SANBORN HEAD

EXHIBIT
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Sanborn, Head & Associates, Inc.
1 Technology Park Drive
Westford, MA 01886
978-392-0900

LETTER OF TRANSMITTAL

To: Bill Clark
William.Clark@libertyutilities.com

Number: 3672.00-002
Date: August 31, 2015
Job #: 3672.00
Via: ☐ Overnight
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WE ARE SENDING YOU: ☒ **Attached** ☐ **Under Separate Cover**

☐ Copy of Report ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of Letter ☐ Change Order ☒ See below

COPIES	DOCUMENT NUMBER	DATE	REVISION	DESCRIPTION
1	–	8/31/15	–	Lebanon Site Fatal Flaw Siting Analysis Memo
1	–	8/12/15	–	Preliminary Design Basis
1	3672.00, G-1	8/31/15	0	Location Plan
1	3672.00, G-2	8/31/15	0	Site Plan
1	3672.00, G-3	8/31/15	0	Site Plan – Flood Plains
1	3672.00, G-4	8/31/15	0	Equipment General Arrangement
1	–	8/31/15	–	LNGFire3 Modeling Output

THESE ARE TRANSMITTED (As Checked Below):

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Remarks:

cc: JMF
MAN
CJF
file

SANBORN, HEAD & ASSOCIATES, INC.

Tom Sudol
Project Manager

(IF ENCLOSURES ARE NOT AS NOTED, PLEASE NOTIFY US IMMEDIATELY)

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Building Trust. Engineering Success.

MEMORANDUM

To: Bill Clark | Liberty Utilities

From: Joan Fontaine and Mike Nicoloro

File: 3672.00

Date: August 31, 2015

Re: LNG Facility Fatal Flaw Siting Analysis for West Lebanon, NH Parcel – Initial Phase

cc: Tom Sudol, Maxwell Quinn | Sanborn Head

Project Overview

Liberty Utilities is evaluating a parcel of land in West Lebanon, NH for the potential siting of an LNG storage and vaporization facility. Liberty Utilities requested Sanborn Head to perform an analysis to assess if there are any fatal flaws with respect to siting an LNG facility. The proposed LNG facility is anticipated to have [redacted], vaporization, LNG transport offloading, and associated natural gas sendout piping. It is also anticipated that CNG tube trailers will deliver CNG to the facility for use in up to six decompression skids.

Tasks Performed As Part of Initial Phase of Analysis

1. Preliminary Design Basis

   We prepared a preliminary design basis that addresses LNG flow rates and natural gas send out flow rates (peak hourly) and associated fluid temperatures and pressures, as well as number of days of on-site storage. A summary table is provided as an attachment to this memo. Key points of the design basis are:

   a. The maximum hourly sendout from the proposed LNG facility is 358 MSCFH which is based on a peak demand estimate from Liberty Utilities. [redacted]

   b. The on-site LNG storage provides an estimated four days of storage for uninterruptible users.

   c. It is assumed that the MAOP of the distribution system will be 60 psig and upstream pressure requirements were estimated based on this MAOP.

2. Data Review – Publicly Available and Phase 1 Environmental Site Assessment Report (ESA)

   We reviewed publicly available information to assess the proximity of the property to an airport and flood plains. Liberty Utilities also provided a Phase 1 ESA performed for the property for another entity. The findings from this data review

are outlined below. Additionally, Sanborn Head has extensive knowledge of the property to the north of the parcel being evaluated – the Lebanon Landfill. Our knowledge of this property as it may relate to the parcel south of it is provided below as well.

a. The Lebanon Municipal Airport's runway is located approximately 6,750 feet (1.3 miles) to the east of the property. This distance does not pose any issue for the layout of the proposed LNG facility with respect to runway and approach distances. Reference Drawing G-1, Location Plan, which depicts where the property is with respect to the airport.

b. Review of both the ESA and the Federal Emergency Management Agency's National Flood Insurance Program published mapping indicate that there are not any flood plains on the property. Refer to Drawing G-3, Site Plan – Flood Plains, which depicts where the flood plain is located with respect to the property.

