Memorandum

To: Mr. John M. Hunt, *de maximis, inc.*

CC:

From: TerraTherm, Inc.

Date: 6/21/2011

Re: SRSNE Constructability and HAZOP Review

On March 7, 2011 a Constructability Review (CR) of the Solvents Recovery Service of New England, Inc. (SRSNE) Superfund Site In-Situ Thermal Remediation (ISTR) project was held at the TerraTherm, Inc. (TTI) office located in Fitchburg, MA and via telephone conference all. Participating at the meeting were:

> TTI: Jim Galligan, Dave Brogan, Prakash Acharya, Renée Lagassé, Larry Conant, Robin Swift, John LaChance, Gregg Crisp, Phil Theriault (phone), and Nick LaChance (phone)

The Constructability Review, focused on reviewing and cross-checking between the site layout and the availability of utilities to coordinate system functionality. In addition, we performed an extensive review of the on-going progress in finalizing the wellfield layout, specifics of the drilling sequence/well installation, and cover. Detailed tables of the discussions, action items, and resolutions have been included in Appendix A. Appendix B includes reference drawings that were used during the CR.

A summary of the items reviewed during the meeting is as follows:

I. Discussion of Site Logistics
II. Discussion of Site Layout
    a. Make reference to available figures, attached to memo in Appendix A
III. Discussion of Site Utilities
    a. Electric
    b. Gas
    c. Sewer
    d. Water
IV. Discussion of Wellfield
    a. Number and type of wells
    b. Stockpiling materials
    c. Drilling sequence
    d. Handling cuttings
    e. Installation
V. Cover
VI. Manifold Runs

10 Stevens Road

Fitchburg, MA 01420

978-343-0300…978-343-2727

VII. Process equipment

On March 14 and 15, 2011 a Hazard and Operability (HAZOP) Review of the Solvents Recovery Service of New England, Inc. (SRSNE) Superfund Site ISTR project was held at the TerraTherm, Inc. (TTI) office located in Fitchburg, MA and via telephone conference all. Participating at the meeting were:

March 14: Jim Galligan, Dave Brogan, Prakash Acharya, Renée Lagassé, Larry Conant, Robin Swift, John LaChance, Gregg Crisp, Phil Theriault (phone).

March 15: Jim Galligan, Dave Brogan, Prakash Acharya, Renée Lagassé, Larry Conant, Robin Swift, John LaChance, Gregg Crisp.

The Hazard and Operability (HAZOP) review was a structured and systematic examination of the current wellfield and electrical design, and the vapor/liquid treatment system piping & instrumental diagram (P&IDs) for the SRSNE Superfund Site. The system was broken down piece-by-piece to identify, evaluate and rank potential problems that may represent risks to personnel, public, equipment, or the environment. The following summarizes how the potential risks were categorized and ranked:

Severities (S) of risk

Level 1	Personnel	Potential for injury requiring first aid
	Public	Minor transient odor or nuisance
	Environmental	Contained release
	Equipment	Damage/loss of equipment up to $10,000
Level 2	Personnel	Potential for severe injury requiring physician's care (i.e. lost-time accident)
	Public	Persistent odor or nuisance, causing multiple complaints
	Environmental	Small uncontained release with potential for minor environmental impact
	Equipment	Damage/loss of equipment worth $10,000 up to $100,000
Level 3	Personnel	Potential for life threatening injuries or fatality
	Public	Exposure to potential injurious hazards
	Environmental	Uncontained release with potential for environmental impact
	Equipment	Damage/loss of equipment greater than $100.000

Likelihood (L) of risk

Level 1	Unlikely	1 event per year
Level 2	Potential	1 event per month
Level 3	Probable	1 event per day

A Risk Ranking (RR) was then calculated for each identified risk by the following equation:

RR= S x L

Where a high RR would represent a highly likely event of a high severity, and where a low RR would represent a low likely event of low severity.

