
TECHNICAL MEMORANDUM

To: Ross Mitchell, P. Eng.
Hatch Mott MacDonald

Date: November 21, 2012

Project No: 12-103-08

Subject: Allison Project – Geotechnical Input to Track 0

Prepared by: Lothar Chan, P. Eng.

Reviewed by: John P. Sully, P. Eng.

MEG Doc. No: GE-2012-103-08-2 Rev. 0
Project Doc. No.: H342445-8730-11-124-0001

1. INTRODUCTION

As part of the upgrade works at Neptune Terminal, North Vancouver, BC, a new track, namely Track 0, is to be constructed. MEG Consulting Limited (M+EG) was retained by Hatch Mott MacDonald (HMM) to perform a geotechnical site investigation and to provide geotechnical input related to the track construction. The scope of work includes:

- Performing Wildcat Dynamic Cone Penetration Tests (DCPT) along the track alignment to define the thickness of the upper loose soil/soft coal, and to determine the thickness of excavation for track preparation work.
- Wall relocation for the mobile equipment shop.
- Spray pole relocation.

The DCPT testing was performed in September 2012 and the data are presented the factual report referenced GE-2012-103-08-1 Rev. 0, Dynamic Cone Penetration Test at Track 0. The general layout of Track 0 is shown on Figure 1.

In addition to the DCPT memorandum, the following documents were used as reference material to carry out the engineering analyses:

- MEG Consulting Ltd., Site Investigation for Allison Feasibility Study – Dumper Building, Conveyor and Shiploader, June 2012.
- MEG Consulting Ltd., Seismic Assessment of Sheet Pile Wall at Berth 1, Neptune Terminal, June 2012.

- MEG Consulting Ltd., Advanced Site Investigation for Allison Advanced – Dumper Building and Conveyor Tunnel, November 2012.

Recommendations related to the track were provided in the previous report (GE-2012-103-08-1) referenced above. The seismic evaluation and the engineering analyses required for the development of foundation solutions for the other structures are presented in this technical memorandum.

2. GEOTECHNICAL CONDITIONS

The soil profile and engineering parameters to be used for the foundation design have been adopted from the shiploader and dumper building locations, based on the site investigation programs carried out in the feasibility and advanced studies. Detailed descriptions and laboratory results obtained from the site investigations are summarized in the reports referenced above. A summary of the ground conditions is provided below.

Based on the DCPT results, the coal layer along the new track alignment has an estimated thickness of 450 mm to 1200 mm. Below the coal layer, the soils are granular and are interpreted to consist mainly of sand and gravel, occasional cobbles. The granular layer extends to about 45 m depth near the northeast end of Track 0 (i.e. near the proposed dumper), and about 20 m at the mobile equipment shop location (i.e. near the berth). The granular layer is underlain by a sandy silt/clay stratum.

Since the foundation options to be used are considered shallow, a representative soil profile has been defined assuming a homogenous condition with the following engineering properties:

- a total unit weight of 18.5 kN/m³;
- a friction angle of 32 degrees.

The average ground water level is estimated to be about 2.5 below the existing ground surface. The ground water level is expected to be influenced primarily by seasonal changes, such as precipitation. The water table is assumed to be located at 1.5 m depth for static analyses and 2.5 m depth for seismic analyses.

The recent site investigation carried out at the dumper location indicates that large particles or boulders may be present and may be scattered throughout the profile. Any foundation work should consider the potential presence of large particles or boulders, and the potential impacts on the construction procedures.

3. SEISMIC CONSIDERATION

The Neptune Terminal is located in North Vancouver, B.C., in an area of important seismic risk. The risk associated with liquefaction at this site has been classified to be moderate to high (NBCC 2005). Considering the potential for the occurrence of liquefaction under the design EQ events, the site is classified as Site Class F as per NBCC 2005.

The track has been assumed to be designed using the life-safety performance level for an earthquake corresponding to a 475-year event. Under the life-safety performance criteria, damage to the track as a result of ground deformations is considered acceptable, providing that a life-threatening condition does not result. For the mobile equipment shop, the foundation is to be designed for no-collapse with ground motions corresponding to a seismic event with a return period of 2,475 years.

The site response analyses were performed based on the soil profiles defined for the dumper and shiploader locations. The analyses were performed using the equivalent linear computer code SHAKE 91 for 475-year seismic events. For the 2,475-year events, non-linear analyses were performed using the program DESRA. The mean seismic response spectra at the ground surface corresponding to 475-year return period are presented on Figure 2 and the 2,475-year response spectra are presented on Figure 3. The mean spectra are based on the results of response analyses using a total of six ground motions records which have been spectrally matched to the input spectra.

The horizontal peak ground acceleration (PGA) associated with the 475-year and 2,475-year earthquake events are estimated to be 0.29 g and 0.45 g, respectively.

3.1 Liquefaction Potential

The liquefaction potential at the Allison site (i.e. dumper and shiploader locations) has been evaluated using the SPT-based liquefaction triggering analysis (Idriss and Boulanger 2008). The results obtained at the dumper and shiploader locations during the feasibility study (February to July, 2012) indicate that the granular soils at the Allison site are deemed to undergo liquefaction or pore pressure build-up under the design earthquake loadings.

Based on the results of the liquefaction assessments carried out in the feasibility study, the zones of liquefaction are estimated to extend to depths of about 25 m to 35 m, but are not expected to be continuous.