c. Geology – We did hit bedrock unexpectedly during the construction of the last cell. There was an error in the bedrock map provided to us. The mapping we have doesn't include the property to the south, so we cannot comment offered on the depth to bedrock. However, considering the information we have to the north, the change in the river direction, bedrock could have a localized high point almost anywhere. That said, considering that the site is a sand and gravel operations, there should be drilling logs that may provide information about bedrock. Also, if continued excavation is a concern, perhaps the site development could involve engineered backfill areas. In this case the backfilling operations should be monitored to assure that a well-compacted foundation is constructed.

d. Landfill Gas – Prior to the installation and operation of the active LFG extraction system, there were some LFG migration issues detected along the landfill's east property boundary. The active system should be the mitigation for this condition. LFG migration to the south is less likely because of the unlined landfill is quite a distance away from the south boundary and the newest landfill cell is significantly deeper than the bottom of the older cells (lined and unlined). Of note is that there are plans (not yet permitted) to expand the landfill further south. This phase of the landfill is some years off. While it is not impossible for LFG to migrate from the unlined cell, or even the lined cell of the landfill gas conveyance piping, if things are well managed, the potential risk is limited.

e. Wetland areas – Considering the site usage, there may be wetlands on the site that could affect the site development. Such information is not typical of an ESA, and a wetland scientist would need to visit the site to verify the presence or absence of wetlands.

3. Conceptual Equipment General Arrangement

   We prepared a conceptual equipment general arrangement drawing that depicts the major system components for the proposed LNG facility. Set back and equipment separation distances and containment requirements in accordance with NFPA 59A were incorporated into this conceptual equipment general arrangement. Reference Drawing G-4, Equipment General Arrangement, provided as an attachment to this memo.

4. Site Plan Drawing

   Refer to Drawing G-2, Site Plan, which overlays the equipment general arrangement onto the property. At this preliminary phase, we did not include the proposed CNG equipment or truck egress and access routes.

5. Conceptual Level Thermal Radiation Modeling

   We performed conceptual level thermal radiation modeling using LNGFire3 modeling software. Climactic data from the last six years was researched to establish the input parameters to the model (e.g., wind speed, relative humidity, temperature) in accordance with the regulations. Exclusion zone radii are depicted on the site plan developed in Item 4, above. Code requires that the 10,000 BTU/hr-ft^2 zone stay within the property boundaries; this is achievable based on this first round of modeling. The modeling printout is provided as an attachment.

Conclusions

The first phase of this fatal flaw analysis has not identified any fatal flaws in areas studied that would pre-empt Liberty Utilities from proceeding with the next level assessment.

Recommended Next Steps

Performing vapor dispersion modeling will be a critical aspect to more definitively qualify the property being considered. We strongly recommend that the vapor dispersion modeling be performed as soon as possible, since it is our experience that keeping the 50% LEL exclusion zone within the property boundaries is typically more challenging than keeping the 10,000 BTU/hr-ft^2 exclusion zone within the property boundaries. Please note that the recommended vapor dispersion modeling will provide worse case conditions. It may even show that the 50% LEL will travel beyond the property limits. Mitigation measures such as insulated concrete, vapor fences and water spray systems would be studied in the detailed design phase if we conclude that the 50% LEL goes beyond property boundaries.

As part of this next phase of the analysis, we may need to consider reducing the amount of on-site storage, using smaller LNG tanks, and optimizing the size of the subimpoundment within the LNG containment in order to meet exclusion zone requirements. Each of these elements will have an impact on the extent of the modeled vapor dispersion zones.