The following presents a summary of items reviewed during the HAZOP:

I. Wellfield
   a. Heater wells
   b. VEW wells
   c. Temperature monitoring wells
   d. Pressure monitoring wells
   e. Surface cover
   f. Wellfield vapor piping

II. Electrical
   a. Utility power
   b. Standby generator
   c. Switchgear
   d. Phone line

III. P&ID 102 Sheet 6 – Treatment System Utilities
   a. Cooling tower W-101
   b. Air compressor Z-104

IV. P&ID 102 Sheet 1 – Gas Conditioning
   a. Moisture separator S-102
   b. Vacuum blower B-101A/B
   c. Caustic Tank T-102

V. P&ID 102 Sheet 2 – Gas Conditioning
   a. Vapor chiller E-102A/B
   b. Moisture separator S-102
   c. Duct heater H-101

VI. P&ID 102 Sheet 3 &4 – Thermal Oxidizer
   a. Burner Z-101A/B
   b. Thermal Oxidizer F-101A/B
   c. Thermal Relief Valve

VII. P&ID 102 Sheet 5 – Quench/Scrubber System
   a. Cooling blower B-105
   b. Emergency water T-108
   c. Quench/Scrubber A-101
   d. Caustic Tank T-101

VIII. P&ID 102 Sheet 7 – Liquid Treatment System
   a. Oil/water Separator S-103
   b. Bag filter FX-101A/B
   c. Air stripper Z-103
   d. Air Stripper vacuum blower B-104A/B
   e. Carbon cells C-101A/B

Detailed tables presenting the identified hazards, their rankings, and the measures/changes that will be taken to mitigate the hazards, if necessary, are included in Appendix C. The P&ID's, Wellfield, and Electrical designs have been attached to Appendix D.

Appendix A

Constructability Table

SRSNE CONSTRUCTABILITY REVEIW WORKSHEET
Date: 3/7/11

System ID	Discussion		Comments
Site Logistics	Access to Targeted Treatment Zone		-Arcadis to provide final grade plan. -Arcadis needs to complete sheet pile installation. -Process equipment aread to be completed while wells are being installed. -Arcadis will do the compacting of the area.
	Structures, fencing, adjacent properties		
	Overhead and underground obstructions and/or utilities		
	Site topography and grading requirements:	by others	
	Site drainage and storm water management:	by others	
Utilites	Electric	Capacity: approx 4.5 MW	
		Location: Southeast of wellfield, south of process equipment area	
	Gas	Capacity: up to 20 MMBtu/hr	
		Location: Northeast of wellfield toward NTCRA 1 Treatment System.	
	Sewer	Capacity: 30 to 60 GPM	
		Location: Northeast of wellfield toward NTCRA 1 Treatment System.	
	Water	Capacity: To be verified	
		Location: Northeast of wellfield toward NTCRA 1 Treatment System.	

SRSNE CONSTRUCTABILITY REVEIW WORKSHEET
Date: 3/7/11

System ID	Discussion		Comments	
Wellfield	Number and types of wells	593 HO	-SOP's will be drafted by Robin and Renee. -Stake ends of HEW.	
		550 VEW		
		200 linear feet of HEW		
	Stockpiling materials:	in wellfield		
	well drilling sequence:	to be determined. Generally from south to north		
	Handling cuttings:	to be determined by *de maximis*		
	Installing heater cans:	manual insertion		
	Installing vapor extraction wells	TT to place screens and fill		
	Installing monitoring wells:	to be determined		
Cover	Stockpiling materials:	to be finalized with contractor. May deliver dry material in bulk		
	Concrete pour:	aerated concrete.	Being finalized by Kevin Crowder	
	Vertical Sections:	to be finalized.	May be aerated concrete behind insulating sheet. Pour lower sections first.	
Manifold Runs	Stockpiling materials:	on-site in wellfield		
	Pipe Runs:	four main 8" headers going to 6" and 4" branches. HEW 6" connector		
	Pipe Support:	Standard pipe supports		
	Line Termination:	transition to process equipment to be finalized.		

SRSNE CONSTRUCTABILITY REVEIW WORKSHEET
Date: 3/7/11

System ID	Discussion		Comments	
Electrical	Power drop pole to Process Equipment area pole:	can this be included with original lower drop?	-Can some portion of power be brought to the site on the northern end to power heaters in the NW corner? No -Secondary containment for transformers. Can we use biodegradable oil?	
	Trenches to transformer pads:	to be finalized with transformer selection		
	Transformer locations:	to be finalized with transformer selection		
	Transformer fencing:	to be finalized with transformer selection		
	Ground grid:	TT to install. Grounding rods at each skid with cross connection		
	AHJ testing requirements:	to be confirmed with client.		
	SCR shed:	On eastern edge of wellfield		
	Distribution panels:	On eastern edge of wellfield		
Process Equipment	Placement:	to be finalized after bids accepted		
	Secondary Containment:	to be determined after equipment is purchased	Secondary containment pad for all equipment? Just caustic tank?	Individual skids, to be finalized after vendors finalized.
Gas Connection	Gas Fitter:	Conatct authorized	Larry to follow up.	
Sewer Connection	No issues	to be completed by *de maximis.*		
Water Connection	No issues	to be completed by *de maximis.*		