3.2 Post-Seismic Ground Deformations

The post-liquefaction reconsolidation settlements induced by pore pressure build-up and liquefaction during earthquake loading have been estimated using the Ishihara and Yoshimi (1992) chart for volumetric strain. The post-seismic settlements under the 2,475-year event

at the mobile equipment shop were estimated to be about 550 mm based on SPT12-03 at the shiploader. Along the track alignment, the post-seismic settlements under the 475-year earthquake are estimated to vary between 100 mm and 450 mm.

The seismic lateral ground deformations will be affected by the surface loading from the coal stockpile and the seismic stability of the berth structure. Based on the previous study performed for the sheet pile wall at Berth 1, the berth structure is expected to undergo extensive damage under the 2,475-year event, which may result in significant lateral soil movements affecting the mobile equipment shop. Remedial actions may be necessary.

4. MOBILE EQUIPMENT SHOP

The wall to be relocated at the mobile equipment shop is to be placed on a 1-m wide strip footing. Four columns spaced at about 6 m are to be supported on the footing. The loading conditions have been provided by HMM and are summarized as follows.

Load Case	Load Combination	Vertical Compression (kN)	Shear Load (kN)	
			Transverse	Longitudinal
I	1.25D + 1.5S + 0.4W	313	8	-
II	1.25D + 1.4W + 0.5S	230	26	-
III	1.0D + 1.0E + 0.25S	230	-	140

As provided by HMM, the loads in the above table correspond to the maximum loads acting on a single column. For load case III, only the end columns will experience the maximum loads.

4.1 Bearing Capacity and Settlements

The engineering parameters defined above have been used to determine the bearing capacity of the strip footing. A friction angle 32 degrees and a total unit weight of 18.5 kN/m³ were used. The following assumptions were used for the calculations for load case I and load case II (i.e. static conditions):

- the loads from the two adjacent columns are assumed to act over a span of 6 m; hence, a footing dimension of 6.0 m by 1.0 m;
- embedment depth of 1 m as provided;
- shear loads are assumed to be applied at 1 m above the base of the footing;
- ground water table at 1.5 m depth.

For the seismic conditions (i.e. load case III), the bearing capacity calculation was performed based on the assumptions below:

- the maximum loads at the end column are applied to both adjacent columns with a 6 m separation;
- an average water table at 2.5 m depth;
- soils below the assumed water table to undergo liquefaction under 2,475-year event;
- a residual strength of 10 kPa was defined for the liquefaction zone.

A geotechnical resistance factor of 0.5 was used to determine the factored bearing capacity under static conditions as per NBCC 2005. For the seismic conditions, a typical resistance factor of 0.8 was used.

A summary of the bearing capacity calculations are shown in the table below.

Load Case	L (m)	B (m)	P (kN)	M (kN.m)	L' (m)	B' (m)	Factored Capacity (kPa)
I	6.0	1.0	626	16	6.0	0.95	272
II			460	52	6.0	0.77	263
III			460	280	4.78	1.0	204

L – foundation length

B – foundation width

P – vertical load

L' – effective foundation length

B' – effective foundation width

M – calculated moment

The settlements under static conditions are expected to be elastic and to occur during construction. For a factored foundation load not exceeding the factored bearing capacity, the static settlements are expected to be less than 25 mm.

For seismic conditions, the post-seismic ground settlement discussed in Section 3.2 of this memorandum can be used. The earthquake-induced settlements (i.e. post-seismic consolidation) are likely not uniform over the area of the footing.

4.2 Sliding Resistance

The sliding resistance along the base of the footing can be determined using a friction angle of 35 degrees. A higher friction angle can only be used for sliding resistance if the soil at the foundation level is to be compacted prior to placing the footing. Assuming that the footing is cast-in-place and the interface is rough, the factored (i.e. 0.8 as per NBCC 2005) coefficient of friction is calculated to be 0.56.

4.3 Coefficient of Subgrade Reaction

The coefficient of subgrade reaction was estimated based on the interpretation performed on SCPT12-09, which the seismic CPT was performed at the shiploader location. The best-

estimate coefficient of subgrade reaction was estimated to be 22 MN/m^3 .

The foundation soils are interpreted to consist of loose to compact granular materials. Typical subgrade reaction values for loose to compact granular materials range from about 10 MN/m^3 to 35 MN/m^3 . The typical values can be used as lower- and upper-bound values.

5. SPRAY POLE FOUNDATION

The construction of Track 0 will require relocation of the existing spray poles. The drawing for the existing spray poles is attached in the appendix. Based on the available information, the existing poles are about 90 ft (27.4 m) long with 11 ft (3.3 m) embedded (i.e. a stick-up of 24.1 m). A typical dimension for a 90-ft (27.4-m) long fir pole with a butt diameter of 15 inches (381 mm) and a tip diameter of 8 inches (203 mm) has been assumed. A representative diameter of 361 mm is used for determining the capacity for a maximum embedment of 6 m.

The axial capacity under static conditions for the 361-mm has been determined in accordance with the recommendations outlined in Canadian Foundation Engineering Manual (CFEM) 4th Edition. The variations with depth of the ultimate axial capacity in compression and tension are presented on Figure 4. A geotechnical resistance factor of 0.45 (as per CHBDC S6-06) is recommended to determine the factored capacity. It should be noted that the structural capacity of the material is not considered in the calculation, and should be verified.

The foundation lateral response has not been considered at this stage. A detailed lateral response analyses may be required prior to finalizing the design.