JMF/MAN: jmf

Encl. Preliminary Design Basis
Drawing G-1, Location Plan

Drawing G-2, Site Plan
Drawing G-3, Site Plan - Flood Plains
Drawing G-4, Equipment General Arrangement
LNGFire3 Modeling Output

P:\3600s\3672.00\Work\Lebanon Site Fatal Flaw Analysis\20150831 Phase 1 of Fatal Flaw Analysis - Memo.docx

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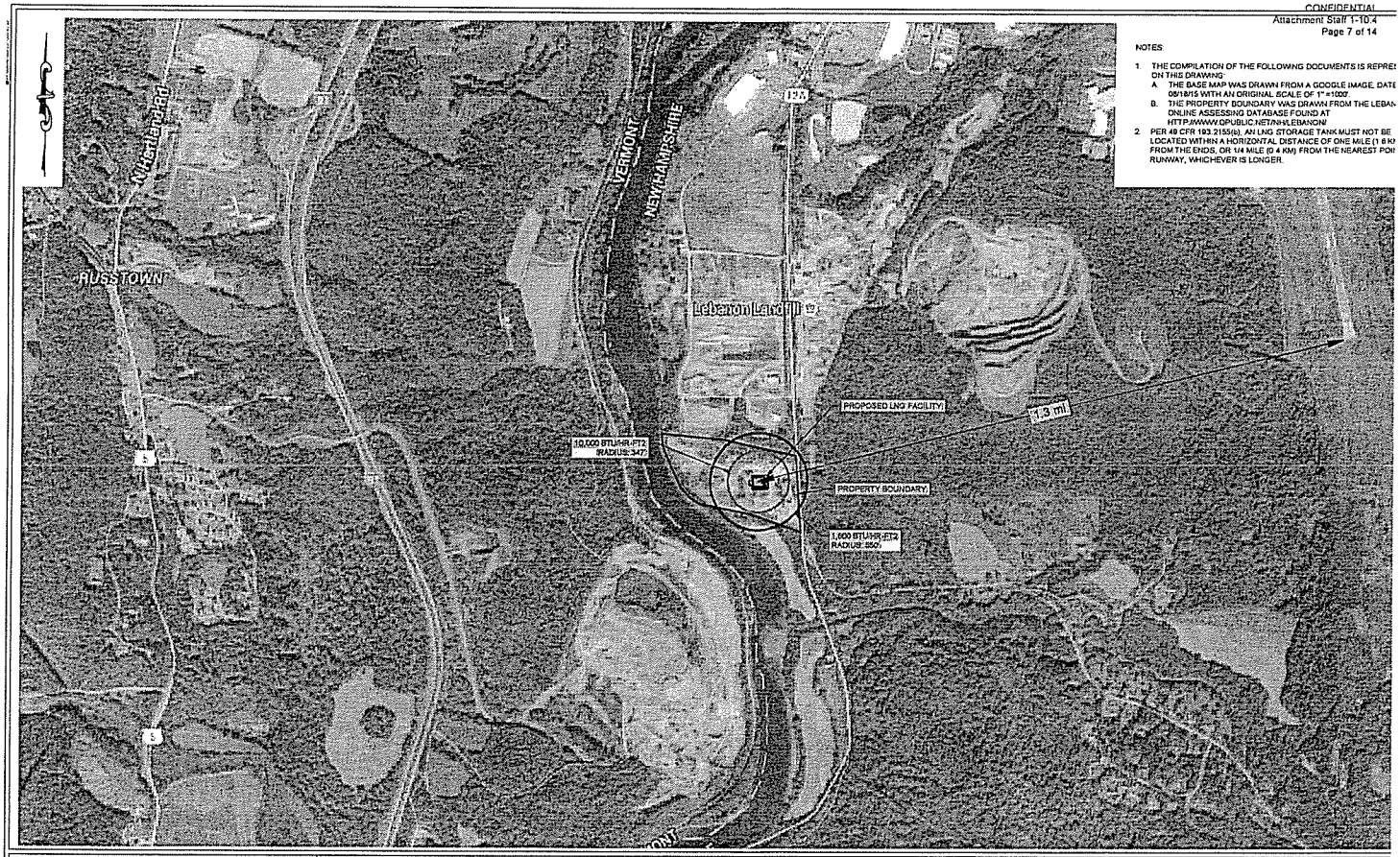
Design Basis Liberty Utilities - Lebanon NH Site Fatal Flaw Analysis					
Equipment/Service	Fluid	Flow Rate	Pressure	Temperature	Comment
LNG Offloading	LNG	200 gpm (maximum)	80 psig (nominal) 100 psig (maximum)	-260 °F	(2) 100% capacity pumps, off-loading stations. Pumps to increase pressure from 20-40 psig in transports to 80 psig nominal pressure in tanks.
LNG Tanks	LNG	--	80 psig (nominal) 100 psig (maximum allowable)	-260 °F	[redacted]
Vaporized LNG	Natural Gas	358 MSCFH (maximum) 45 MSCFH (minimum)	70 psig	50 °F	Maximum hourly flow rate based on peak demand estimate from Liberty Utilities (does not include Dartmouth College). Minimum flow rate assumes an 8:1 turndown.
NG Sendout	Natural Gas	358 MSCFH (maximum) 45 MSCFH (minimum)	60 psig	50 °F	Pressure based on distribution system MAOP.
LNG Vaporizer	TBD	--	--	--	6.5 MMBtu/hr - required heat output.
Boil Off Gas	Natural Gas	0.74 MSCFH	80 psig	-240 °F	Assumes a boil off rate of 0.1 % per day of the 90% full tank volume.
Boil Off Gas (after ambient heat exchanger)	Natural Gas	0.74 MSCFH	70 psig	Ambient Temperature less 20 °F	Downstream of ambient heat exchanger.