Appendix B

Figures Referenced

-“Operations Area NTCRA 1 Containment Area and Former Cianci Property Map”
-“Pre-ISTR Site Plan T-1”
-SRSNE Vapor Trunk Lines Vapor Manifold ELEV Detail”
-“Well Installations with Possible NAPL at the SRSNE Superfund Site”

PHASE 1

PHASE 2

N

APPROX. SCALE

0 20' 40' 60' 80'

LEGEND

- HEATER WELL 15' – 80
- HEATER WELL 18' – 262
- HEATER WELL 24' – 251
- THERMAL TREATMENT ZONE
- SURFACE COVER

REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
A	02/25/11	DC			3/2: ADDED SUBSTATION	

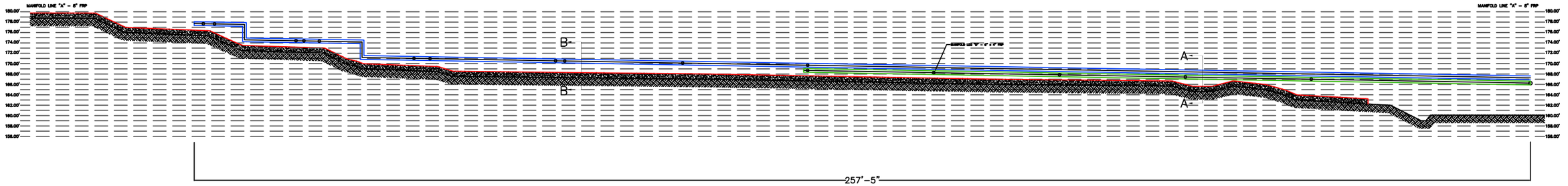
TERRATHERM

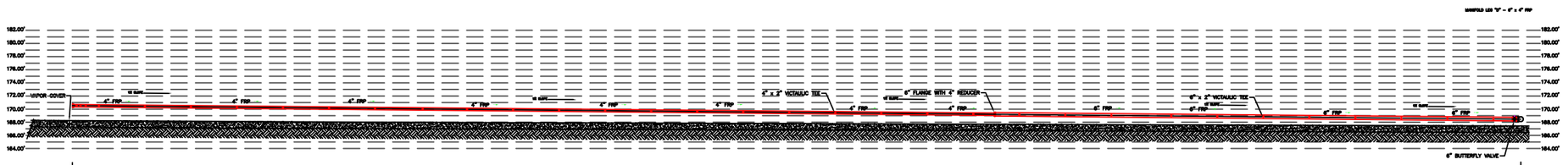
SRSNE SUPERFUND SITE

WELLFIELD LAYOUT

SIZE	FILE NO.	DWG NO.	REV
D	E102	E102	A

SCALE: AS SHOWN | DNS | SHEET 1 OF 1



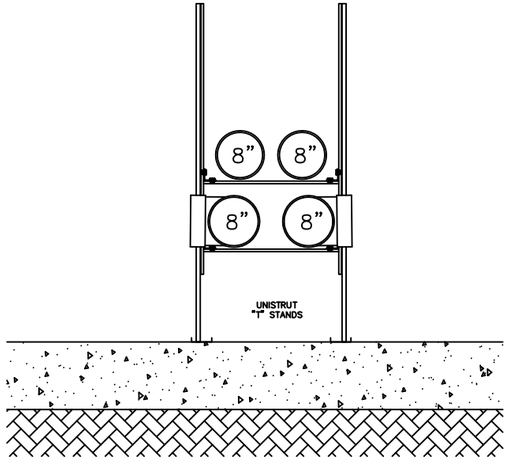


PRELIMINARY

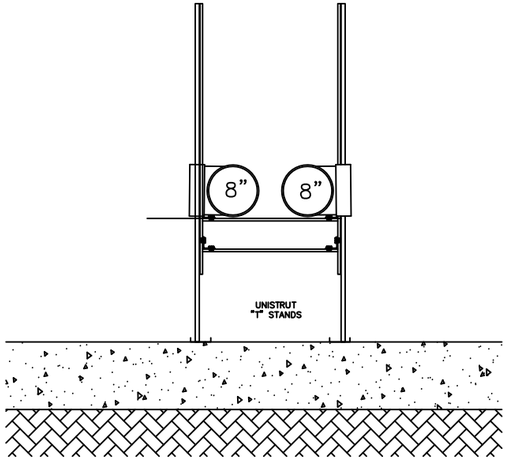
APPROX. SCALE

0 120' 240' 360' 480'

VAPOR LINE CROSS SECTION DETAIL A
SCALE: NTS



VAPOR LINE CROSS SECTION DETAIL B
SCALE: NTS



REVISIONS						
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
A	3/7/11	DB			ISSUED FOR REVIEW	

TERRATHERM INC.

