drain Specification

Short Form – Three Manufacturers

4" Systems

The following specification is for a 4" wide H-20 loading system with a 5-1/2" – 6" wide grate. These systems are suitable for indoor applications and selected-outdoor applications that require H-20 loading. Caution should be exercised in specifying 4" systems in outdoor, roadway, and parking lot applications due to the susceptibility of all small systems to clogging. Alternate grates for ADA applications are included. In areas subject to solid tire forklift traffic or vehicles turning while on top of the grate, a ductile iron grate may be advisable.

Manufactured Trench Drains:

Trench drains shall be a pre-engineered, manufactured system that conforms to the design loading requirements of AASHTO H-20 and HS-20 with the following minimum requirements:

1. A method of forming a round bottom channel pre-sloped to a minimum of .5% (1/16" per foot.) installed in standard eight foot sections. *[Specifier may substitute flat bottom or veebottom].*

2. A steel, cast iron, or ductile iron frame with anchors at 45 degrees into the surrounding concrete.

3. A cast iron or ductile iron grate conforming to Federal Specification RR-F-621C.

4. A locking device which directly connects the grate to the frame.

Acceptable systems are:

EconoDrainTM ; Series #4 with steel frame and grate #EG-0424-CI-B by MultiDrain Systems (800) 433-1119. *[Specifier may substitute #EG-0424-DI-B for ductile iron grate or #EG –0424-CI-ADA for ADA compliant grate].*

Flo-ThruTM; Model Z-806 with steel frame and grate #Z-806-CG by Zurn. (716) 665-1132

[Specifier may substitute #Z-806-DG for ductile iron grate or #Z –806-HPD for ADA compliant grate].

ACO DrainTM ; FG 100 System with steel frame and grate #460by ACO Polymer Products , Inc. (216) 285-7000

[Specifier may substitute #461 for ductile iron grate or #477ADA for ADA compliant grate].

Alternate systems must be submitted for approval prior to the bid date.

Print

Trench Drain Specification

Short Form – Three Manufacturers

8" Systems

The following specification is for a 8" wide H-20 loading system with a 10" wide grate. These systems are suitable for indoor applications and outdoor applications that require H-20 loading. Alternate grates for ADA applications are included. In areas subject to solid tire forklift traffic or vehicles turning while on top of the grate, a ductile iron grate may be advisable. In areas where large volumes of fluid must enter the system in a short period of time, a steel bar grate may be advisable.

Manufactured Trench Drains:

Trench drains shall be a pre-engineered, manufactured system that conforms to the design loading requirements of AASHTO H-20 and HS-20 with the following minimum requirements:

1. A method of forming a round bottom channel pre-sloped to a minimum of .5% (1/16" per foot.)Installed in standard eight foot sections. *[Specifier may substitute flat bottom or vee bottom].*

2. A steel, cast iron, or ductile iron frame with anchors at 45 degrees into the surrounding concrete.

3. A cast iron or ductile iron grate conforming to Federal Specification RR-F-621C.

4. A locking device which directly connects the grate to the frame.

Acceptable systems are:

EconoDrain™; Series #8 with steel frame and grate #EG-0824-CI-B by MultiDrain Systems (800) 433-1119. *[Specifier may substitute #EG-0824-DI-B for ductile iron grate or #EG –0824-CI-ADA for ADA compliant grate].*

Flo-Thru™; Model Z-886 with steel frame and grate #Z-812-CG by Zurn. (716) 665-1132 *[Specifier may substitute #Z –812-HPD for ADA compliant grate].*

ACO Drain™; FG 200 with steel frame and 10" cast iron grate by ACO (216) 285-7000

[Specifier may substitute "10" Ductile Iron" for ductile iron grate or "10" ADA Compliant Grate" for ADA compliant grate].

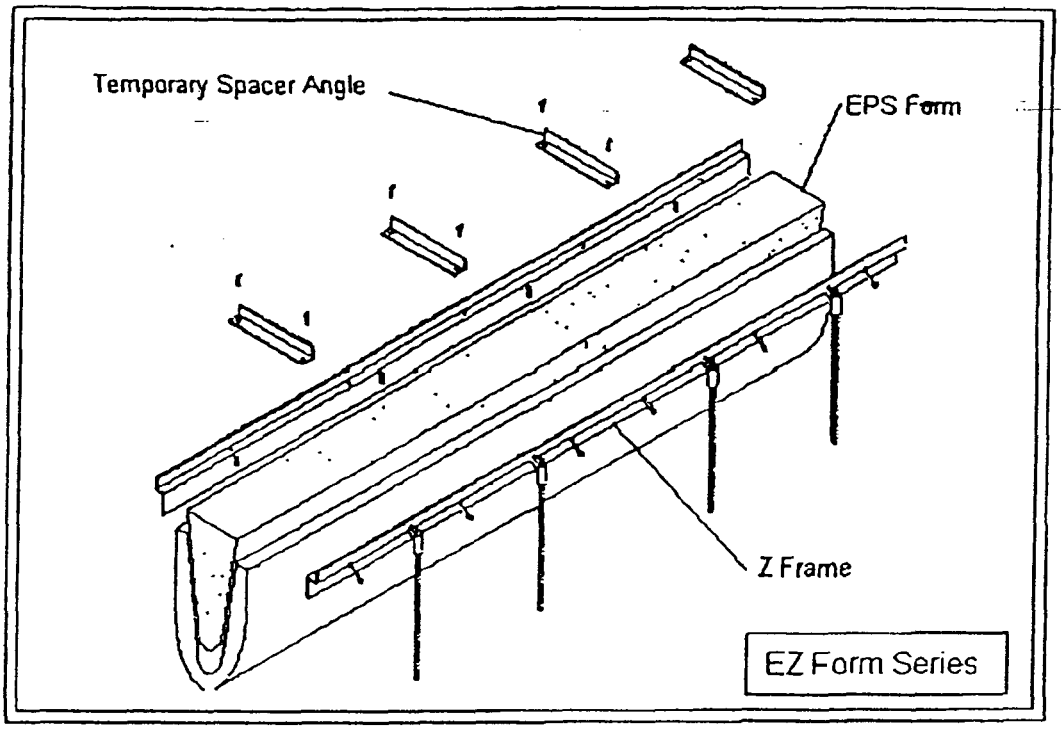
Alternate systems must be submitted for approval prior to the bid date.

Print

Back

EZ Form™

The surface drainage solution for projects requiring trenches wider than 12".



EZ Form is available in virtually any width and depth and includes our patented Z frame and spacer angle configuration designed to provide an easy, yet precise installation with excellent results. A wide variety of gratings are available to meet the requirements of most projects.

Available Gratings:

- Gray Cast Iron
- Ductile Cast Iron
- Galvanized Steel
- Fiberglass
- Cast Aluminum

Available Frames:

- Galvanized Steel (Hot-dipped)
- Stainless Steel

Trench Drain Specification

Short Form – Three Manufacturers

12" Systems

The following specification is for a 12" wide H-20 loading system with a 14" wide grate. These systems are suitable for indoor applications and outdoor applications that require H-20 loading. Alternate grates for ADA applications are included. In areas subject to solid tire forklift traffic or vehicles turning while on top of the grate, a ductile iron grate may be advisable. In areas where large volumes of fluid must enter the system in a short period of time, a steel bar grate may be advisable.

Manufactured Trench Drains:

Trench drains shall be a pre-engineered, manufactured system that conforms to the design loading requirements of AASHTO H-20 and HS-20 with the following minimum requirements:

1. A method of forming a round bottom channel pre-sloped to a minimum of .5% (1/16" per foot.)installed in standard eight foot sections. *[Specifier may substitute flat bottom or vee bottom].*

2. A steel, cast iron, or ductile iron frame with anchors at 45 degrees into the surrounding concrete.

3. A cast iron or ductile iron grate conforming to Federal Specification RR-F-621C.

4. A locking device which directly connects the grate to the frame.

Acceptable systems are:

EconoDrainTM ; Series #12 with steel frame and grate #EG-1224-CI-B by MultiDrain Systems (800) 433-1119. *[Specifier may substitute #EG-1224-DI-B for ductile iron grate or #EG –1224-CI-ADA for ADA compliant grate].*

Flo-Thru TM; Model Z-886 with steel frame and grate #Z-812-CG by Zurn. (716) 665-1132*[Specifier may substitute #Z –812-HPD for ADA compliant grate].*

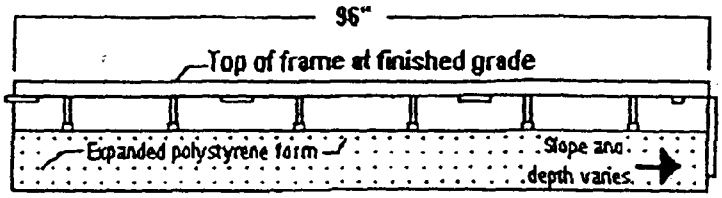
ACO DrainTM; Aquaduct 12" System with 14" Cast Iron Grate (216) 285-7000

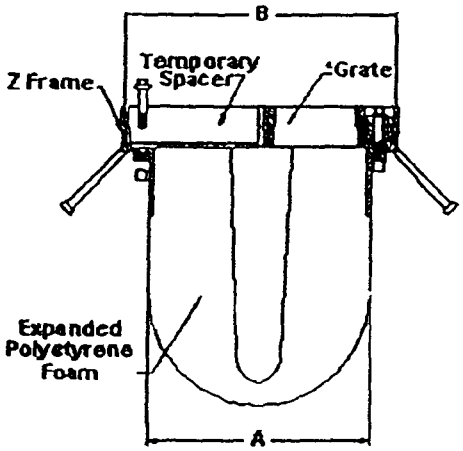
[Specifier may substitute "14" Ductile Iron" for ductile iron grate or "14" ADA Compliant Grate" for ADA compliant grate].

Alternate systems must be submitted for approval prior to the bid date.

Print

Back





-STANDARD-

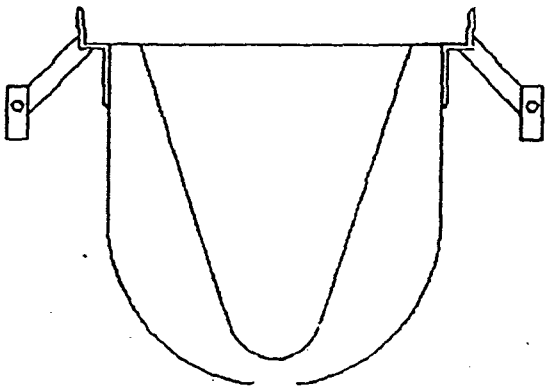
A	B	WIDTH	SLOPE	LENGTH	DEPTH
4"	REFER TO ECONODRAIN SYSTEMS				
8"					
12"	14 3/16"	14"	.5%	8'	8"-48"
16"	18 1/4"	17"	.5%	8'	12"-48"
18"	20 1/4"	20"	.5%	8'	12"-48"
24"	26 1/4"	26"	.5%	8'	12"-48"

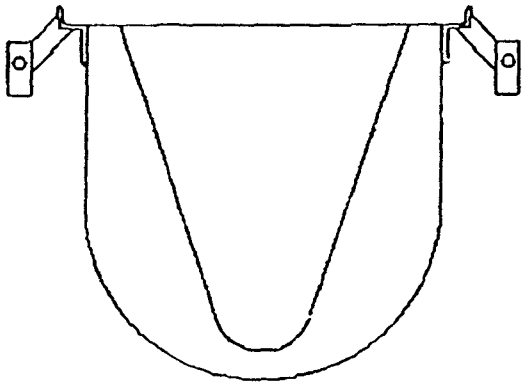
Custom Slopes and Depths available

*BOLTED GRATES OPTIONAL

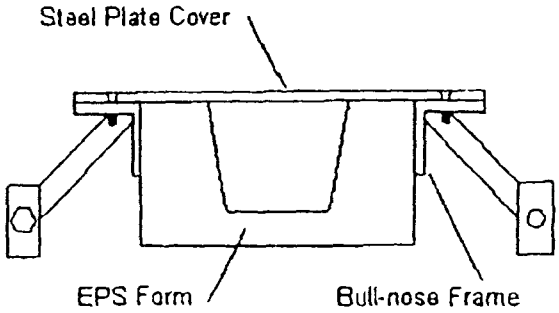
EZ Form with Z Frame Designed to Accommodate a Heavy Duty Grate

EZ Form with Z Frame Designed to Accommodate a Light Duty Grate



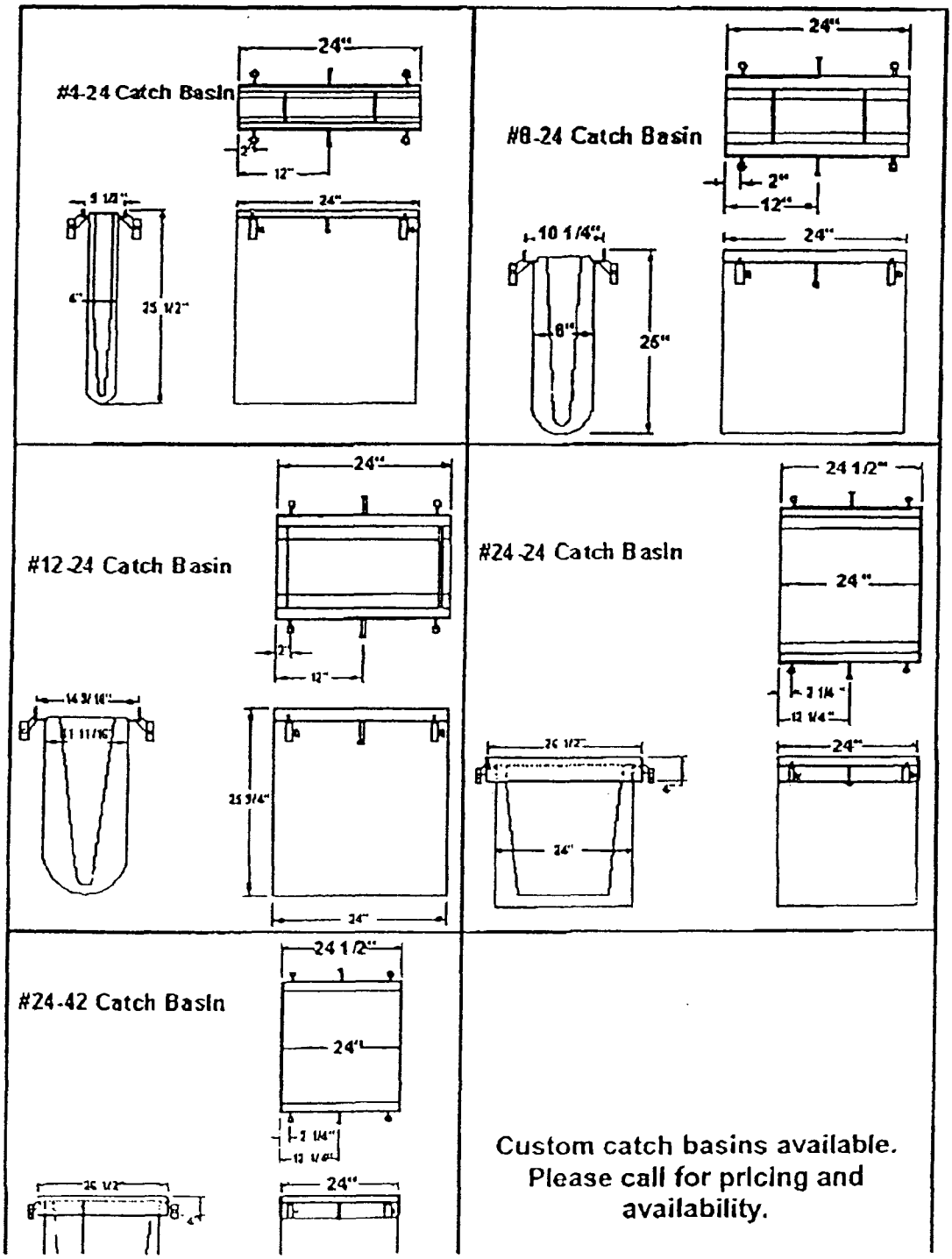


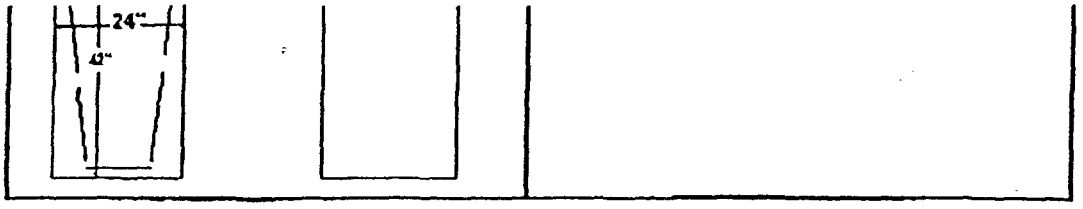
Sidewalk / Utility Trench Series



Catch Basins

MultiDrain Systems features catch basins to meet the requirements of virtually any project. Our catch basins utilize steel frames (coated, galvanized or stainless steel) with expanded polystyrene forms. Catch basin forms may be used with any of our trench forming systems including the MultiDrain and Aviation systems. Covers are available in the same materials and loading as the various trench forming systems. Custom form configurations are also available. Please call for pricing and availability.





[Home] [Free Info] [EconoDrain] [Specifications] [EZ Form]
[Aviation Series] [Catch Basins] [MultiDrain] [E-Z Frame] [E-mail]

MultiDrain *Systems*
Atlanta, Ga.
Phone: 1-800-433-1119
Fax: 1-800-731-9636

Copyright 2000 by **MultiDrain** *Systems*

CALCULATION COVER SHEET

PROJECT New Bedford Harbor Superfund Site OU#1

SUBJECT Footing Design

CLIENT U.S. Army Corps of Engineers – New England District (USACE – NED)

CALCULATION NO. S-02 PROJECT NO. 5197.1720.9302

NO OF SHEETS _____ DESIGN LEVEL _____

CALCULATION BY OTHERS _____ YES _____ NO

PREPARER J. Zhao

REVIEWED BY M. Hsieh DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____ YES _____ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Calculation Record

Client Name: USACE- New England District Page 1 of 54

Project Name: New Bedford Harbor – Dewatering Facility Project No.: 5197.1720.9302.00010

Calculation Title: Footing Design for Dewatering Building and Support Building

Calculation No./File No.: Rev. 1

Calculation Is: (check all that apply) ☒ Preliminary ☐ Final ☐ Nuclear Safety-Related

Objective Design reinforced footings for dewatering building and support building for both strength and service conditions.

Unverified Assumptions Requiring Subsequent Verification

No.	Assumption	Verified By	Date
1	No architectural drawings available at the time of calculation. Column reactions need to be verified once the drawings and certified data become available.		
2			
3			

See Page 2 of this calculation for additional assumptions.

This Section Used for Computer Generated Calculations

Program Name/Number: MathCAD Version: 2001

Evidence of or reference to computer program verification, if applicable:
MathCAD consists of user defined worksheets.

Bases or reference thereto supporting application of the computer program to the physical problem:

Review and Approval

Rev	Prepared By	Date	Verified By	Date	Approved By	Date
0	Mandy Loeffler	1/25/02				
1	Jeff Zhao	4/26/02				

Summary of Footing Design

The Rev. 1 of Footing Design for Dewatering Building and Support Building consists of

1) Revised calculation of interior and exterior footings for the Dewatering Building per Mike Hsieh's comments on the 90% submittal.
2) Newly added footing design for the Support Building.

Allowable soil pressure used in footing design were per discussions and the chart provided by Mark Otten. It is understood that, when soil pressure is limited within the range, footing settlement should be less than 1".

The designers have consulted Dutton & Garfiedld, Inc., a Butler builder, and obtained column reaction forces for the Dewatering Building (see Appendix 1). Due to several afterward revisions of column locations, however, the origina data were no longer valid for the latest layout (but shall provide a reasonable baseline). Because of this, the worst loaded columns from the original data were selected in the design calculations. Refined design is suggested once the pre-engineered buildings have been contracted out and certified column reaction data become available.

The column reaction forces of the Support Building were estimated manually by some simplified method. Again, once certified column reaction data become available, the Support Building footing design can be refined.

Content of Calculation:

1. Dewatering Building – Interior Footings p. 4 ~ 18
2. Dewatering Building – Exterior Footings p. 19 ~ 33
3. Support Building Footings p. 34 ~ 54
4. Appendix 1

NO SNOW LOAD
THE WORST CASE FOR
OVERTURNING CHECK

C. Design Loads

External Load

is

C
L
P

dead load	$P_{dl} := 19.95 \cdot k$	$Q_{dl} := 2.41 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 0 \cdot k$	$Q_{ll} := 0 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := -15.34 \cdot k$	$Q_{wind} := 2.56 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind}$$

$$P_e = 4.61\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind}$$

$$Q_e = 4.97\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind}$$

$$M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2)$$

$$P_f = 9.1\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D)$$

$$P_s = 9.7\,k$$

$$P := P_e + P_f + P_s$$

$$P = 23.4\,k$$

$$Q := Q_e$$

$$Q = 5\,k$$

$$M := M_e + Q \cdot (h + D)$$

$$M = 22.37\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 40.7k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot (1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind})$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 5.8\,k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot (1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind})$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 26.08\,k \cdot ft$$

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$

$e = 11.5\,in$ < B/6

Footing area provided $A := B \cdot L$

$A = 5184\,in^2$

Compared with required $A_{trial} := \frac{P}{p_{all}}$

$A_{trial} = 562.2\,in^2$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := if\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 1.27\,ksf$ OK

F. Shear Strength Design - Beam Shear

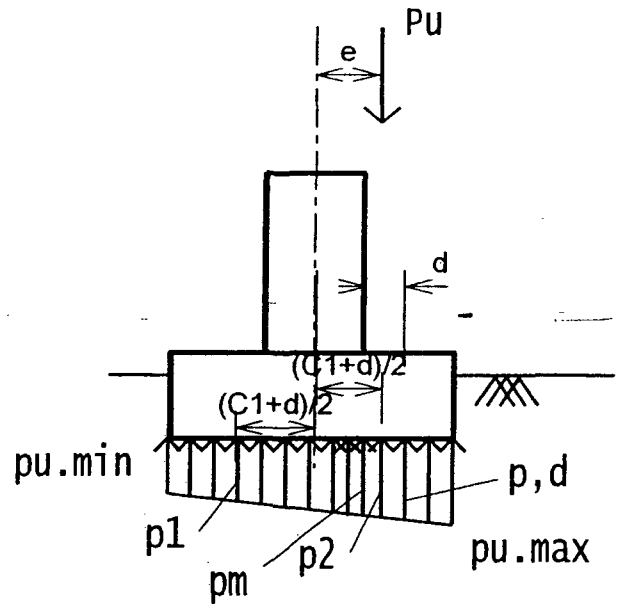
$$e_u := \frac{M_u}{P_u}$$

$e_u = 7.7\,in$ < B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$

$A_{shear} = 6.25\,ft^2$

F1. Case I (e_u < B/6)



Case I

Soil pressure

$$p_{u.max} := \frac{P_u}{A} + 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.max} = 1.85\,ksf$

$$p_{u.min} := \frac{P_u}{A} - 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.min} = 0.41\,ksf$

$$p_d := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2} + d\right)}{B}$$

$p_d = 1.6\,ksf$

Design Shear

$$V_u := A_{shear} \cdot \frac{p_d + p_{u.max}}{2}$$

$V_u = 10.8\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 112.25\,k$ > V_u, OK

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 10.83\,ft$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G1. Case I (e_u < B/6)

$$p_1 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} - \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_1 = 0.8\,ksf$$

$$p_2 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} + \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_2 = 1.46\,ksf$$

Design shear

$$V_u := P_u - \frac{(p_1 + p_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

$$V_u = 32.4\,k$$

Shear strength

$$V := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \end{bmatrix}$$

$$\phi V_n := 0.85\cdot\min(V)$$

$$\phi V_n = 405.34\,k$$ > V_u, OK

H. Flexural Strength Design

H1. Case I (e_u < B/6)

$$p_m := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2}\right)}{B}$$

$$p_m = 1.31\,ksf$$

Design moment

$$M_{u.design} := p_m \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right) \cdot L \cdot \frac{\left(\frac{B}{2} - \frac{C_1}{2}\right)}{2} + 0.5 \cdot (p_{u.max} - p_m) \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right)^2 \cdot L \cdot \frac{2}{3}$$

$$M_{u.design} = 25.42\,k \cdot ft$$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 22.37\,k \cdot ft$$

Resisting moment

$$M_r := P \cdot \frac{B}{2}$$

$$M_r = 70.28\,k \cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$FS_{ot} = 3.14$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu \cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$FS_{sliding} = 3.3$ > 1.5, OK

FOSTER WHEELER ENVIRONMENTAL CORPORATION	Owner__USACOE Project____New Bedford Harbor __ Project No.__5197.1720.3392.00010 Title___Dewatering Facility Foundation _____Footings for Interior Columns (RUN 2)	Computed By____GZ___ Date_____4/26/02 Verified By Date Page

Purpose: Sizing rentangular footing to support columns.

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

Column reaction data from Dutton & Garfield, Inc. (See Appendex 1)

B. Design Parameters

$f'_c := 4000 \cdot psi$

$f_y := 60 \cdot ksi$

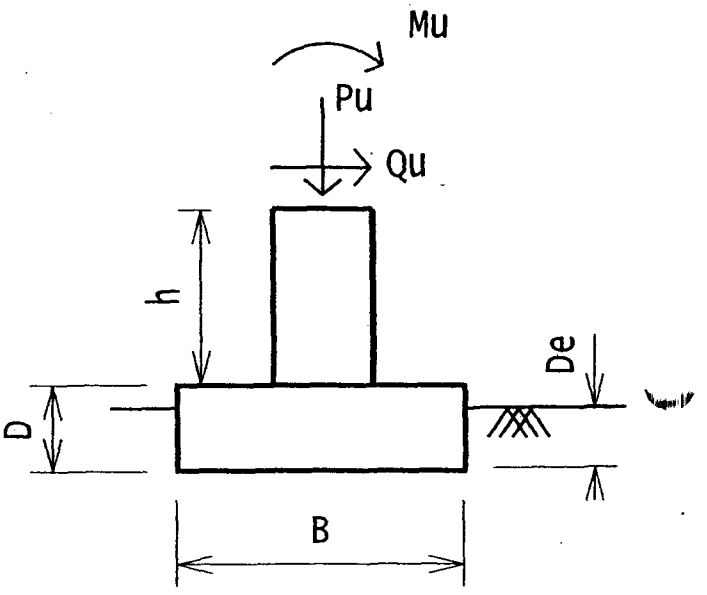
Soil unit weight $\gamma_s := 0.115 \cdot \frac{k}{ft^3}$

Concrete unit weight $\gamma_c := 0.15 \cdot \frac{k}{ft^3}$

Allowable soil bearing $p_{all} := 6 \cdot ksf$

Soil friction coefficient $\mu := 0.7$

Frost depth = 4 ft



Trial dimensions of footing:

$B := 6 \cdot ft$ $\frac{B}{6} = 12 in$

$L := 6 \cdot ft$

$h := 3 \cdot ft$

$C_1 := 1.5 \cdot ft$

$C_2 := 1.5 \cdot ft$

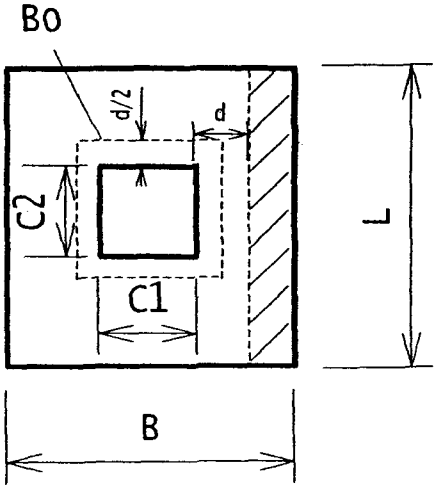
$D := 1.5 \cdot ft$

$D_e := 4 \cdot ft$

$d_b := 1 \cdot in$

$d := D - 3 \cdot in - \left(\frac{1}{2}\right) \cdot d_b$

$d = 14.5 in$



C. Design Loads

WITH SNOW LOAD, THE WORST CASE FOR SOIL PRESSURE CHECK & FOOTING REINFORCEMENT DESIGN

External Load

dead load	$P_{dl} := 19.95 \cdot k$	$Q_{dl} := 2.41 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 56.49 \cdot k$	$Q_{ll} := 7.10 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := -15.34 \cdot k$	$Q_{wind} := 2.56 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind}$$

$$P_e = 61.1\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind}$$

$$Q_e = 12.07\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind}$$

$$M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2)$$

$$P_f = 9.1\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D)$$

$$P_s = 9.7\,k$$

$$P := P_e + P_f + P_s$$

$$P = 79.9\,k$$

$$Q := Q_e$$

$$Q = 12.1\,k$$

$$M := M_e + Q \cdot (h + D)$$

$$M = 54.32\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 136.7\,k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot \left(1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind}\right)$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 15.4\,k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot \left(1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind}\right)$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 69.5\,k \cdot ft$$

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$

$e = 8.2\,in$ < B/6

Footing area provided $A := B \cdot L$

$A = 5184\,in^2$

Compared with required $A_{trial} := \frac{P}{p_{all}}$

$A_{trial} = 1918\,in^2$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := if\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 3.73\,ksf$ OK

F. Shear Strength Design - Beam Shear

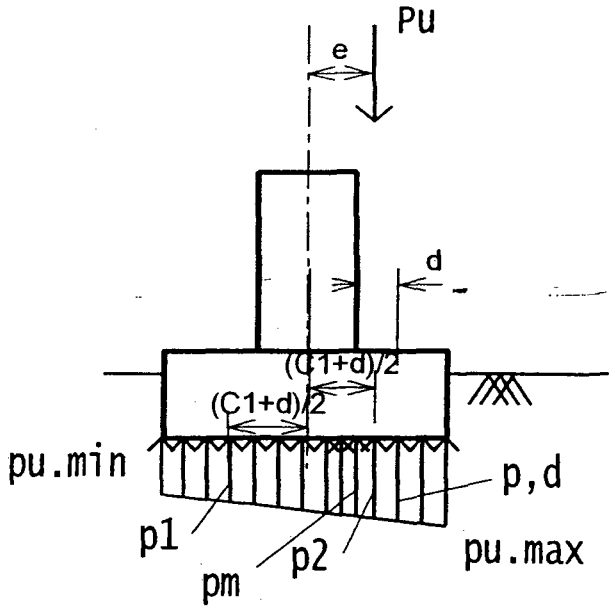
$$e_u := \frac{M_u}{P_u}$$

$e_u = 6.1\,in$ < B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$

$A_{shear} = 6.25\,ft^2$

F1. Case I (e_u < B/6)



Case I

Soil pressure

$$p_{u.max} := \frac{P_u}{A} + 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.max} = 5.73\,ksf$

$$p_{u.min} := \frac{P_u}{A} - 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.min} = 1.87\,ksf$

$$p_d := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2} + d\right)}{B}$$

$p_d = 5.06\,ksf$

Design Shear

$$V_u := A_{shear} \cdot \frac{p_d + p_{u.max}}{2}$$

$V_u = 33.71\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 112.25\,k$ > V_u, OK

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 10.83\,\text{ft}$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G1. Case I (e_u < B/6)

$$p_1 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} - \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_1 = 2.93\,\text{ksf}$$

$$p_2 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} + \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_2 = 4.67\,\text{ksf}$$

Design shear

$$V_u := P_u - \frac{(p_1 + p_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

$$V_u = 108.86\,\text{k}$$

Shear strength

$$V := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot\text{psi}\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot\text{psi}\cdot B_0\cdot d \end{bmatrix}$$

$$\phi V_n := 0.85\cdot\min(V)$$

$$\phi V_n = 405.34\,\text{k}$$ > V_u, OK

H. Flexural Strength Design

H1. Case I ($e_u < B/6$)

$$p_m := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2}\right)}{B}$$

$$p_m = 4.28\,ksf$$

Design moment

$$M_{u.design} := p_m \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right) \cdot L \cdot \frac{\left(\frac{B}{2} - \frac{C_1}{2}\right)}{2} + 0.5 \cdot (p_{u.max} - p_m) \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right)^2 \cdot L \cdot \frac{2}{3}$$

$$M_{u.design} = 79.67\,k \cdot ft$$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 54.32\,k \cdot ft$$

Resisting moment

$$M_r := P \cdot \frac{B}{2}$$

$$M_r = 239.75\,k \cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$FS_{ot} = 4.41$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu \cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$FS_{sliding} = 4.63$ > 1.5, OK

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	26-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Interior Footings	Date:	
	Mu.design	Page	of

Exposure: ● Interior ○ Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	79.67 kips*ft		
Average Load Factor =	1.55		
Service Moment =	617 kips*in		
Bar Spacing =	14 in		
Width, b =	66 in		
Slab Thickness=	18 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	14.625 in
ϕ =	0.9	#Bars =	4.714286 — 5 #6
Normal/Severe exposure (0/1) =	0	A_{steel}=	2.074286 in^2

#6 @ 14 in. spacing

Moment Check

	w =	0.019025	
	ρ =	0.001268	
	$A_{srequired}$ =	1.224261 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	20.63714 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	3.2175 in^2	
	$4/3*A_{srequired}$ =	1.632348 in^2	ok

Crack Check

β =	1.35	
E_c =	3604.997 ksi	
n =	8.044391	
d_c=	3.375 in	
A=	94.5 in^2	
NA =	2.478296 mm	
f_s =	21.54921 ksi	
z=	147.2312 kips/in	
Required =	155.5556 kips/in	ok

ACI-350 Check

	Z =	115 kips/in	no good
	fs =	21.54921 ksi	
	Max Spacing =	12 in	no good
Actual ->	ρ =	0.002149	

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Owner USACOE
Project New Bedford Harbor
Project No. 5197.1720.3392.00010
Title Dewatering Facility Foundation
Footings for Exterior Columns

Computed By GZ
Date 4/26/02
Verified By
Date
Page

(RUN 3)

Purpose: Sizing rentangular footing to support columns.