6. CLOSURE

The analyses presented in this memorandum were carried out using conservative engineering parameters. The assumed soil conditions may be different from the actual. Prior to construction, the foundation soils should be inspected to verify the assumptions that were used in this technical memorandum.

M+EG has prepared this report in a manner consistent with a level of care and skill ordinarily exercised by members of the engineering and geoscience professions currently practicing in British Columbia subject to the time limits and physical constraints applicable to this report and the project being developed. No other warranty, expressed or implied, is made.

The soil conditions and depths of material are based on the results obtained from the geotechnical information available from geotechnical investigations performed in the area. The classification and identification of geomaterials has been based on commonly accepted procedures employed by the practicing geotechnical community and some judgment is involved. Boundaries between soil types may be transitional as opposed to abrupt. As a

November 2012

result, M+EG does not warrant or guarantee the exactness of the descriptions or any interpretations at locations away from specific testing locations.

The document has been prepared for the specific site, design objective and development described to M+EG. The data contained in the report are specific to this project as we understand it and are not applicable to any other project or site location. M+EG cannot be responsible for use of this document, or parts thereof, for other than this project or site unless M+EG is requested to review and, if necessary, revise the document.

The information, recommendations, estimates and opinions contained in this document are for the sole benefit of Hatch Mott MacDonald. No other party may use or rely on the information contained herein, in whole or any portion, without the written consent of MEG Consulting Limited.

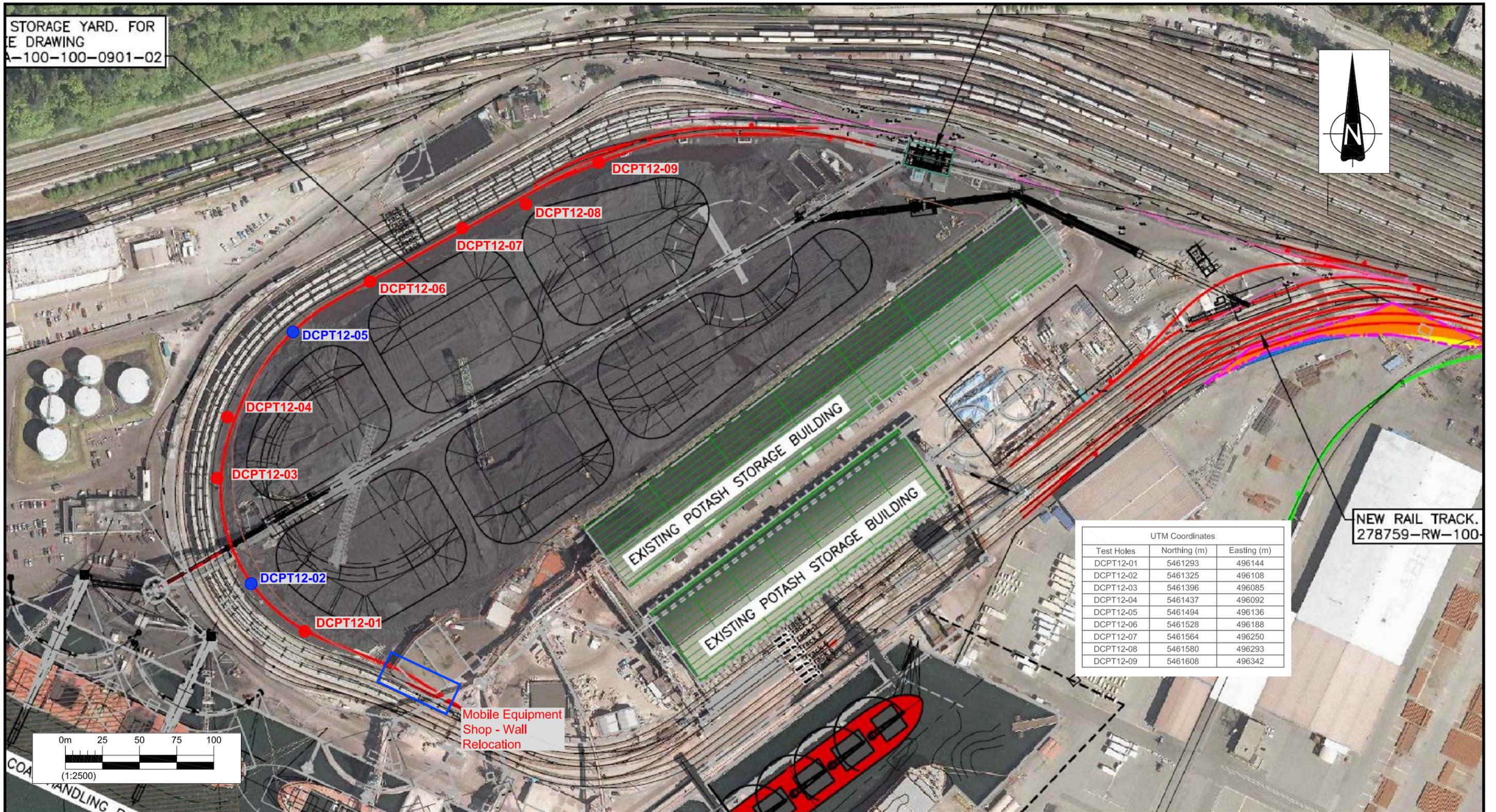
Sincerely,
MEG CONSULTING LIMITED

Reviewed by:

Lothar Chan, P. Eng.
Geotechnical Engineer

John P. Sully, Ph.D., P.Eng.
Principal

FIGURES



UTM Coordinates		
Test Holes	Northing (m)	Easting (m)
DCPT12-01	5461293	496144
DCPT12-02	5461325	496108
DCPT12-03	5461396	496085
DCPT12-04	5461437	496092
DCPT12-05	5461494	496136
DCPT12-06	5461528	496188
DCPT12-07	5461564	496250
DCPT12-08	5461580	496293
DCPT12-09	5461608	496342

Mobile Equipment Shop - Wall Relocation

LEGEND

- Location of Dynamic Cone Penetration Test
- Testing Cancelled

Client



Consultant



DWN BY:

CH

CHK'D BY:

LC

APP.