NOTES:

1. THE COMPILATION OF THE FOLLOWING DOCUMENTS IS REPRES
ON THIS DRAWING:
   A. THE BASE MAP WAS DRAWN FROM A GOOGLE IMAGE, DATE
   08/18/15 WITH AN ORIGINAL SCALE OF 1" =1000'.
   B. THE PROPERTY BOUNDARY WAS DRAWN FROM THE LEBA
   ONLINE ASSESSING DATABASE FOUND AT
   HTTP://WWW.OPUBLIC.NET/NH/LEBANON/
2. PER 49 CFR 193.2155(a) AN LNG STORAGE TANK MUST NOT BE
LOCATED WITHIN A HORIZONTAL DISTANCE OF ONE MILE (1.6 KI
FROM THE ENDS, OR 1/4 MILE (0.4 KM) FROM THE NEAREST POI
RUNWAY, WHICHEVER IS LONGER.

SANBORN HEAD

GRAPHICAL SCALE
500' 250' 0' 500' 1000'

NO	DATE	DESCRIPTION	BY
0	08/31/15	ISSUED TO CLIENT - PHASE I FATAL FLAW	MJQ

DRAWN BY: MJQ
DESIGNED BY: MJQ
REVIEWED BY: JMF
PROJECT MGR: JMF
PIC: MAN
DATE: AUGUST 2015

LEBANON SITE FATAL FLAW ANALYSIS
LIBERTY UTILITIES
LEBANON, NH

LOCATION PLAN

PROJE
36
SHEET

NOTES:

1. THE COMPILATION OF THE FOLLOWING DOCUMENTS IS REPRESENTED ON THIS DRAWING.
   A. THE BASE MAP WAS DRAWN FROM A GOOGLE IMAGE, DATED 05/18/15 WITH AN ORIGINAL SCALE OF 1" =200'.
   B. THE PROPERTY BOUNDARY WAS DRAWN FROM THE LEBANON ONLINE ASSESSING DATABASE FOUND AT HTTP://WWW.OPUBUC.NET/NH/LEBANON.

LEGEND

- PROPERTY LIMIT
- 10,000 BTU/HR/FT² THERMAL RADIATION ZONE
- 1,500 BTU/HR/FT² THERMAL RADIATION ZONE

~10,000 BTU/HR/FT²: THE NEAREST POINT LOCATED OUTSIDE THE OWNER'S PROPERTY LINE THAT CAN BE BUILT UPON.

~1,500 BTU/HR/FT²: THE NEAREST POINT LOCATED OUTSIDE THE OWNER'S PROPERTY LINE THAT CAN BE USED FOR OUTDOOR ASSEMBLY BY GROUPS OF 50 OR MORE PERSONS.