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

Column reaction data from Dutton & Garfield, Inc. (See Appendex 1)

B. Design Parameters

$f'_c := 4000 \cdot psi$

$f_y := 60 \cdot ksi$

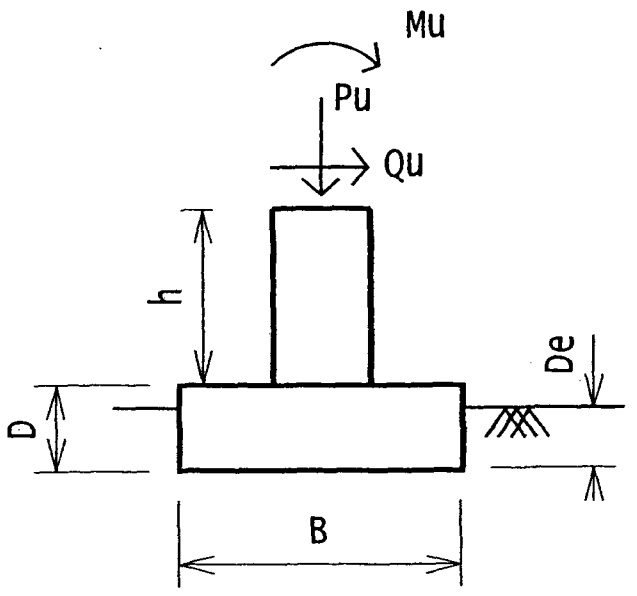
Soil unit weight $\gamma_s := 0.115 \cdot \frac{k}{ft^3}$

Concrete unit weight $\gamma_c := 0.15 \cdot \frac{k}{ft^3}$

Allowable soil bearing $p_{all} := 6 \cdot ksf$

Soil friction coefficient $\mu := 0.7$

Frost depth = 4 ft



Trial dimensions of footing:

$B := 5 \cdot ft$ $\frac{B}{6} = 10 in$

$L := 5 \cdot ft$

$h := 3.5 \cdot ft$

$C_1 := 1.5 \cdot ft$

$C_2 := 1.5 \cdot ft$

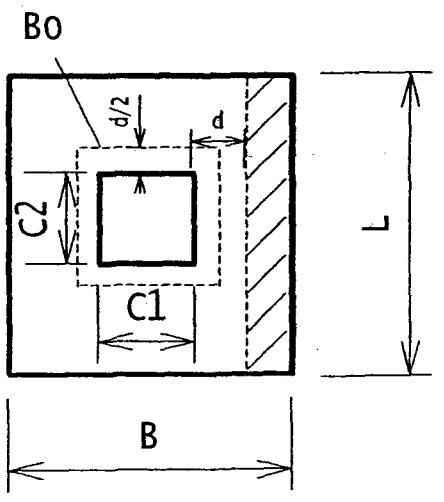
$D := 1 \cdot ft$

$D_e := 4 \cdot ft$

$d_b := 1 \cdot in$

$d := D - 3 \cdot in - \left(\frac{1}{2}\right) \cdot d_b$

$d = 8.5 in$



C. Design Loads

NO SNOW LOAD, FOR OVERTURNING CHECK

External Load

dead load	$P_{dl} := 11.71 \cdot k$	$Q_{dl} := 2.12 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 0 \cdot k$	$Q_{ll} := 0 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := -11.45 \cdot k$	$Q_{wind} := 1.38 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind} \qquad P_e = 0.26\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind} \qquad Q_e = 3.5\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind} \qquad M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2) \qquad P_f = 4.9\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D) \qquad P_s = 7.85\,k$$

$$P := P_e + P_f + P_s \qquad P = 13\,k$$

$$Q := Q_e \qquad Q = 3.5\,k$$

$$M := M_e + Q \cdot (h + D) \qquad M = 15.75\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 23.3\,k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot \left(1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind}\right)$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 4\,k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot \left(1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind}\right)$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 17.93\,k \cdot ft$$

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$

$e = 14.5\,in$ > B/6

Footing area provided $A := B \cdot L$

$A = 3600\,in^2$

Compared with required $A_{trial} := \frac{P}{p_{all}}$

$A_{trial} = 313\,in^2$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := \text{if}\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 1.35\,ksf$ OK

F. Shear Strength Design - Beam Shear

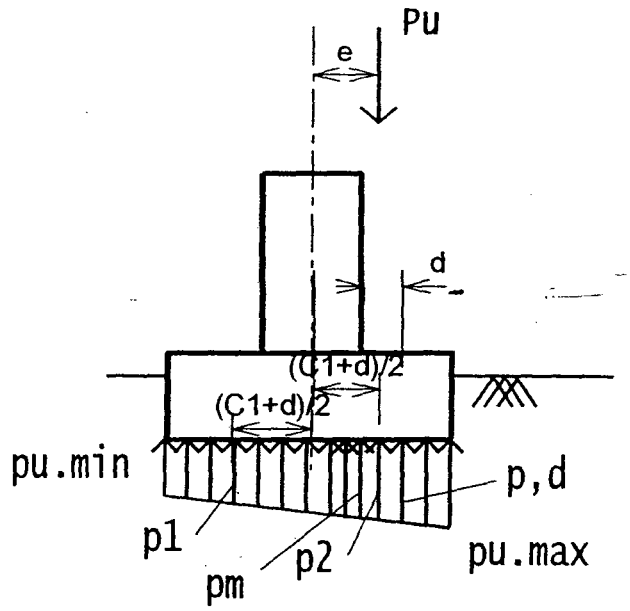
$$e_u := \frac{M_u}{P_u}$$

$e_u = 9.2\,in$ < B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$

$A_{shear} = 5.21\,ft^2$

F1. Case I (e_u < B/6)



Case I

Soil pressure

$$p_{u.max} := \frac{P_u}{A} + 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.max} = 1.79\,ksf$

$$p_{u.min} := \frac{P_u}{A} - 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.min} = 0.07\,ksf$

$$p_d := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2} + d\right)}{B}$$

$p_d = 1.43\,ksf$

Design Shear

$$V_u := A_{shear} \cdot \frac{p_d + p_{u.max}}{2}$$

$V_u = 8.4\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 54.83\,k$ > V_u, OK

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 8.83\,ft$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G1. Case I (e_u < B/6)

$$p_1 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} - \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_1 = 0.55\,ksf$$

$$p_2 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} + \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_2 = 1.31\,ksf$$

Design shear

$$V_u := P_u - \frac{(p_1 + p_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

$$V_u = 18.75\,k$$

Shear strength

$$V := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \end{bmatrix}$$

$$\phi V_n := 0.85\cdot\min(V)$$

$$\phi V_n = 193.75\,k$$ > V_u, OK

H. Flexural Strength Design

H1. Case I ($e_u \leq B/6$)

$$p_m := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2}\right)}{B}$$

$$p_m = 1.19\,ksf$$

Design moment

$$M_{u.design} := p_m \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right) \cdot L \cdot \frac{\left(\frac{B}{2} - \frac{C_1}{2}\right)}{2} + 0.5 \cdot (p_{u.max} - p_m) \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right)^2 \cdot L \cdot \frac{2}{3}$$

$$M_{u.design} = 12.19\,k \cdot ft$$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 15.75\,k \cdot ft$$

Resisting moment

$$M_r := P \cdot \frac{B}{2}$$

$$M_r = 32.6\,k \cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$FS_{ot} = 2.07$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu \cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$FS_{sliding} = 2.61$ > 1.5, OK

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Owner USACOE
Project New Bedford Harbor
Project No. 5197.1720.3392.00010
Title Dewatering Facility Foundation
Footings for Exterior Columns

Computed By GZ
Date 4/26/02
Verified By
Date
Page

(RUN 1)

Purpose: Sizing rentangular footing to support columns.

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

Column reaction data from Dutton & Garfield, Inc. (See Appendex 1)

B. Design Parameters

$f'_c := 4000 \cdot psi$

$f_y := 60 \cdot ksi$

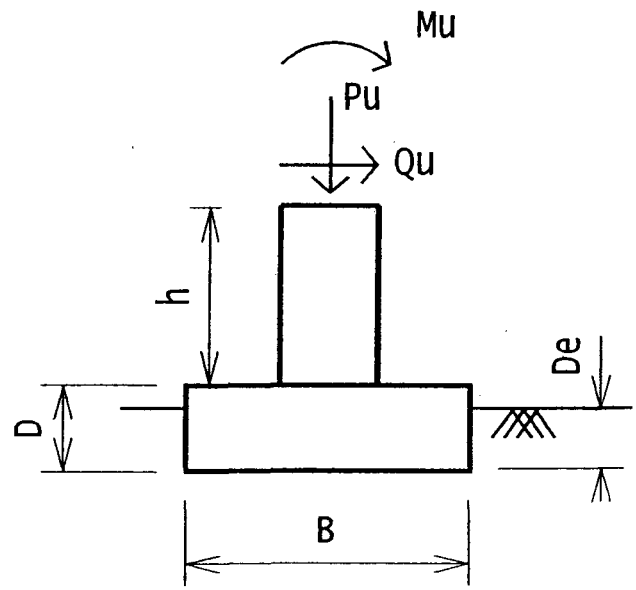
Soil unit weight $\gamma_s := 0.115 \cdot \frac{k}{ft^3}$

Concrete unit weight $\gamma_c := 0.15 \cdot \frac{k}{ft^3}$

Allowable soil bearing $p_{all} := 6 \cdot ksf$

Soil friction coefficient $\mu := 0.7$

Frost depth = 4 ft



Trial dimensions of footing:

$B := 5 \cdot ft$

$\frac{B}{6} = 10 in$

$L := 5 \cdot ft$

$h := 3.5 \cdot ft$

$C_1 := 1.5 \cdot ft$

$C_2 := 1.5 \cdot ft$

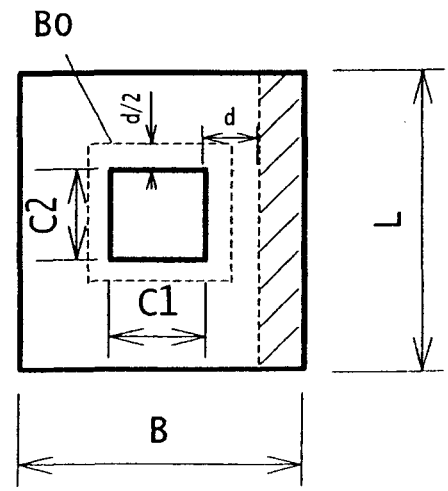
$D := 1 \cdot ft$

$D_e := 4 \cdot ft$

$d_b := 1 \cdot in$

$d := D - 3 \cdot in - \left(\frac{1}{2}\right) \cdot d_b$

$d = 8.5 in$



C. Design Loads

WITH SNOW LOAD, FOR SOIL PRESSURE CHECK & FOOTING REINFORCEM. DESIGN

External Load

dead load	$P_{dl} := 11.71 \cdot k$	$Q_{dl} := 2.12 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 31.88 \cdot k$	$Q_{ll} := 6.26 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := -11.45 \cdot k$	$Q_{wind} := 1.38 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind}$$

$$P_e = 32.14\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind}$$

$$Q_e = 9.76\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind}$$

$$M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2)$$

$$P_f = 4.9\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D)$$

$$P_s = 7.85\,k$$

$$P := P_e + P_f + P_s$$

$$P = 44.9\,k$$

$$Q := Q_e$$

$$Q = 9.8\,k$$

$$M := M_e + Q \cdot (h + D)$$

$$M = 43.92\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 77.5k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot \left(1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind}\right)$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 13.6k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot \left(1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind}\right)$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 61.25k \cdot ft$$

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$

$e = 11.7\,in$ > B/6

Footing area provided $A := B \cdot L$ $A = 3600\,in^2$

Compared with required $A_{trial} := \frac{P}{p_{all}}$

$A_{trial} = 1078.1\,in^2$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := if\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 3.93\,ksf$ OK

F. Shear Strength Design - Beam Shear

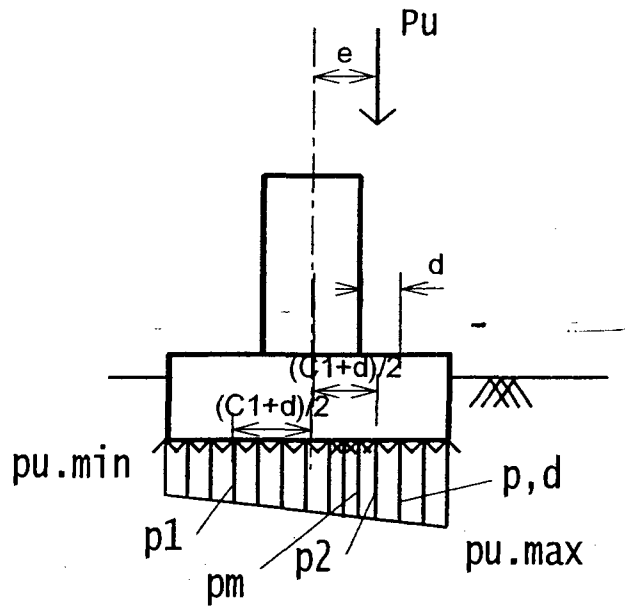
$$e_u := \frac{M_u}{P_u}$$

$e_u = 9.5\,in$ < B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$

$A_{shear} = 5.21\,ft^2$

F1. Case I (e_u < B/6)



Case I

Soil pressure

$$p_{u.max} := \frac{P_u}{A} + 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.max} = 6.04\,ksf$

$$p_{u.min} := \frac{P_u}{A} - 6 \cdot \frac{M_u}{B^2 \cdot L}$$

$p_{u.min} = 0.16\,ksf$

$$p_d := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2} + d\right)}{B}$$

$p_d = 4.81\,ksf$

Design Shear

$$V_u := A_{shear} \cdot \frac{p_d + p_{u.max}}{2}$$

$V_u = 28.27\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 54.83\,k$ > V_u, OK

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 8.83\,ft$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G1. Case I (e_u < B/6)

$$p_1 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} - \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_1 = 1.8\,ksf$$

$$p_2 := p_{u.min} + (p_{u.max} - p_{u.min})\cdot\frac{\left[\frac{B}{2} + \frac{(C_1 + d)}{2}\right]}{B}$$

$$p_2 = 4.4\,ksf$$

Design shear

$$V_u := P_u - \frac{(p_1 + p_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

$$V_u = 62.38\,k$$

Shear strength

$$V := \begin{bmatrix} \left(2 + \frac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \end{bmatrix}$$

$$\phi V_n := 0.85\cdot\min(V)$$

$\phi V_n = 193.75\,k$ > V_u, OK

H. Flexural Strength Design

H1. Case I (e_u < B/6)

$$p_m := p_{u.min} + (p_{u.max} - p_{u.min}) \cdot \frac{\left(\frac{B}{2} + \frac{C_1}{2}\right)}{B}$$

$$p_m = 3.98\,ksf$$

Design moment

$$M_{u.design} := p_m \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right) \cdot L \cdot \frac{\left(\frac{B}{2} - \frac{C_1}{2}\right)}{2} + 0.5 \cdot (p_{u.max} - p_m) \cdot \left(\frac{B}{2} - \frac{C_1}{2}\right)^2 \cdot L \cdot \frac{2}{3}$$

$$M_{u.design} = 40.99\,k \cdot ft$$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 43.92\,k \cdot ft$$

Resisting moment

$$M_r := P \cdot \frac{B}{2}$$

$$M_r = 112.3\,k \cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$FS_{ot} = 2.56$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu \cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$FS_{sliding} = 3.22$ > 1.5, OK

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	26-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Exterior Footings	Date:	
	Mu.design	Page	of

Exposure: ○ Interior ● Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	40.99 kips*ft		
Average Load Factor =	1.55		
Service Moment =	317 kips*in		
Bar Spacing =	11 in		
Width, b =	54 in		
Slab Thickness=	12 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	8.625 in
ϕ =	0.9	#Bars =	4.909091 — 5 #6
Normal/Severe exposure (0/1) =	0	A_{steel}=	2.16 in^2

#6 @ 11 in. spacing

Moment Check

	w =	0.034722	
	ρ =	0.002315	
	$A_{srequired}$ =	1.078124 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	9.957783 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	1.5525 in^2	
	$4/3*A_{srequired}$ =	1.437498 in^2	ok

Crack Check

β =	1.35		
E_c =	3604.997	ksi	
n =	8.044391		
d_c=	3.375	in	
A=	74.25	in^2	
NA =	2.056074	mm	
f_s =	18.50431	ksi	
z=	116.662	kips/in	
Required =	128.8889	kips/in	ok

ACI-350 Check

Z =	115	kips/in	no good
fs =	18.50431	ksi	
Max Spacing =	12	in	ok
Actual -> ρ =	0.004638		

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

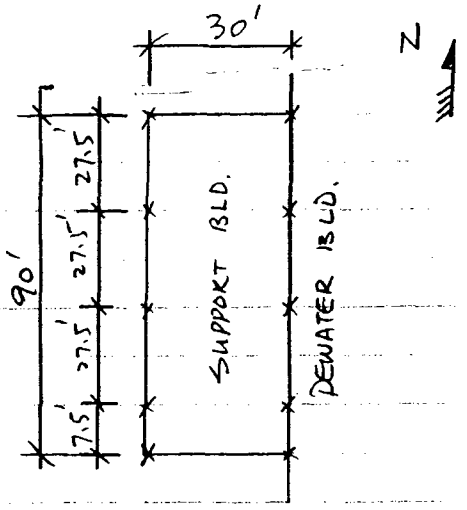
NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

1. DEAD LOADS



ASSUME ROOF + COL. + WALL = 20 K
SHARED BY 8 COLUMNS.
$20^K/8 = 2.5^K$ /COL.

2. MIN. ROOF LIVE LOAD

16 PSF PER NEW DESIGN INFO.

ROOF AREA:

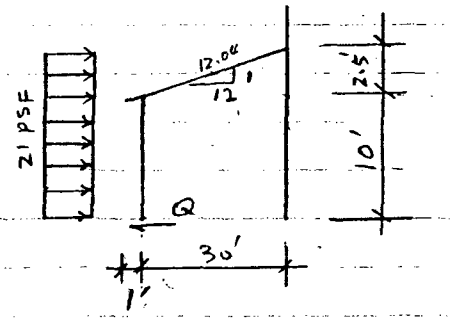
$31' \times \frac{12.04}{12} = 31.1'$

$31.1' \times 92' = 2{,}862$ SF

$2862 \times 16 = 45.8$ K

SHARED BY 8 COL.

$45.8/8 = 5.7$ K/COL.



(NOTE: W-E DIRECTION DOESNOT CONTROL)

3. SNOW LOAD

$P_g = 30$ PSF — PER NEW INFO.

$C_e = 0.7$ — PER NEW INFO.

$C_t = 1.0$ — PER TABLE 7-3, ASCE 7-95

$I = 1.1$ — PER NEW INFO.

$P_f = 0.7\, C_e C_t I P_g$

$= 0.7 \times 0.7 \times 1 \times 1.1 \times 30$

$= 16.2$ PSF

16.2 PSF × 2862 SF = 46.4 K

SHARED BY 8 COL.

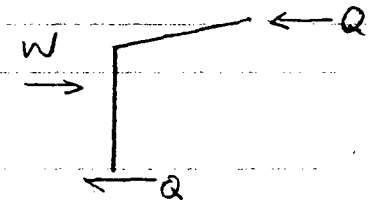
46.4 K / 8 = 5.8 K/COL.

4. WIND LOADS

USE VELOCITY PRESSURE q_z = 21 PSF (SEE CALC SHEET ON NEXT P.) BASED ON THE STRUCTURAL CONFIGURATION. WIND-INDUCED HORIZONTAL LOADING SHALL CONTROL THE COL. FOOTING DESIGN. CONSERVATIVELY ASSUME THE HOR. WIND LOAD IS SHARED AMONG 4 BAYS, AND CENTER BAYS TAKE TWICE AS MUCH HOR. LOADING THAN EDGE BAYS.

12.5′ × 92′ = 1150 SF

1150 × 21 PSF = 24.2 K



MAX. WIND LOAD ON WORST COL.

24.2K / (2×3) = 4.0 K

5. SEISMIC LOADS

BY EXAMINATION, SEISMIC LOADS DO NOT CONTROL

[(2.5 K + 5.8 K) × 0.11 = 0.9 K/COL. << WIND LOAD]

Owner:	New Bedford	Computed by:	Jeff Zhao
Plant:	Support Bld. Unit:	Date:	04/24/2002
Proj No.:	File No:	Checked by:	
Title:	Wind Load Calculation	Date:	
	ASCE7-95	Page: of:	

Building Category = III
Basic Wind, V = 90 mph
Importance Factor = 1.15
Exposure = C
Gust Factor = 0.85
Cf = 2.00 table 6-9 (refer to table 6-6 thru 6-10)

Velocity Pressure, qz = 0.00256 * Kz * Kzt * V^2 * I (psf)

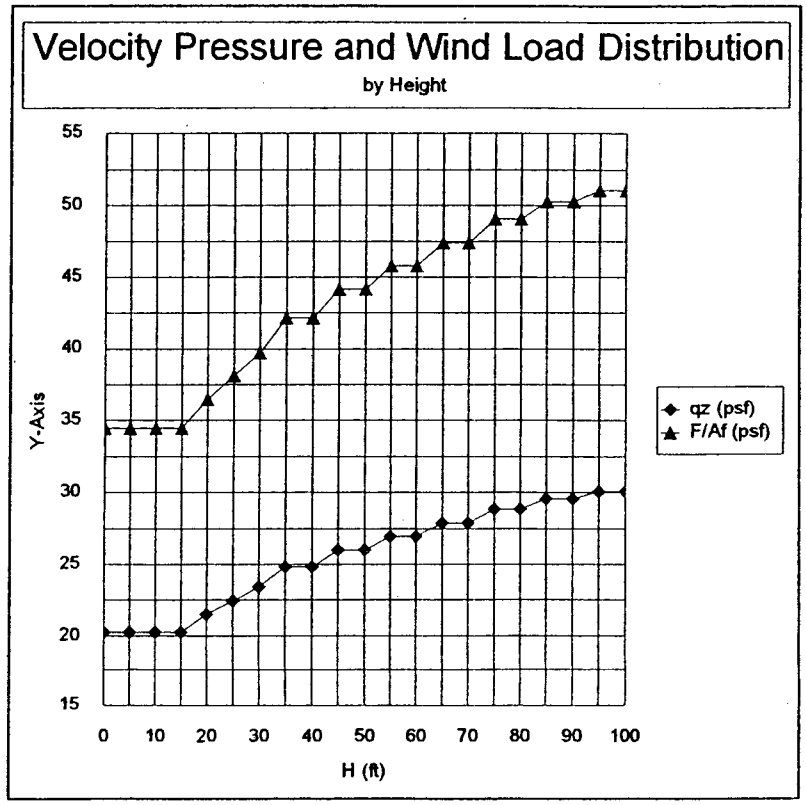
Kzt = 1.00

For open buildings and other structures - Components and Cladding

F = qz * G * Cf * Af

Velocity Pressure and Wind Load Distribution
by Height

H (ft)	Kz	qz (psf)	F/Af (psf)
0	0.85	20.27	34.46
5	0.85	20.27	34.46
10	0.85	20.27	34.46
15	0.85	20.27	34.46
20	0.90	21.46	36.48
25	0.94	22.42	38.11
30	0.98	23.37	39.73
35	1.04	24.80	42.16
40	1.04	24.80	42.16
45	1.09	25.99	44.19
50	1.09	25.99	44.19
55	1.13	26.95	45.81
60	1.13	26.95	45.81
65	1.17	27.90	47.43
70	1.17	27.90	47.43
75	1.21	28.85	49.05
80	1.21	28.85	49.05
85	1.24	29.57	50.27
90	1.24	29.57	50.27
95	1.26	30.05	51.08
100	1.26	30.05	51.08



FOSTER WHEELER ENVIRONMENTAL CORPORATION	Owner__USACOE_____	Computed By____GZ___
	Project____New Bedford Harbor __	Date_____4/24/02_____
	Project No.__5197.1720.3392.00010_____	Verified By_____
	Title___Dewatering Facility Foundation _____	Date_____
	_____Footing for Support Building Columns ____	Page_____

(RUN 5)

Purpose: Sizing rentangular footing to support interior columns.

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

New Design Information received on 4/5/02

B. Design Parameters

$f'_c := 4000 \cdot psi$

$f_y := 60 \cdot ksi$

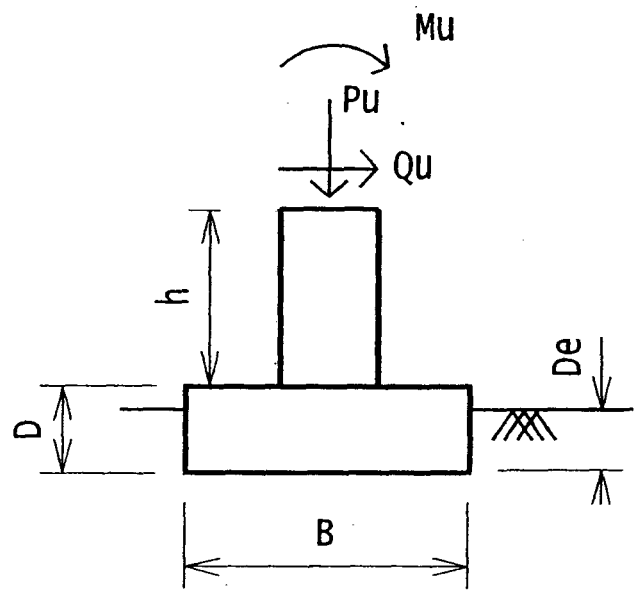
Soil unit weight $\gamma_s := 0.115 \cdot \frac{k}{ft^3}$

Concrete unit weight $\gamma_c := 0.15 \cdot \frac{k}{ft^3}$

Allowable soil bearing $p_{all} := 6 \cdot ksf$

Soil friction coefficient $\mu := 0.7$

Frost depth = 4 ft



Trial dimensions of footing:

$B := 5 \cdot ft$ $\frac{B}{6} = 10 in$

$L := 5 \cdot ft$

$h := 3.5 \cdot ft$

$C_1 := 1.5 \cdot ft$

$C_2 := 1.5 \cdot ft$

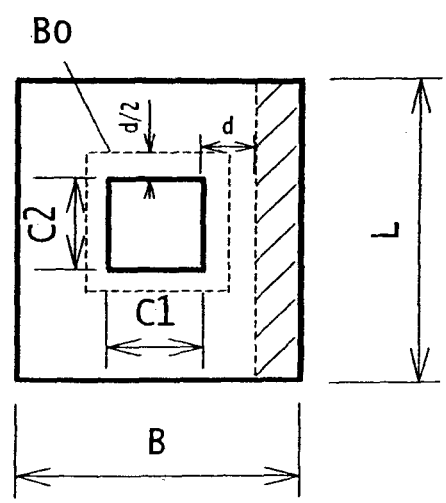
$D := 1 \cdot ft$

$D_e := 4 \cdot ft$

$d_b := 1 \cdot in$

$d := D - 3 \cdot in - \left(\frac{1}{2}\right) \cdot d_b$

$d = 8.5 in$



SNOW LOAD

C. Design Loads

External Load

dead load	$P_{dl} := 2.5 \cdot k$	$Q_{dl} := 0 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 5.8 \cdot k$	$Q_{ll} := 0 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := 0 \cdot k$	$Q_{wind} := 4 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind}$$

$$P_e = 8.3\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind}$$

$$Q_e = 4\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind}$$

$$M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2)$$

$$P_f = 4.9\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D)$$

$$P_s = 7.8\,k$$

$$P := P_e + P_f + P_s$$

$$P = 21.1\,k$$

$$Q := Q_e$$

$$Q = 4\,k$$

$$M := M_e + Q \cdot (h + D)$$

$$M = 18\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 40.7\,k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot \left(1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind}\right)$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 5.8\,k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot \left(1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind}\right)$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

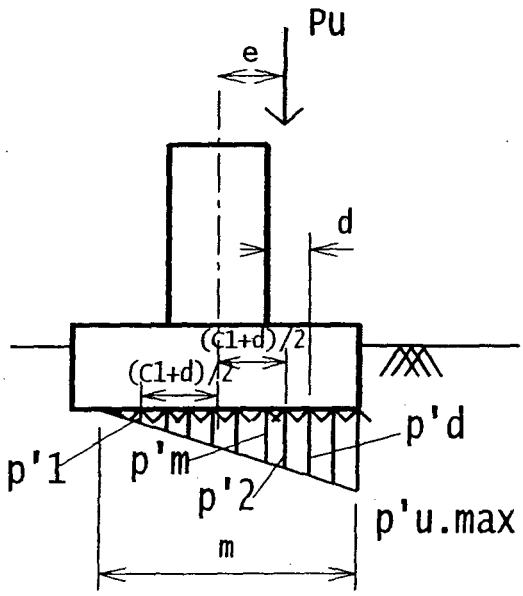
$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 26.08\,k \cdot ft$$

$$p'_d := \begin{cases} \dfrac{\left[m - \left(\dfrac{B}{2} - \dfrac{C_1}{2} - d\right)\right]}{m} \cdot p'_{u.max} & \text{if } m > \left(\dfrac{B - C_1 - 2d}{2}\right) \\ 0 \cdot ksf & \text{otherwise} \end{cases}$$

$p'_d = 1.49\,ksf$



Case II

Design shear

$$V'_u := A_{shear} \cdot \frac{(p'_d + p'_{u.max})}{2}$$

$V'_u = 9.11\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 54.8\,k$ $> V'_u$, OK

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$ $\quad e = 10.2\,in$ $\quad$ > B/6

Footing area $A := B \cdot L$ $\quad A = 3600\,in^2$

Compared with $A_{trial} := \frac{P}{p_{all}}$ $\quad A_{trial} = 505.9\,in^2$ $\quad$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := if\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 1.71\,ksf$ $\quad$ OK

F. Shear Strength Design - Beam Shear

$e_u := \frac{M_u}{P_u}$ $\quad e_u = 13.9\,in$ $\quad$ > B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$ $\quad A_{shear} = 5.21\,ft^2$

F2. Case II (e_u >B/6)

$m := 3 \cdot \left(\frac{B}{2} - e_u\right)$ $\quad m = 48.4\,in$

$p'_{u.max} := 2 \cdot \frac{P_u}{m \cdot L}$ $\quad p'_{u.max} = 2.01\,ksf$

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 8.83\,ft$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G2. Case II (e_u >B/6)

For m > B/2+(C1+d)/2

$$p'_1 := p'_{u.max}\cdot\frac{\left(m - \frac{B}{2} - \frac{C_1 + d}{2}\right)}{m}$$

$$p'_2 := p'_{u.max}\cdot\frac{\left(m - \frac{B}{2} + \frac{C_1 + d}{2}\right)}{m}$$

$$V'_{u1} := P_u - \frac{(p'_1 + p'_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

For B/2 - (C1+d)/2 < m < B/2+(C1+d)/2

$$V'_{u2} := P_u - 0.5\cdot p'_2\cdot\left[m - \frac{B}{2} + \frac{(C_1 + d)}{2}\right]\cdot(C_2 + d)$$

For m < B/2 - (C1+d)/2

$$V'_{u3} := P_u$$

Design shear

$$V'_u := \begin{cases} V'_{u1} & \text{if } m > \dfrac{(B + C_1 + d)}{2} \\ V'_{u2} & \text{if } \dfrac{(B + C_1 + d)}{2} > m > \dfrac{(B - C_1 - d)}{2} \\ V'_{u3} & \text{if } m < \dfrac{(B - C_1 - d)}{2} \end{cases}$$

$V'_u = 16.5k$

Footing shear strength

$$V := \begin{bmatrix} \left(2 + \dfrac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \end{bmatrix}$$

$\phi V_n := 0.85\cdot \min(V)$

$\phi V_n = 193.7k$ > V'u OK

H. Flexural Strength Design

H2. Case II (e_u >B/6)

$$p'_m := \begin{cases} p'_{u.max}\cdot\dfrac{\left[m - \left(\dfrac{B}{2} - \dfrac{C_1}{2}\right)\right]}{m} & \text{if } m > \dfrac{(B - C_1)}{2} \\ 0\cdot ksf & \text{otherwise} \end{cases}$$

$$M'_{u.design} := p'_m\cdot\left(\frac{B}{2} - \frac{C_1}{2}\right)\cdot L\cdot\frac{\left(\dfrac{B}{2} - \dfrac{C_1}{2}\right)}{2} + 0.5\cdot(p'_{u.max} - p'_m)\cdot\left(\frac{B}{2} - \frac{C_1}{2}\right)^2\cdot L\cdot\frac{2}{3}$$

$M'_{u.design} = 13.15k\cdot ft$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 18\,k\cdot ft$$

Resisting moment

$$M_r := P\cdot\frac{B}{2}$$

$$M_r = 52.7\,k\cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$$FS_{ot} = 2.93$$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu\cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$$FS_{sliding} = 3.69$$ > 1.5, OK

FOSTER WHEELER ENVIRONMENTAL CORPORATION	Owner USACOE Project New Bedford Harbor Project No. 5197.1720.3392.00010 Title Dewatering Facility Foundation Footing for Support Building Columns	Computed By GZ Date 4/24/02 Verified By Date Page

(RUN 6)

Purpose: Sizing rentangular footing to support interior columns.