JPS

SCALE

AS SHOWN

PROJECT

ALLISON - NEPTUNE TERMINAL
Track 0

TITLE

TEST HOLE LOCATION PLAN

DATE:

November, 2012

DOC No:

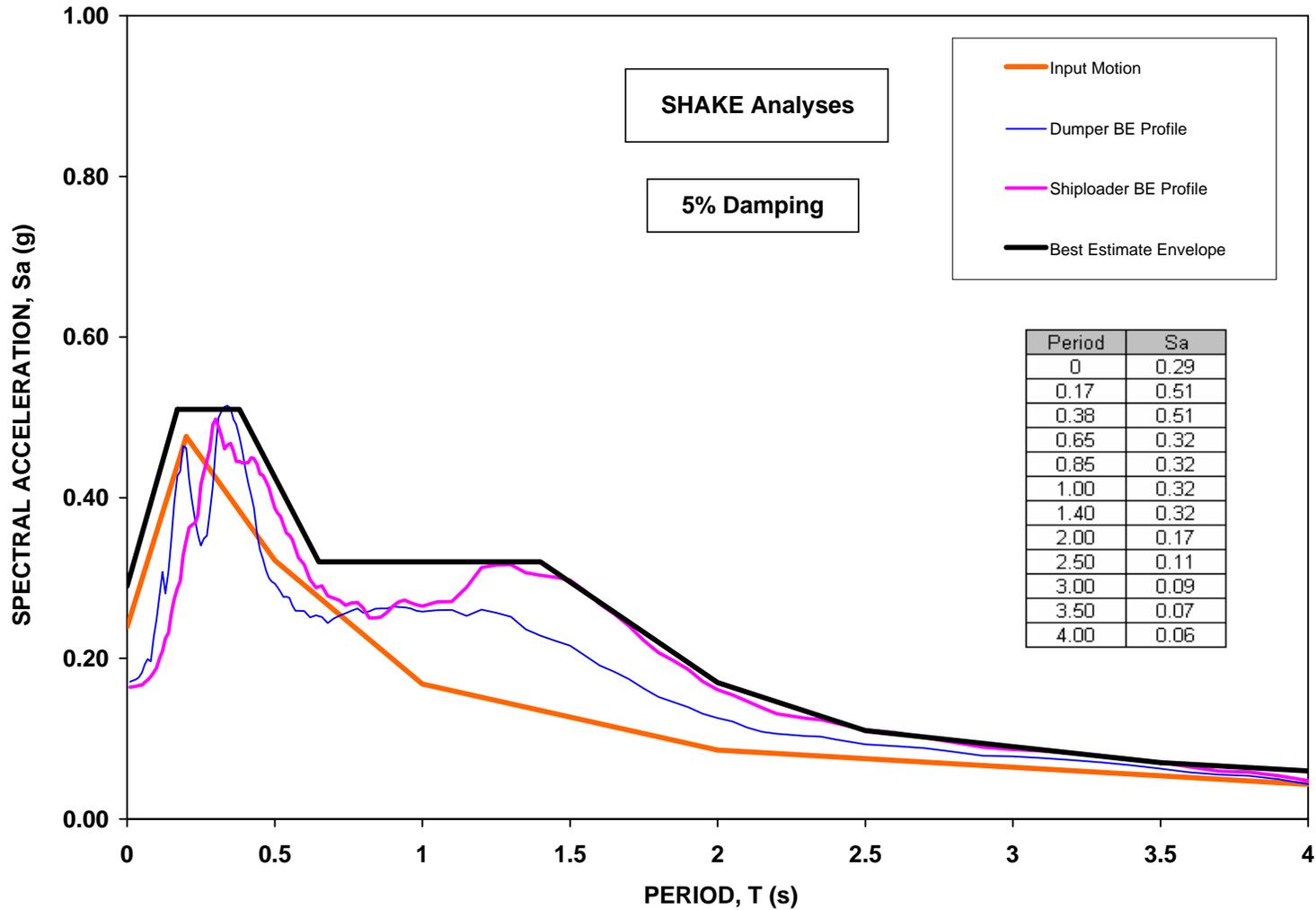
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