SANBORN HEAD

GRAPHICAL SCALE
100' 50' 0' 100' 200'

NO	DATE	DESCRIPTION	BY
0	08/31/15	ISSUED TO CLIENT - PHASE I FATAL FLAW	MJO

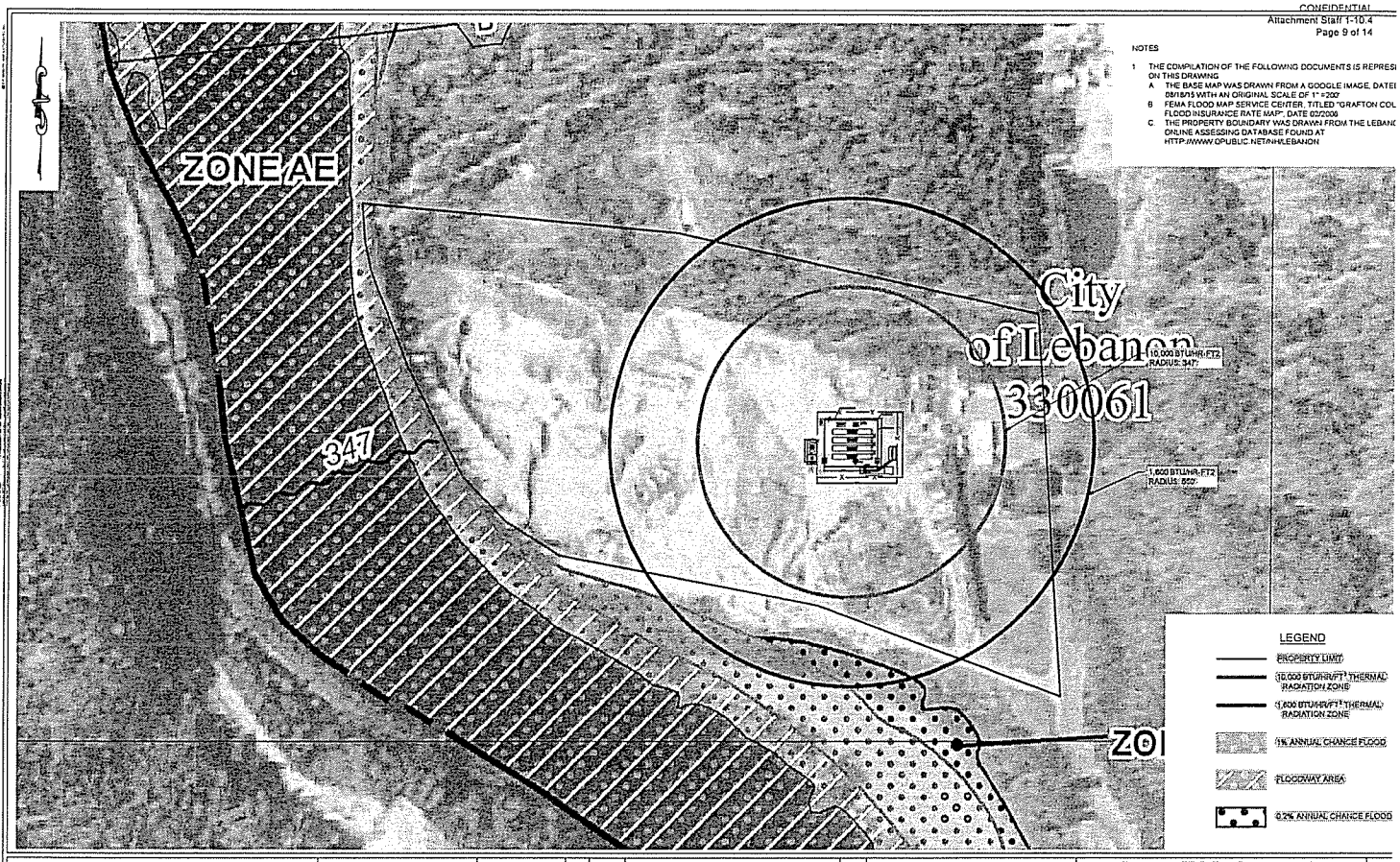
DRAWN BY: MJO
DESIGNED BY: MJO
REVIEWED BY: JMF
PROJECT MGR: JMF
PIC: MAN
DATE: AUGUST 2015