Units: $k := 1000 \cdot lbf$ $ksi := 1000 \cdot psi$ $psf := \frac{lbf}{ft^2}$ $ksf := 1000 \cdot psf$ $kN := 1000 \cdot newton$

A. Design References

New Design Information received on 4/5/02

B. Design Parameters

$f_c := 4000 \cdot psi$

$f_y := 60 \cdot ksi$

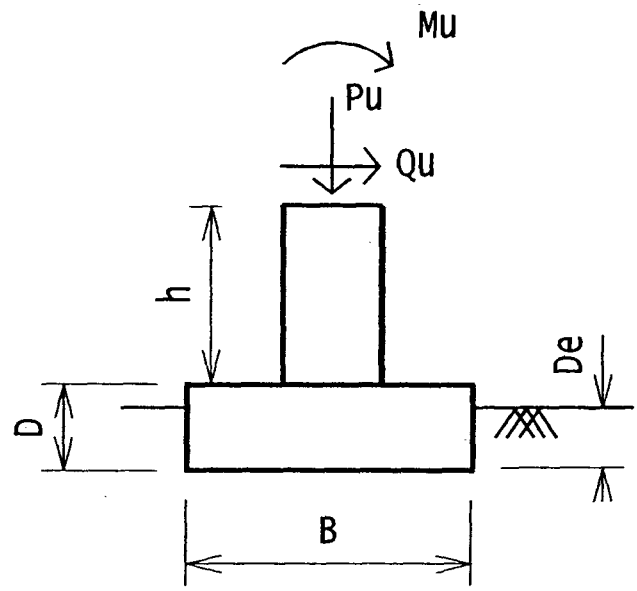
Soil unit weight $\gamma_s := 0.115 \cdot \frac{k}{ft^3}$

Concrete unit weight $\gamma_c := 0.15 \cdot \frac{k}{ft^3}$

Allowable soil bearing $p_{all} := 6 \cdot ksf$

Soil friction coefficient $\mu := 0.7$

Frost depth = 4 ft



Trial dimensions of footing:

$B := 5 \cdot ft$

$L := 5 \cdot ft$

$h := 3.5 \cdot ft$

$C_1 := 1.5 \cdot ft$

$C_2 := 1.5 \cdot ft$

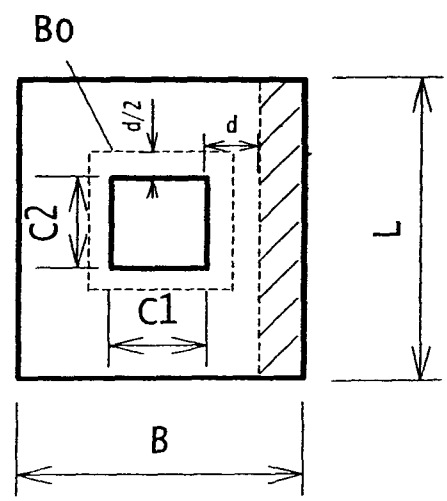
$D := 1 \cdot ft$

$D_e := 4 \cdot ft$

$d_b := 1 \cdot in$

$d := D - 3 \cdot in - \left(\frac{1}{2}\right) \cdot d_b$

$d = 8.5\ in$



C. Design Loads

NO SNOW LOAD

External Load

dead load	$P_{dl} := 2.5 \cdot k$	$Q_{dl} := 0 \cdot k$	$M_{dl} := 0 \cdot k \cdot ft$
live load	$P_{ll} := 0 \cdot k$	$Q_{ll} := 0 \cdot k$	$M_{ll} := 0 \cdot k \cdot ft$
wind load	$P_{wind} := 0 \cdot k$	$Q_{wind} := 4 \cdot k$	$M_{wind} := 0 \cdot k \cdot ft$
seismic load	(doesn't control)		

Sum of external loads:

$$P_e := P_{dl} + P_{ll} + P_{wind} \qquad P_e = 2.5\,k$$

$$Q_e := Q_{dl} + Q_{ll} + Q_{wind} \qquad Q_e = 4\,k$$

$$M_e := M_{dl} + M_{ll} + M_{wind} \qquad M_e = 0\,k \cdot ft$$

Footing Self Weight

$$P_f := \gamma_c \cdot (B \cdot L \cdot D + h \cdot C_1 \cdot C_2)$$

$$P_f = 4.9\,k$$

Design Load for Soil Pressure

$$P_s := \gamma_s \cdot (B \cdot L - C_1 \cdot C_2) \cdot (D_e - D) \qquad P_s = 7.8\,k$$

$$P := P_e + P_f + P_s \qquad P = 15.3\,k$$

$$Q := Q_e \qquad Q = 4\,k$$

$$M := M_e + Q \cdot (h + D) \qquad M = 18\,k \cdot ft$$

Design Load for Footing Strength

$$P_{u1} := 1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll}$$

$$P_{u2} := 0.75 \cdot (1.4 \cdot P_f + 1.4 \cdot P_{dl} + 1.7 \cdot P_{ll} + 1.7 \cdot P_{wind})$$

$$P_{u3} := 0.9 \cdot (P_f + P_{dl}) + 1.3 \cdot P_{wind}$$

$$PV := \begin{pmatrix} P_{u1} \\ P_{u2} \\ P_{u3} \end{pmatrix}$$

$$P_u := \max(PV)$$

$$P_u = 10.4\,k$$

$$Q_{u1} := 1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll}$$

$$Q_{u2} := 0.75 \cdot \left(1.4 \cdot Q_{dl} + 1.7 \cdot Q_{ll} + 1.7 \cdot Q_{wind}\right)$$

$$Q_{u3} := 0.9 \cdot Q_{dl} + 1.3 \cdot Q_{wind}$$

$$QV := \begin{pmatrix} Q_{u1} \\ Q_{u2} \\ Q_{u3} \end{pmatrix}$$

$$Q_u := \max(QV)$$

$$Q_u = 5.2\,k$$

$$M_{u1} := 1.4 \cdot M_{dl} + 1.7 \cdot M_{ll}$$

$$M_{u2} := 0.75 \cdot \left(1.4 \cdot M_{dl} + 1.7 \cdot M_{ll} + 1.7 \cdot M_{wind}\right)$$

$$M_{u3} := 0.9 \cdot M_{dl} + 1.3 \cdot M_{wind}$$

$$MV := \begin{pmatrix} M_{u1} \\ M_{u2} \\ M_{u3} \end{pmatrix}$$

$$M_u := \max(MV) + Q_u \cdot (h + D)$$

$$M_u = 23.4\,k \cdot ft$$

D. Footing Sizing

Eccentricity $e := \frac{M}{P}$

$e = 14.1\,in$ > B/6

Footing area $A := B \cdot L$

$A = 3600\,in^2$

Compared with $A_{trial} := \frac{P}{p_{all}}$

$A_{trial} = 366.7\,in^2$ OK

E. Soil Bearing Pressure

$$f := \frac{P}{A} + 6 \cdot \frac{M}{B^2 \cdot L}$$

$$g := 2 \cdot \frac{P}{3 \cdot L \cdot \left(\frac{B}{2} - e\right)}$$

$$p_{max} := if\left(e < \frac{B}{6}, f, g\right)$$

$p_{max} = 1.54\,ksf$ OK

F. Shear Strength Design - Beam Shear

$$e_u := \frac{M_u}{P_u}$$

$e_u = 27\,in$ > B/6

Shear area (shaded area) $A_{shear} := \left(\frac{B}{2} - \frac{C_1}{2} - d\right) \cdot L$

$A_{shear} = 5.21\,ft^2$

F2. Case II (e_u >B/6)

$$m := 3 \cdot \left(\frac{B}{2} - e_u\right)$$

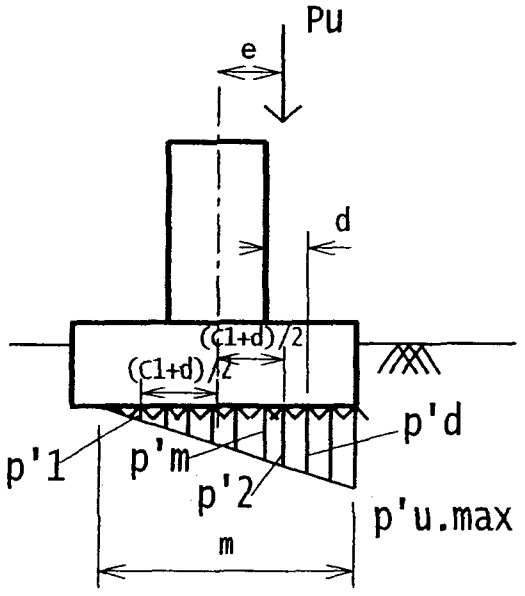
$m = 9\,in$

$$p'_{u.max} := 2 \cdot \frac{P_u}{m \cdot L}$$

$p'_{u.max} = 5.53\,ksf$, OK

$$p'_d := \begin{cases} \dfrac{\left[m - \left(\dfrac{B}{2} - \dfrac{C_1}{2} - d\right)\right]}{m} \cdot p'_{u.max} & \text{if } m > \left(\dfrac{B - C_1 - 2d}{2}\right) \\ 0 \cdot ksf & \text{otherwise} \end{cases}$$

$p'_d = 0\,ksf$



Case II

Design shear

$$V'_u := A_{shear} \cdot \frac{(p'_d + p'_{u.max})}{2}$$

$V'_u = 14.4\,k$

Shear strength

$$\phi V_n := 0.85 \cdot 2 \cdot \left(\sqrt{4000} \cdot psi\right) \cdot L \cdot d$$

$\phi V_n = 54.8\,k$ $> V'_u$, OK

G. Shear Strength Design - Punching Shear

$$B_0 := 2\cdot(C_1 + d + C_2 + d)$$

$$B_0 = 8.83\,ft$$

$$\beta := \begin{pmatrix} \frac{C_2}{C_1} \\ \frac{C_1}{C_2} \end{pmatrix}$$

$$\beta_c := \max(\beta)$$

$$\beta_c = 1$$

G2. Case II (e_u >B/6)

For m > B/2+(C1+d)/2

$$p'_1 := p'_{u.max}\cdot\frac{\left(m - \frac{B}{2} - \frac{C_1 + d}{2}\right)}{m}$$

$$p'_2 := p'_{u.max}\cdot\frac{\left(m - \frac{B}{2} + \frac{C_1 + d}{2}\right)}{m}$$

$$V'_{u1} := P_u - \frac{(p'_1 + p'_2)}{2}\cdot(C_1 + d)\cdot(C_2 + d)$$

For B/2 - (C1+d)/2 < m < B/2+(C1+d)/2

$$V'_{u2} := P_u - 0.5\cdot p'_2\cdot\left[m - \frac{B}{2} + \frac{(C_1 + d)}{2}\right]\cdot(C_2 + d)$$

For m < B/2 - (C1+d)/2

$$V'_{u3} := P_u$$

Design shear

$$V'_u := \begin{cases} V'_{u1} & \text{if } m > \dfrac{(B + C_1 + d)}{2} \\ V'_{u2} & \text{if } \dfrac{(B + C_1 + d)}{2} > m > \dfrac{(B - C_1 - d)}{2} \\ V'_{u3} & \text{if } m < \dfrac{(B - C_1 - d)}{2} \end{cases}$$

$V'_u = 10.4\,k$

Footing shear strength

$$V := \begin{bmatrix} \left(2 + \dfrac{4}{\beta_c}\right)\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \\ 4\cdot\sqrt{4000}\cdot psi\cdot B_0\cdot d \end{bmatrix}$$

$\phi V_n := 0.85\cdot \min(V)$

$\phi V_n = 193.7\,k$ > V'u OK

H. Flexural Strength Design

H2. Case II (e_u >B/6)

$$p'_m := \begin{cases} p'_{u.max}\cdot\dfrac{\left[m - \left(\dfrac{B}{2} - \dfrac{C_1}{2}\right)\right]}{m} & \text{if } m > \dfrac{(B - C_1)}{2} \\ 0\cdot ksf & \text{otherwise} \end{cases}$$

$$M'_{u.design} := p'_m\cdot\left(\frac{B}{2} - \frac{C_1}{2}\right)\cdot L\cdot\frac{\left(\dfrac{B}{2} - \dfrac{C_1}{2}\right)}{2} + 0.5\cdot(p'_{u.max} - p'_m)\cdot\left(\frac{B}{2} - \frac{C_1}{2}\right)^2\cdot L\cdot\frac{2}{3}$$

$M'_{u.design} = 28.23\,k\cdot ft$

I. Overturning Check

Overturning moment

$$M_{ot} := M$$

$$M_{ot} = 18\,k\cdot ft$$

Resisting moment

$$M_r := P\cdot\frac{B}{2}$$

$$M_r = 38.2\,k\cdot ft$$

$$FS_{ot} := \frac{M_r}{M_{ot}}$$

$$FS_{ot} = 2.12$$ > 1.5, OK

J. Sliding Check

Sliding resistance force $F_r := \mu\cdot P$

$$FS_{sliding} := \frac{F_r}{Q}$$

$$FS_{sliding} = 2.67$$ > 1.5, OK

FWENC

Owner:	USACE	Comp'd By:	Jeff Zhao
Plant:	New Bedford	Date:	25-Apr-02
Project No.:	5197.1720.9302.00010 File No:	Chckd By:	
Title:	Dewatering Foundation - Support Bld. Footing	Date:	
	Mu.design	Page	of

Exposure: ○ Interior ● Exterior

Member: ○ Beam ● Slab

Bar Size: ○ #3 ○ #4 ○ #5 ● #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Stirrup Size: ● None ○ #3 ○ #4 ○ #5 ○ #6 ○ #7 ○ #8 ○ #9 ○ #10 ○ #11 ○ #14 ○ #18

Factored Moment =	28.23 kips*ft		
Average Load Factor =	1.55		
Service Moment =	219 kips*in		
Bar Spacing =	16 in		
Width, b =	56 in		
Slab Thickness=	12 in		
cover =	3.00 in	Bar Area =	0.44 in^2
f'c =	4000 psi	Bar Diameter =	0.75 in
f_y =	60 ksi	Stirrup Diameter =	0 in
E_s =	29000 ksi	d=	8.625 in
ϕ =	0.9	#Bars =	3.5
Normal/Severe exposure (0/1) =	0	A_{steel}=	1.54 in^2

#6 @ 16 in. spacing

Moment Check

	w =	0.022897	
	ρ =	0.001526	
	$A_{srequired}$ =	0.737273 in^2	ok
	β =	0.85	
	ρ_b =	0.028507	
	ρ_{max} =	0.02138	
	A_{max} =	10.32659 in^2	ok
(ACI 10.5.3)	ρ_{min} =	0.003333	
	A_{min} =	1.6100 in^2	
	$4/3*A_{srequired}$ =	0.983031 in^2	ok

Crack Check

β =	1.35		
E_c =	3604.997	ksi	
n =	8.044391		
d_c=	3.375	in	
A=	108	in^2	
NA =	1.744739	mm	
f_s =	17.64408	ksi	
z=	126.037	kips/in	
Required =	128.8889	kips/in	ok

ACI-350 Check

Z =	115	kips/in	no good
fs =	17.64408	ksi	
Max Spacing =	12	in	no good
Actual -> ρ =	0.003188		

w = 0.85 - (SQRT(.7225-)(1.7*$M_{factored}$/(ϕ*f'_c*b*d^2)))

ρ = w*f'_c/f_y

$A_{srequired}$ = ρ*b*d

β = 0.85-0.05(f'c-4000)/1000

ρ_b =0.85*(β*(f'c/fy)*(87/(87+fy))

ρ_{max} =0.75*ρ_b

A_{max} =ρ_{max}*b*d

ρ_{min} =greater of (3*SQRt(f'c)/fy) and 200/fy

A_{min} =ρ_{min}*b*d

d = thickness-cover-stirrup diameter-bar diameter/2

d_c = cover+stirrup diameter + bar diameter/2

A = width*2*(cover+(diameter of first layer of bars)/2)/#Bars

#Bars = Width/spacing

Ec = 57000*SQRT(f'c)

n = Es/Ec

NA = [-As*n*#BARS+((As*n*#BARS)^2+(2*As*n*#BARS*b*d))^(1/2)]/b

fs = [Ms/#BARS]/[(d-NA/3)*As] (Reinforced Concrete Mechanics and Design, MacGregor, pg 343)

z = fs*(dc*A)^(1/3) (ACI-318 10.6.4)

Required = (175 or 145)*1.2/β

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY _____ DATE _____ SHEET 54 OF ____

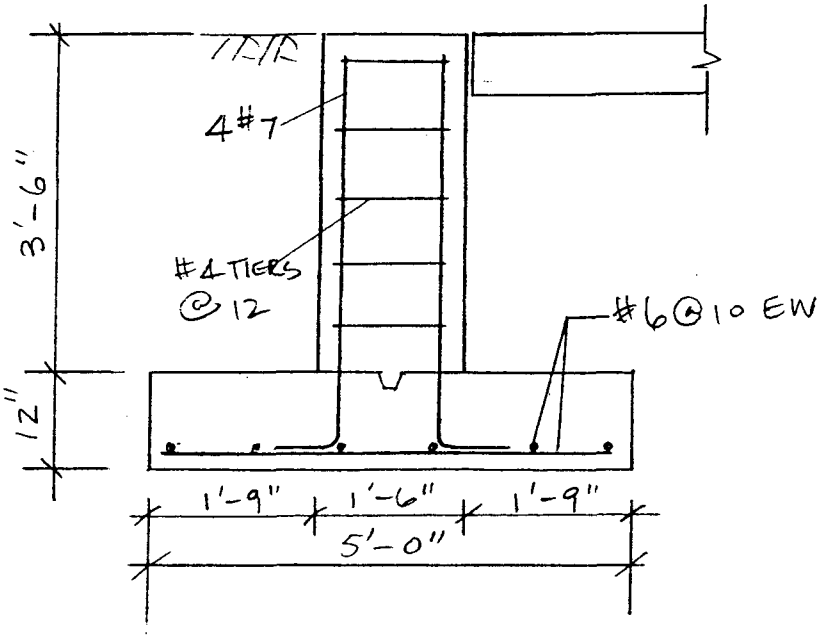
CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT NEW BEDFORD - DEWATERING

SUBJECT SUPPORT BUILDING - FOOTING

BASED ON THE ABOVE ANALYSIS, THE FOLLOWING FOOTING STRUCTURE IS PROPOSED.



APPENDIX 1

BUTLER

Northeast Region Quote Department, Annville, PA
Fax (717) 867-3248 / Phone (717) 867-3218

facsimile transmittal

To: MANDY LOEFFLER Fax: 9-1-281-596-0308

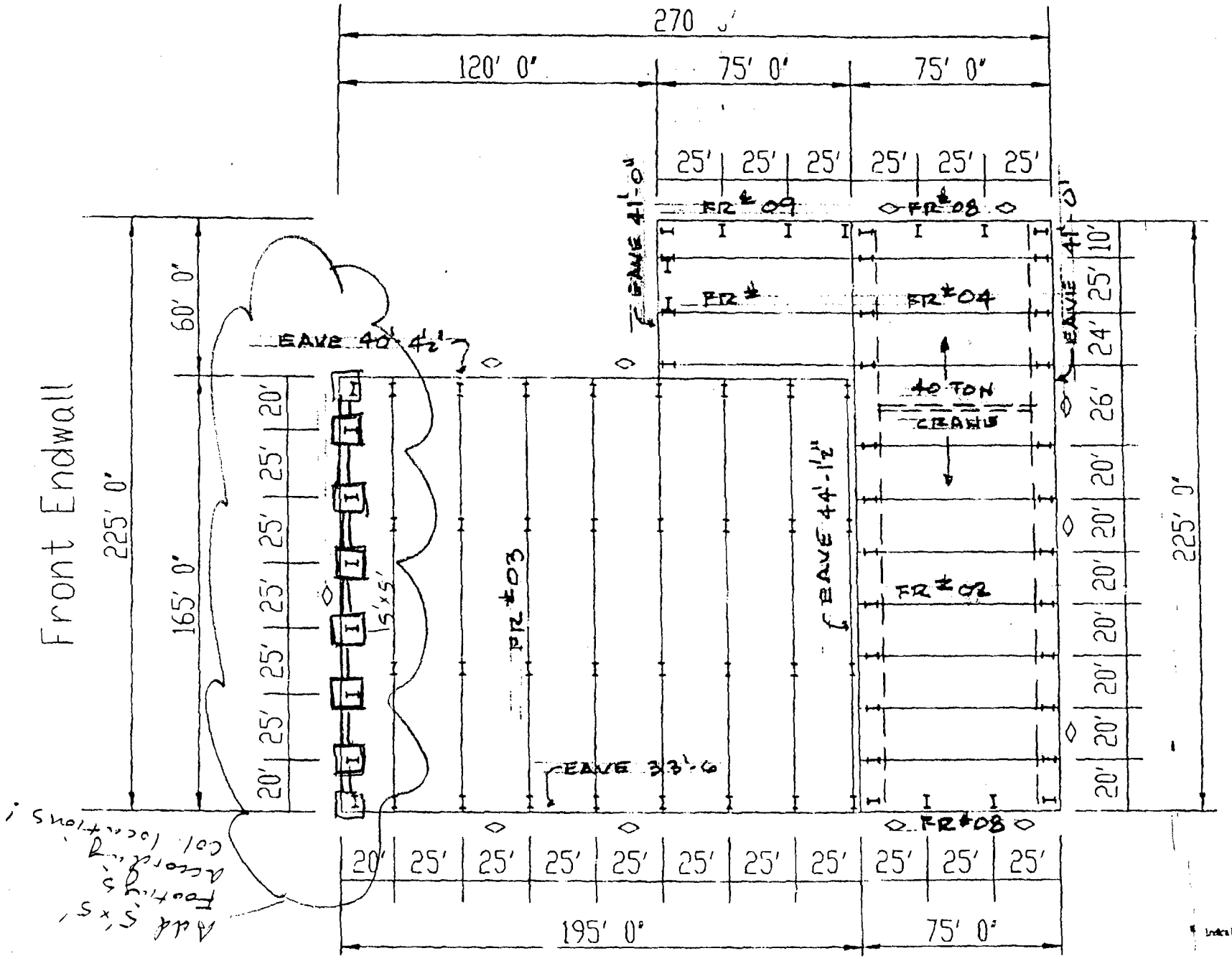
From: Stephen Eisenacher Date: 01/17/02

Re: Pages: 28

CC:

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply

Notes:



* Indicates the wall where Front Endwall is labeled.

◆ Indicates a braced bay or section.

Widespan™ ADVANTAGE© Buildings Mfg. Co. Kansas City, MO	Builder: Dutton & Garfield, Inc.	Project: Foster Wheeler	Building Description: 165' x 195' x 33'-6" 75' x 225' x 41' 75' X 60' X 41'	Drawing Title: Building Plan	DUTGARADV Ver-1.50.0 1/16/02 PM

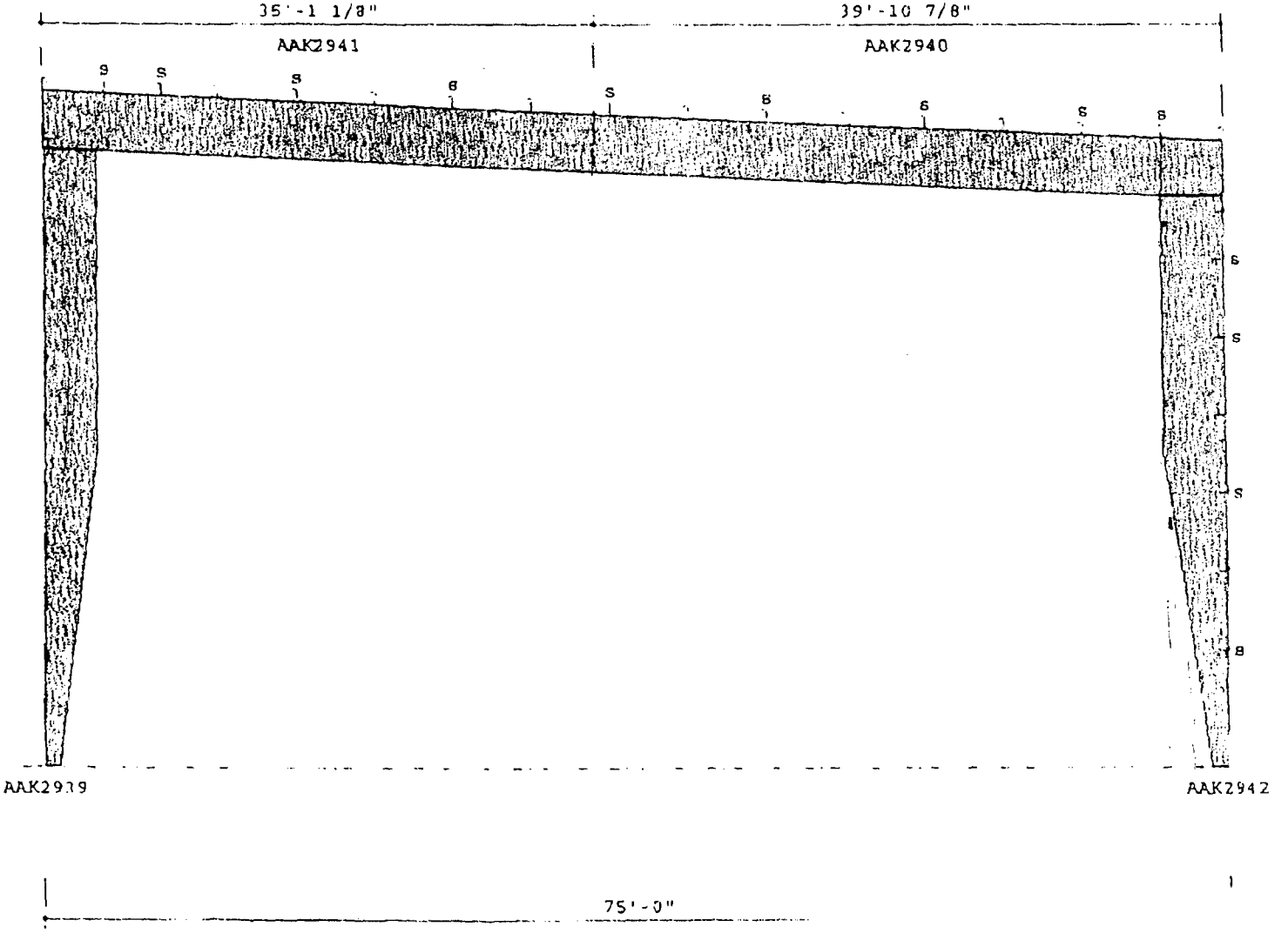
FRAME DESIGN - CROSS SECTION

DATE: 1/17/02
TIME: 8:14:13 AM

PAGE:

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # 02 DESCRIPTION LRST WIDTH 75'-0" HEIGHT 43'-11" SLOPE 0.500 TO 12

Eave 43'-11" LRST Slope 1/2:12 Eave 40'-9 1/2"
Clear Height 39'-3 3/4" Clear Height 36'-6"



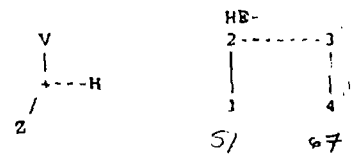
F R A M E D E S I G N - R E A C T I O N S

ATE: 01/17/02
TIME: 08:13 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # CO-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 02	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		LRST	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



P Delta Analysis Performed

No.	Loading Combination	1H	1V	4H	4V	Sum H	Sum V
1	DL + CLL + SL	7.76	32.83	-7.76	31.85	0.00	64.69
2	.67DL + WLL + IP	-12.08	-12.03	-6.47	-1.52	-18.55	-13.55
3	.67DL + WLR + IP	4.97	-3.59	11.39	-13.06	16.35	-16.65
4	.67DL + WLL + IS	-10.25	-5.54	-7.79	4.40	-18.03	-1.14
5	.67DL + WLR + IS	6.80	2.90	10.08	-7.14	16.87	-4.24
6	DL+CLL+.5SL+WLL+IP	-7.90	5.13	-10.65	15.34	-18.55	20.47
7	DL+CLL+.5SL+WLR+IP	9.14	13.58	7.21	3.79	16.35	17.37
8	DL+CLL+.5SL+WLL+IS	-6.07	11.62	-11.96	21.26	-18.03	32.88
9	DL+CLL+.5SL+WLR+IS	10.97	20.07	5.90	9.71	16.87	29.78
10	DL+CLL+SL+.5WLL+.5IP	1.37	24.60	-10.64	29.23	-9.28	53.83
11	DL+CLL+SL+.5WLR+.5IP	9.89	28.82	-1.71	23.45	8.18	52.28
12	DL+CLL+SL+.5WLL+.5IS	2.28	27.85	-11.30	32.19	-9.02	60.03
13	DL+CLL+SL+.5WLR+.5IS	10.80	32.07	-2.37	26.41	8.44	58.48
14	.67DL + CL + .8EQL	0.92	7.36	-2.46	8.31	-1.54	15.67
15	.67DL + CL + .8EQR	2.43	9.00	-0.89	6.67	1.54	15.67
16	DL + CL + .6SL+.8EQL	4.71	23.02	-6.25	23.66	-1.54	46.69
17	DL + CL + .6SL+.8EQR	6.22	24.66	-4.69	22.02	1.54	46.69
18	.67DL + EWP + IP	2.95	-8.03	-3.08	-8.62	-0.13	-16.65
19	DL+CLL+.5SL+EWP+IP	7.13	9.14	-7.26	8.23	-0.13	17.37
20	DL+CLL+SL+.5EWP+.5IP	8.88	26.60	-8.95	25.67	-0.06	52.28
21	DL+CL+.75SL+CHL	12.87	31.86	0.33	21.57	13.20	53.44
22	DL+CL+.75SL+CHR	-0.21	22.56	-12.99	30.87	-13.20	53.44
23	DL+CL+.5WLL+CHL	2.63	8.40	1.43	3.53	4.05	11.93
24	DL+CL+.5WLL+CHR	-10.45	-0.90	-11.89	12.83	-22.35	11.93
25	DL+CL+.5WLR+CHL	11.15	12.62	10.36	-2.24	21.51	10.38
26	DL+CL+.5WLR+CHR	-1.93	3.32	-2.96	7.06	-4.89	10.38

PAGE.04
717 857 3220
JAN 17 2002 12:51

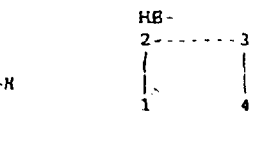
F R A M E D E S I G N - R E A C T I O N S

DATE: 01/17/02
TIME: 08:13 AM

ORDER # 012034 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 02	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		LRST	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



ID	Load Case	1H	1V	4H	4V	Sum H	Sum V
DL	DEAD LOAD	1.07	6.61	-1.07	5.57	0.00	12.19
CLL	COLLATERAL LOAD	0.96	3.75	-0.96	3.75	0.00	7.50
SL	SNOW LOAD	5.74	22.47	-5.74	22.53	0.00	45.00
WLL	WIND LOAD LEFT	-11.88	-13.22	-6.41	-2.29	-18.29	-15.51
WLR	WIND LOAD RIGHT	5.16	-4.77	11.45	-13.84	16.61	-18.61
IP	WIND INT PRESSURE	-0.91	-3.24	0.66	-2.96	-0.26	-6.20
IS	WIND INT SUCTION	0.91	3.24	-0.66	2.96	0.26	6.20
EQ	SEISMIC LOAD	0.94	-1.02	-0.98	1.02	-1.92	0.00
SLR	SNOWLOAD RIGHT SLOPE	5.62	22.03	-5.62	22.07	0.00	44.10
EWP	EW WIND PRESSURE	3.15	-9.21	-3.02	-9.40	0.13	-18.61
EWS	EW WIND SUCTION	3.15	-9.21	-3.02	-9.40	0.13	-18.61
CHR	CR	-6.54	-4.65	-6.66	4.65	-13.20	0.00
CHL	CR	6.54	4.65	6.66	-4.65	13.20	0.00
PDE	P Delta Unit Story S	0.03	-0.54	-0.03	0.54	0.00	0.00

F R A M E D E S I G N - C R O S S S E C T I O N

DATE: 1/17/02
TIME: 8:10:47 AM

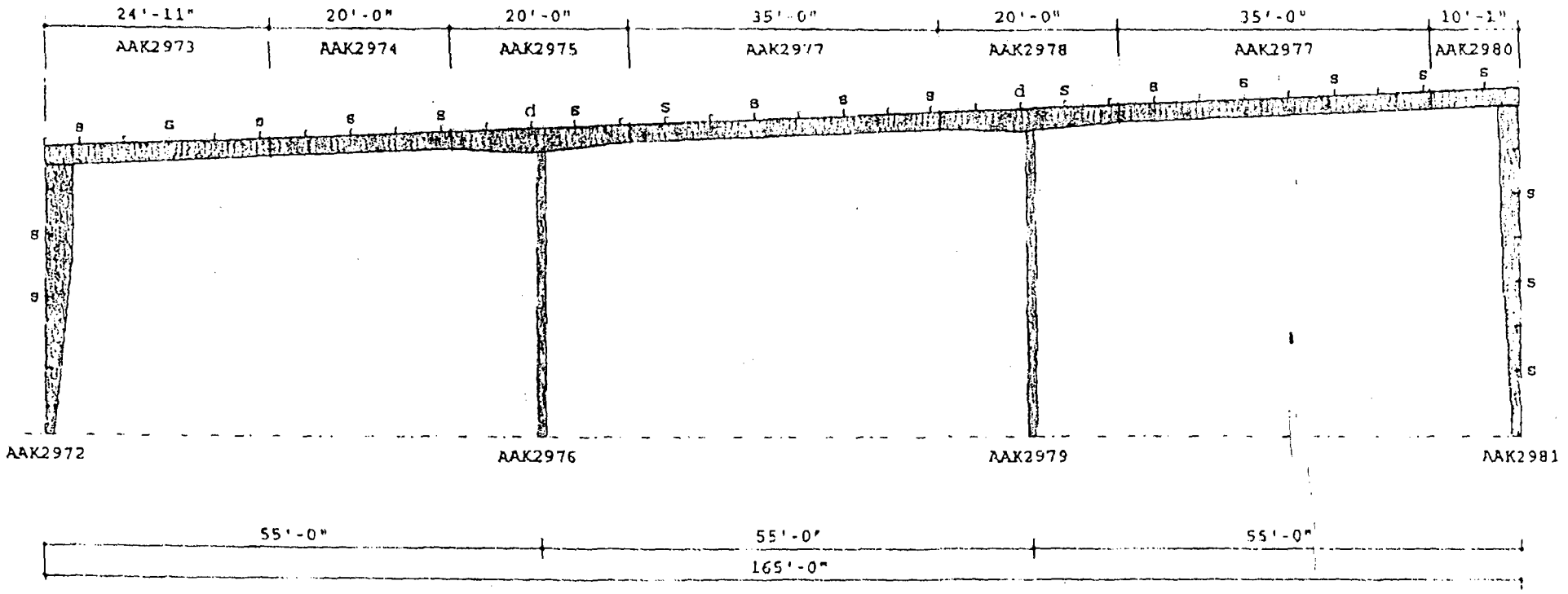
PAGE:

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # 03 DESCRIPTION MRST WIDTH 165'-0" HEIGHT 33'-3 1/2" SLOPE 0.500 TO 12

Eave 33'-3 1/2" Slope 1/2:12
Clear Height 30'-3 1/2"

MRST

Eave 40'-2"
Clear Height 37'-3 1/4"



F R A M E D E S I G N - R E A C T I O N S

DATE: 01/17/02
TIME: 08:10 AM

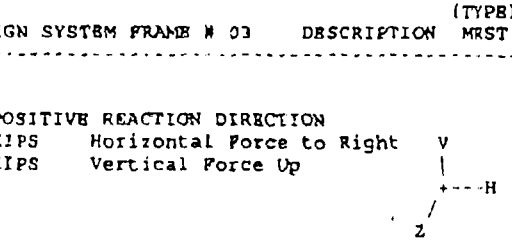
40 41 42 43

ORDER # 012334 BUILDER - BOILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 03	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		MRST	165' 0"	33'-6"	30 PSF	90 MPH	MASS 97	0.500 TO 12

25 26 47 48
35 36 37 38
29 21 27 28

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



P Delta Analysis Performed

No.	Loading Combination	1H	1V	4H	4V	6H	6V	8H	8V	Sum H	Sum V
1	DL + CLL + SL	4.92	25.01	-1.27	57.78	0.01	58.57	-3.66	24.86	0.00	156.22
2	.67DL + WLL + IP	-9.36	-10.54	-1.57	-16.90	-1.44	-19.45	-3.42	-6.72	-15.79	-53.60
3	.67DL + WLR + IP	6.96	-1.89	3.93	-19.52	2.47	-24.66	8.48	-9.00	21.83	-45.07
4	.67DL + WLL + IS	-8.88	-5.95	-2.20	-4.56	-1.70	-7.64	-4.43	-1.33	-17.21	-19.48
5	.67DL + WLR + IS	7.43	2.69	3.30	-7.18	2.20	-2.85	7.48	-3.61	20.41	-10.95
6	DL+CLL+.5SL+WLL+IP	-6.67	2.96	-2.26	14.31	-1.43	12.15	-5.42	6.69	-15.79	36.11
7	DL+CLL+.5SL+WLR+IP	9.64	11.60	3.24	11.68	2.47	16.94	6.48	4.41	21.83	44.64
8	DL+CLL+.5SL+WLL+IS	-6.19	7.54	-2.90	26.65	-1.70	23.96	-6.43	12.07	-17.21	70.23
9	DL+CLL+.5SL+WLR+IS	10.12	16.19	2.60	24.02	2.21	28.75	5.48	9.79	20.41	78.76
10	DL+CLL+SL+.5WLL+.5IP	0.07	18.64	-2.01	46.82	-0.71	46.25	-5.24	20.39	-7.89	132.10
11	DL+CLL+SL+.5WLR+.5IP	8.23	22.96	0.74	45.51	1.24	48.65	0.71	19.25	10.92	136.37
12	DL+CLL+SL+.5WLL+.5IS	0.31	20.93	-2.33	52.99	-0.84	52.16	-5.75	23.08	-8.61	149.16
13	DL+CLL+SL+.5WLR+.5IS	8.46	25.25	0.42	51.68	1.11	54.55	0.21	21.94	10.21	153.43
14	.67DL + CL + .8EQL	-0.76	3.67	-1.35	13.59	-0.79	11.85	-1.43	6.16	-4.33	35.26
15	.67DL + CL + .8EQR	2.69	6.95	0.86	10.82	0.80	13.05	-0.02	4.45	4.33	35.26
16	DL + CL + .6SL+.8EQL	1.26	15.24	-1.84	42.51	-0.52	40.28	-3.21	18.70	-4.33	116.72
17	DL + CL + .6SL+.8EQR	5.13	19.20	0.23	39.15	0.80	41.75	-1.83	16.62	4.33	116.72
18	.67DL + EWP + IP	3.91	-8.19	0.66	-18.99	0.35	-17.75	-4.57	-8.67	0.35	-53.60
19	DL+CLL+.5SL+EWP+IP	6.59	5.30	-0.03	12.22	0.36	13.85	-6.57	4.74	0.35	36.11
20	DL+CLL+SL+.5EWP+.5IP	5.70	19.81	-0.89	45.77	0.18	47.10	-5.82	19.42	0.13	132.10

ID	Load Case	1H	1V	4H	4V	6H	6V	8H	8V	Sum H	Sum V
DL	DEAD LOAD	0.50	3.29	-0.12	7.50	0.00	7.74	-0.38	3.32	0.00	21.85
CLL	COLLATERAL LOAD	0.63	3.10	0.16	7.18	0.00	7.26	-0.47	3.08	0.00	20.62
SL	SNOW LOAD	3.78	18.62	-0.98	43.10	0.01	43.57	-2.81	18.46	0.00	123.75
WLL	WIND LOAD LEFT	-9.46	-10.45	-1.80	-15.75	-1.57	-18.73	-3.67	-6.25	-16.50	-51.18
WLR	WIND LOAD RIGHT	6.86	-1.81	3.70	-18.38	2.34	-13.94	8.23	-8.53	21.12	-42.65
IP	WIND INT PRESSURE	-0.24	-2.29	0.32	-6.17	0.13	-5.91	0.50	-2.69	0.71	-17.06
IS	WIND INT SUCTION	0.24	2.29	-0.32	6.17	-0.13	5.91	-0.50	2.69	-0.71	17.06
EQ	SEISMIC LOAD	-2.15	-2.05	-1.38	1.74	-0.99	-0.75	-0.88	1.07	-5.43	0.00
SLL	SNOW LOAD LEFT SLOPE	3.71	18.25	-0.96	42.24	0.01	42.70	-2.75	18.09	0.00	121.28
EWP	EW WIND PRESSURE	3.81	-8.11	0.43	-17.84	0.22	-17.04	-4.81	-8.20	-0.36	-51.18
EWS	EW WIND SUCTION	3.81	-8.11	0.43	-17.84	0.22	-17.04	-4.81	-8.20	-0.36	-51.18
PDE	P Delta Unit Story S	-0.23	0.38	0.08	0.32	0.15	-0.15	0.01	0.20	0.00	0.00

717 857 3220
JAN 17 2002 12:52

F R A M E D E S I G N - C R O S S S E C T I O N

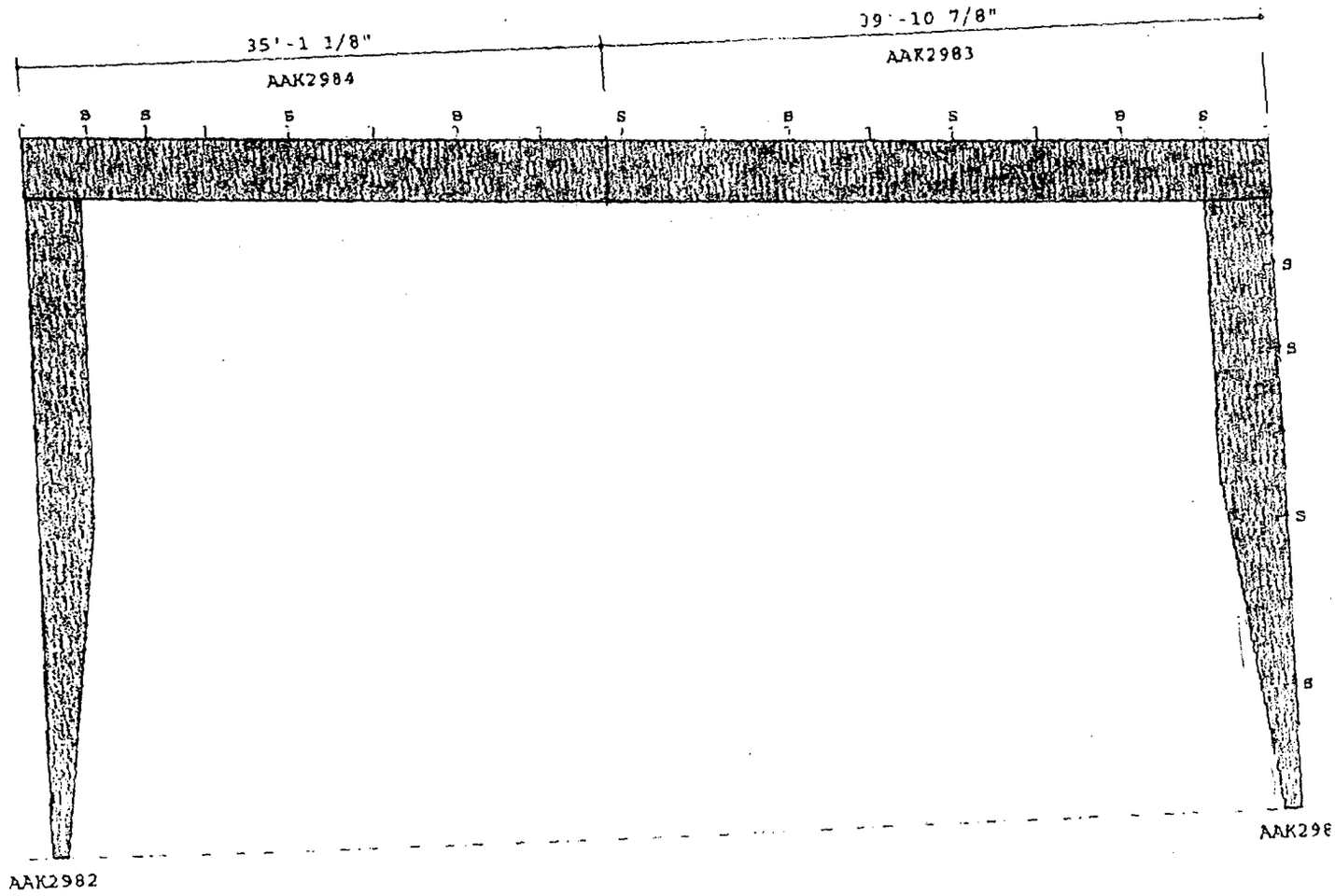
PAGE:

DATE: 1/17/02
TIME: 8:08:24 AM

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # C4 DESCRIPTION LRST WIDTH 75'-0" HEIGHT 43'-11" SLOPE 0.500 TO 12

LRST Slope 1/2:12 Eave 40'-9 1/2"
Clear Height 36'-6"

Eave 43'-11"
Clear Height 39'-3 3/4"



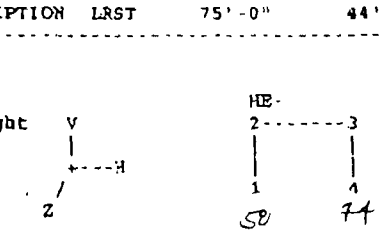
FRAME DESIGN - REACTIONS

DATE: 01/17/02
TIME: 08:07 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 04	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		LRST	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



P Delta Analysis Performed

No.	Loading Combination	1H	1V	4H	4V	Sum H	Sum V
1	DL + CLL + SL	9.51	76.45	-9.51	38.65	0.00	115.10
2	.67DL + WLL + IP	-7.96	-28.28	-6.64	-3.44	-14.60	-31.72
3	.67DL + WLR + IP	2.41	-16.05	14.30	-17.17	16.71	-33.23
4	.67DL + WLL + IS	-5.99	-12.73	-8.61	4.26	-14.60	-8.47
5	.67DL + WLR + IS	4.38	-0.50	12.33	-9.47	16.71	-9.37
6	DL+CLL+.5SL+WLL+IP	-2.83	12.86	-11.78	17.17	-14.60	30.03
7	DL+CLL+.5SL+WLR+IP	7.55	25.09	9.16	3.44	16.71	28.52
8	DL+CLL+.5SL+WLL+IS	-0.86	28.41	-13.75	24.87	-14.60	53.28
9	DL+CLL+.5SL+WLR+IS	9.52	40.64	7.19	11.14	16.71	51.78
10	DL+CLL+SL+.5WLL+.5IP	5.12	58.78	-12.42	34.88	-7.30	93.66
11	DL+CLL+SL+.5WLR+.5IP	10.30	64.89	-1.95	28.02	8.35	92.91
12	DL+CLL+SL+.5WLL+.5IS	6.10	66.55	-13.40	38.73	-7.30	105.28
13	DL+CLL+SL+.5WLR+.5IS	11.29	72.66	-2.93	31.87	8.35	104.53
14	.67DL + CL + .8EQL	1.05	15.47	-2.94	9.76	-1.89	25.23
15	.67DL + CL + .8EQR	2.97	17.49	-1.08	7.74	1.89	25.23
16	DL + CL + .6SL+.8EQL	5.72	52.84	-7.60	28.51	-1.89	81.35
17	DL + CL + .6SL+.8EQR	7.64	54.87	-5.75	26.49	1.89	81.35
18	.67DL + EWP + IP	-3.73	-23.53	-3.65	-11.50	-7.38	-35.03
19	DL+CLL+.5SL+EWP+IP	1.41	17.61	-8.79	9.11	-7.38	26.72
20	DL+CLL+SL+.5EWP+.5IP	7.24	61.15	-10.93	30.85	-3.69	92.01
21	DL+CL+.75SL+CHL	14.50	66.98	-1.30	27.03	13.20	94.01
22	DL+CL+.75SL+CHR	0.98	57.67	-14.18	36.34	-13.20	94.01
23	DL+CL+.5WLL+CHL	5.78	10.83	0.62	4.27	5.90	15.10
24	DL+CL+.5WLL+CHR	-8.25	1.52	-12.25	13.58	-20.50	15.10
25	DL+CL+.5WLR+CHL	10.46	16.94	11.09	-2.60	21.55	14.34
26	DL+CL+.5WLR+CHR	-3.06	7.63	-1.78	6.71	-4.85	14.34

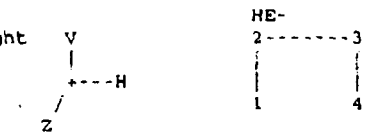
F R A M E D E S I G N - R E A C T I O N S

DATE: 01/17/02
TIME: 08:07 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM	FRAME # 04	DESCRIPTION	(TYPE) LRST	(WIDTH) 75'-0"	(HEIGHT) 44'-1 1/2"	(SNOW) 30 PSF	(WIND) 90 MPH	(CODE/YEAR) MASS 97	(SLOPE) 0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



ID	Load Case	1H	1V	4H	4V	Sum H	Sum V
DL	DEAD LOAD	1.23	10.54	-1.23	6.12	0.00	16.66
CLL	COLLATERAL LOAD	1.18	9.41	-1.18	4.65	0.00	14.06
SL	SNOW LOAD	7.10	56.49	-7.10	27.89	0.00	84.38
WLL	WIND LOAD LEFT	-7.81	-27.57	-6.79	-3.69	-14.60	-31.26
WLR	WIND LOAD RIGHT	2.56	-15.34	14.15	-17.42	16.71	-32.77
IP	WIND INT PRESSURE	-0.98	-7.78	0.98	-3.85	0.00	-11.63
IS	WIND INT SUCTION	0.98	7.78	-0.98	3.85	0.00	11.63
EQ	SEISMIC LOAD	-1.20	-1.27	-1.16	1.27	-2.36	0.00
SLL	SNOW LOAD LEFT SLOPE	-0.07	27.80	0.07	-0.24	0.00	27.56
SLR	SNOWLOAD RIGHT SLOPE	7.03	27.56	-7.03	27.57	0.00	55.13
EWP	EW WIND PRESSURE	-3.57	-22.82	-3.81	-11.75	-7.38	-34.57
EWS	EW WIND SUCTION	-3.57	-22.82	-3.81	-11.75	-7.38	-34.57
CHR	CR	-6.76	-4.66	-6.44	4.66	-13.20	0.00
CHL	CR	6.76	4.66	6.44	-4.66	13.20	0.00
PDE	P Delta Unit Story S	0.00	-0.54	0.00	0.54	0.00	0.00

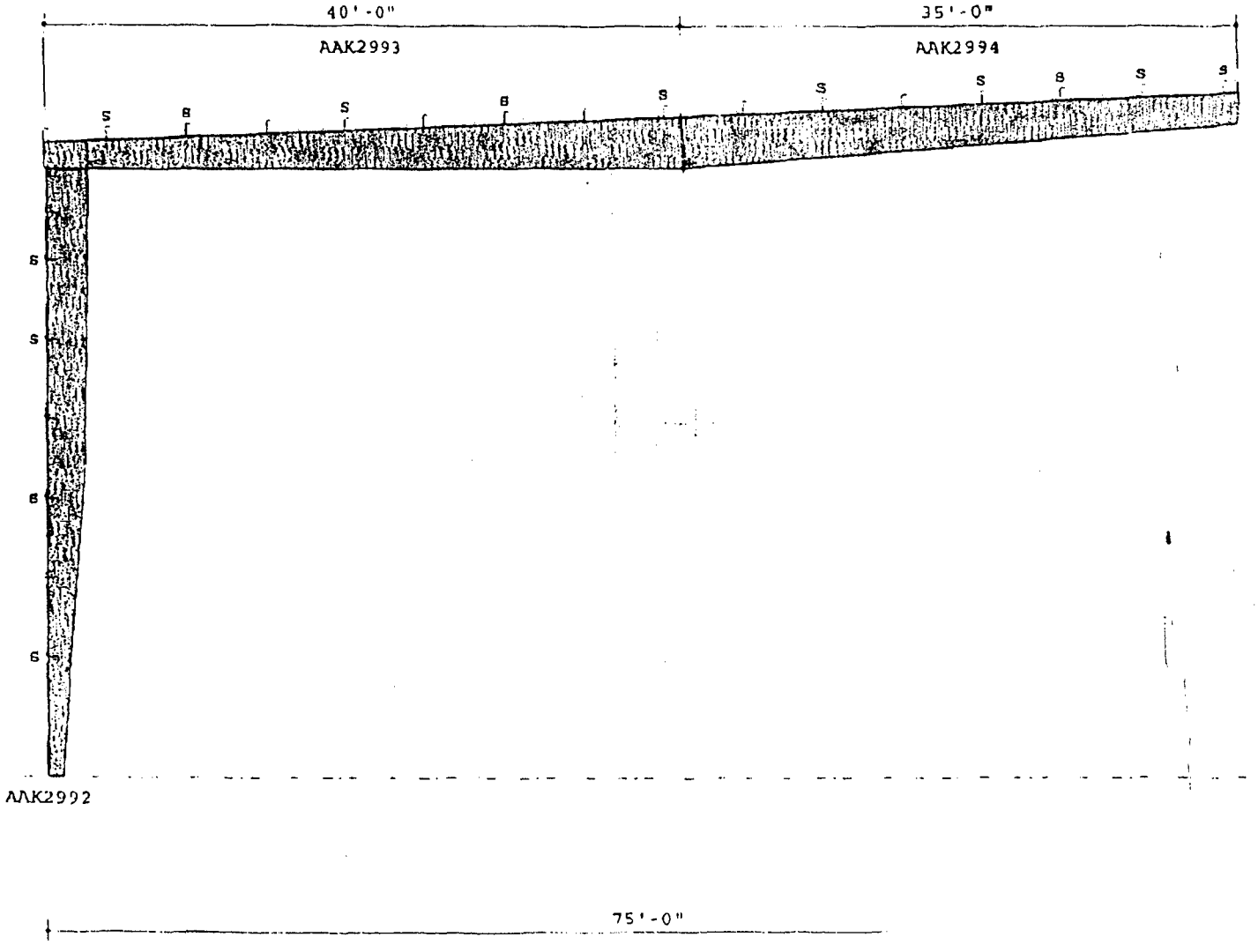
FRAME DESIGN - CROSS SECTION

DATE: 1/17/02
TIME: 12:25:23 PM

PAGE:

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # 06 DESCRIPTION LRST WIDTH 75'-0" HEIGHT 40'-9 1/2" SLOPE 0.500 TO 12

Eave 40'-9 1/2" Slope 1/2:12 LRST Eave 43'-11"
Clear Height 38'-3 3/8" Clear Height 41'-1 1/2"



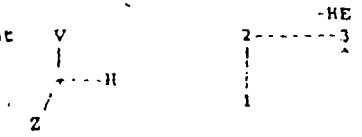
F R A M E D E S I G N - R E A C T I O N S

DATE: 01/15/02
TIME: 04:03 PM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 06	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		LRST	75'-0"	41'-0"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up



P Delta Analysis Performed

No.	Loading Combination	1H	1V	3H	3V	Sum H	Sum V
1	DL + CLL + SL	8.38	43.73	-8.38	32.57	0.00	76.30
2	.67DL + WLL + IP	-8.04	-12.52	-3.32	-11.35	-11.36	-23.87
3	.67DL + WLR + IP	1.24	-11.47	8.33	-8.52	9.57	-19.99
4	.67DL + WLL + IS	-6.31	-3.72	-5.69	-4.64	-12.01	-8.36
5	.67DL + WLR + IS	2.96	-2.67	5.96	-1.81	8.92	-4.48
6	DL+CLL+.5SL+WLL+IP	3.51	10.89	-7.85	6.26	-11.36	17.15
7	DL+CLL+.5SL+WLR+IP	5.76	11.94	3.80	9.09	9.57	21.03
8	DL+CLL+.5SL+WLL+IS	-1.79	19.69	-10.22	12.98	-12.01	32.66
9	DL+CLL+.5SL+WLR+IS	7.49	20.74	1.43	15.80	8.92	36.54
10	DL+CLL+SL+.5WLL+.5IP	4.00	35.28	-9.68	25.51	-5.68	60.79
11	DL+CLL+SL+.5WLR+.5IP	8.63	35.81	-3.85	26.92	4.78	62.73
12	DL+CLL+SL+.5WLL+.5IS	4.86	39.68	-10.86	23.86	-6.00	68.54
13	DL+CLL+SL+.5WLR+.5IS	9.50	40.20	-5.04	30.28	4.46	70.48
14	.67DL + CL + .8EQL	1.77	9.76	-3.66	6.76	-1.89	16.53
15	.67DL + CL + .8EQR	1.76	9.63	0.13	6.90	1.89	16.53
16	DL + CL + .6SL+.8EQL	5.88	31.05	-7.77	22.75	-1.89	53.80
17	DL + CL + .6SL+.8EQR	5.87	30.91	-3.98	22.88	1.89	53.80
18	.67DL + EWP + IP	3.46	-14.01	12.60	-9.85	16.05	-23.87
19	DL+CLL+.5SL+EWP+IP	7.98	9.40	8.07	7.76	16.05	17.15
20	DL+CLL+SL+.5EWP+.5IP	9.74	34.53	-1.72	26.25	8.03	60.79

ID	Load Case	1H	1V	3H	3V	Sum H	Sum V
DL	DEAD LOAD	1.08	6.54	-1.08	4.13	0.00	10.67
CLL	COLLATERAL LOAD	1.04	5.31	-1.04	4.06	0.00	9.38
SL	SNOW LOAD	6.26	31.88	-6.26	24.37	0.00	56.25
WLL	WIND LOAD LEFT	-7.90	-12.50	-3.79	-10.76	-11.68	-23.26
WLR	WIND LOAD RIGHT	1.38	-11.45	7.86	-7.93	9.24	-19.39
IP	WIND INT PRESSURE	-0.86	-4.40	1.19	-3.36	0.32	-7.75
IS	WIND INT SUCTION	0.86	4.40	-1.19	3.36	-0.32	7.75
EQ	SEISMIC LOAD	0.01	0.08	-2.36	-0.08	-2.36	0.00
SLL	SNOW LOAD LEFT SLOPE	6.13	31.24	-6.13	23.88	0.00	55.13
EWP	EW WIND PRESSURE	3.60	-14.00	12.13	-9.27	15.73	-23.26
EWS	EW WIND SUCTION	3.60	-14.00	12.13	-9.27	15.73	-23.26
PDE	P Delta Unit Story S	1.00	0.04	-1.00	-0.04	0.00	0.00

F R A M E D E S I G N - C R O S S S E C T I O N

DATE: 1/17/02
TIME: 8:25:09 AM

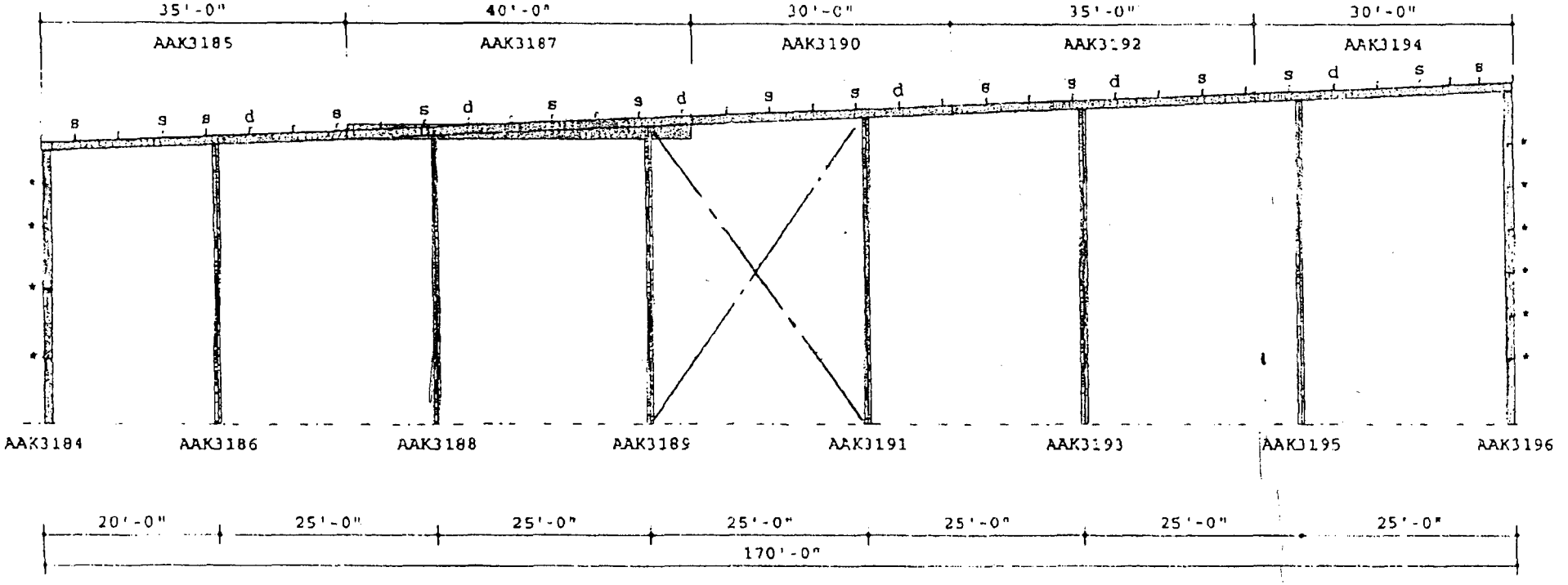
PAGE:

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # 07 DESCRIPTION EWSS WIDTH 170'-0" HEIGHT 33'-3 1/2" SLOPE 0.500 TO 12

Eave 33'-3 1/2" Slope 1/2:12
Clear Height 31'-6 1/2"

EWSS

Eave 40'-4 1/2"
Clear Height 38'-6 1/2"



Jan-17-02 1:34PM; 717 857 3220; Sent by: Mfg. Co.; PAGE.13 717 857 3220 JAN 17 2002 12:54

717 657 3220

JAN 17 2002 12:54

F R A M E D E S I G N - R E A C T I O N S

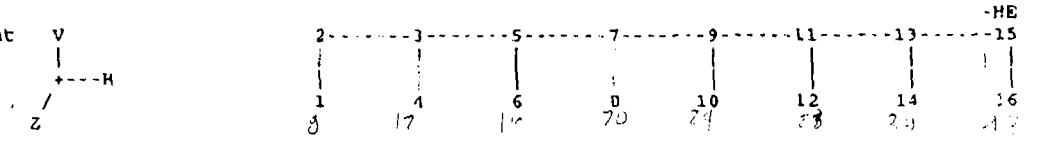
DATE: 01/17/02
TIME: 08:24 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00 00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 07	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		BWSS	170'-0"	33'-6"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION

H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



P Delta Analysis Performed

No.	Loading Combination	1H	1V	3Z	4V	4Z	5Z	6V	6Z	7Z	8H	8V	8Z	9Z
1	DL + CLL + SL	0.12	4.23	0.00	11.73	0.00	0.00	12.35	0.00	0.00	0.00	12.54	0.00	0.00
2	.67DL + WLL + IP	-2.11	-0.41	0.00	-4.40	0.00	0.00	-3.73	0.00	0.00	-3.85	-9.22	0.00	0.00
3	.67DL + WLR + IP	1.40	-1.34	0.00	-2.70	0.00	0.00	-3.30	0.00	0.00	0.00	6.47	0.00	0.00
4	.67DL + WLL + IS	-2.10	0.39	0.00	-1.99	0.00	0.00	-1.22	0.00	0.00	-4.52	-7.70	0.00	0.00
5	.67DL + WLR + IS	1.41	-0.53	0.00	-0.29	0.00	0.00	-0.79	0.00	0.00	0.00	7.99	0.00	0.00
6	DL+CLL+.5SL+WLL+IP	-2.05	1.83	0.00	1.90	0.00	0.00	2.91	0.00	0.00	-3.81	-2.53	0.00	0.00
7	DL+CLL+.5SL+WLR+IP	1.46	0.91	0.00	3.60	0.00	0.00	3.34	0.00	0.00	0.00	13.16	0.00	0.00
8	DL+CLL+.5SL+WLL+IS	-2.04	2.64	0.00	4.31	0.00	0.00	5.42	0.00	0.00	-4.48	-1.02	0.00	0.00
9	DL+CLL+.5SL+WLR+IS	1.48	1.71	0.00	6.01	0.00	0.00	5.85	0.00	0.00	0.00	14.67	0.00	0.00
10	DL+CLL+SL+.5WLL+.5IP	-0.94	3.78	0.00	8.98	0.00	0.00	9.90	0.00	0.00	-1.85	7.27	0.00	0.00
11	DL+CLL+SL+.5WLR+.5IP	0.81	3.32	0.00	9.63	0.00	0.00	10.12	0.00	0.00	0.00	15.11	0.00	0.00
12	DL+CLL+SL+.5WLL+.5IS	-0.94	4.18	0.00	10.18	0.00	0.00	11.16	0.00	0.00	-2.19	8.02	0.00	0.00
13	DL+CLL+SL+.5WLR+.5IS	0.82	3.72	0.00	11.03	0.00	0.00	11.37	0.00	0.00	0.00	15.87	0.00	0.00
14	.67DL + CL + .8EQL	-0.01	0.93	0.00	2.64	0.00	0.00	2.67	0.00	0.00	-2.06	-0.12	0.00	0.00
15	.67DL + CL + .8EQR	0.06	1.05	0.00	2.46	0.00	0.00	2.68	0.00	0.00	0.00	5.79	0.00	0.00
16	DL + CL + .6SL+.8EQL	0.04	2.97	0.00	8.37	0.00	0.00	8.70	0.00	0.00	-2.02	5.96	0.00	0.00
17	DL + CL + .6SL+.8EQR	0.12	3.09	0.00	8.19	0.00	0.00	8.71	0.00	0.00	0.00	11.87	0.00	0.00
18	.67DL + EWS + IP	2.28	-4.36	-9.90	9.28	-9.15	-11.32	-10.96	-10.49	-11.65	0.00	-6.87	-10.82	-11.97
19	.67DL + EWP + IS	2.29	-3.56	9.90	-6.87	9.15	11.32	-8.45	10.49	11.65	0.00	-5.35	10.82	11.97
20	DL+CLL+.5SL+EWS+IP	2.34	-2.12	-9.90	-2.97	-9.15	-11.32	-4.32	-10.49	-11.65	0.00	-0.18	-10.82	-11.97
21	DL+CLL+.5SL+EWP+IS	2.35	-1.32	9.90	-0.56	9.15	11.32	-1.81	10.49	11.65	0.00	1.33	10.82	11.97
22	DL+CLL+SL+.5EWS+.5IP	1.25	1.81	-4.95	6.54	-4.58	-5.66	6.29	-5.25	-5.82	0.00	8.44	-5.41	-5.99
23	DL+CLL+SL+.5EWP+.5IS	1.26	2.21	4.95	7.74	4.58	5.66	7.54	5.25	5.82	0.00	9.20	5.41	5.99