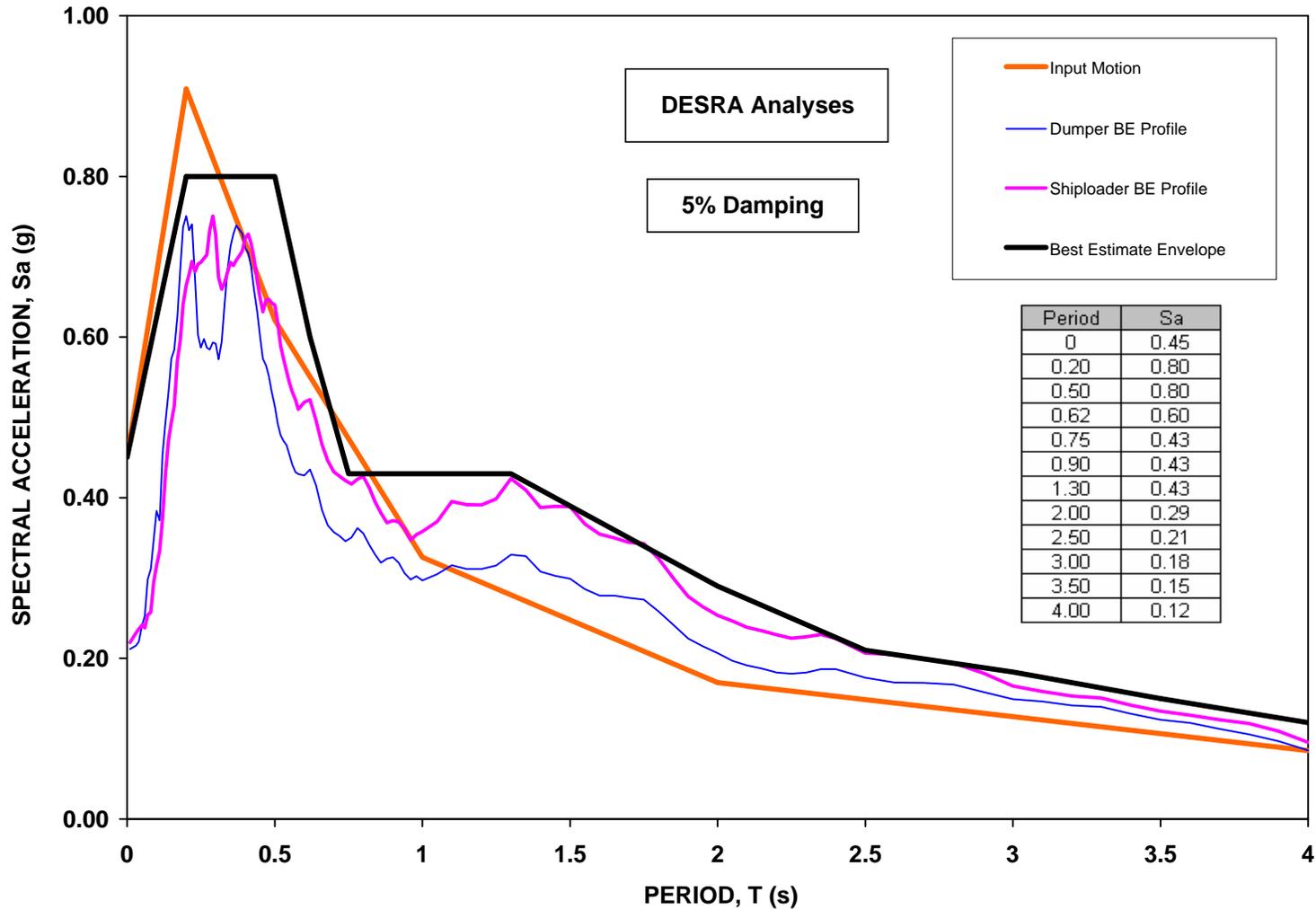
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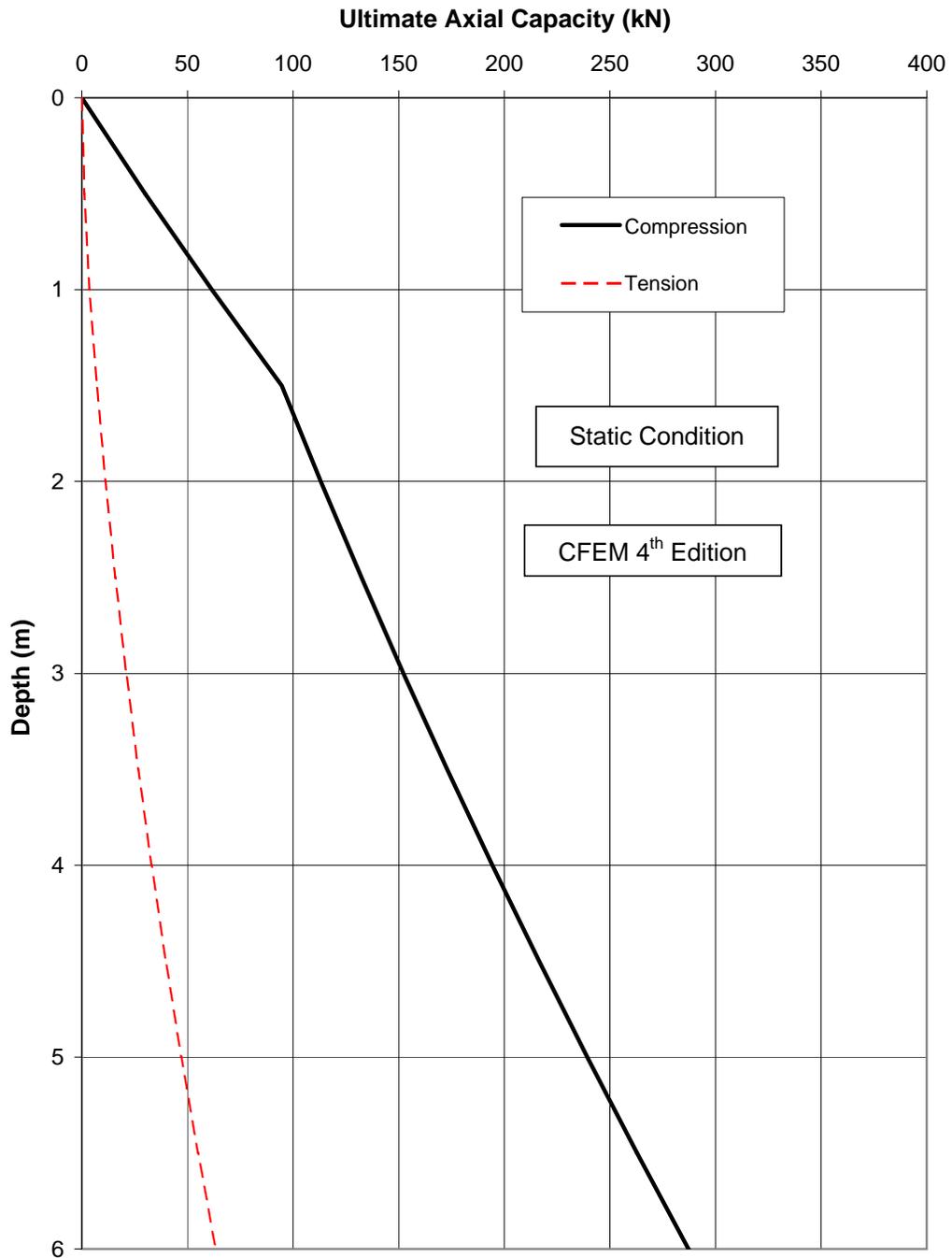
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FIGURE No.