LEBANON SITE FATAL FLAW ANALYSIS
LIBERTY UTILITIES
LEBANON, NH

SITE PLAN

PROJECT NUMBER: 3672.00

SHEET NUMBER: G-2



NOTES

1 THE COMPILATION OF THE FOLLOWING DOCUMENTS IS REPRESI
ON THIS DRAWING
A THE BASE MAP WAS DRAWN FROM A GOOGLE IMAGE, DATEI
08/18/15 WITH AN ORIGINAL SCALE OF 1" =200'
B FEMA FLOOD MAP SERVICE CENTER, TITLED "GRAFTON COU
FLOOD INSURANCE RATE MAP", DATE 07/2008
C THE PROPERTY BOUNDARY WAS DRAWN FROM THE LEBANO
ONLINE ASSESSING DATABASE FOUND AT
HTTP://WWW.DPUBLIC.NET/NH/LEBANON

SANBORN HEAD

GRAPHICAL SCALE
100' 50' 0' 100' 200'

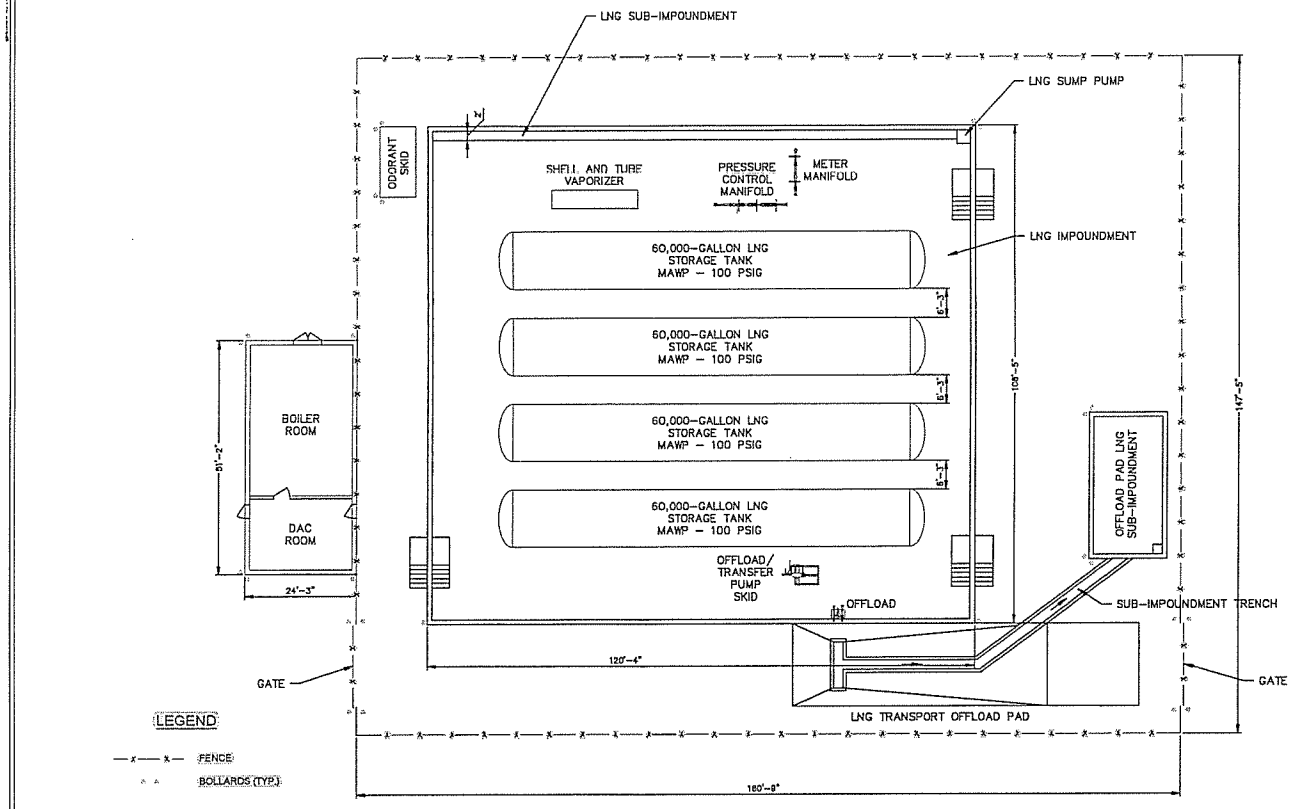
NO	DATE	DESCRIPTION	BY
0	08/31/15	ISSUED TO CLIENT - PHASE I FATAL FLAW	MJQ

DRAWN BY: MJQ
DESIGNED BY: MJQ
REVIEWED BY: JMF
PROJECT MGR: JMF
PIC: MAN
DATE: AUGUST 2015

LEBANON SITE FATAL FLAW ANALYSIS
LIBERTY UTILITIES
LEBANON, NH

SITE PLAN - FLOOD PLAINS

PROJECT NO. 36
SHEET



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GRAPHICAL SCALE

NO.	DATE	DESCRIPTION	BY
0	08/31/15	ISSUED TO CLIENT - PHASE 1 FATAL FLAW	TFS

DRAWN BY TFS
DESIGNED BY TFS
REVIEWED BY JMF
PROJECT MGR JMF
PIC MAN
DATE AUGUST 2015

LEBANON SITE FATAL FLAW ANALYSIS
LIBERTY UTILITIES
LEBANON, NH

EQUIPMENT GENERAL ARRANGEMENT

PROJECT NUMBER 3758.00

SHEET NUMBER G-4

RECTANGULAR DIKE FIRE
TRENCH FIRE

FUEL
Name	: LNG LIGHT (METHANE)
Pool temperature	: -258.79 ° F

CONSTANT PROPERTIES
Molecular weight	: 16.04
Boiling point	: -258.79 ° F
Critical temperature	: -116.68 ° F
Critical pressure	: 667.2 psi
Heat of combustion	: 2.15E+04 Btu/lb
Flame temperature	: 1880 ° F