No.	Loading Combination	10H	10V	10Z	11Z	12V	12Z	13Z	14V	14Z	16H	16V	Sum H	Sum V
1	DL + CLL + SL	0.08	12.45	0.00	0.00	12.39	0.00	0.00	13.49	0.00	-0.20	5.64	0.00	84.81
2	.67DL + WLL + IP	0.00	1.76	0.00	0.00	-3.65	0.00	0.00	-3.15	0.00	-1.59	-1.98	-7.56	24.76
3	.67DL + WLR + IP	6.59	-12.29	0.00	0.00	-2.61	0.00	0.00	-4.20	0.00	2.56	-0.57	10.55	20.54
4	.67DL + WLL + IS	0.00	5.20	0.00	0.00	-1.20	0.00	0.00	-0.50	0.00	-1.64	-0.87	-8.26	-7.89
5	.67DL + WLR + IS	5.92	-8.86	0.00	0.00	-0.17	0.00	0.00	-1.55	0.00	2.51	0.54	9.84	-3.67
6	DL+CLL+.5SL+WLL+IP	0.00	8.40	0.00	0.00	2.93	0.00	0.00	4.02	0.00	-1.70	1.00	-7.56	20.46
7	DL+CLL+.5SL+WLR+IP	6.63	-5.66	0.00	0.00	3.96	0.00	0.00	2.97	0.00	2.45	2.41	10.55	24.68
8	DL+CLL+.5SL+WLL+IS	0.00	11.83	0.00	0.00	5.37	0.00	0.00	6.67	0.00	-1.74	2.11	-8.26	37.34
9	DL+CLL+.5SL+WLR+IS	5.96	-2.23	0.00	0.00	6.41	0.00	0.00	5.62	0.00	2.40	3.52	9.84	41.56
10	DL+CLL+SL+.5WLL+.5IP	0.00	12.66	0.00	0.00	9.87	0.00	0.00	11.17	0.00	-0.98	4.31	-3.78	67.94
11	DL+CLL+SL+.5WLR+.5IP	3.37	5.63	0.00	0.00	10.38	0.00	0.00	10.64	0.00	1.09	5.02	5.27	70.05
12	DL+CLL+SL+.5WLL+.5IS	0.00	14.38	0.00	0.00	11.09	0.00	0.00	12.49	0.00	-1.01	4.87	-4.13	76.38
13	DL+CLL+SL+.5WLR+.5IS	3.04	7.35	0.00	0.00	11.61	0.00	0.00	11.97	0.00	1.07	5.57	4.92	78.48
14	.67DL + CL + .8EQL	0.00	5.72	0.00	0.00	2.90	0.00	0.00	3.08	0.00	-0.06	1.37	-2.13	19.19

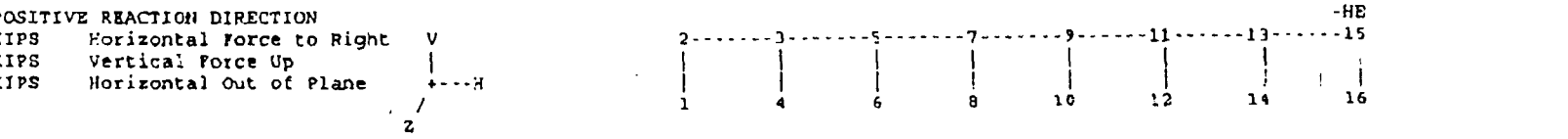
F R A M E D E S I N - R E A C T I O N S

DATE: 01/17/02
TIME: 08:24 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 07	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		EWSB	170'-0"	33'-6"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



No.	Loading Combination	10H	10V	10Z	11Z	12V	12Z	13Z	14V	14Z	16H	16V	Sum H	Sum V
15	.67DL + CL + .8EQR	2.09	-0.07	0.00	0.00	2.85	0.00	0.00	3.12	0.00	-0.01	1.30	2.13	19.19
16	DL + CL + .6SL+.8EQL	0.00	11.75	0.00	0.00	8.89	0.00	0.00	9.60	0.00	-0.16	4.09	-2.13	60.33
17	DL + CL + .6SL+.8EQR	2.13	5.96	0.00	0.00	8.83	0.00	0.00	9.65	0.00	-0.11	4.02	2.13	60.33
18	.67DL + BWS + IP	2.48	-13.90	-11.14	-12.29	-10.54	-11.46	-12.62	-9.76	-11.79	-2.65	-5.49	2.11	-71.17
19	.67DL + EWP + IS	1.81	-10.47	11.14	12.29	-8.10	11.46	12.62	-7.11	11.79	-2.69	-4.38	1.41	-54.29
20	DL+CLL+.5SL+BWS+IP	2.52	-7.27	-11.14	-12.29	-3.97	-11.46	-12.62	-2.59	-11.79	-2.75	-2.51	2.11	-25.94
21	DL+CLL+.5SL+EWP+IS	1.85	-3.84	11.14	12.29	-1.53	11.46	12.62	0.06	11.79	-2.80	-1.40	1.41	-9.07
22	DL+CLL+SL+.5EWS+.5IP	1.32	4.83	-5.57	-6.15	6.42	-5.73	-6.31	7.86	-5.89	-1.51	2.55	1.05	64.74
23	DL+CLL+SL+.5EWP+.5IS	0.98	6.54	5.57	6.15	7.64	5.73	6.31	9.19	5.89	-1.54	3.11	0.70	53.17

No.	Loading Combination	Sum Z
1	DL + CLL + SL	0.00
2	.67DL + WLL + IP	0.00
3	.67DL + WLR + IP	0.00
4	.67DL + WLL + IS	0.00
5	.67DL + WLR + IS	0.00
6	DL+CLL+.5SL+WLL+IP	0.00
7	DL+CLL+.5SL+WLR+IP	0.00
8	DL+CLL+.5SL+WLL+IS	0.00
9	DL+CLL+.5SL+WLR+IS	0.00
10	DL+CLL+SL+.5WLL+.5IP	0.00
11	DL+CLL+SL+.5WLR+.5IP	0.00
12	DL+CLL+SL+.5WLL+.5IS	0.00
13	DL+CLL+SL+.5WLR+.5IS	0.00
14	.67DL + CL + .8EQL	0.00
15	.67DL + CL + .8EQR	0.00
16	DL + CL + .6SL+.8EQL	0.00
17	DL + CL + .6SL+.8EQR	0.00
18	.67DL + BWS + IP	-134.60
19	.67DL + EWP + IS	134.60
20	DL+CLL+.5SL+BWS+IP	-134.60
21	DL+CLL+.5SL+EWP+IS	134.60
22	DL+CLL+SL+.5EWS+.5IP	-67.30
23	DL+CLL+SL+.5EWP+.5IS	67.30

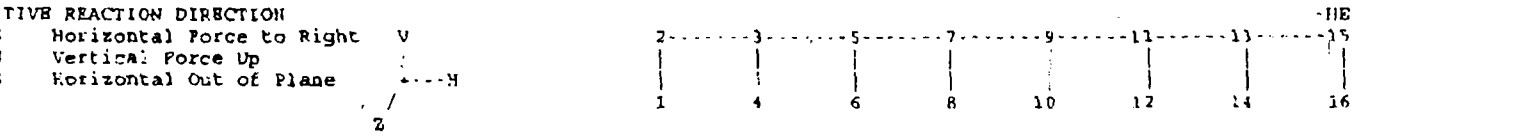
F R A M E D E S I G N - R E A C T I O N S

DATE: 01/17/02
TIME: 08:24 AM

ORDER # 012334 BUILDER BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME #	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
C7		EWSS	170'-0"	33'-6"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



ID	Load Case	1H	1V	3Z	4V	4Z	5Z	6V	6Z	7Z	8H	8V	8Z	9Z
DL	DEAD LOAD	0.01	0.74	0.00	1.66	0.00	0.00	1.72	0.00	0.00	0.00	1.98	0.00	0.00
CLL	COLLATERAL LOAD	0.02	0.50	0.00	1.44	0.00	0.00	1.52	0.00	0.00	0.00	1.51	0.00	0.00
SL	SNOW LOAD	0.09	3.00	0.00	8.63	0.00	0.00	9.10	0.00	0.00	0.00	9.05	0.00	0.00
WLL	WIND LOAD LEFT	-2.11	-0.50	0.00	-4.31	0.00	0.00	-3.63	0.00	0.00	-4.20	-9.79	0.00	0.00
WLR	WIND LOAD RIGHT	1.60	-1.43	0.00	-2.61	0.00	0.00	-3.20	0.00	0.00	0.00	5.91	0.00	0.00
IP	WIND INT PRESSURE	-0.01	-0.40	0.00	-1.20	0.00	0.00	-1.25	0.00	0.00	0.00	-0.76	0.00	0.00
IS	WIND INT SUCTION	0.01	0.40	0.00	1.20	0.00	0.00	1.25	0.00	0.00	-0.34	0.76	0.00	0.00
EQ	SEISMIC LOAD	-0.05	-0.08	0.00	0.11	0.00	0.00	-0.01	0.00	0.00	-2.59	-3.69	0.00	0.00
SLL	SNOW LOAD LEFT SLOPE	0.09	2.94	0.00	8.46	0.00	0.00	8.93	0.00	0.00	0.00	8.87	0.00	0.00
EWP	EW WIND PRESSURE	2.28	-4.45	9.90	-9.19	9.15	11.32	-10.86	10.49	11.65	0.00	-7.43	10.82	11.97
EWS	EW WIND SUCTION	2.28	4.45	-9.90	-9.19	-9.15	-11.32	-10.86	-10.49	-11.65	0.00	7.43	-10.82	11.97
PDE	P Delta Unit Story S	0.04	-0.03	0.00	0.04	0.00	0.00	0.00	0.00	0.00	-0.83	-1.39	0.00	0.00

ID	Load Case	10H	10V	10Z	11Z	12V	12Z	13Z	14V	14Z	16H	16V	Sum H	Sum V
DL	DEAD LOAD	0.01	1.99	0.00	0.00	2.09	0.00	0.00	2.23	0.00	-0.02	1.01	0.00	13.41
CLL	COLLATERAL LOAD	0.01	1.49	0.00	0.00	1.47	0.00	0.00	1.61	0.00	-0.03	0.66	0.00	10.20
SL	SNOW LOAD	0.06	8.95	0.00	0.00	8.83	0.00	0.00	9.65	0.00	-0.15	3.97	0.00	61.20
WLL	WIND LOAD LEFT	0.00	2.15	0.00	0.00	-3.82	0.00	0.00	-3.31	0.00	-1.60	-2.10	-7.91	-25.31
WLR	WIND LOAD RIGHT	6.25	-11.91	0.00	0.00	-2.79	0.00	0.00	-4.37	0.00	2.55	-0.69	10.20	-21.09
IP	WIND INT PRESSURE	0.34	-1.72	0.00	0.00	-1.22	0.00	0.00	-1.33	0.00	0.02	-0.55	0.35	-9.44
IS	WIND INT SUCTION	0.00	1.72	0.00	0.00	1.22	0.00	0.00	1.33	0.00	-0.02	0.56	-0.35	9.44
EQ	SEISMIC LOAD	0.00	3.62	0.00	0.00	0.04	0.00	0.00	-0.33	0.00	-0.03	0.04	2.67	0.00
SLL	SNOW LOAD LEFT SLOPE	0.06	8.79	0.00	0.00	8.65	0.00	0.00	9.46	0.00	-0.15	3.89	0.00	59.98
EWP	EW WIND PRESSURE	2.14	-13.52	11.14	12.29	-10.72	11.46	12.62	-9.93	11.79	-2.66	-5.61	1.76	-71.72
EWS	EW WIND SUCTION	2.14	-13.52	-11.14	-12.29	-10.72	-11.46	-12.62	-9.93	-11.79	-2.66	-5.61	1.76	-71.72
PDE	P Delta Unit Story S	0.15	1.36	0.00	0.00	0.01	0.00	0.00	-0.02	0.00	0.07	0.02	-0.57	0.00

$0.75(1.4D + 1.7L + 1.3W)$

PAGE.15
717 857 3220
JAN 17 2002 12:55

F R A M E D E S I G N - S T R E S S S U M M A R Y

DATE: 01/17/02
TIME: 08:24 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP

DESIGN SYSTEM FRAME # 07	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		EWSS	170'-0"	33'-6'	30 PSF	90 MPH	MASS 97	0.500 TO 12

BRACING MEMBERS

NUMBER	MODULE NO.	ROD DIRECTION	JOINTS	ROD DIA	TENSILE STRENGTH	ACTUAL FORCE	ALLOW FORCE	STRESS RATIO	LOAD COND
1	4	/	8 9	0.750	80	-7.93	14.32	0.554	4
2	4	\	7 10	0.750	80	-11.40	14.32	0.796	7

MEMBER NO. 1 JOINT 1 - 2

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	31.54	55.	8	5.00 FT	12.00 IN	12.00 IN	5.000 X .250	.100	5.000 X .250	0.311	21

CONTROLLING ACTIONS

SECT. NO.	AXIAL FORCE (KIPS)	AXIAL MOMENT (IN-KIP)	MAXIMUM STRESSES AXIAL (KSI)	FBO (KSI)	FBI (KSI)	ALLOWABLE STRESSES FA (KSI)	FBO (KSI)	FBI (KSI)	SHEAR FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	-1.51	-187.63	-0.41	-11.37	-11.37	43.99	43.99	36.57	3.00	10.06	0.299	18

MEMBER NO. 2 JOINT 2 - 3

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	20.00	55.	5	5.00 FT	12.00 IN	12.00 IN	5.000 X .250	.100	5.000 X .250	0.506	1

CONTROLLING ACTIONS

SECT. NO.	AXIAL FORCE (KIPS)	AXIAL MOMENT (IN-KIP)	MAXIMUM STRESSES AXIAL (KSI)	FBO (KSI)	FBI (KSI)	ALLOWABLE STRESSES FA (KSI)	FBO (KSI)	FBI (KSI)	SHEAR FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	-0.11	-262.63	-0.03	-15.92	-15.92	33.00	33.00	31.48	-5.45	7.54	0.723	1

MEMBER NO. 3 JOINT 4 - 3 Rotated 90 degrees

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	20.00	55.	4	5.00 FT	12.00 IN	12.00 IN	8.000 X .250	.120	8.000 X .250	1.029	18
2	12.33	55.	3	4.11 FT	12.00 IN	12.00 IN	8.000 X .250	.100	8.000 X .250	0.747	18

F R A M E D E S I G N - C R O S S S E C T I O N

DATE: 1/17/02
TIME: 8:31:50 AM

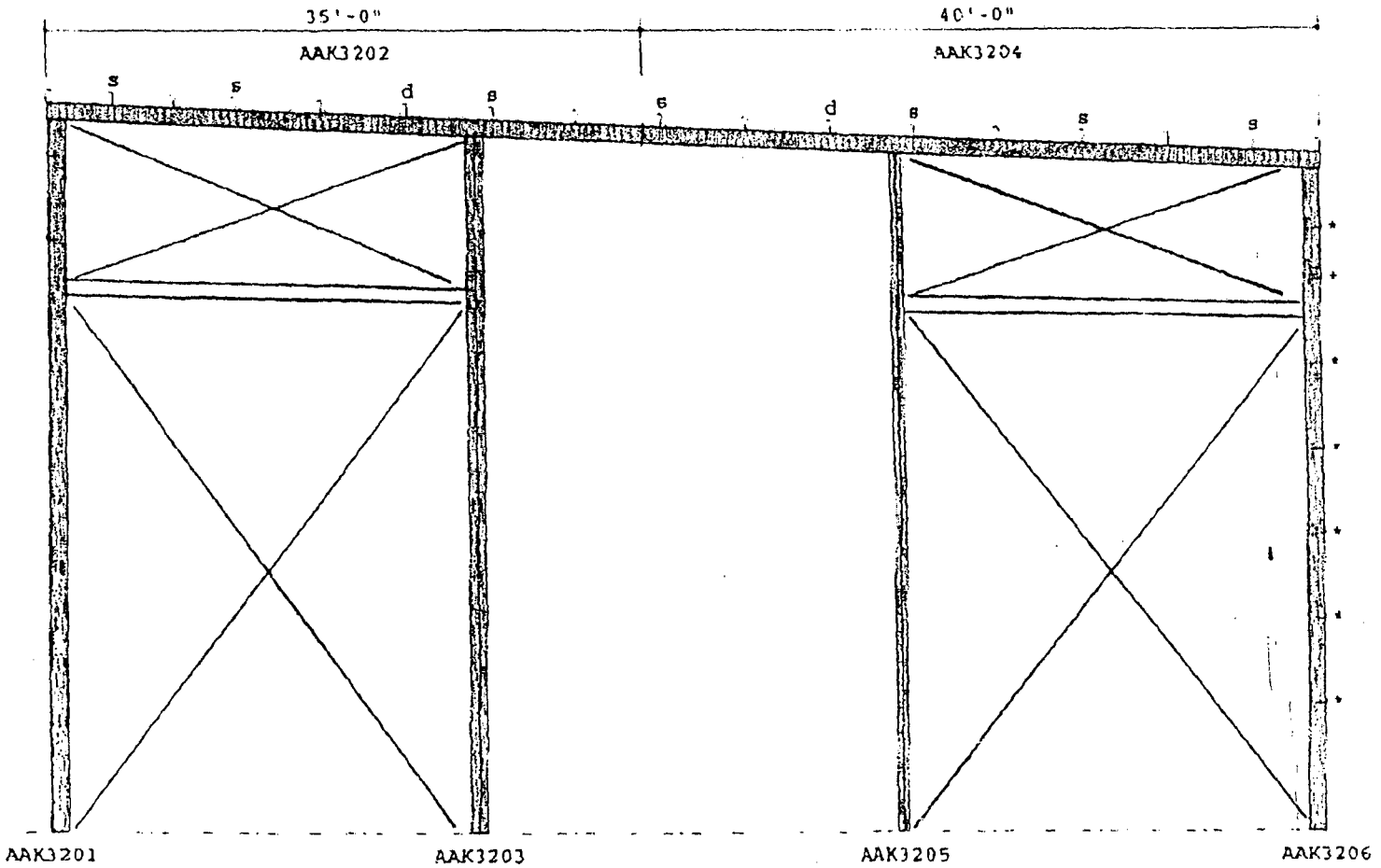
PAGE:

ORDER #012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -
DESIGN SYSTEM FRAME # C8 DESCRIPTION EWSS WIDTH 75'-0" HEIGHT 43'-11" SLOPE 0.500 TO 12

Eave 43'-11"
Clear Height 42'-0 7/8"

EWSS

Slope 1/2:12 Eave 40'-9 1/2"
Clear Height 39'-0 1/2"



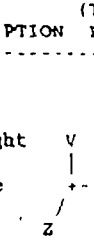
F R A M E D E S I G N - R E A C T I O N S

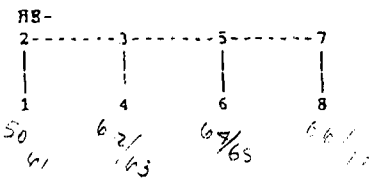
DATE: 01/17/02
TIME: 08:42 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM	FRAME # 08	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
			EWSS	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane





P Delta Analysis Performed

No.	Loading Combination	1H	1V	3Z	4H	4V	4Z	5Z	6H	6V	6Z	8H	8V	Sum H
1	DL + CLL + SL	0.33	7.56	0.00	0.00	11.02	0.00	0.00	-0.01	10.94	0.00	-0.12	6.44	0.00
2	.67DL + WLL + IP	-5.12	-3.70	0.00	0.00	1.95	0.00	0.00	-2.61	-6.63	0.00	-1.54	4.03	-9.28
3	.67DL + WLR + IP	1.68	3.62	0.00	1.89	-6.13	0.00	0.00	0.00	0.36	0.00	4.60	-3.75	8.18
4	.67DL + WLL + IS	-4.93	-2.49	0.00	0.00	3.82	0.00	0.00	-2.49	-4.28	0.00	-1.60	4.80	-9.02
5	.67DL + WLR + IS	1.76	4.83	0.00	2.01	-4.25	0.00	0.00	0.00	2.70	0.00	4.67	-2.98	8.44
6	DL+CLL+.5SL+WLL+IP	-4.94	-0.19	0.00	0.00	7.72	0.00	0.00	-2.62	-0.86	0.00	-1.71	7.17	-9.28
7	DL+CLL+.5SL+WLR+IP	1.87	7.13	0.00	1.89	-0.35	0.00	0.00	0.00	6.13	0.00	4.42	-0.61	8.18
8	DL+CLL+.5SL+WLL+IS	-4.75	1.03	0.00	0.00	9.60	0.00	0.00	-2.49	1.49	0.00	-1.78	7.94	-9.02
9	DL+CLL+.5SL+WLR+IS	1.95	8.35	0.00	2.00	1.53	0.00	0.00	0.00	8.47	0.00	4.48	0.16	8.44
10	DL+CLL+SL+.5WLL+.5IP	-2.24	4.59	0.00	0.00	11.27	0.00	0.00	-1.32	6.96	0.00	-1.08	7.71	-4.64
11	DL+CLL+SL+.5WLR+.5IP	1.17	8.25	0.00	0.54	7.23	0.00	0.00	0.00	10.45	0.00	1.98	3.82	4.09
12	DL+CLL+SL+.5WLL+.5IS	-2.15	5.20	0.00	0.00	12.21	0.00	0.00	-1.25	8.13	0.00	-1.11	8.09	-4.51
13	DL+CLL+SL+.5WLR+.5IS	1.21	8.86	0.00	1.00	8.17	0.00	0.00	0.00	11.62	0.00	2.01	4.20	4.22
14	.67DL + CL + .8EQL	-0.29	2.23	0.00	0.00	3.33	0.00	0.00	-0.37	1.95	0.00	-0.08	2.74	-0.74
15	.67DL + CL + .8EQR	0.09	3.45	0.00	0.33	2.08	0.00	0.00	0.00	3.29	0.00	0.32	1.44	0.74
16	DL + CL + .6SL+.8EQL	-0.12	5.51	0.00	0.00	8.60	0.00	0.00	-0.38	7.21	0.00	-0.24	5.64	-0.74
17	DL + CL + .6SL+.8EQR	0.25	6.73	0.00	0.33	7.35	0.00	0.00	0.00	8.55	0.00	0.16	4.34	0.74
18	.67DL + EWS + IP	2.15	-3.47	-13.71	0.00	-7.46	-12.89	-13.39	-0.55	-9.23	-12.56	-2.37	-2.81	-0.78
19	.67DL + EWP + IS	2.35	-2.26	13.71	0.00	-5.58	12.89	13.39	-0.43	-6.88	12.56	-2.44	-2.04	-0.52
20	DL+CLL+.5SL+EWS+IP	2.33	0.05	-13.71	0.00	-1.60	-12.89	-13.39	-0.56	-3.45	-12.56	-2.55	0.34	-0.78
21	DL+CLL+.5SL+EWP+IS	2.53	1.26	13.71	0.00	0.20	12.89	13.39	-0.43	-1.11	12.56	-2.61	1.10	-0.52
22	DL+CLL+SL+.5EWS+.5IP	1.40	4.71	-6.86	0.00	6.57	-6.44	-6.70	-0.29	5.66	-6.28	-1.50	4.29	-0.39
23	DL+CLL+SL+.5EWP+.5IS	1.49	5.32	6.86	0.00	7.51	6.44	6.70	-0.22	6.83	6.28	-1.53	4.69	-0.26
24	DL+CL+.75SL+CHL	1.16	81.53	0.00	0.00	9.18	0.00	0.00	-0.03	9.12	0.00	-1.12	80.50	0.00
25	DL+CL+.75SL+CHR	0.49	25.63	0.00	0.00	9.13	0.00	0.00	-0.01	9.05	0.00	-0.48	24.53	0.00
26	DL+CL+.5WLL+CHL	-2.56	76.15	0.00	0.00	4.21	0.00	0.00	-1.30	-0.03	0.00	-1.71	79.25	-4.57
27	DL+CL+.5WLL+CHR	-2.22	20.24	0.00	0.00	4.16	0.00	0.00	-1.28	-0.09	0.00	-1.07	23.28	-4.57
28	DL+CL+.5WLR+CHL	1.84	79.81	0.00	0.95	0.17	0.00	0.00	0.00	3.46	0.00	1.36	75.36	4.15
29	DL+CL+.5WLR+CHR	1.16	23.90	0.00	0.97	0.12	0.00	0.00	0.00	3.40	0.00	2.03	19.39	4.15

No.	Loading Combination	Sum V	Sum Z
1	DL + CLL + SL	35.96	0.00
2	.67DL + WLL + IP	-4.35	0.00
3	.67DL + WLR + IP	-5.90	0.00
4	.67DL + WLL + IS	1.85	0.00
5	.67DL + WLR + IS	0.30	0.00
6	DL+CLL+.5SL+WLL+IP	13.85	0.00
7	DL+CLL+.5SL+WLR+IP	12.30	0.00
8	DL+CLL+.5SL+WLL+IS	20.06	0.00

PAGE.19
717 857 3220
JAN 17 2002 12:55

F R A M E D E S I G N - R E A C T I O N S

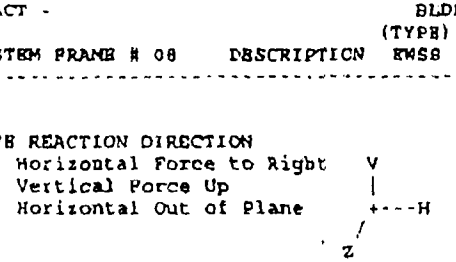
DATE: 01/17/02
TIME: 08:42 AM

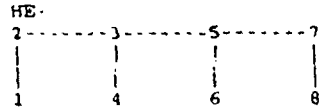
ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - BNDR GRP -

DESIGN SYSTEM FRAME # 08	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		EWSS	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION

H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane





No.	Loading Combination	Sum V	Sum Z
9	DL+CLL+.5SL+WLR+IS	18.51	0.00
10	DL+CLL+SL+.5WLL+.5IP	30.53	0.00
11	DL+CLL+SL+.5WLR+.5IP	29.76	0.00
12	DL+CLL+SL+.5WLL+.5IS	33.63	0.00
13	DL+CLL+SL+.5WLR+.5IS	32.86	0.00
14	.67DL + CL + .8EQL	10.26	0.00
15	.67DL + CL + .8EQR	10.26	0.00
16	DL + CL + .6SL+.8EQL	26.96	0.00
17	DL + CL + .6SL+.8EQR	26.96	0.00
18	.67DL + EWS + IP	-22.96	-52.55
19	.67DL + EWP + IS	-16.76	52.55
20	DL+CLL+.5SL+EWS+IP	-4.76	-52.55
21	DL+CLL+.5SL-EWP+IS	1.45	52.55
22	DL+CLL+SL+.5EWS+.5IP	21.23	-26.28
23	DL+CLL+SL+.5EWP+.5IS	24.33	26.28
24	DL+CL+.75SL+CHL	180.34	0.00
25	DL+CL+.75SL+CHR	68.34	0.00
26	DL+CL+.5WLL+CHL	159.58	0.00
27	DL+CL+.5WLL+CHR	47.58	0.00
28	DL+CL+.5WLR+CHL	158.81	0.00
29	DL+CL+.5WLR+CHR	46.81	0.00

ID	Load Case	1H	1V	3Z	4H	4V	4Z	5Z	6H	5V	6Z	8H	8V	Sum H
DL	DEAD LOAD	0.03	3.34	0.00	0.00	2.15	0.00	0.00	0.00	2.01	0.00	-0.03	2.22	0.00
CLL	COLLATERAL LOAD	0.04	0.60	0.00	0.00	1.27	0.00	0.00	0.00	1.28	0.00	-0.04	0.60	0.00
SL	SNOW LOAD	0.25	3.62	0.00	0.00	7.60	0.00	0.00	-0.01	7.66	0.00	-0.25	3.62	0.00
WLL	WIND LOAD LEFT	-5.05	-5.33	0.00	0.00	1.45	0.00	0.00	-2.55	-6.80	0.00	-1.55	2.93	-9.15
WLR	WIND LOAD RIGHT	1.70	1.99	0.00	1.95	-6.63	0.00	0.00	0.00	0.19	0.00	4.66	-4.85	8.31
IP	WIND INT PRESSURE	-0.10	-0.61	0.00	0.00	-0.94	0.00	0.00	-0.06	-1.17	0.00	0.03	-0.38	-0.13
IS	WIND INT SUCTION	0.04	0.61	0.00	0.06	0.94	0.00	0.00	0.00	1.17	0.00	0.03	0.38	0.13
EQ	SEISMIC LOAD	-0.44	-0.76	0.00	0.00	0.78	0.00	0.00	-0.47	-0.84	0.00	-0.02	0.82	-0.93
SLR	SNOWLOAD RIGHT SLOPE	0.25	3.55	0.00	0.00	7.45	0.00	0.00	-0.01	7.51	0.00	-0.24	3.54	0.00
EWP	EW WIND PRESSURE	2.23	-5.10	13.71	0.00	-7.96	12.89	13.39	-0.49	-9.40	12.56	-2.38	-3.91	-0.65
EWS	EW WIND SUCTION	2.23	-5.10	-13.71	0.00	-7.96	-12.89	-13.39	-0.49	-9.40	-12.56	-2.38	-3.91	-0.65
CHR	CR	0.23	18.97	0.00	0.00	0.02	0.00	0.00	-0.01	0.02	0.00	-0.22	18.99	0.00
CHL	CR	0.89	74.88	0.00	0.00	0.07	0.00	0.00	-0.03	0.09	0.00	-0.86	74.97	0.00
PDE	P Delta Unit Story S	-0.31	-0.83	0.00	0.33	0.85	0.00	0.00	-0.17	-0.90	0.00	0.14	0.88	0.00

F R A M E D E S I G N - R E A C T I O N S

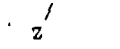
ATE: 01/17/02
TIME: 08:42 AM

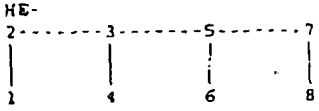
ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 08	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		BNBS	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION

H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane





ID	Load Case	Sum V	Sum Z
DL	DEAD LOAD	9.71	0.00
CLL	COLLATERAL LOAD	3.75	0.00
SL	SNOW LOAD	22.50	0.00
WLL	WIND LOAD LEFT	-7.75	0.00
WLR	WIND LOAD RIGHT	-9.31	0.00
IP	WIND INT PRESSURE	-3.10	0.00
IS	WIND INT SUCTION	3.10	0.00
EQ	SEISMIC LOAD	0.00	0.00
SLR	SNOWLOAD RIGHT SLOPE	22.05	0.00
EWP	EW WIND PRESSURE	-26.37	52.55
EWS	EW WIND SUCTION	-26.37	-52.55
CHR	CR	38.00	0.00
CHL	CR	150.00	0.00
PDE	P Delta Unit Story S	0.00	0.00

F R A M E D E S I G N - S T R E S S S U M M A R Y

DATE: 01/17/02
TIME: 08:42 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
DESIGN SYSTEM FRAME # 08 DESCRIPTION	EWSS	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

BRACING MEMBERS

NUMBER	MODULE NO.	ROD DIRECTION	JOINTS	ROD DIA	TENSILE STRENGTH	ACTUAL FORCE	ALLOW FORCE	STRESS RATIO	LOAD COND
1	1	/	1 3	0.500	80	-4.64	6.23	0.745	6
2	3	/	6 7	0.500	80	-4.99	6.23	0.802	6
3	1	\	2 4	0.500	80	-4.04	6.23	0.649	5
4	3	\	5 8	0.500	80	-4.34	6.23	0.698	5

MEMBER NO. 1 JOINT 1 - 2

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	42.08	55.	10	5.00 FT	12.75 IN	12.75 IN	14.000 X .625	.188	14.000 X .625	0.821	24

CONTROLLING ACTIONS

SECT. NO.	AXIAL FORCE (KIPS)	MOMENT (IN-KIP)	MAXIMUM STRESSES AXIAL (KSI)	FBO (KSI)	FBI (KSI)	ALLOWABLE STRESSES FA (KSI)	FBO (KSI)	FBI (KSI)	SHEAR FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	80.14	-370.72	4.08	-3.54	-3.54	8.52	33.00	16.31	5.12	58.85	0.087	2

MEMBER NO. 2 JOINT 3 - 2

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	23.84	55.	6	5.00 FT	12.00 IN	12.00 IN	5.000 X .250	.100	5.000 X .250	0.479	1

CONTROLLING ACTIONS

SECT. NO.	AXIAL FORCE (KIPS)	MOMENT (IN-KIP)	MAXIMUM STRESSES AXIAL (KSI)	FBO (KSI)	FBI (KSI)	ALLOWABLE STRESSES FA (KSI)	FBO (KSI)	FBI (KSI)	SHEAR FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	0.55	-246.05	0.15	-14.92	-14.92	33.00	33.00	31.48	4.97	7.54	0.659	1

MEMBER NO. 3 JOINT 4 - 3 Rotated 90 degrees

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	41.08	55.	9	5.00 FT	12.25 IN	12.25 IN	9.000 X .375	.120	9.000 X .375	0.977	18

F R A M E D E S I G N - S T R E S S S U M M A R Y

DATE: 01/17/02
TIME: 08:31 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # C8	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		BWSS	75'-0"	44'-1 1/2"	30 PSF	90 MPH	MASS 97	0.500 TO 12

BRACING MEMBERS

NUMBER	MODULE NO.	ROD DIRECTION	JOINTS	ROD DIA	TENSILE STRENGTH	ACTUAL FORCE	ALLOW FORCE	STRESS RATIO	LOAD COND
1	1	/	1 3	0.750	80	-8.52	10.74	0.793	27
2	3	/	6 7	0.875	70	-12.80	13.89	0.921	27
3	1	\	2 4	0.750	80	-8.39	10.74	0.781	28
4	3	\	5 8	0.875	70	-12.59	13.89	0.907	28

MEMBER NO. 1 JOINT 1 - 2

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	42.08	55.	10	5.00 FT	12.75 IN	12.75 IN	10.000 X .625	.160	10.000 X .625	0.987	24

CONTROLLING ACTIONS

	---AXIAL---		---MAXIMUM STRESSES---			---ALLOWABLE STRESSES---			---SHEAR---			
SECT. NO.	FORCE (KIPS)	MOMENT (IN-KIP)	AXIAL (KSI)	FBO (KSI)	FBI (KSI)	FA (KSI)	FBO (KSI)	FBI (KSI)	FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	9.86	-784.83	0.69	-10.42	-10.42	4.26	33.00	11.65	7.83	31.98	0.245	27