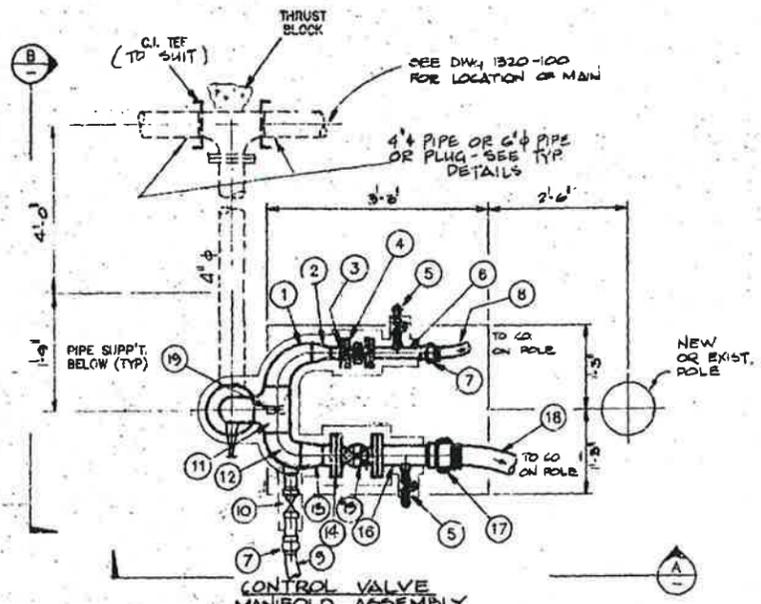
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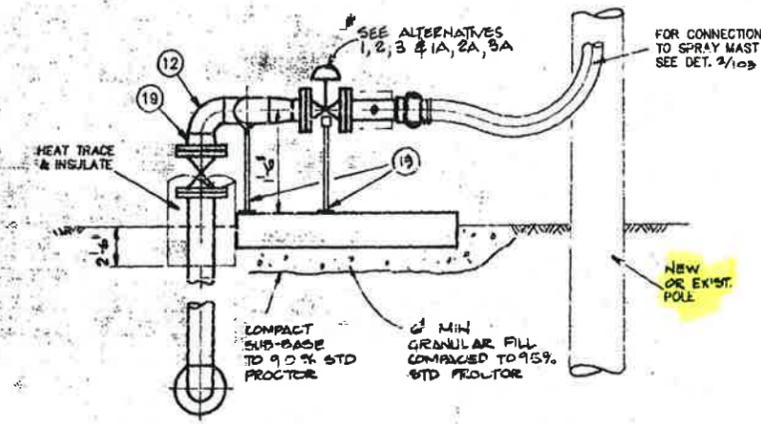