CALCULATED PROPERTIES
Liquid compressibility factor	: 0.004
Liquid density	: 29.69 lb/cu ft

DIMENSIONS
Pool width	: 147.5 ft
Pool length	: 181.0 ft
Pool liquid height	: 4.0 ft
Height of flame base	: 4.0 ft
Height for Radiation Calculations	: 4.0 ft

LOCAL AMBIENT CONDITIONS
Air temperature	: 3.0 ° F
Ambient pressure	: 1.0 atm
Wind speed	: 27.0 mph
Relative humidity	: 24.0%

RESULTS
Mass burning rate	: 0.023 lb/ft² s
Flame length	: 207.57 ft
Flame tilt from vertical (front view)	: 60.14°
Flame tilt from vertical (side view)	: 58.99°
Flame drag ratio (front view)	: 1.52
Flame drag ratio (side view)	: 1.41
Maximum emissive power	: 60,230 Btu/ft² hr
Effective emissive power (front view)	: 60229.68 Btu/ft² hr
Effective emissive power (side view)	: 60229.68 Btu/ft² hr

Front view (view along dike/trench width)

Thermal flux (Btu/ft² hr)	Distance from center of pool (ft)
1000	449.84
4000	563.40
1600	729.22

Side view (view along dike/trench length)

Thermal flux (Btu/ft² hr)	Distance from center of pool (ft)
1000	447.06
4000	553.37
1600	706.63

Maximum emissive power : 190.0 kW/m**2

Front view (view along dike/trench width)

Distance from center of pool (ft)	Thermal flux to horizontal target (Btu/ft² hr)	Thermal flux to vertical target (Btu/ft² hr)	Maximum flux to target (Btu/ft² hr)
110.63	Target in flame	Target in flame	Target in flame
147.50	Target in flame	Target in flame	Target in flame
184.38	50,920	28,482	53,814
221.25	46,751	27,572	50,823
295.00	32,383	23,538	39,309
368.75	13,484	17,814	22,339
442.50	4,203	9,864	10,721
590.00	675.72	3,292	3,360