MEMBER NO. 2 JOINT 3 - 2

SECT. NO.	LENGTH (FT)	YIELD STRESS	NO. SEGS	MAX SEG SIZE	DEPTH AT START	DEPTH AT END	OUTER FL.	WEB THK.	INNER FL.	COMB. STRESS RATIO	LOAD COND
1	9.99	55.	3	5.00 FT	12.00 IN	12.00 IN	5.000 X .250	.100	5.000 X .250	0.476	1
2	13.85	55.	4	3.92 FT	12.00 IN	12.00 IN	5.000 X .250	.140	5.000 X .250	0.506	25

CONTROLLING ACTIONS

	---AXIAL---		---MAXIMUM STRESSES---			---ALLOWABLE STRESSES---			---SHEAR---			
SECT. NO.	FORCE (KIPS)	MOMENT (IN-KIP)	AXIAL (KSI)	FBO (KSI)	FBI (KSI)	FA (KSI)	FBO (KSI)	FBI (KSI)	FORCE (KIPS)	ALLOW (KIPS)	STRESS RATIO	LOAD COND
1	0.52	-244.74	0.14	-14.84	-14.84	33.00	33.00	31.48	5.03	7.54	0.666	1
2	4.43	-265.04	1.08	-15.28	-15.28	33.00	33.00	32.31	-3.97	20.70	0.192	1

DATE: 1/17/02
TIME: 10:48:23 AM

F R A M E D E S I G N - C R O S S S E C T I O N

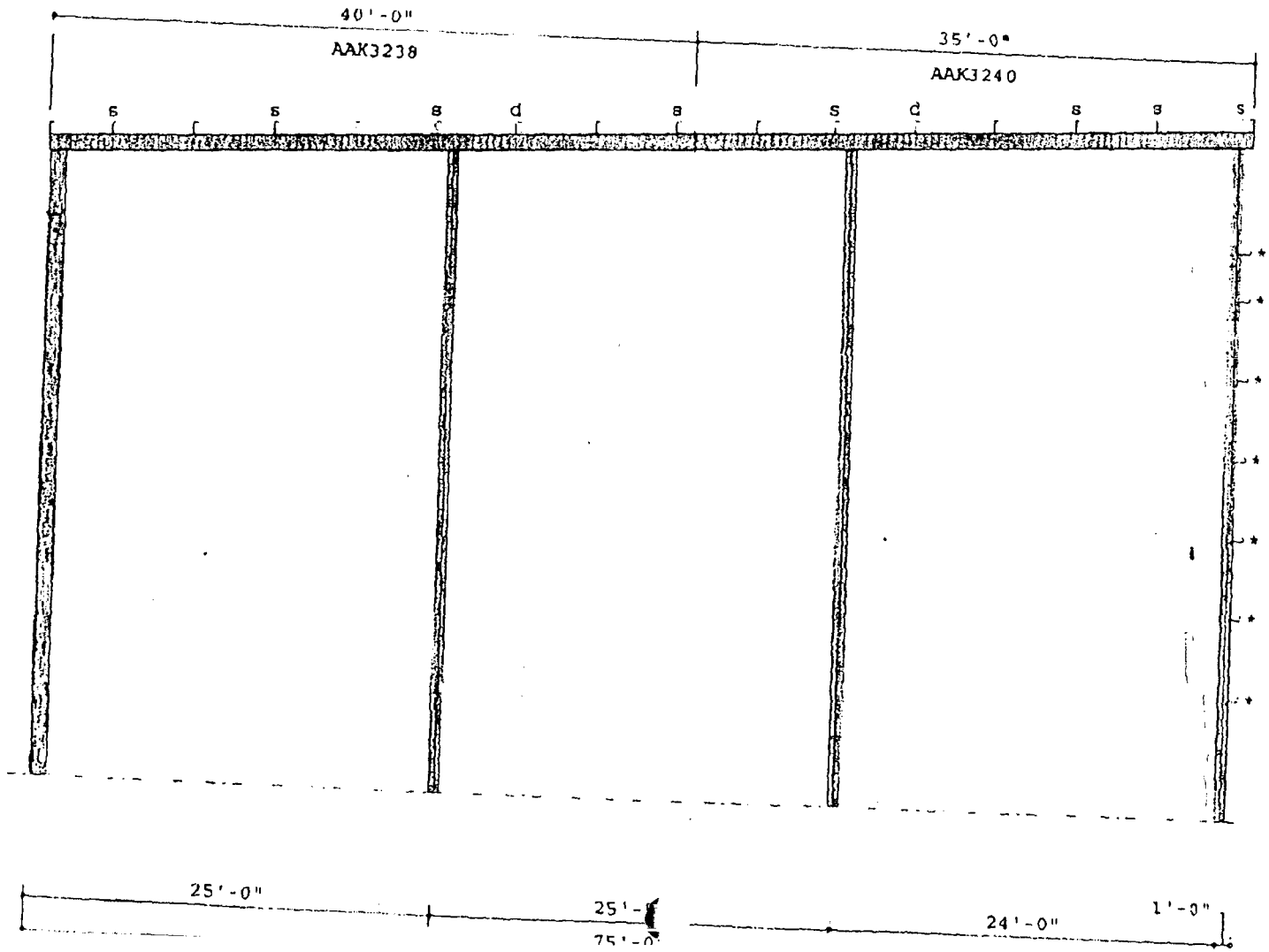
ORDER #012334 BUILDER -
BLDR CONTACT
DESIGN SYSTEM FRAME # 09 DESCRIPTION EWWX WIDTH 75'-0" HEIGHT 40'-9 1/2" SLOPE 0.500 TO 12
BLDR PHONE # 000-000-0000 BUILDER ORDER # PROJ NAME -
BUILDER ACCOUNT # 00-00-000-00
ENGR GRP -

PAGE:

Eave 40'-9 1/2" Slope 1/2:12
Clear Height 39'-0 1/2"

EWWX

Eave 43'-11"
Clear Height 42'-1 1/2"



JAN 17 2002 12:57 717 857 3220 PAGE.24

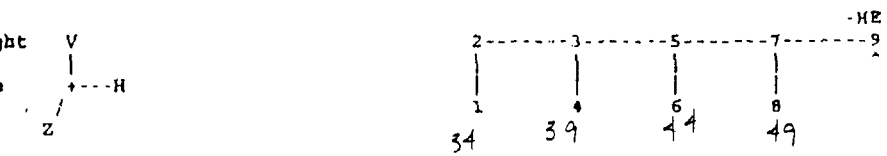
F R A M E D E S I G N - R E A C T I O N S

DATE: 01/17/02
TIME: 10:48 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 09	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		EWWX	75'-0"	41'-0"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION
H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



P Delta Analysis Performed

No.	Loading Combination	1H	1V	3Z	4H	4V	4Z	5Z	6H	6V	6Z	7Z	8H	8V
1	DL + CLL + SL	-0.01	6.06	0.00	0.00	11.55	0.00	0.00	-0.01	11.80	0.00	0.00	0.00	5.62
2	.67DL + WLL + IP	-2.47	-0.01	0.00	0.00	-3.05	0.00	0.00	-0.02	-3.19	0.00	0.00	0.00	-0.28
3	.67DL + WLR + IP	1.63	0.09	0.00	0.02	-2.55	0.00	0.00	0.00	-2.56	0.00	0.00	0.02	0.05
4	.67DL + WLL + IS	-2.47	0.84	0.00	0.00	-0.81	0.00	0.00	-0.02	-0.90	0.00	0.00	0.00	0.54
5	.67DL + WLR + IS	1.63	0.94	0.00	0.02	-0.31	0.00	0.00	0.00	-0.27	0.00	0.00	0.02	0.87
6	DL+CLL+.5SL+WLL+IP	-2.47	2.87	0.00	0.00	3.04	0.00	0.00	-0.01	3.04	0.00	0.00	0.00	2.42
7	DL+CLL+.5SL+WLR+IP	1.63	2.97	0.00	0.02	3.54	0.00	0.00	0.00	3.67	0.00	0.00	0.01	2.75
8	DL+CLL+.5SL+WLL+IS	-2.48	3.72	0.00	0.00	5.29	0.00	0.00	-0.02	5.33	0.00	0.00	0.00	3.23
9	DL+CLL+.5SL+WLR+IS	1.63	3.82	0.00	0.01	5.78	0.00	0.00	0.00	5.96	0.00	0.00	0.01	3.56
10	DL+CLL+SL+.5WLL+.5IP	-1.24	5.24	0.00	0.00	9.32	0.00	0.00	-0.01	9.49	0.00	0.00	0.00	4.76
11	DL+CLL+SL+.5WLR+.5IP	0.82	5.29	0.00	0.00	9.57	0.00	0.00	0.00	9.81	0.00	0.00	0.00	4.93
12	DL+CLL+SL+.5WLL+.5IS	-1.24	5.67	0.00	0.00	10.44	0.00	0.00	-0.02	10.64	0.00	0.00	0.00	5.17
13	DL+CLL+SL+.5WLR+.5IS	0.82	5.72	0.00	0.00	10.69	0.00	0.00	0.00	10.95	0.00	0.00	0.00	5.33
14	.67DL + CL + .8EQL	-0.01	2.14	0.00	0.00	2.77	0.00	0.00	-0.01	2.81	0.00	0.00	0.00	1.91
15	.67DL + CL + .8EQR	0.00	2.15	0.00	0.00	2.73	0.00	0.00	0.00	2.80	0.00	0.00	0.00	1.95
16	DL + CL + .6SL+.8EQL	-0.01	6.81	0.00	0.00	8.32	0.00	0.00	-0.01	8.49	0.00	0.00	0.00	4.40
17	DL + CL + .6SL+.8EQR	0.00	6.82	0.00	0.00	8.28	0.00	0.00	0.00	8.47	0.00	0.00	0.00	4.44
18	.67DL + EWS + IP	2.86	-2.51	-13.39	0.04	-9.30	-12.56	-13.44	0.00	-9.42	-12.63	-7.01	0.04	-2.36
19	.67DL + EWP + IS	2.86	-1.66	13.39	0.04	-7.06	12.56	13.44	0.00	-7.13	12.63	7.01	0.04	-1.54
20	DL+CLL+.5SL+EWS+IP	2.86	0.37	-13.39	0.04	-3.21	-12.56	-13.44	0.00	-3.19	-12.63	-7.01	0.03	0.34
21	DL+CLL+.5SL+EWP+IS	2.86	1.22	13.39	0.04	-0.96	12.56	13.44	0.00	-0.90	12.63	7.01	0.03	1.15
22	DL+CLL+SL+.5EWS+.5IP	1.43	3.99	-6.70	0.01	6.20	-6.28	-6.72	0.00	6.38	-6.31	-3.51	0.01	3.72
23	DL+CLL+SL+.5EWP+.5IS	1.43	4.42	6.70	0.01	7.32	6.28	6.72	0.00	7.52	6.31	3.51	0.01	4.13
24	DL+CL+.75SL+CHL	0.90	80.31	0.00	0.00	9.53	0.00	0.00	-0.01	9.74	0.00	0.00	0.94	79.83
25	DL+CL+.75SL+CHR	0.22	24.29	0.00	0.00	9.52	0.00	0.00	-0.01	9.73	0.00	0.00	0.24	23.86
26	DL+CL+.5WLL+CHL	-0.33	77.37	0.00	0.00	1.78	0.00	0.00	-0.01	1.78	0.00	0.00	0.94	76.94
27	DL+CL+.5WLL+CHR	-1.01	21.35	0.00	0.00	1.77	0.00	0.00	-0.01	1.78	0.00	0.00	0.24	20.97
28	DL+CL+.5WLR+CHL	1.73	77.42	0.00	0.00	2.03	0.00	0.00	0.00	2.10	0.00	0.00	0.94	77.11
29	DL+CL+.5WLR+CHR	1.05	21.40	0.00	0.01	2.02	0.00	0.00	0.00	2.09	0.00	0.00	0.24	21.14

No.	Loading Combination	8Z	9H	Sum H	Sum V	Sum Z
1	DL + CLL + SL	0.00	0.02	0.00	35.03	0.00
2	.67DL + WLL + IP	0.00	-2.06	-4.54	-6.53	0.00
3	.67DL + WLR + IP	0.00	2.15	3.83	-4.98	0.00
4	.67DL + WLL + IS	0.00	-2.31	-4.80	-0.32	0.00
5	.67DL + WLR + IS	0.00	1.90	3.57	1.23	0.00
6	DL+CLL+.5SL+WLL+IP	0.00	-2.05	-4.54	11.37	0.00
7	DL+CLL+.5SL+WLR+IP	0.00	2.16	3.83	12.92	0.00
8	DL+CLL+.5SL+WLL+IS	0.00	-2.31	-4.80	17.57	0.00

PAGE.25
717 857 3220
JAN 17 2002 12:57

F R A M E D E S I G N - R E A C T I O N S

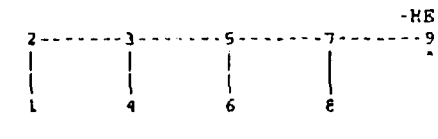
DATE: 01/17/02
TIME: 10:48 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM FRAME # 09	DESCRIPTION	(TYPE)	(WIDTH)	(HEIGHT)	(SNOW)	(WIND)	(CODE/YEAR)	(SLOPE)
		BWWX	75'-0"	41'-0"	30 PSF	90 MPH	MASS 97	0.500 TO 12

POSITIVE REACTION DIRECTION

H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



No.	Loading Combination	8Z	9H	Sum H	Sum V	Sum Z
9	DL+CLL+.5SL+WLR+IS	0.00	1.91	3.57	19.12	0.00
10	DL+CLL+SL+.5WLL+.5IP	0.00	-1.02	-2.27	28.82	0.00
11	DL+CLL+SL+.5WLR+.5IP	0.00	1.09	1.91	29.60	0.00
12	DL+CLL+SL+.5WLL+.5IS	0.00	-1.14	-2.40	31.92	0.00
13	DL+CLL+SL+.5WLR+.5IS	0.00	0.97	1.78	32.70	0.00
14	.67DL + CL + .8EQL	0.00	-0.73	-0.74	9.63	0.00
15	.67DL + CL + .8EQR	0.00	0.73	0.74	9.63	0.00
16	DL + CL + .6SL+.8EQL	0.00	-0.72	-0.74	26.03	0.00
17	DL + CL + .6SL+.8EQR	0.00	0.74	0.74	26.03	0.00
18	.67DL + EWS + IP	-6.60	4.19	7.13	-23.59	-65.63
19	.67DL + EWP + IS	6.60	3.94	6.87	-17.38	65.63
20	DL+CLL+.5SL+EWS+IP	-6.60	4.20	7.13	-5.69	-65.63
21	DL+CLL+.5SL+EWP+IS	6.60	3.95	6.87	0.51	65.63
22	DL+CLL+SL+.5EWS+.5IP	-3.30	2.11	3.57	20.29	-32.82
23	DL+CLL+SL+.5EWP+.5IS	3.30	1.99	3.44	23.39	32.82
24	DL+CL+.75SL+CHL	0.00	-1.82	0.00	179.40	0.00
25	DL+CL+.75SL+CHR	0.00	-0.45	0.00	67.40	0.00
26	DL+CL+.5WLL+CHL	0.00	-2.93	-2.34	157.87	0.00
27	DL+CL+.5WLL+CHR	0.00	-1.56	-2.34	45.87	0.00
28	DL+CL+.5WLR+CHL	0.00	-0.82	1.85	158.65	0.00
29	DL+CL+.5WLR+CHR	0.00	0.55	1.85	46.65	0.00

ID	Load Case	1H	1V	3Z	4H	4V	4Z	5Z	6H	6V	6Z	7Z	8H	8V
DL	DEAD LOAD	0.00	2.43	0.00	0.00	2.08	0.00	0.00	0.00	2.12	0.00	0.00	0.00	2.14
CLL	COLLATERAL LOAD	0.00	0.52	0.00	0.00	1.35	0.00	0.00	0.00	1.38	0.00	0.00	0.00	0.50
SL	SNOW LOAD	-0.01	3.11	0.00	0.00	8.11	0.00	0.00	-0.01	8.29	0.00	0.00	0.00	2.98
WLL	WIND LOAD LEFT	-2.47	-1.21	0.00	0.00	-3.33	0.00	0.00	-0.02	-3.46	0.00	0.00	0.00	-1.30
WLR	WIND LOAD RIGHT	1.53	-1.11	0.00	0.02	-2.83	0.00	0.00	0.00	-2.84	0.00	0.00	0.02	-0.97
IP	WIND INT PRESSURE	0.00	-0.43	0.00	0.00	-1.12	0.00	0.00	0.00	-1.14	0.00	0.00	0.00	-0.41
IS	WIND INT SUCTION	0.00	0.43	0.00	0.00	1.12	0.00	0.00	0.00	1.14	0.00	0.00	0.00	0.41
EQ	SEISMIC LOAD	-0.01	-0.01	0.00	0.00	0.03	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	-0.03
SLL	SNOW LOAD LEFT SLOPE	-0.01	3.05	0.00	0.00	7.95	0.00	0.00	-0.01	8.13	0.00	0.00	0.00	2.92
EWP	EW WIND PRESSURE	2.86	-3.71	13.39	0.04	-9.58	12.56	13.44	0.00	-9.69	12.63	7.01	0.04	-3.38
EWS	EW WIND SUCTION	2.86	-3.71	-13.39	0.04	-9.58	-12.56	-13.44	0.00	-9.69	-12.63	-7.01	0.04	-3.38
CHR	CR	0.23	19.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	18.99
CHL	CR	0.91	75.02	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.94	74.96
PDE	P Delta Unit Story S	0.16	0.00	0.00	0.33	0.02	0.00	0.00	0.32	0.01	0.00	0.00	0.17	-0.03

PAGE.26
717 897 3220
JAN 17 2002 12:58

F R A M E D E S I G N - R E A C T I O N S

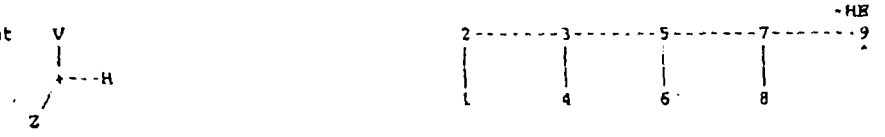
DATE: 01/17/02
TIME: 10:48 AM

ORDER # 012334 BUILDER - BUILDER ORDER # BUILDER ACCOUNT # 00-00-000-00
BLDR CONTACT - BLDR PHONE # 000-000-0000 PROJ NAME - ENGR GRP -

DESIGN SYSTEM	FRAME # 09	DESCRIPTION	(TYPE) EWWX	(WIDTH) 75'-0"	(HEIGHT) 41'-0"	(SHOW) 30 PSF	(WIND) 90 MPH	(CODE/YEAR) MASS 97	(SLOPE) 0.500 TO 12

POSITIVE REACTION DIRECTION

H KIPS Horizontal Force to Right
V KIPS Vertical Force Up
Z KIPS Horizontal Out of Plane



ID	Load Case	8Z	9H	Sum H	Sum V	Sum Z
DL	DEAD LOAD	0.00	0.00	0.00	8.78	0.00
CLL	COLLATERAL LOAD	0.00	0.00	0.00	3.75	0.00
SL	SNOW LOAD	0.00	0.01	0.00	22.50	0.00
WLL	WIND LOAD LEFT	0.00	-2.19	-4.67	-9.31	0.00
WLR	WIND LOAD RIGHT	0.00	2.03	3.70	-7.75	0.00
IP	WIND INT PRESSURE	0.00	0.13	0.13	-3.10	0.00
IS	WIND INT SUCTION	0.00	-0.13	-0.13	3.10	0.00
EQ	SEISMIC LOAD	0.00	-0.91	-0.93	0.00	0.00
SLL	SNOW LOAD LEFT SLOPE	0.00	0.01	0.00	22.05	0.00
EWP	EW WIND PRESSURE	6.60	4.06	7.00	-26.37	65.63
EWS	EW WIND SUCTION	-6.60	4.06	7.00	-26.37	65.63
CHR	CR	0.00	-0.47	0.00	38.00	0.00
CHL	CR	0.00	-1.84	0.00	150.00	0.00
PDE	P Delta Unit Story S	0.00	-0.99	0.00	0.00	0.00

COLUMN LOAD FACTORS

New Bedford Harbor

Equation A: U = 1.4D + 1.7L
D: Dead Load (DL), Collateral Load (CLL)
L: Snow Load (SL), Crane Load (CL)

Equation B: U = 0.75 (1.4D + 1.7L + 1.7W)
D: Dead Load (DL), Collateral Load (CLL)
L: Snow Load (SL), Crane Load (CL)
W: Wind Load from Left (WLL)

Equation C: U = 0.75 (1.4D + 1.7L + 1.7W)
D: Dead Load (DL), Collateral Load (CLL)
L: Snow Load (SL), Crane Load (CL)
W: Wind Load from Right (WLR)

Equation D: U = 0.9D +1.3W
D: Dead Load (DL), Collateral Load (CLL)
W: Wind Load from Left (WLL)

Equation E: U = 0.9D +1.3W
D: Dead Load (DL), Collateral Load (CLL)
W: Wind Load from Right (WLR)

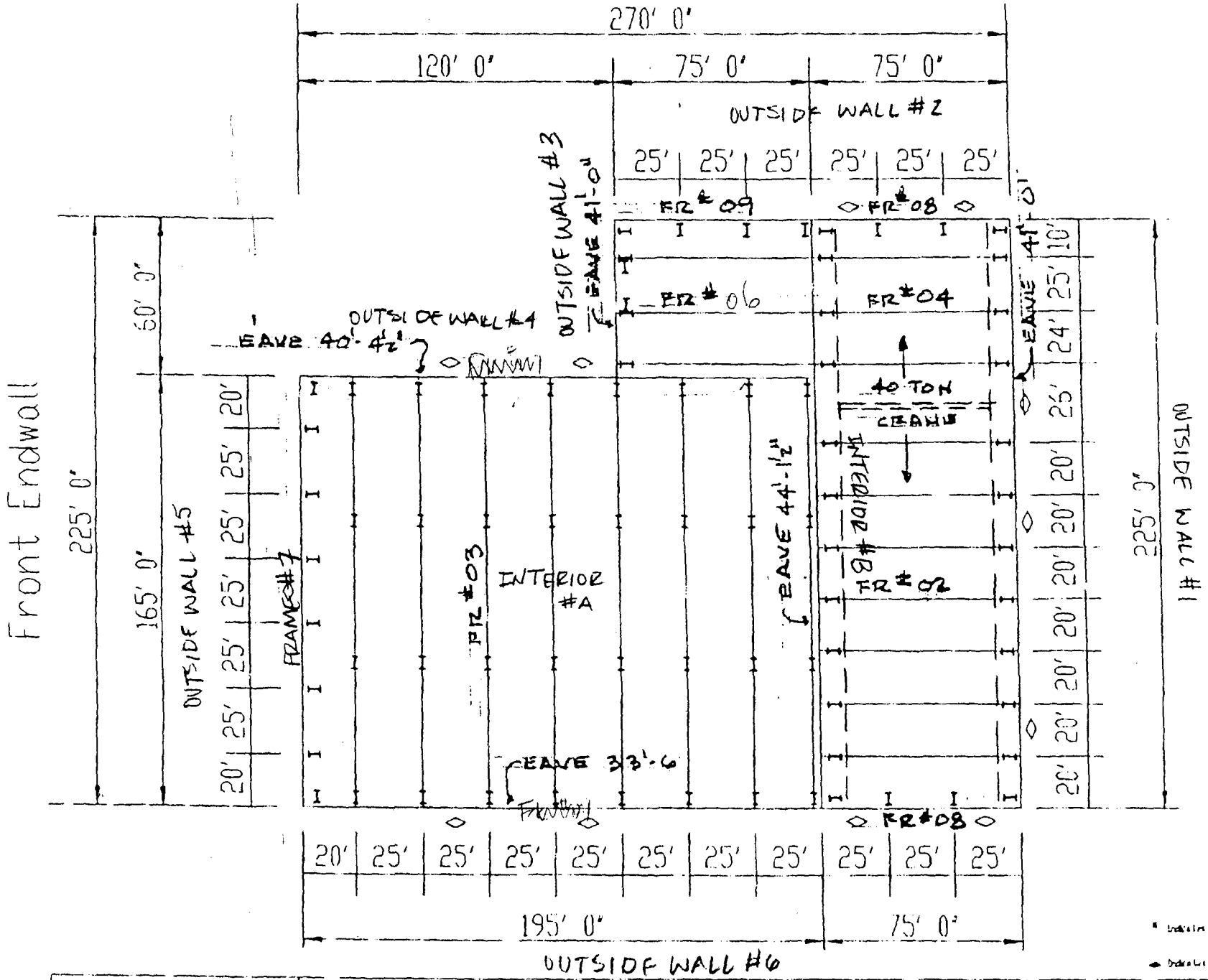
Equation F: U = 0.75 (1.4*D + 1.7L + 1.87E)
D: Dead Load (DL), Collateral Load (CLL)
L: Snow Load (SL), Crane Load (CL)
E: Seismic Load (EQ)

Equation G: U = 0.9D + 1.43E
D: Dead Load (DL), Collateral Load (CLL)
E: Seismic Load (EQ)

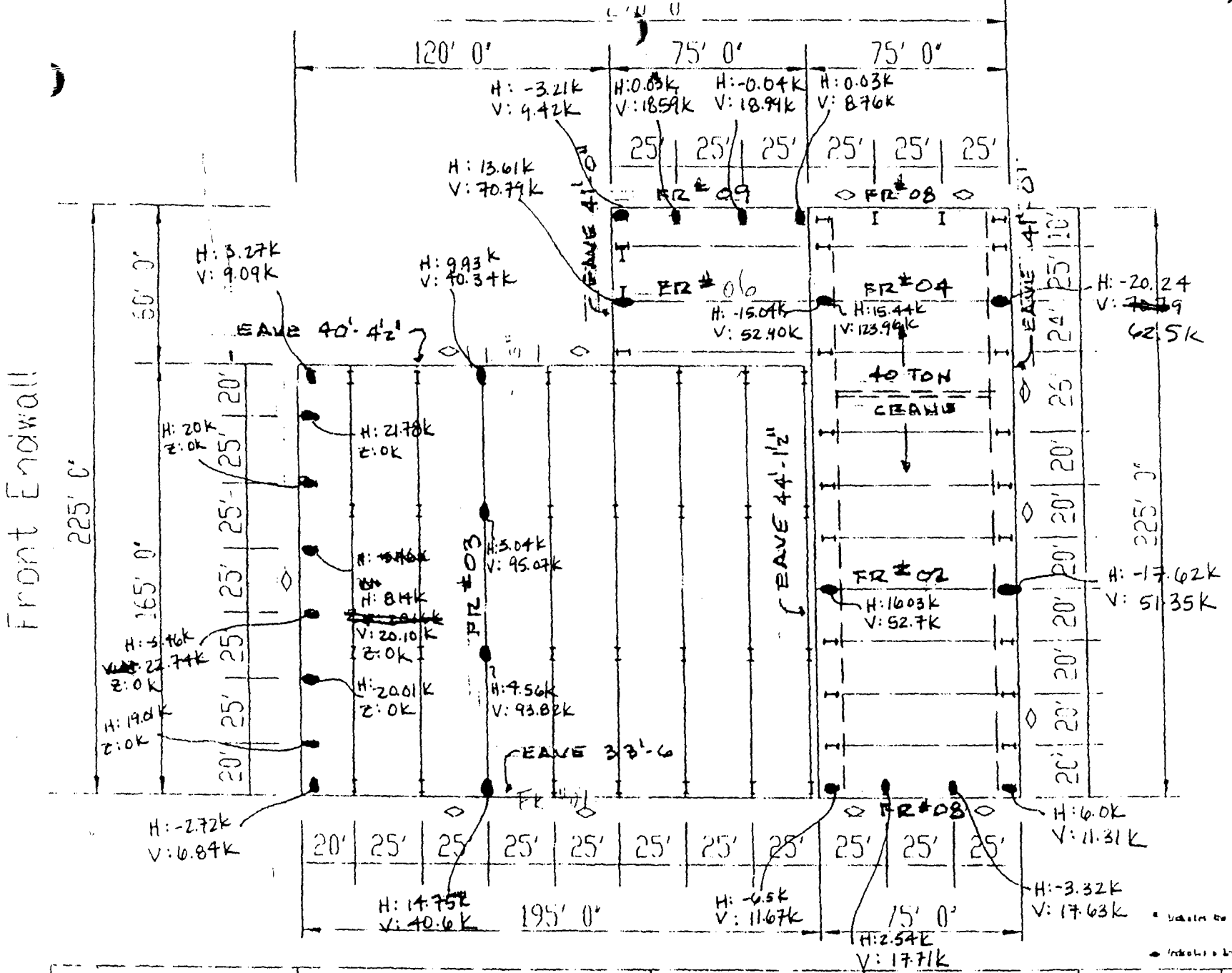
Frame	Joint	DL	CLL	SL	WLL	WLR	EQ	CL	Eq. A	Eqn. B	Eqn. C	Eqn. D	Eqn. E	Eqn. F	Eqn. G	DESIGN			
Frame #2	54H	1.07	0.96	5.74	-11.88	5.16	-0.94		12.60	-5.70	16.03	-13.62	8.54	8.13	0.48	16.03	INT #B	-4.11	12.93
	54V	6.61	3.75	22.47	-13.22	-4.77	-1.02		52.70	22.67	33.45	-7.86	3.12	38.10	7.87	52.70			
	70H	-1.07	-0.96	-5.74	-6.41	11.45	-0.98		-12.60	-17.62	5.15	-10.16	13.06	-10.82	-3.23	-17.62	OW #1	-14.18	3.68
	70V	5.57	3.75	22.53	-2.29	-13.84	1.02		51.35	35.59	20.87	5.41	-9.60	39.94	9.85	51.35			
Frame #3	17H	0.50	0.63	3.78	-9.46	6.86	-2.15		8.01	-6.06	14.75	-11.28	9.94	2.99	-2.06	14.75	OW #6	-4.55	11.77
	17V	3.29	3.10	18.62	-10.45	-1.81	-2.05		40.60	17.13	28.14	-7.83	3.40	27.57	2.82	40.60			
	18H	-0.12	-0.16	-0.98	-1.80	3.70	-1.38		-2.06	-3.84	3.17	-2.59	4.56	-3.48	-2.23	4.56	INT #A	-3.06	2.44
	18V	7.50	7.18	43.10	-15.75	-18.38	1.74		93.82	50.29	46.93	-7.26	-10.68	72.81	15.70	93.82			
	19H	0.00	0.00	0.01	-1.57	2.34	-0.99		0.02	-1.99	3.00	-2.04	3.04	-1.38	-1.42	3.04	INT #A	-1.56	2.35
	19V	7.74	7.26	43.57	-18.73	-13.94	-0.75		95.07	47.42	53.53	-10.85	-4.62	70.25	12.43	95.07			
	20H	-0.38	-0.47	-2.81	-3.67	8.23	-0.88		-5.97	-9.15	6.02	-5.54	9.93	-5.71	-2.02	9.93	OW #4	-7.33	4.57
	20V	3.32	3.08	18.46	-6.25	-8.53	1.07		40.34	22.29	19.38	-2.37	-5.33	31.76	7.29	40.34			
Frame #4	59H	1.23	1.18	7.10	-7.81	2.56	-1.20		15.44	1.63	14.85	-7.98	5.50	9.90	0.45	15.44		1.70	12.07
	59V	10.54	9.41	56.49	-27.57	-15.34	-1.27		123.96	57.82	73.41	-17.89	-1.99	91.19	16.14	123.96	INT #B		
	75H	-1.23	-1.18	-7.10	-6.79	14.15	-1.16		-15.44	-20.24	6.46	-11.00	16.23	-13.21	-3.83	-20.24	OW #1	-16.30	4.64
	75V	6.12	4.65	27.89	-3.69	-17.42	1.27		62.49	42.16	24.66	4.90	-12.95	48.65	11.51	62.49			