SRSNE
VAPOR TRUNK LINES
VAPOR MANIFOLD ELEV DETAILS

SIZE	FILE NO.	DWG NO.	REV
D	SRS-5101	SRS-5101	A

SCALE 1"=80' | DNS | SHEET 1 OF 1

Relocated fiber optic line route

Terracing provides 10- to 12-ft access roads to allow drill rig access to sloped area while minimizing fill volume. TerraTherm to confirm that drill rig will be able to install wells at target locations using this layout.

Assumed property acquisition area

This well constricts grading north to the property line... can it be eliminated?

This will be the planned electric utility drop point. TerraTherm to design ISTR power distribution assuming this source location.

We'll move this location to the location indicated, as well as a second pole to the north.

TerraTherm to confirm size and location of equipment staging area

Planned utility connection area

N/F
Jadel Farms, Inc.
Vol. 327 p. 888

N/F
Raymond & Yolanda Yorski
Vol. 323 p. 950

SURFACE COVER

OVERBURDEN NAPL AREA

~125'

PROCESS EQUIPMENT AREA

NTCRA 1 TREATMENT SYSTEM BUILDING

TP #4

TP #5

PRELIMINARY
NOT FOR CONSTRUCTION

CITY:SYRACUSE, NY - DIV/GROUP:ENV/CAD DB:KMD GJD RLS LD: PIC: PM:J. MORGAN TM:J. MORGAN LYR:ON=*;OFF=*REF*
G:\ENV\CAD\STRACUSE\ACT\B0054634\0000\01400\DWG\CONTRACT\54634306.dwg LAYOUT: T-1 SAVED: 1/21/2010 3:09 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ---PLOTSTYLETABLE: PLTCONT1.CTB PLOTTED: 1/21/2010 3:12 PM BY: DECLERCQ, BRIAN
XREFS:
54634X00
54634X01
54634X03
54634X02
IMAGES:
PROJECTNAME: ---

1"=30' 30' 0 30' 60'

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:

USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: JEFFREY HOLDEN
Professional Engineer's No.: 0023403
State: CT
Date Signed:
Project Mgr.:
Designed by: JEM
Drawn by: KLS
Checked by: PHB

ARCADIS U.S., INC.