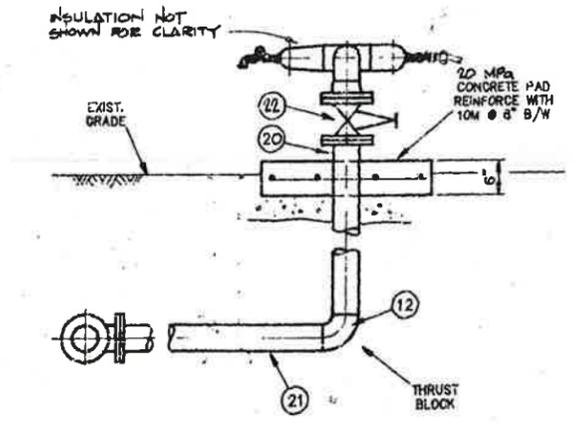
APPENDIX



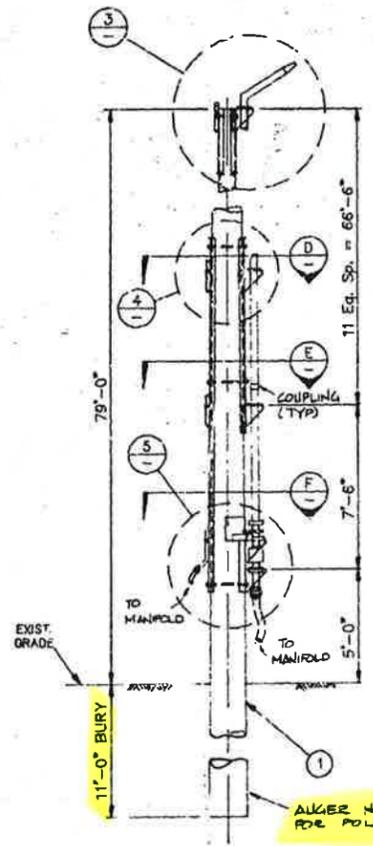
DETAIL 1
3/4"=1'-0"



SECTION A
3/4"=1'-0"

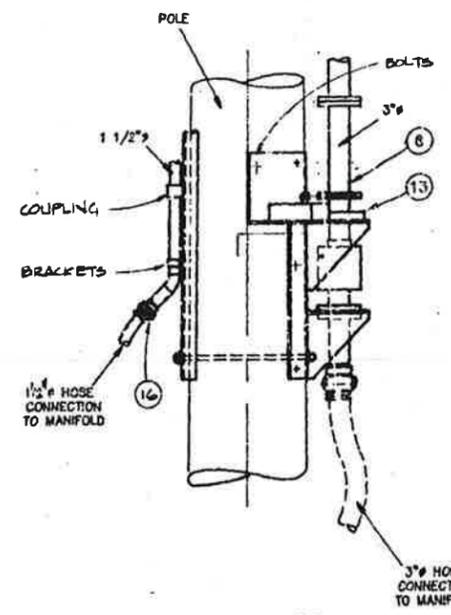


SECTION B
3/4"=1'-0"



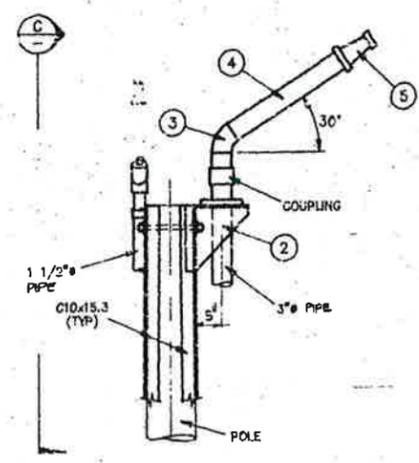
PIPE SPRAY MAST ASSEMBLY
DETAIL 2
1/4"=1'-0"

NOTE: EXISTING POLES ARE NOT TO BE MODIFIED

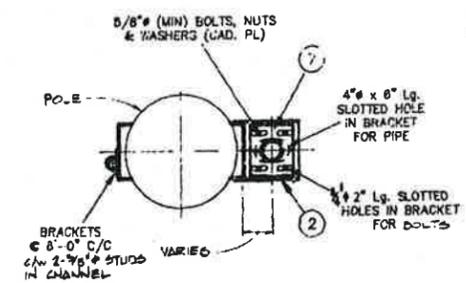


DETAIL 5
3/4"=1'-0"

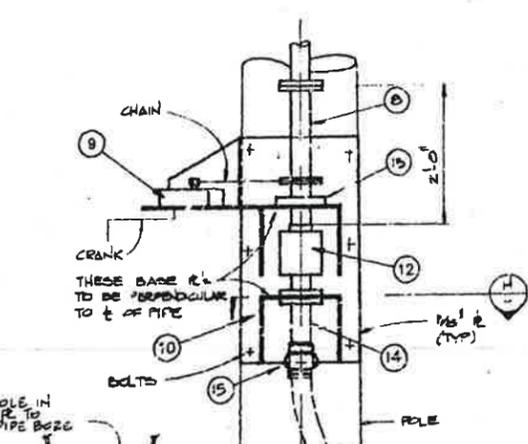
NOTES
1) SUPPORT (8) TO BE FIXED TO POLE FIRST THEN CHANNELS & THEN GUIDE BRACKETS (2) TO BE ALIGNED & WELD WELDED TO CHANNEL. TO ACCORDANCE WITH CONNECTION
2) GENERAL NOTES DWG 1320-104
3) SITE PLAN & LENGTHS DWG 1320-100
4) ENGINEER TO APPROVE SUB-BASE



DETAIL 3
3/4"=1'-0"

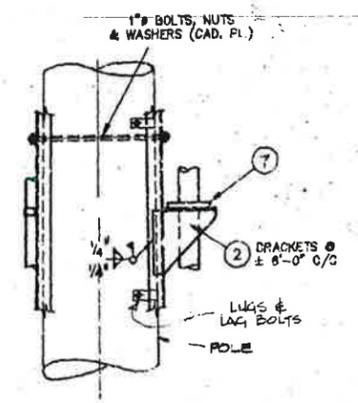


SECTION D
3/4"=1'-0"

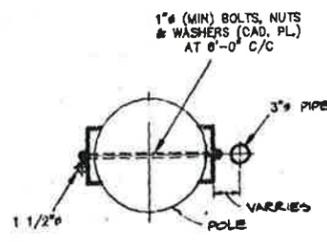


SECTION G
3/4"=1'-0"