Frame	Joint	DL	CLL	SL	WLL	WLR	EQ	CL	Eq. A	Eqn. B	Eqn. C	Eqn. D	Eqn. E	Eqn. F	Eqn. G	DESIGN			
Frame #6	30H	1.08	1.04	6.26	-7.90	1.38	0.01		13.61	0.14	11.97	-8.36	3.70	10.22	1.92	13.61	OW #3	0.48	9.76
	30V	6.54	5.31	31.88	-12.50	-11.45	0.08		70.79	37.15	38.49	-5.59	-4.22	53.20	10.78	70.79			
	59H	-1.08	-1.04	-6.26	-3.79	7.86	-2.36		-13.61	-15.04	-0.19	-6.84	8.31	-13.52	-5.28	-15.04	INT #B	-12.17	-0.52
	59V	4.13	4.06	24.37	-10.76	-7.93	-0.08		52.90	25.95	29.56	-6.62	-2.94	39.56	7.26	52.90			
Frame #7	1H	0.01	0.02	0.09	-2.11	1.40	-0.05		0.20	-2.54	1.93	-2.72	1.85	0.08	-0.04	-2.72	Corner	-1.99	1.52
	1V	0.74	0.50	3.00	-0.50	-1.43	-0.08		6.84	4.49	3.30	0.47	-0.74	5.01	1.00	6.84			
	2H	1.66	1.44	8.63	-4.31	-2.61	0.11		19.01	8.76	10.93	-2.81	-0.60	14.41	2.95	19.01	OW #5	7.42	9.12
	2Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	3H	1.72	1.52	9.10	-3.63	-3.20	-0.01		20.01	10.38	10.92	-1.80	-1.24	14.99	2.90	20.01	OW #5	8.71	9.14
	3Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	4H	0.00	0.00	0.00	-4.20	0.00	-2.59		0.00	-5.36	0.00	-5.46	0.00	-3.63	-3.70	-5.46		-4.20	0.00
	4V	1.98	1.51	9.05	-9.79	5.91	-3.69		20.27	2.72	22.74	-9.59	10.82	10.03	-2.14	22.74	OW #5		
	4Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	5H	0.01	0.01	0.06	0.00	6.25	0.00		0.13	0.10	8.07	0.02	8.14	0.10	0.02	8.14			
	5V	1.99	1.49	8.96	2.15	-11.91	3.62		20.10	17.82	-0.11	5.93	-12.35	20.16	8.31	20.16	OW #5	14.59	0.53
	5Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	6H	2.09	1.47	8.83	-3.82	-2.79	0.04		20.00	10.13	11.44	-1.76	-0.42	15.05	3.26	20.00	OW #5	8.57	9.60
	6Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	7H	2.23	1.61	9.65	-3.31	-4.37	-0.03		21.78	12.12	10.76	-0.85	-2.23	16.29	3.41	21.78	OW #5	10.18	9.12
	7Z	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	8H	-0.02	-0.03	-0.15	-1.60	2.55	-0.03		-0.33	-2.28	3.01	-2.13	3.27	-0.29	-0.09	3.27	Corner	-1.80	2.35
	8V	1.01	0.66	3.97	-2.1	-0.69	0.04		9.09	4.14	5.94	-1.23	0.61	6.87	1.56	9.09			
Frame #8	50H	0.03	0.04	0.25	-5.05	1.70	-0.44		0.52	-6.05	2.56	-6.50	2.27	-0.22	-0.57	-6.50	OW #6	-4.73	2.02
	50V	3.34	0.60	3.62	-5.33	1.99	-0.76		11.67	1.96	11.29	-3.38	6.13	7.69	2.46	11.67			
	62H	0.00	0.00	0.00	0.00	1.95	0.00		0.00	0.00	2.49	0.00	2.54	0.00	0.00	2.54	OW #6	0.00	1.95
	62V	2.15	1.27	7.60	1.45	-6.63	0.78		17.71	15.13	4.83	4.96	-5.54	14.37	4.19	17.71			
	64H	0.00	0.00	-0.01	-2.55	0.00	-0.47		-0.02	-3.26	-0.01	-3.32	0.00	-0.67	-0.67	-3.32	OW #6	-2.56	-0.01
	64V	2.01	1.28	7.66	-6.80	0.19	-0.84		17.63	4.55	13.46	-5.88	3.21	12.04	1.76	17.63			
	66H	-0.03	-0.04	-0.25	-1.55	4.66	-0.02		-0.52	-2.37	5.55	-2.08	6.00	-0.42	-0.09	6.00	Corner	-1.87	4.34
	66V	2.22	0.60	3.62	2.93	-4.85	0.82		10.10	11.31	1.39	6.35	-3.77	8.73	3.71	11.31			
Frame #8	61H	0.03	0.04	0.25	-5.05	1.70	-0.44		0.52	-6.05	2.56	-6.50	2.27	-0.22	-0.57	-6.50	OW #2	-4.73	2.02
	61V	3.34	0.60	3.62	-5.33	1.99	-0.76		11.67	1.96	11.29	-3.38	6.13	7.69	2.46	11.67			
	63H	0.00	0.00	0.00	0.00	1.95	0.00		0.00	0.00	2.49	0.00	2.54	0.00	0.00	2.54	OW #2	0.00	1.95
	63V	2.15	1.27	7.60	1.45	-6.63	0.78		17.71	15.13	4.83	4.96	-5.54	14.37	4.19	17.71			
	65H	0.00	0.00	-0.01	-2.55	0.00	-0.47		-0.02	-3.26	-0.01	-3.32	0.00	-0.67	-0.67	-3.32	OW #2	-2.56	-0.01
	65V	2.01	1.28	7.66	-6.80	0.19	-0.84		17.63	4.55	13.46	-5.88	3.21	12.04	1.76	17.63			
	77H	-0.03	-0.04	-0.25	-1.55	4.66	-0.02		-0.52	-2.37	5.55	-2.08	6.00	-0.42	-0.09	6.00	Corner	-1.87	4.34
	77V	2.22	0.60	3.62	2.93	-4.85	0.82		10.10	11.31	1.39	6.35	-3.77	8.73	3.71	11.31			

Frame	Joint	DL	CLL	SL	WLL	WLR	EQ	CL	Eq. A	Eqn. B	Eqn. C	Eqn. D	Eqn. E	Eqn. F	Eqn. G	DESIGN			
Frame #9	34H	0.00	0.00	-0.01	-2.47	1.63	-0.01		-0.02	-3.16	2.07	-3.21	2.12	-0.03	-0.01	-3.21	Corner	-2.48	1.62
	34V	2.43	0.52	3.11	-1.21	-1.11	-0.01		9.42	5.52	5.65	1.08	1.21	7.05	2.64	9.42			
	39H	0.00	0.00	0.00	0.00	0.02	0.00		0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.03	OW#2	0.00	0.02
	39V	2.08	1.35	8.11	-3.33	-2.83	0.03		18.59	9.70	10.33	-1.24	-0.59	13.98	3.13	18.59			
	44H	0.00	0.00	-0.01	-0.02	0.00	-0.01		-0.02	-0.04	-0.01	-0.03	0.00	-0.03	-0.01	-0.04	OW#2	-0.03	-0.01
	44V	2.12	1.38	8.29	-3.46	-2.84	0.01		18.99	9.83	10.62	-1.35	-0.54	14.26	3.16	18.99			
	49H	0.00	0.00	0.00	0.00	0.02	0.00		0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.03	OW#2	0.00	0.02
	49V	2.14	0.50	2.98	-1.30	-0.97	-0.03		8.76	4.91	5.33	0.69	1.12	6.53	2.33	8.76			



Widespan ADVANTAGE	Dutton & Garfield, Inc.	Foster Wheeler	165' x 195' x 33'-6' 75' x 225' x 41' 75' X 60' X 41'	Building Plan 1/100" = 1'-0"	DUTGARADV Ver-1.50.0.18 1/16/0 34 PM



Widespan™ ADVANTAGE®

Dutton & Garfield, Inc.

Project: Foster Wheeler

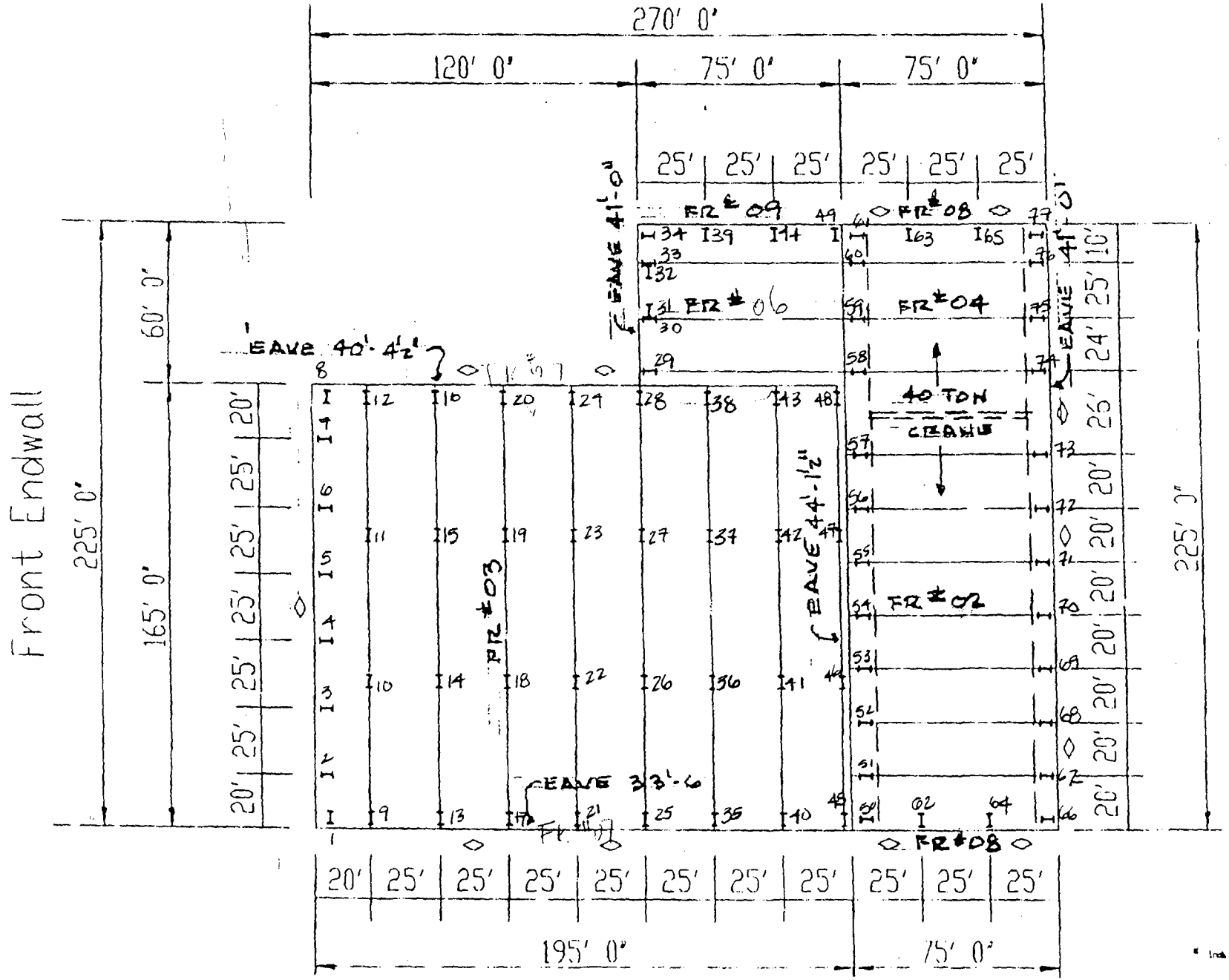
Building Description: 165' x 195' x 33'-6" / 75' x 225' x 41' / 75' X 60' X 41'

Drawing Title: Building Plan

DUTGARADV Ver 1.500.48 1/16/02 2:34 PM

Scale: 1/100" = 1'-0"

Jan 17 02 1:3 PM; 717 857 3220;



Widespan™ ADVANTAGE®

Builder: Dutton & Garfield, Inc.

Project: Foster Wheeler

Building Description: 165' x 195' x 33'-6'; 75' x 225' x 41'; 75' X 60' X 41'

Drawing title: Building Plan

Scale: 1/100" = 1'-0"

DUTGAR.ADV
Ver-1.50.0.48
1/16 2:34 PM

ATTACHMENT 1
CALCULATION COVER SHEET

PROJECT: New Bedford Harbor Superfund Site: Estimate of total settlement of spread footings

CLIENT : USACE/EPA

CALCULATION NO.: 1 S-03 PROJECT NO.:5197.1720.3392.00010

NO OF SHEETS 17 DESIGN LEVEL: 2

CALCULATION BY OTHERS____YES X NO PREPARER: A.Tognon

REVIEWED BY [illegible] DATE 3/6/02

ASSUMPTIONS THAT REQUIRE CONFIRMATION: X YES___NO

ASSUMPTIONS CONFIRMED BY _____DATE_____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	all	A.Tognon 02/28/2002		

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	MZ	3/6/02					CALC NO.:

TABLE OF CONTENTS

GENERAL INFORMATION 2
- DESCRIPTION: NEW BEDFORD HARBOR SPREAD FOOTING TOTAL SETTLEMENT ESTIMATES 2
- METHODOLOGY 2
- ASSUMPTIONS 4
- SITE CONDITIONS AND ENGINEERING PARAMETERS 4
- MATERIAL PARAMETERS 4
  - Estimation of Elastic Modulus From Standard Penetration Testing 4
  - Evaluation Of Standard Penetration Testing 4
- CRITERIA: EVALUATION OF SETTLEMENT 5
  - Schmertmann's method for computing settlement of footings on cohesionless soil. 5
  - Modified Meyerhoff's Method for Estimating Settlement based upon STP Data 7
  - Immediate Elastic Settlement of Rectangular Footings by Timoshenko and Goodier. 8
- SUMMARY OF RESULTS 10
- CONCLUSIONS 10
- REFERENCES 11

LIST OF EXHIBITS

Exhibit 1 - Evaluation of Standard Penetration Testing

Exhibit 2 – Scmertmann's Methods Output from SCMERT

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	ma	3/4/02					CALC NO.:

GENERAL INFORMATION

DESCRIPTION: New Bedford Harbor Spread Footing Total Settlement Estimates

The following presents total settlement confirmation for the spread footing design for the New Bedford Harbor Dewatering Building. Total settlements for the dewatering building footings are estimated using the service loads provided from the structural analysis.

METHODOLOGY

The structural calculations for the footing design were reviewed to obtain column service loads applied to the footings. Service loads were used to estimate total immediate settlement of the spread footings. The structural calculation package indicated that:

- Column loads were selected from calculations provided by Dutton and Garfield Inc., which provided factored and service column loads for a Butler prefabricated steel building.
- The structural design calculations for the footings indicated that interior and exterior column service loads were based upon the worst case column loads observed for all interior and exterior columns respectively (NOTE: based upon verbal confirmation, pending receipt of plan view of column load distribution and selection rational to confirm).

The structural design of the footings were based upon the service loads presented in Table 1.

For the total settlement estimates conducted herein are based upon the combined dead and live loads provided by the structural design calculations, given in Table 2.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	TMZ	3/6/02					CALC NO.:

Table 1 - Service Loads Reported from Structural Design Calculations

Interior Column Footings

Square 6' by 6' footings	Vertical kip	Horizontal kip
Dead Load	19.95	2.41
Live Load	56.49	7.1
Wind Load	-15.34	2.56
	61.1	12.07
Self Weight of Footing	9.9	
Soil Weight	11.04	
	20.94	

Total Service Loads

Total Vertical Force Acting on Footing	82.04	kip
Total Horizontal Force Acting on Footing	12.07	kip
Total Moment Acting on Footing	54.32	kip*ft

Exterior Column Footings

Square 5' by 5' footings	Vertical kip	Horizontal kip
Dead Load	11.71	2.12
Live Load	31.88	6.26
Wind Load	-11.45	1.38
	32.14	9.76
Self Weight of Footing	4.93	
Soil Weight	9.16	
	14.09	

Total Service Loads

Total Vertical Force Acting on Footing	46.23	kip
Total Horizontal Force Acting on Footing	9.76	kip
Total Moment Acting on Footing	43.92	kip*ft

Table 2 - Service Loads Used in Total Settlement Calculations

Interior Column Footings

Square 6' by 6' footings	Vertical kip
Dead Load	19.95
Live Load	56.49
	76.44

Exterior Column Footings

Square 5' by 5' footings	Vertical kip
Dead Load	11.71
Live Load	31.88
	43.59

4/7

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	ha	3/4/02					CALC NO.:

ASSUMPTIONS

- Service loads obtained from the structural calculations are representative of the column loads expected.
- Column loads are assumed to be applied uniformly to the base of the footings.
- Footings are assumed to be located at an elevation of approximately 6 ft NGVD a minimum of 4 ft below the final grade (assumed 10 ft NGVD)

SITE CONDITIONS AND ENGINEERING PARAMETERS

GROUNDWATER CONDITIONS

One previously installed monitoring well, MW-D3, was used to determine the groundwater levels for the site. Groundwater elevations fluctuate with the tide and range from 1.0 to 2.8 feet NGVD. Groundwater levels for test pits TP-D7 and TP-D10 were noted at 7 ft and 9 ft below grade, which translates to approximately to 0 to 0.5 NGVD, based upon survey data of ground surface elevations interpolated within the locations of the test pits. Variations may largely be associated with seasonal variations and existing shoreline groundwater elevations are likely influenced by tidal fluctuations. Groundwater levels for the total settlement evaluations were assumed an average of the readings at 1 ft NGVD. Changes in the groundwater levels after construction of the bulkhead, are assumed to be negligible in this evaluation.

MATERIAL PARAMETERS

Estimation of Elastic Modulus From Standard Penetration Testing

Elastic parameters for the foundation design were estimated using the results from the standard penetration testing conducted during the geotechnical investigation at the proposed location of the dewatering building foundation.

Evaluation Of Standard Penetration Testing

Standard penetration values were evaluated using the standard penetration values and corrected standard penetration values. Corrected values were adjusted for overburden pressure, adjustment factors for equipment and drilling operations were not included in the correction.

Exhibit 1 - Evaluation of Standard Penetration Testing presents the results of the standard penetration testing for borings FD 201 through FD 208, as well as the results from previous soil borings FD 19, CSO-D1, CSO-D2 and BL 106. Reported STP numbers are field values.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	mz	3/6/02					CALC NO.:

Corrected penetration numbers (N') differed only slightly from uncorrected values (N). Overburden correction typically increased standard penetration slighty (2 to 3 blows per foot) with the exceptions of the top fill layer which increased by by 20 blows per foot. Corrected values in the top fill layer were strongly influence by gravel and cobbles encountered frequently during the drilling. Hence uncorrected standard penetration values (N) were used for estimating soil properties.

CRITERIA: EVALUATION OF SETTLEMENT

Settlement estimates for the footings of the dewatering building were evaluated using three methods for estimating settlements for foundations on cohesionless soil:

1. Schmertmann's Method for Computing Settlement of Footings on Cohesionless Soil
2. Modified Meyerhoff's Method for Estimating Settlement based upon STP Data
3. Immediate Elastic Settlement of Rectangular Footings by Timoshenko and Goodier

Settlements are estimated based upon service loads obtained in the structural design calculations.

Schmertmann's method for computing settlement of footings on cohesionless soil.

For the Schmertmann's method soil strata was divided into representative layers and assigned appropriate elastic parameters for each layer. Elastic moduli are estimated from the standard penetration testing given previously in Exhibit 1. Table 3 presents the representative elastic moduli for each layer and the applicable depth intervals.

Table 3 - Soil Moduli Used for Layers in Schmertmann Settlement Estimates

Layer	Elevation (ft, NGVD)	Depth Interval	N (blows)	E_{S1} (psf)	E_{S2} (psf)	E_{S3} (psf)	E_{S4} (psf)	E_{AVE} (psf)
1	6	0 to 2	25	208854	194234	262500	190479	214017
2	4	2 to 11	12	140977	112781	126000	110601	122590
3	-5	11 to 14.5	5	104427	68922	52500	67589	73360
4	-8.5	14.5 to 20	10	130534	100250	105000	98312	108524
5	-14	>20	20	182748	162906	210000	167949	180901

Where,

$E_{s1} = 250(N+15)$ kPa — Saturated Sand

$E_{s2} = 300(N+6)$ kPa — Silt, Sandy Silt

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	[illegible]	3/4/02					CALC NO.:

$E_{s3} = 7.5\ (1-\nu)\ N$ ton/ft^2 where $\nu = 0.3$ — Sand (Farrent 1963)

$E_{s4} = C(N+6)$ kg/cm^2 for $N < 15$ where $C = 3.0$ — Silt with sand (Bergemann 1974)

$E_{s4} = 40 + C(N-6)$ kg/cm^2 for $N > 15$ where $C = 3.0$

$$E_{ave} = \frac{\Sigma E_{ij}}{n_i}$$

$$E_{ave} = \frac{E_{s1} + E_{s2} + E_{s3} + E_{s4}}{4}$$

Scmertmann's Method Derivation

$$\delta = C_1 \cdot C_2 \cdot C_3 \cdot q' \cdot \sum_{i=1}^{n} \frac{I_{zi} \cdot H_i}{E_i}$$

δ - settlement of footing
q' - net bearing pressure
n - number of soil layers
I_{zi} - strain influence factor I_z at midpoint of soil layer I
H_i - thickness of soil layer i
E_i - elastic Modulus of soil layer i

Where C factors are represented by:

C_1 - depth factor $\quad C_1 = 1 - 0.5 \cdot \frac{\sigma_d'}{q'}$

C_2 - secondary creep factor $\quad C_2 = 1 + 0.2 \cdot \log\left\langle \frac{t}{0.1} \right\rangle$

C_3 - shape factor $\quad C_3 = 1.03 - 0.03 \cdot \left\langle \frac{L}{B} \right\rangle \geq 0.73$

σ_d' - effective stress at a depth D below ground surface
t - time since application of load, assumed 50 years
B - footing width
L - footing length

And the strain influence factors for a square footings described by:

$$I_z = 0.1 + \frac{z_f}{B} \cdot (2 \cdot I_{zp} - 0.2) \quad \text{for } z_f = 0 \text{ to } \frac{B}{2}$$

$$I_z = 0.667 \cdot I_{zp} \left\langle 2 - \frac{z_f}{B} \right\rangle \quad \text{for } z_f = B \text{ to } 2B$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	[illegible]	3/4/02					CALC NO.:

$$I_{zp} = 0.5 + 0.1\sqrt{\frac{q'}{\sigma_{vp}'}}$$

I_{zp} - peak strain influence factor
σ_{vp}' - initial vertical effective stress at depth of peak strain influence factor
(D+ B/2 for square footings)
z_f - depth from bottom of footing to midpoint of layer

Settlement estimates were conducted using SCHMERT, a software program developed by Coduto (1994). Results of the Scmertmann's method are presented in Table 4 Output is included as Exhibit 2

Table 4 - Total Settlements estimated using Schmertmann's Method

Column Location	Column Load (kips)	Settlement δ (in)
Interior	76.44	1.18
Exterior	44.6	0.74

Modified Meyerhoff's Method for Estimating Settlement based upon STP Data

The Modified Meyerhoff Method is one of the most popular methods of estimating settlements based upon standard penetration values. The method is typically seen as a conservative estimate of settlement, which typically overpredicts the settlement by a factor of 2.

For $B < 4ft$

$$\frac{\delta}{B_r} = \frac{0.44 \cdot q'/\sigma_r}{N_{ave} \cdot K_d}$$

For $B > 4ft$

$$\frac{\delta}{B_r} = \frac{0.68 \cdot q'/\sigma_r}{N_{ave} \cdot K_d} \cdot \left\langle \frac{B}{B + B_r} \right\rangle^2$$

where,
δ - settlement
B_r - reference width = 1ft = 12 in
q' - net bearing pressure
σ_r - reference stress - 2000 lb/ft^2
N_{ave} - weighted average of standard penetration value between base of the footing to a depth 2B below
B - footing width

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	mz	3/4/02					CALC NO.:

K_d - depth factor = $1 + 0.33\frac{D}{B} < 1.33$

Table 5 -Settlement estimate using the Meyerhoff Method

Column	Average STP N (blows)	Column Load P (k)	Net Bearing Pressure Q (psf)	Footing Width B (ft)	Footing Depth D (ft)	Depth Factor Kd	Settlement δ (in)
Interior	12.1	76.44	2111	6	4	1.333	2.14
Exterior	12.1	44.6	1239	6	4	1.333	1.25

Immediate Elastic Settlement of Rectangular Footings by Timoshenko and Goodier

$$\Delta H = q_o \cdot B' \frac{1-\nu^2}{E_s} \cdot \left\langle I_1 + \frac{1-2\nu}{1\ \ \nu} \cdot I_2 \right\rangle \cdot I_F$$

where,

ΔH - settlement
B' - least lateral dimension of footing, square $B' = B/2$
q_o - intensity of contact pressure
E_s, ν - elastic modulus and poisson's ratio of soil
I_1, I_2, I_F - influence factors
L - length of footing

$$I_1 = \frac{1}{\pi} \cdot \left\langle M \cdot \ln \frac{\left(1+\sqrt{M^2+1} \cdot \sqrt{M^2+N^2}\right)}{M \cdot \left(1+\sqrt{M^2+N^2+1}\right)} + \ln \frac{\left(M+\sqrt{M^2+1}\right) \cdot \sqrt{1+N^2}}{M+\sqrt{M^2+N^2+1}} \right\rangle$$

$$I_2 = \frac{N}{2\pi} \cdot \tan^{-1} \left\langle \frac{M}{N\ \ \sqrt{M^2+N^2+1}} \right\rangle$$

where,

$M = L/B$

$N = H/B'$

I_F is taken from Figure G

Elastic moduli were taken as weighted average over depth 2B

Figure G - Influence Factor I_F

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	nz	7/6/02					CALC NO.:

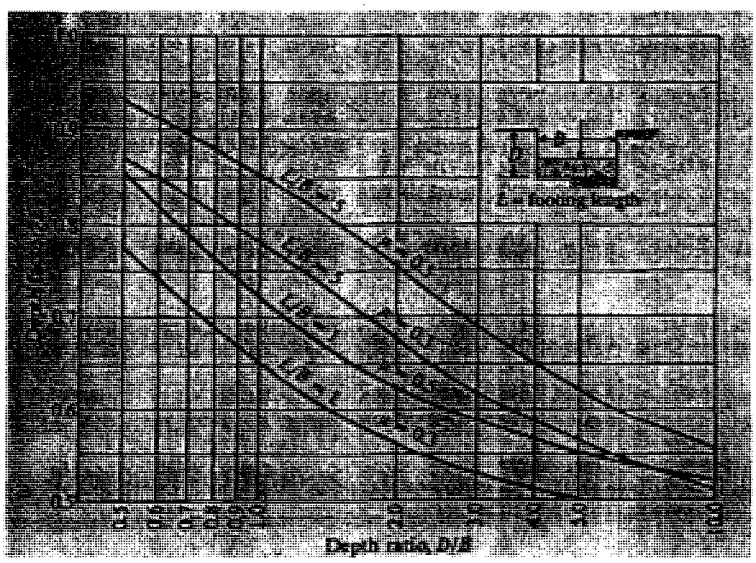


Table 6 - Immediate Elastic Settlement of Rectangular Footings

Column Load	Contact Pressure	Footing Depth	Footijng Length	Footing width		
P	q_o	D	L	B	B'	H
kip	psf	ft	ft	ft	ft	ft
76.44	2123	4.00	6.00	6.00	3	12.00
44.6	1784	4.00	5.00	5.00	2.5	10.00

		Poisson ratio	Influence Factor			Influence Factor		FFACTOR or Fig
N=H/B'	M=L/B	ν	I_1	I_2	Is	D/B	L/B	I_F
			ft	ft	ft			
4	1	0.3	0.4082	0.0375	0.4296	0.67	1.00	0.7600
4	1	0.3	0.4082	0.0375	0.4296	0.80	1.00	0.6900

Nstp	E_{s1}	E_{s2}	E_{s3}	E_{s4}	E_{ave}	m	DH
	psf	psf	psf	psf	psf		ft
12.1	141499	113408	127050	111215	123293	4	0.74
12.1	141499	113408	127050	111215	123293	4	0.47

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	MZ	3/6/02					CALC NO.:

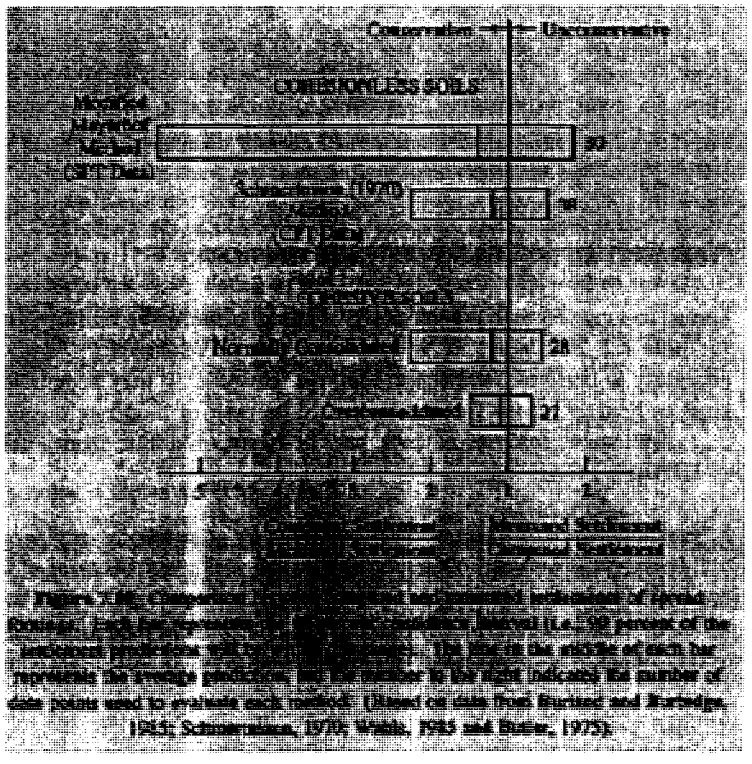
SUMMARY OF RESULTS

Location	Column Load kip	Scmertmann's Method inches	Meyerhoff's Method inches	Timoshenko and Goodier method inches
Interior	76.44	1.2	2.1	0.7
Exterior	44.6	0.7	1.3	0.5

CONCLUSIONS

Differences in the settlement estimates are associated with the conservatism inherent in each method. Figure H presents a the relative conservatism in two of the methods. It would be assumed by the comparison of the Meyerhoff and Schmertmann methods that the Timoshenko and Goodier method is less conservative than the Schmertmann method. Total settlements are less than the maximum allowable recommeneded (USACE EM 1110-1-1904) for framed structures. Total settlements are provided for the service loads obtained from the structural design of the dewatering building, any deviations from the assumptions made therein will ultimately result in changes to total settlements realized in the field.