SRSNE SUPERFUND SITE • SOUTHINGTON, CONNECTICUT
PRE-ISTR DESIGN REPORT

PRE-ISTR SITE PLAN

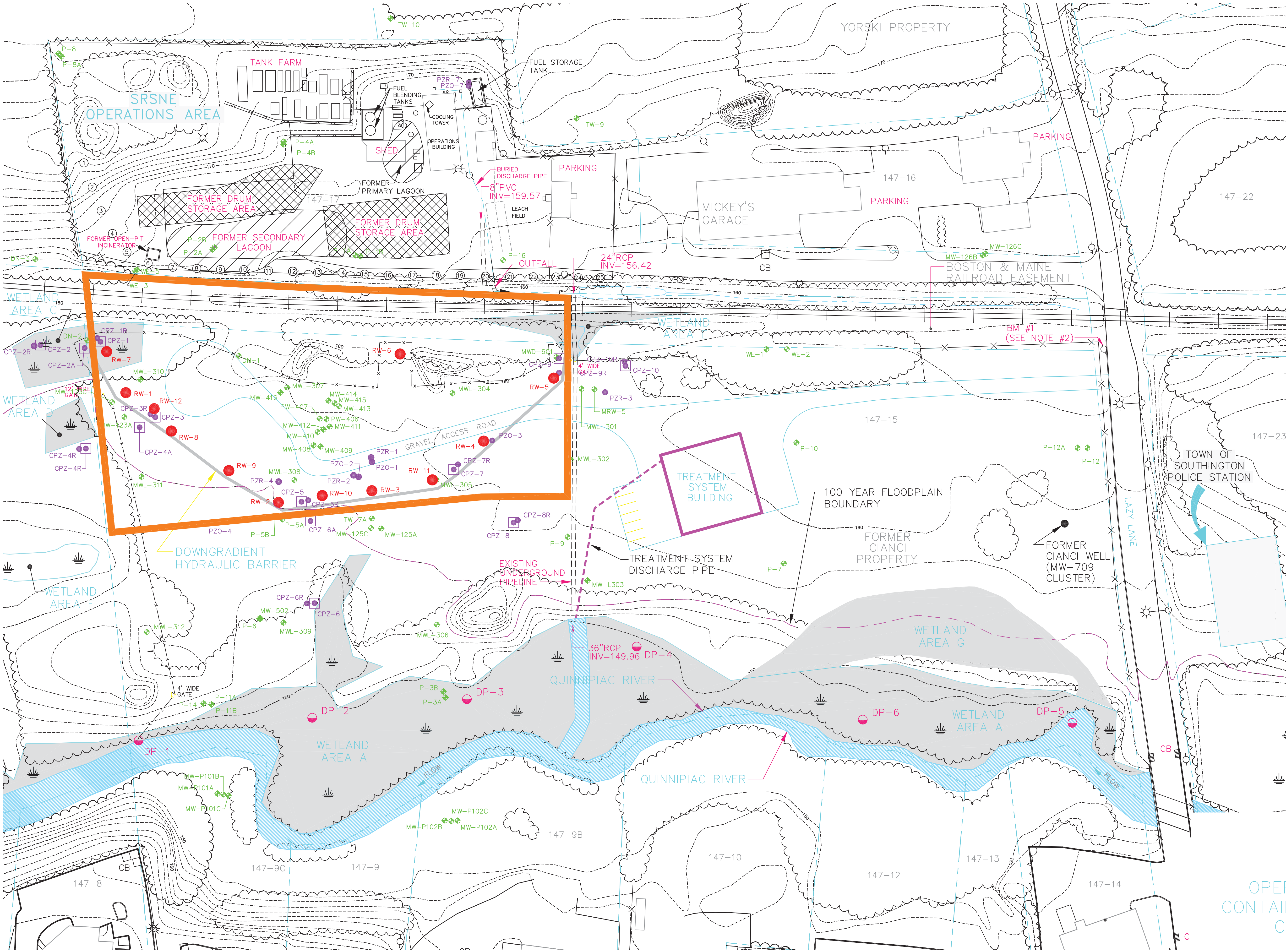
GENERAL

ARCADIS Project No.
B0054634.0000.01400

Date
FEBRUARY 2010

ARCADIS
6723 TOWPATH ROAD
P.O. BOX 66
SYRACUSE, NY 13214-0066
TEL. 315.446.9120

T-1



LEGEND

	PROPERTY LINE
	100-YEAR FLOOD LIMIT
	WATER
	RIVER
	WETLAND
	NTCRA 1 CONTAINMENT AREA
	EXISTING STRUCTURE
	VEGETATION
	EXISTING CONTOUR
	FENCE
P-10	PREVIOUSLY INSTALLED MONITORING WELL
PZR-3	NTCRA 1 PIEZOMETER
CPZ-10	NTCRA 1 COMPLIANCE PIEZOMETER
RW-1	NTRCA 1 OVERBURDEN EXTRACTION WELL
DP-5	WETLAND DRIVE POINT
147-12	LOT NUMBER
	ABOVE-GROUND TANK
(12)	FORMER ON-SITE INTERCEPTOR SYSTEM EXTRACTION WELL
	UTILITY POLE
	LIGHTING
	PROPOSED COMPLIANCE PIEZOMETER

NOTES

1. SITE PLAN TAKEN FROM DIVERSIFIED TECHNOLOGIES CORP., 556 WASHINGTON AVE., NORTH HAVEN, CT, DATED 6/93. TOPOGRAPHY REPORTED TO HAVE BEEN DIGITIZED FROM TOWN OF SOUTHINGTON TOPOGRAPH MAPS G-7, G-8, G-9; PHOTOGRAPHY DATED NOV. 1978, SCALE: 1"=100'. PROPERTY LINES REPORTED TO HAVE BEEN DIGITIZED AND LOT NUMBERS TAKEN FROM "PROPERTY MAP, TOWN OF SOUTHINGTON" MAPS 134 & 147, SCALE: 1"=100' BY DIVERSIFIED TECHNOLOGIES CORPORATION.
2. BENCHMARK #1 IS AT ELEVATION 164.03. PK NAIL; S'LY SIDE; POLE #9049.
3. THE 100-YEAR FLOOD LIMIT AND WETLAND AREAS WERE TAKEN FROM THE FINAL REMEDIAL INVESTIGATION REPORT (HNUS, MAY 1994). THE 100-YEAR FLOOD LIMIT WAS REVISED TO FOLLOW THE ELEVATION 156 CONTOUR BASED ON INFORMATION PROVIDED BY THE SOUTHINGTON TOWN ENGINEER.
4. THE LOCATIONS OF EXISTING DRIVE POINTS, WELLS AND PIEZOMETERS ARE APPROXIMATE ONLY.