885.00	83.49	866.18	870.15
1,475	9.80	212.43	212.65

Side view (view along dike/trench length)

Distance from center of pool (ft)	Thermal flux to horizontal target (Btu/ft² hr)	Thermal flux to vertical target (Btu/ft² hr)	Maximum flux to target (Btu/ft² hr)
135.75	Target in flame	Target in flame	Target in flame
181.00	51,700	28,537	54,292
226.25	46,029	27,286	50,136
271.50	37,608	24,214	42,920
362.00	15,879	17,458	23,598
452.50	3,850	8,659	9,475
543.00	1,127	4,172	4,321
724.00	211.57	1,456	1,472
1,086	30.99	418.92	420.03
1,810	4.04	109.05	109.11

CONFINED POOL FIRE MODEL

RECTANGULAR DIKE FIRE
TRENCH FIRE

FUEL
Name : LNG LIGHT (METHANE)
Pool temperature : -258.79 ° F

CONSTANT PROPERTIES
Molecular weight : 16.04
Boiling point : -258.79 ° F
Critical temperature : -116.68 ° F
Critical pressure : 667.2 psi
Heat of combustion : 2.15E+04 Btu/lb
Flame temperature : 1880 ° F

CALCULATED PROPERTIES
Liquid compressibility factor : 0.004
Liquid density : 29.69 lb/cu ft

DIMENSIONS
Pool width : 109.0 ft
Pool length : 121.0 ft
Pool liquid height : 4.0 ft
Height of flame base : 4.0 ft
Height for Radiation Calculations : 1.64 ft

LOCAL AMBIENT CONDITIONS
Air temperature : 3.0 ° F
Ambient pressure : 1.0 atm
Wind speed : 27.0 mph
Relative humidity : 24.0%

RESULTS
Mass burning rate : 0.023 lb/ft² s
Flame length : 168.21 ft
Flame tilt from vertical (front view) : 61.75°
Flame tilt from vertical (side view) : 61.2°
Flame drag ratio (front view) : 1.57
Flame drag ratio (side view) : 1.51
Maximum emissive power : 60,230 Btu/ft² hr
Effective emissive power (front view) : 60229.67 Btu/ft² hr
Effective emissive power (side view) : 60229.67 Btu/ft² hr

Front view (view along dike/trench width)

Thermal flux (Btu/ft² hr)	Distance from center of pool (ft)
1000	347.07
4000	430.45
1600	550.98

Side view (view along dike/trench length)

Thermal flux (Btu/ft² hr)	Distance from center of pool (ft)
1000	345.92
4000	426.71
1600	542.61

Maximum emissive power : 190.0 kW/m**2
Front view (view along dike/trench width)

Distance from center of pool (ft)	Thermal flux to horizontal target (Btu/ft² hr)	Thermal flux to vertical target (Btu/ft² hr)	Maximum flux to target (Btu/ft² hr)
81.75	Target in flame	Target in flame	Target in flame
109.00	Target in flame	Target in flame	Target in flame
136.25	51,564	25,283	53,266
163.50	47,767	26,254	50,890
218.00	35,543	22,694	40,739
272.50	18,413	18,323	25,975
327.00	6,272	11,362	12,977
436.00	916.51	3,688	3,800

654.00	101.00	907.39	912.93
1,090	11.14	214.03	214.31

Side view (view along dike/trench length)

Distance from center of pool (ft)	Thermal flux to horizontal target (Btu/ft² hr)	Thermal flux to vertical target (Btu/ft² hr)	Maximum flux to target (Btu/ft² hr)
90.75	Target in flame	Target in flame	Target in flame
121.00	Target in flame	Target in flame	Target in flame
151.25	49,806	26,027	52,254
181.50	44,097	25,187	47,797
242.00	28,203	19,986	34,005
302.50	10,763	14,175	17,798
363.00	3,142	7,419	8,057
484.00	485.64	2,380	2,429
726.00	59.60	618.58	621.43
1,210	7.02	151.49	151.65