Figure H - Comparison between computed and measured settlements



FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	[illegible]	3/4/02					CALC NO.:

REFERENCES

1. Joseph E. Bowles (1996) "Foundation Analyses and Design", 5th Edition, McGrawHill, New York, NY

2. ASCE (1964) "Design of Foundations of Foundations for the Control of Settlement", Soil Mechanics and Foundations Division, American Society of Civil Engineers, June 16-19, Evanston, IL

3. Donald P. Coduto (1994) "Foundation Design", Prentice Hall, Englewood Cliffs, NJ

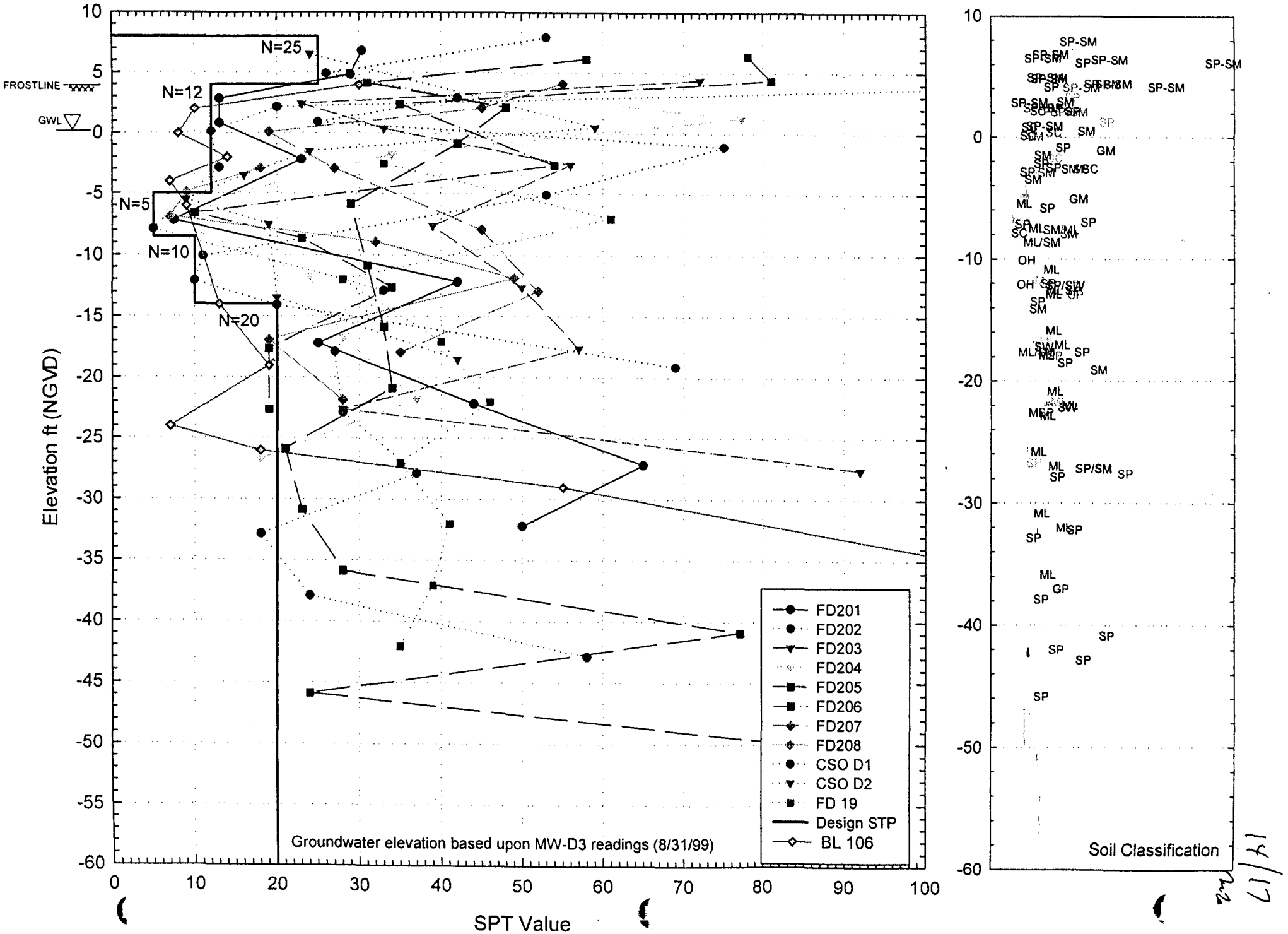
FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	MR	3/6/02					CALC NO.:

EXHIBIT 1

EVALUATION OF STANDARD PENETRATION TESTING

Figure A - Evaluation of Standard Penetration Testing



FOSTER WHEELER ENVIRONMENTAL CORPORATION

CLIENT:	EPA/NE-UACE						PROJECT: New BedfordHarbor Superfund Site
SUBJECT:	Total Settlement Estimates						
BY/DATE:	ARMT	02/27/02					PROJECT NO.: 5197.1720.3392.00010
CHKD/DATE:	[illegible]	3/4/02					CALC NO.:

EXHIBIT 2

SCMERTMANN'S METHODS OUTPUT FROM SCMERT

10/17
nza

SCHMERT - Version 1.0 (c) 1994 by Prentice Hall, Inc.
Settlement of Spread Footings on Cohesionless Soils
Using Schmertmann's Method

Title: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Units of Measurement: English
(Press ALT-U to change)

Date: **********
Time: 06:23 PM

Footing Shape: Square
(Press ALT-S to change)

Footing Width	=	6.00	ft
Footing Depth	=	4.00	ft
Applied Load	=	76	k
Elapsed Time	=	50.0	yr
Soil Unit Weight			
Above Groundwater	=	120.0	lb/ft3
Below Groundwater	=	125.0	lb/ft3
Depth to Groundwater	=	5.0	ft

****
* RESULTS *
*
*Bearing Pressure *
* Gross q = 2603 lb/ft2 *
* Net q'= 2123 lb/ft2 *
*
*Settlement = 1.18 in *
*
****

Depth Interval Upper (ft)	Depth Interval Lower (ft)	Soil Modulus (lb/ft2)	Influence Factor Iz	Compression (ft)	Strain (%)
0.0	4.0				
4.0	4.5	214017	0.148	0.00100	0.20
4.5	5.0	214017	0.243	0.00164	0.33
5.0	5.5	214017	0.338	0.00229	0.46
5.5	6.0	214017	0.433	0.00293	0.59
6.0	6.5	122590	0.528	0.00625	1.25
6.5	7.0	122590	0.624	0.00737	1.47
7.0	7.5	122590	0.653	0.00772	1.54
7.5	8.0	122590	0.615	0.00728	1.46
8.0	8.5	122590	0.578	0.00684	1.37
8.5	9.0	122590	0.541	0.00640	1.28
9.0	9.5	122590	0.504	0.00596	1.19
9.5	10.0	122590	0.466	0.00552	1.10
10.0	10.5	122590	0.429	0.00507	1.01
10.5	11.0	122590	0.392	0.00463	0.93
11.0	11.5	122590	0.354	0.00419	0.84
11.5	12.0	122590	0.317	0.00375	0.75
12.0	12.5	122590	0.280	0.00331	0.66
12.5	13.0	122590	0.242	0.00287	0.57

07/17
ma

Depth Interval Upper (ft)	Depth Interval Lower (ft)	Soil Modulus (lb/ft2)	Influence Factor Iz	Compression (ft)	Strain (%)
13.0	14.0	73360	0.187	0.00737	0.74
14.0	15.0	73360	0.112	0.00442	0.44
15.0	16.0	73360	0.037	0.00147	0.15
16.0	17.0	73360	0.000	0.00000	0.00
17.0	18.0	108524	0.000	0.00000	0.00
18.0	19.0	108524	0.000	0.00000	0.00
19.0	20.0	108524	0.000	0.00000	0.00
20.0	21.0	108524	0.000	0.00000	0.00
21.0	22.0	108524	0.000	0.00000	0.00
22.0	23.0	180901	0.000	0.00000	0.00
23.0	24.0	180901	0.000	0.00000	0.00
24.0	25.0	180901	0.000	0.00000	0.00
25.0	26.0	180901	0.000	0.00000	0.00
26.0	27.0	180901	0.000	0.00000	0.00
27.0	28.0	180901	0.000	0.00000	0.00
28.0	29.0	180901	0.000	0.00000	0.00
29.0	30.0	180901	0.000	0.00000	0.00
30.0	32.0	180901	0.000	0.00000	0.00
32.0	34.0	180901	0.000	0.00000	0.00
34.0	36.0	180901	0.000	0.00000	0.00
36.0	38.0	180901	0.000	0.00000	0.00
38.0	40.0	180901	0.000	0.00000	0.00
40.0	42.0	180901	0.000	0.00000	0.00
42.0	44.0	180901	0.000	0.00000	0.00
44.0	46.0	180901	0.000	0.00000	0.00
46.0	48.0	180901	0.000	0.00000	0.00
48.0	50.0	180901	0.000	0.00000	0.00
50.0	52.0	180901	0.000	0.00000	0.00
52.0	54.0	180901	0.000	0.00000	0.00
54.0	56.0	180901	0.000	0.00000	0.00
56.0	58.0	180901	0.000	0.00000	0.00
58.0	60.0	180901	0.000	0.00000	0.00
60.0	62.0	180901	0.000	0.00000	0.00
62.0	64.0	180901	0.000	0.00000	0.00
64.0	66.0	180901	0.000	0.00000	0.00

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 5

PROJECT NBH-Dewatering Facility SUBJECT Potable Water Calcs for Personnel Area

CLIENT USACE

CALCULATION NO. U-01 PROJECT NO. 5197.1720.9302.00010

NO OF SHEETS 5 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	1-5	D.Martoccia (1/15/02) DM	K. Bogatch (1/17/02) KB	
1	1-5	D.Martoccia (5/22/02) DM	K. Bogatch (5/24/02) KB	
2	1-5	D.Martoccia (10/10/02) DM	K. Bogatch (10/16/02) KB	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 10/10/02 SHEET 2 OF 5

CHKD. BY K. Bogatch DATE 10/16/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED POTABLE WATER REQUIREMENTS (REVISED 10/02)

Water Use Assumptions:

- Personnel Support Area (from sanitary calcs.) = 142 gal/min
- Ten (10) garden hoses (¾" 25' head) @ 5gal/min each[1] = 50 gal/min
- Lawn sprinkler (30,000 ft^2 lawn, 1 in/week)[1] = 1.78 gal/min
- Dewatering equipment (assume 50 gal/min) = 50 gal/min

Total projected required potable water flow rate at one minute of time: 243.8 gal/min

Total projected required potable water flow rate = 244 gal/min

Assume that 75% of the fixtures, garden hoses, sprinklers, etc will operate at the same time[6]

Therefore, 244 gpm x 0.75 = 183 gpm = **0.408 ft^3/s**

6-inch cast iron pipe capacity:

Assume that a 6-inch diam. cast iron pipe will be used[2]

- Using Hazen-Williams Equation[7]

$$Q = 1.318CAR^{0.63}S^{0.54}$$

C = Hazen-William's roughness coefficient. C = 100 for a cast iron pipe[3]

A = Area of pipe. = $(3.14/4)(6/12)^2 = 0.196\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(6/12) = 0.125 ft

S = Slope of pipe

Assume the connection elevation at the Facility is 5.5 feet (surface elevation of 9.5 minus frost line depth of 4 feet)

Assume the connection elevation in Hervey Tichon Avenue is 3.13 (surface elevation of 7.13 minus frost line depth of 4 feet)

Slope of pipe = 5.5 – 3.13 ÷ 120 = 0.02 ft/ft

- Total capacity of 6-inch diam. cast iron pipe at 2.0% slope is:

$Q = 1.318(100)(0.196)(0.125)^{0.63}(0.02)^{0.54}$

$= \mathbf{0.843\ ft^3/s}$

- 6-inch pipe capacity > projected required potable water flow rate

$0.843\ ft^3/s > 0.408\ ft^3/s$

Therefore, a 6-inch diam. cast iron pipe has enough capacity to handle the projected required potable water flow rate.

Pressure at Facility:

- Assumptions:
  1. Water temperature in pipe is 60° F
  2. Pipe material is iron[2]
  3. P_A at street connection is 89 psi[4]
  4. Z_A is assumed to be at an elevation of 3.13 feet
  5. Z_B is assumed to be at an elevation of 5.5 feet
  6. Length of 6-inch pipe is 120 feet

- Using Bernoulli's equation[3]:

$$P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$$

P_A = Pressure at point A (i.e. at street connection)

ρ = Density of water at 60° F[3]

v_A = Velocity of water in 6-inch pipe at point A (i.e. street connection)

Z_A = Elevation of 6-inch pipe at point A (i.e. street connection)

P_B = Pressure at point B (i.e. at building)

v_B = Velocity of water in 6-inch pipe at point B (i.e. at building)

Z_B = Elevation of 6-inch pipe at point B (i.e. at building)

h_f = Head loss in pipe due to friction[3]

$h_f = fL_e v^2/2D_i g$

f = Darcy friction factor

L_e = Equivalent length

v = Velocity in pipe

D_i = Inside diameter of pipe[3]

g = Gravitational acceleration

- Determining head loss due to friction (h_f)

First determine Reynolds Number (R_e) in which[3]

$R_e = vD_i/\nu$

$v = Q/A_i$

where Q = Flow rate through 6-inch pipe (projected flow rate calculated previously)

A_i = Interior area of 6-inch pipe[3] = 0.196 ft^2 for class D

$v = 0.408\ ft^3/s \div 0.196\ ft^2 = 2.08\ ft/s$

D_i = Internal diameter[3] = 0.5 ft for class D

ν = Kinematic energy = 1.217×10^{-5} from Appendix 14A[3]

$R_e = (2.08\ ft/s)(0.5\ ft) \div 1.217 \times 10^{-5} = 8.55 \times 10^4$

ϵ = Pipe roughness coefficient = 0.0008 for iron pipe in Appendix 17A[3]

$\epsilon / D_i = 0.0008/0.5 = 0.0016$

Determine the friction factor (f) using the Moody charts in Appendix 17B[3]

f = **0.0241**

Determine L_e:

L_e = Length of pipe + Equivalent length of valves and fittings[3]

Standard radius elbow (5)	5 x 7.2	=	36 feet
Gate valve (2)	2 x 2.6	=	5.2 feet
Swing check valve (1)	1 x 52.0	=	52.0 feet
Water meter (1)	1 x 75.0	=	75.0 feet
			Total = 168.2 feet

L_e = 120 feet + 168.2 feet = **288.2 feet**

$h_f = (0.0241)(288.2)(2.08)^2 \div 2(0.5)(32.2) = 0.93 \text{ feet} \cong$ **1.0 feet**

- $P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$ => velocity heads cancel out, therefore

$P_A/\rho + Z_A = P_B/\rho + Z_B + h_f$

$(89 \text{ lb/in}^2)(144 \text{ in}^2/\text{ft}^2)/62.37 + 3.3 \text{ feet} = P_B\ (144 \text{ in}^2/\text{ft}^2)/62.37 + 5.5 \text{ feet} + 1.0 \text{ feet}$

$P_B = 87.6$ psi

As per 2.14h of the Commonwealth of Massachusetts Fuel Gas and Plumbing Code[5], the maximum pressure allowed at the building is 80 psi therefore, an approved pressure reducing valve may be required to be installed in the water service line near the entrance to the Facility should the pressure prove to be greater than 80 psi once the 6-inch line is constructed and connected.

References:

1. Waste Water Engineering -Third Edition, by Metcalf and Eddy. According to Table 2-7.
2. As per the New Bedford Water Department, potable water lines are generally 4-inch diameter iron pipes. However, a 6-inch diameter water line is used in this scenario.
3. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
4. As per the New Bedford Water Department, the pressure in the 12-inch water line located in Hervey Tichon Avenue is 89 psi.
5. Commonwealth of Massachusetts Fuel Gas and Plumbing Code compiled as in full force and effect: 8/22/97.
6. As per the New Bedford Water Department, when sizing potable water lines, it can be assumed that 75% of the fixtures, hoses, etc. are operating at the same time.
7. Water Resources Engineering, Third Edition. Page 279.

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 5

PROJECT NBH-Dewatering Facility SUBJECT Fire Water Supply Calcs for Facility

CLIENT USACE

CALCULATION NO. U-02 PROJECT NO. 5197.1720.9302.00010

NO OF SHEETS 5 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	1-5	D.Martoccia (1/18/02) DM	K. Bogatch (1/21/02) KB	
1	1-5	D.Martoccia (5/22/02) DM	K. Bogatch (5/24/02) KB	
2	1-5	D.Martoccia (10/14/02) DM	K. Bogatch (10/22/02) KB	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D.Martoccia DATE 10/14/02 SHEET 2 OF 5

CHKD. BY K. Bogatch DATE 10/22/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED FIRE SUPPRESSION SYSTEM WATER REQUIREMENTS (REVISED 10/02)

Water Use Assumptions:

- Assume one standpipe riser is required for the fire suppression system
- Minimum flow rate in one standpipe riser[1] is 500 gal/min

To be conservative, assume that the total projected required water flow rate for fire suppression system is 750 gal/min

Total projected fire suppression system required flow rate = 750 gal/min = **1.67 ft^3/s**

8-inch cast iron pipe capacity:

Assume that an 8-inch diameter cast iron water line will be used

- Using Hazen-Williams Equation[5]

$Q = 1.318CAR^{0.63}S^{0.54}$

C = Hazen-William's roughness coefficient. C = 100 for a cast iron pipe[4]

A = Area of pipe. = $(3.14/4)(8/12)^2 = 0.349\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(8/12) = 0.167 ft

S = Slope of pipe

Assume the connection elevation at the Facility is 5.5 feet (surface elevation of 9.5 minus frost line depth of 4 feet)

Assume the connection elevation in Hervey Tichon Avenue is 3.13 (surface elevation of 7.13 minus frost line depth of 4 feet)

Slope of pipe = 5.5 – 3.13 ÷ 120 = 0.02 ft/ft

- Total capacity of 8-inch diameter cast iron pipe at 2% slope is:

$Q = 1.318(100)(0.349)(0.167)^{0.63}(0.02)^{0.54}$

= **1.80 ft^3/s**

- 8-inch pipe capacity >> projected fire suppression system required water flow rate

1.80 ft^3/s >> 1.67 ft^3/s

Therefore, an 8-inch diam. cast iron pipe has enough capacity to handle the total projected fire suppression system required water flow rate.

- In addition, according to Table 5-7 of the NFPA Codes, an 8-inch diameter pipe is required for total accumulated flows of 1251 gpm and over. Therefore, a piping diameter of 8-inch is more than adequate.

Pressure at Facility:

- Assumptions:
  1. Water temperature in pipe is 60° F
  2. Pipe material is iron
  3. P_A at street connection is 89 psi[3]
  4. Z_A is assumed to be at an elevation of 3.13 feet
  5. Z_B is assumed to be at an elevation of 45.5 feet (Top of building foundation is assumed to be at an elevation of 9.5 feet plus the height of building which is 36 feet)
  6. Length of 8-inch pipe is 156 feet (120 feet of horizontal pipe plus 36 feet vertical pipe)

- Using Bernoulli's equation[2]:

$$P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$$

P_A = Pressure at point A (i.e. at street connection)

ρ = Density of water at 60° F[2]

v_A = Velocity of water in 8-inch pipe at point A (i.e. street connection)

Z_A = Elevation of 8-inch pipe at point A (i.e. street connection)

P_B = Pressure at point B (i.e. at the top of building)

v_B = Velocity of water in 8-inch pipe at point B (i.e. at top of building)

Z_B = Elevation of 8-inch pipe at point B (i.e. at top of building)

h_f = Head loss in pipe due to friction[2]

$h_f = fL_ev^2/2D_ig$

f = Darcy friction factor

L_e = Equivalent length

v = Velocity in 8-inch pipe

D_i = Inside diameter of 8-inch pipe[2]

g = Gravitational acceleration

- Determining head loss due to friction (h_f)

First determine Reynolds Number (R_e) in which[2]

$R_e = vD_i/v$

$v = Q/A_i$

where Q = Anticipated flow rate through 8-inch pipe = 1.67 ft^3/s

A_i = Interior area of 8-inch pipe[2] = 0.358 ft^2 for class D

$v = 1.67\ ft^3/s \div 0.358\ ft^2 = 4.66\ ft/s$

D_i = Internal diameter[2] = 0.675 ft for class D[2]

v = Kinematic energy = 1.217×10^{-5} from Appendix 14A[2]

$R_e = (4.66\ ft/s)(0.675\ ft) \div 1.217 \times 10^{-5} = 2.58 \times 10^5$

ϵ = Hazen-Williams Pipe roughness coefficient = 0.0008 for iron pipe in Appendix 17A[2]

$\epsilon / D_i = 0.0008/0.675 = 0.0012$

Determine the friction factor (f) using the Moody charts in Appendix 17B[2]

f = ***0.0208***

Determine L_e:

L_e = Length of pipe + Equivalent length of valves and fittings[4]

Standard radius elbow (5)	5 x 18	=	90 feet
Gate valve (2)	2 x 4	=	8 feet
Swing Check Valve	1 x 45	=	45 feet
Water meter, *if required* (1)	1 x 100	=	100 feet
			Total = 243 feet

L_e = 156 feet + 243 feet = **399 feet**

$h_f = (0.0208)(399)(4.66)^2 \div 2(0.675)(32.2) = 4.2$ feet $\cong$ **5.0 feet**

- $P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$ => velocity heads cancel out, therefore

$P_A/\rho + Z_A = P_B/\rho + Z_B + h_f$

$(89\ lb/in^2)(144\ in^2/ft^2)/62.37 + 3.13\ feet = P_B\ (144 in^2/ft^2)/62.37 + 45.5\ feet + 5\ feet$

$P_B = 68.5$ psi

As per 1012.3 of the Commonwealth of Massachusetts State Building Code[1], the minimum pressure at the topmost outlet of each riser is must be 65 psi. The above calculations indicate that this requirement is met. However, should the pressure at the top of the riser prove to be lower than 65 psi once the water line for the fire suppression system is constructed and connected in the field, a pressure enhancer can be used to increase the pressure if the need arises.

References:

1. Commonwealth of Massachusetts State Building Code, Fifth Edition. Section 1012.3
2. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
3. As per the New Bedford Water Department, the pressure in the 12-inch water line located in Hervey Tichon Avenue is 89 psi.
4. National Fire Code Set – 2000 November Meeting Edition
5. Water Resources Engineering, Third Edition. Page 279

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 4

PROJECT NBH-Dewatering Facility SUBJECT Sanitary Calcs for Personnel Area

CLIENT USACE

CALCULATION NO. U-03 PROJECT NO. 5197.1720.9302.00010

NO OF SHEETS 4 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	1-4	D.Martoccia (1/08/02) D.M.	K. Bogatch (1/10/02)	
1	1-4	D.Martoccia (5/22/02) D.M	K. Bogatch (5/24/02)	
2	1-4	D.Martoccia (10/09/02) D.M.	K. Bogatch (10/15/02)	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 10/09/02 SHEET 2 OF 4

CHKD. BY K. Bogatch DATE 10/15/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED SANITARY FLOW RATES (REVISED 10/02)

Sources of Discharge:

- 11 showers (each @ 3 gpm[1]) = 33 gpm
- 4 toilets (each @ 15.35 gpm[1]) = 61.4 gpm
- 1 urinal (each @ 15 gpm[1]) = 15 gpm
- 5 basins (each @ 4.5 gpm[1]) = 22.5 gpm
- Misc. discharge = 10 gpm

141.9 gpm ≈ 142 gpm

- Therefore, the max. projected sanitary flow rate at a given point of time = 135 gal/min
- Assume that 75% of the fixtures will operate at the same time[5]

Therefore, 142 gal/min x 0.75 = 106.5 gal/min = **0.237 ft^3/s**

Because the minimum diameter pipe to connect into an existing New Bedford sanitary line must be 6-inches, the capacity of a 6-inch PVC pipe must be determined.[2] In addition, since a 4-inch PVC sanitary line may be used in proximity to the Facility or trailers[3], its capacity must be calculated.

6-inch PVC pipe capacity:

- Using Manning's Equation[4]

$Q = (1.49/n)AR^{2/3}S^{1/2}$

n = Manning's roughness coefficient. n = 0.010 for a PVC pipe[4]

A = Area of pipe. = $(3.14/4)(Diam)^2 = (3.14/4)(6/12)^2 = 0.1963\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(6/12) = 0.125 ft

S = Slope of pipe

Assume slope of pipe is 1% = 0.01

- Total capacity of 6-inch diam. PVC pipe at 1% slope is:

$Q = (1.49/0.010)(0.1963)(0.125)^{2/3}(0.01)^{1/2}$

= **0.731 ft^3/s**

- 6-inch pipe capacity > max. projected sanitary flow rate

0.731 ft^3/s > 0.237 ft^3/s

Therefore, a 6" diam. PVC pipe has enough capacity to handle the total maximum projected sanitary flow rate if 75% of all the fixtures were running at the same time.

4-inch PVC pipe capacity:

- Using Manning's Equation[4]

$Q = (1.49/n)AR^{2/3}S^{1/2}$

n = Manning's roughness coefficient. n = 0.010 for a PVC pipe[4]

A = Area of pipe. = $(3.14/4)(4/12)^2 = 0.0872\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(4/12) = 0.0833 ft

S = Slope of pipe

Assume slope of pipe is 1% = 0.01

- Total capacity of 4-inch diam. PVC pipe at 1% slope is:

$Q = (1.49/0.010)(0.0872)(0.0833)^{2/3}(0.01)^{1/2}$

$= \mathbf{0.248\ ft^3/s}$

- 4-inch pipe capacity > max. projected sanitary flow rate

$0.248\ ft^3/s > 0.237\ ft^3/s$

Therefore, a 4-inch diam. PVC pipe has enough capacity to handle the total maximum projected sanitary flow rate if 75% of all the fixtures were running at the same time.

Summary:

In summary, as per the New Bedford Department of Engineering, the minimum diameter of a proposed sanitary line connecting into an existing New Bedford sanitary line is 6 inches. The proposed sanitary line can be a 4-inch diam. line in proximity to the Facility and then increase to a 6-inch line. The above calculations indicate that a 6-inch or a 4-inch PVC pipe has enough hydraulic capacity to handle the projected sanitary flow rate if 75% of all the fixtures were running at the same time.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 10/09/02 SHEET 4 OF 4

CHKD. BY K. Bogatch DATE 10/15/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED SANITARY FLOW RATES (REVISED 10/02)

References:

1. Common Wealth of Massachusetts Fuel Gas and Plumbing Code – compiled 08/22/97.
2. As per the New Bedford Department of Engineering, the minimum diameter of a proposed sanitary line connecting into an existing New Bedford sanitary line is 6 inches.
3. As per the New Bedford Department of Engineering, the proposed sanitary line can be 4 inches in diameter in proximity to the Facility.
4. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
5. As per the New Bedford Water Department, when sizing potable water lines, it can be assumed that 75% of the fixtures, hoses, etc. are operating at the same time.

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 4

PROJECT NBH-Dewatering Facility SUBJECT Sanitary Calcs for Support Trailers

CLIENT USACE

CALCULATION NO. U-04 PROJECT NO. 5197.1720.9302.00010

NO OF SHEETS 4 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	1-5	D.Martoccia (9/12/02) D.M	K. Bogatch (10/10/02) KB	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D.Martoccia DATE 09/12/02 SHEET 2 OF 8

CHKD. BY K. Bogatch DATE 10/10/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED SANITARY FLOW RATES FOR NEW LOCATION OF SUPPORT TRAILERS

Sources of Discharge:

Assumptions: 1) Assume that each trailer and the guard shack will have a bathroom

- 3 toilets (each @ 15.35 gpm[1]) = 46.1 gpm
- 3 urinal (each @ 15 gpm[1]) = 45.0 gpm
- 3 basins (each @ 4.5 gpm[1]) = 13.5 gpm
- Misc. discharge = 10 gpm

  114.6 gpm ≈ 115 gpm

- Therefore, the max. projected sanitary flow rate at a given point of time = 115 gal/min = **0.256 ft^3/s**

Because the minimum diameter pipe to connect into an existing New Bedford sanitary line must be 6-inches, the capacity of a 6-inch PVC pipe must be determined.[2] In addition, since a 4-inch PVC sanitary line may be used in proximity to the trailers[3], its hydraulic capacity must be calculated.

6-inch PVC pipe capacity:

- Using Manning's Equation[4]

$Q = (1.49/n)AR^{2/3}S^{1/2}$

n = Manning's roughness coefficient. n = 0.010 for a PVC pipe[4]

A = Area of pipe. = $(3.14/4)(Diam)^2 = (3.14/4)(6/12)^2 = 0.1963\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(6/12) = 0.125 ft

S = Slope of pipe

The design slope of pipe is 2% = 0.02

- Total capacity of 6-inch diam. PVC pipe at 2% slope is:

$Q = (1.49/0.010)(0.1963)(0.125)^{2/3}(0.02)^{1/2}$

= 1.03 ft^3/s

- 6-inch pipe capacity > max. projected sanitary flow rate

1.03 ft^3/s >> 0.256 ft^3/s

Therefore, a 6" diam. PVC pipe has enough capacity to handle the total maximum projected sanitary flow rate if all the fixtures were running at the same time.

4-inch PVC pipe capacity:

- Using Manning's Equation[4]

$Q = (1.49/n)AR^{2/3}S^{1/2}$

n = Manning's roughness coefficient. n = 0.010 for a PVC pipe[4]

A = Area of pipe. = $(3.14/4)(4/12)^2 = 0.0872\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(4/12) = 0.0833 ft

S = Slope of pipe

Assume slope of pipe is 2% = 0.02

- Total capacity of 4-inch diam. PVC pipe at 2% slope is:

$Q = (1.49/0.010)(0.0872)(0.0833)^{2/3}(0.02)^{1/2}$

$= \mathbf{0.350\ ft^3/s}$

- 4-inch pipe capacity > max. projected sanitary flow rate

$0.350\ ft^3/s >> 0.256\ ft^3/s$

Therefore, a 4-inch diam. PVC pipe has enough capacity to handle the total maximum projected sanitary flow rate if all the fixtures in the support trailers/guard shack were running at the same time.

Summary:

In summary, as per the New Bedford Department of Engineering, the minimum diameter of a proposed sanitary line connecting into an existing New Bedford sanitary line is 6 inches. The proposed sanitary line can be a 4-inch diam. line in proximity to the support trailers and then increase to a 6-inch line. Therefore, a 6-inch or 4-inch PVC pipe has enough capacity to process the total maximum projected sanitary flow rate if all the fixtures in the support trailers/guard shack were running at the same time.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D.Martoccia DATE 09/12/02 SHEET 4 OF 8

CHKD. BY K. Bogatch DATE 10/10/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED SANITARY FLOW RATES FOR NEW LOCATION OF SUPPORT TRAILERS

References:

1. Common Wealth of Massachusetts Fuel Gas and Plumbing Code – compiled 08/22/97.
2. As per the New Bedford Department of Engineering, the minimum diameter of a proposed sanitary line connecting into an existing New Bedford sanitary line is 6 inches.
3. As per the New Bedford Department of Engineering, the proposed sanitary line can be 4 inches in diameter in proximity to the trailers.
4. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.

ATTACHMENT 1
CALCULATION COVER SHEET

Sheet 1 of 5

PROJECT NBH-Dewatering Facility SUBJECT Potable Water Calcs for Support Trailers

CLIENT USACE

CALCULATION NO. U-05 PROJECT NO. 5197.1720.9302.00010

NO OF SHEETS 5 DESIGN LEVEL _____

CALCULATION BY OTHERS ____ YES X NO PREPARER

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION ___ YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	1-5	D.Martoccia (9/19/02) DM	K. Bogatch (10/10/02) KB	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 09/19/02 SHEET 2 OF 3

CHKD. BY K.Bogatch DATE 10/10/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED POTABLE WATER REQUIREMENTS (FOR NEW LOCATION OF SUPPORT TRAILERS/GUARD SHACK)

Water Use Assumptions:

Assumptions: Assume that each trailer and the guard shack will have a bathroom

- 3 toilets (each @ 15.35 gpm[1]) = 46.1 gpm
- 3 urinal (each @ 15 gpm[1]) = 45 gpm
- 3 basins (each @ 4.5 gpm[1]) = 13.5 gpm

104.6 gpm

Total projected required potable water flow rate at any point in time = 104.6 gal/min

Assume that 75% of the fixtures will operate at the same time[5]

Therefore, 104.6 gpm x 0.75 = 78.5 gpm = ***0.175 ft³/s***

4-inch cast iron pipe capacity:

Assume that a 4-inch diam. cast iron pipe will be used[2]

- Using Hazen-Williams Equation[6]

$Q = 1.318CAR^{0.63}S^{0.54}$

C = Hazen-William's roughness coefficient. C = 100 for a cast iron pipe[3]

A = Area of pipe. = $(3.14/4)(4/12)^2 = 0.0872\ ft^2$

R = Hydraulic radius = ¼ Diam = ¼(4/12) = 0.0833 ft

S = Slope of pipe

Assume the connection elevation in Herman Melville Blvd. is at elev. 5.67 feet (surface elevation of 9.67 minus frost line depth of 4 feet)

Assume connection elevation to Support Trailers is at elev. 5.0 feet (surface elevation of 9.0 minus frost line depth of 4 feet)

Slope = (5.67'-5.0') ÷ 80 feet = 0.00838 ft/ft

- Total capacity of 4-inch diam. cast iron pipe at 0.838% slope is:

$Q = 1.318(100)(0.0872)(0.0833)^{0.63}(0.00838)^{0.54}$

= **0.182 ft³/s**

- 4-inch pipe capacity > projected required potable water flow rate or

  $0.182\ ft^3/s > 0.175\ ft^3/s$

  Therefore, a 4-inch diam. cast iron pipe has enough hydraulic capacity to process the projected required potable water flow rate.

Pressure at Support Trailers:

- Assumptions:
  1. Water temperature in pipe is 60° F
  2. Pipe material is iron[2]
  3. P_A at street connection is 89 psi[4]
  4. Z_A is assumed to be at an elevation of 5.67 feet
  5. Z_B is assumed to be at an elevation of 5.0 feet
  6. Length of 4-inch pipe is 80 feet

- Using Bernoulli's equation[3]:

$$P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$$

P_A = Pressure at point A (i.e. at street connection)

ρ = Density of water at 60° F[3]

v_A = Velocity of water in 4-inch pipe at point A (i.e. street connection)

Z_A = Elevation of 4-inch pipe at point A (i.e. street connection)

P_B = Pressure at point B (i.e. at support trailers)

v_B = Velocity of water in 4-inch pipe at point B (i.e. at support trailers)

Z_B = Elevation of 4-inch pipe at point B (i.e. at support trailers)

h_f = Head loss in pipe due to friction[3]

$$h_f = fL_e v^2/2D_i g$$

f = Darcy friction factor

L_e = Equivalent length

v = Velocity in pipe

D_i = Inside diameter of pipe[3]

g = Gravitational acceleration

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY D. Martoccia DATE 09/19/02 SHEET 4 OF 5

CHKD. BY K.Bogatch DATE 10/10/02 OFS NO. 5197.1720.9302.00010 DEPT. NO.

CLIENT USACE

PROJECT NEW BEDFORD HARBOR DEWATERING FACILITY

SUBJECT PROJECTED POTABLE WATER REQUIREMENTS (FOR NEW LOCATION OF SUPPORT TRAILERS/GUARD SHACK)

- Determining head loss due to friction (h_f)

First determine Reynolds Number (R_e) in which[3]

$R_e = vD_i/\nu$

$v = Q/A_i$

where Q = Flow rate through 4-inch pipe (projected flow rate calculated previously)

A_i = Interior area of 4-inch pipe[3] = 0.085 ft^2 for class D

$v = 0.175\ ft^3/s \div 0.085\ ft^2 = 2.06\ ft/s$

D_i = Internal diameter[3] = 0.33 ft for class D

ν = Kinematic viscosity = 1.217×10^{-5} from Appendix 14A[3]

$R_e = (2.06\ ft/s)(0.33\ ft) \div 1.217 \times 10^{-5} = 5.59 \times 10^4$

ϵ = Pipe roughness coefficient = 0.0008 for iron pipe in Appendix 17A[3]

$\epsilon / D_i = 0.0008/0.33 = 0.00242$

Determine the friction factor (f) using the Moody charts in Appendix 17B[3]

f = **0.0274**

Determine L_e:

L_e = Length of pipe + Equivalent length of valves and fittings[3]

Standard radius elbow (5)	5 x 4.8	=	24.0 feet
Gate valve (2)	2 x 2.4	=	4.8 feet
Swing check valve (1)	1 x 31.0	=	31.0 feet
Water meter (1)	1 x 50	=	50.0 feet
			Total = 109.8 feet

L_e = 80 feet + 109.8 feet = 189.8 feet ≈ **200 feet**

$h_f = (0.0274)(200)(2.06)^2 \div 2(0.33)(32.2) = 1.09$ feet ≈ **1.10 feet**

- $P_A/\rho + v_A^2/2g + Z_A = P_B/\rho + v_B^2/2g + Z_B + h_f$ => velocity heads cancel out, therefore

$P_A/\rho + Z_A = P_B/\rho + Z_B + h_f$

$(89\ lb/in^2)(144\ in^2/ft^2)/62.37 + 5.67\ feet = P_B\ (144\ in^2/ft^2)/62.37 + 5\ feet + 1.10\ feet$

$P_B = 88.81\ psi$

As per 2.14h of the Commonwealth of Massachusetts Fuel Gas and Plumbing Code[1], the maximum pressure allowed at the building is 80 psi therefore, an approved pressure reducing valve may be required to be installed in the water service line should the pressure prove to be greater than 80 psi once the 4-inch line is constructed and connected.

References:

1. Commonwealth of Massachusetts Fuel Gas and Plumbing Code - compiled 8/22/97.
2. As per the New Bedford Water Department, potable water lines are generally 4-inch diameter iron pipes.
3. Civil Engineering Reference Manual – Seventh Edition, by M. Lindeburg.
4. As per the New Bedford Water Department, the pressure in the 16-inch water line located in Herman Melville Blvd. is 89 psi.
5. As per the New Bedford Water Department, when sizing potable water lines, it can be assumed that 75% of the fixtures, hoses, etc. are operating at the same time.
6. Water Resources Engineering, Third Edition. Page 279.