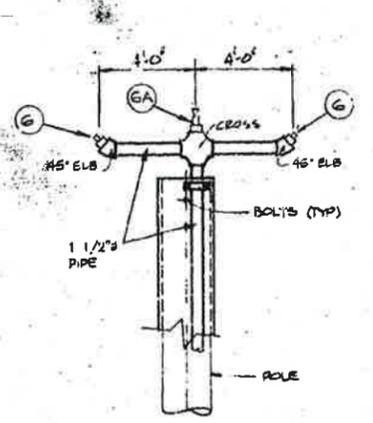
SECTION H



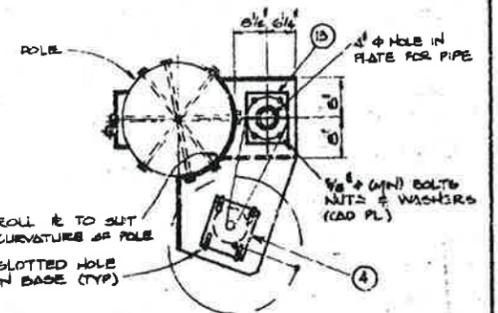
DETAIL 4
3/4"=1'-0"



SECTION E
N.T.S.



SECTION C
3/4"=1'-0"



SECTION F
3/4"=1'-0"

BILL OF MATERIALS FOR CONTROL VALVE ASSEMBLY

NOTES:
1) All flanges ANSI or 150 lb. slip on or weld neck.
2) All piping, Steel ASTM A53, SCHD 40. All fittings steel butt weld.
3) See specifications for detail requirements. Submit shop drawings.

ITEM	QTY	DESCRIPTION (QUANTITIES ARE FOR ONE ASSEMBLY - 7 REQ'D)
1.	1 (x 7 typ)	4" x 3" Reducing 90° elbow.
2.	1	3" x 1 1/2" Reducer (PE x PE)
3.	1	1 1/2" Weld Neck Flange or Threaded Adaptor.
4.	1	1 1/2" Solenoid Valve (See Specifications) (Fl. or Thd.)
5.	2	Automatic Drain Valve (See Specifications).
6.	1	1 1/2" Spool Piece c/w Weldolet and Kam-Lok Assembly.
7.	2	1 1/2" Kam-Lok Quick Disconnect Assembly.
8.	1	1 1/2" Flexible Hose (200 psi) (See Specifications).
9.	N/A	1 1/2" Thrd. Globe/Gate Valve c/w Third Spool Pieces. # WELDOLET
10.	1	4" x 4" Tee, c/w 1 1/2" (PE x PE x PE).
11.	1	4" x 3" Reducer (PE x PE).
12.	3	4" x 3" Reducer (PE x PE).
13.	1	3" Weld Neck Flange
14.	1	3" Solenoid Valve (F x F). ALT #12, #13 OR 3" BUTTERFLY VALVE ACT (1A, 2A, 3A, 4A)
15.	2	3" Spool Piece c/w Weldolet & Kam-Lok Assembly
16.	1	3" Kam-Lok Quick Disconnect Assembly.
17.	1	3" Hose (200 psi - See Specifications).
18.	1	4" Weld Neck Flange.
19.	1	4" Spool Piece (F x PE).
20.	1	4" Spool Piece (F x PE).
21.	1	4" Spool Piece (F x PE).
22.	1	4" OS & Y Gate Valve (F x F).

BILL OF MATERIALS FOR PIPE SPRAY MAST ASSEMBLY

ITEM	QTY	DESCRIPTION (QUANTITIES ARE FOR ONE ASSEMBLY - 5 REQ'D)
1.	1 (x 5 Typ)	90 foot Class #1 or better owner supplied treated fir pole.
2.	12	Support guide brackets fabricated from 3/8" steel plate.
3.	1	3 inch steel spool nozzle tube, 24 inches long. Connect to nozzle (Item #5) with thread adaptor.
4.	1	0.790 Dia. Reinforced Straight Box Nozzle. See Specs.
5.	1	3/4 inch full jet nozzles. See Specifications.
6.	2	3/4 inch Veejet nozzle. See Specifications.
6a.	1	1 inch thick (9" x 9") teflon guide blocks, c/w 4" diameter hole for pipe and slotted holes for fasteners.
7.	12	3 inch spool x 24" long (F x thread) c/w sprocket. Chain drive assembly.
8.	1	Base support assembly, 3/8" plate.
9.	1	Owner supplied rotating swirl coupling (F x FT)
10.	1	1 1/2 inch thick (9" x 9") teflon base guide block c/w holes for pipe and fasteners.
11.	N/A	3 inch spool piece x 12" long (F x thread)
12.	1	3 inch Kam-Lok Quick Disconnect Assembly.
13.	1	3 inch Hose (200 psi - See Specifications).
14.	1	4" Weld Neck Flange.
15.	1	4" Spool Piece (F x PE).
16.	1	4" Spool Piece (F x PE).

OMNI ENGINEERING INC.

NEPTUNE BULK TERMINALS (CANADA) LTD.
COAL PILE SPRAY SYSTEM
MANIFOLD & POLE
DETAILS

Design: AS BUILT
Date: 16 Apr 1990
Drawing Number: 1320-103

203 - 1880 Lloyd Ave, North Vancouver B.C. V7P 2N6 985-0508

Scale: SHOWN
Revision Number: 2

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