0 50' 100'
GRAPHIC SCALE

OPERATIONS AREA, NTCRA 1 CONTAINMENT AREA, AND FORMER CIANCI PROPERTY MAP

X: 08331X01, 08331X05
L: ON=*, OFF=*,REF VIEW: 50
P: PAGESET/SYR-DL2B1
5/24/05 SYR-85-PGL DMJ GJD
08331009/FEASIBILITY/08331B01.DWG

Appendix C

HAZOP Table

HAZOP WORKSHEET
SRSNE Superfund Site HAZOP Review Date: 3/14/11 - 3/15/11
Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
1) Sheets SRS-5102, E102, C107, C109 - Wellfield, Heater Wells, Probes and Vapor Manifold									
1-1 Heater Wells	1) Heater overheats	Potential heater failure	1	2	2	Monitoring thermocouples are installed two per circuit leg minimum, schedule 80 pipe.	Monitor TCs daily, limit temp to 1200°F, profile heater temps weekly, set at the hottest depth. Heater temperature monitoring system to be automated.		Bring back up TCs into Temperature Monitoring Point (TMP) system; consider separate monitor system for heater TCs to avoid electrical issues on wellfield TMP system
		Multiple heater failure in same area	1	2	2	Recircuit after profiling heaters.	Consider having an alarm for all the back-up TCs for the circuits.		
	2) Heater Thermocouple Fails	Loss of heater monitoring	1	1	1	Type K inconel thermocouples utilized for high temp application, flex cord connector typical to minimize damage at connector. Back up TCs installed on each circuit leg, keep spares on site			
	3) Heater shorts electrically	Potential current to ground	2	2	4	Circuit breaker, fused SCR, ceramic insulators. Keep spare heaters on site. Monitor circuit amperage regularly	Visual check of cables, connections, ohmmeter/megohmmeter check for shorts at the commissioning phase. Isolate circuit leg/heater remove, repair , replace as necessary. Use IR cameras to look for trouble spots.		
	4) Heater well leaks	COCs released to the atmosphere, H&S issue	1	2	2	Robust well design, additional well liner is included to prevent the leak	Whenever well leaks, use the available SOP to prevent liquid and vapor leak to the atmosphere. Drager tubes at site and ambient air monitoring.		
1-2 VEW	1) VEW well clogs	Potential COCs / steam leakage at surface cover penetrations with decreased vapor control	1	1	1	Well screen / sandpack sized properly, SS screens, concrete surface cover, redundant vapor extraction capacity in wellfield	Check vacuum well riser temps regularly for flow indication, address blockage when detected.		
	2) VEW connection material degradation	Potential vacuum leakage, maintenance issues	1	2	2	Threaded connections minimized (thin wall of the thread and hose barb are the first to corrode through), condensing collection points minimized. Slope connections to manifold pipe from riser.	Riser may need to be insulated to minimize condensing corrosion		
	3) Vaporization of NAPL	LEL generation	2	1	2	Sufficient water vapor is present to maintain safe LELs.			
1-3 Temperature Monitoring Wells	1) Temperature sensor malfunctions, reading high or low	No hazard concern - operational	1	1	1	Run instrument wiring away from power cable, cross at 90 degree angle, check temp monitoring well for liquid. Shielded cable for protection.			
1-4 Pressure Monitoring Wells	1) Positive pressure readings	May indicate potential for surface vapor release	1	1	1	Redundant vacuum coverage, concrete surface cover	Check vacuum wells in the area, adjust as necessary. Conduct daily wellfield observation.		
1-5 Surface Cover	1) Surface cracking occurs or surface damage	May allow surface water penetration, ambient air vacuum leakage, vapor release or moisture intrusion may affect insulating value	1	2	2	Surface cover may be installed in lifts with control joints, surface seal, etc.	Monitor and repair, seal, etc.		

HAZOP WORKSHEET
SRSNE Superfund Site HAZOP Review Date: 3/14/11 - 3/15/11
Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
1-6 Wellfield Vapor Piping	1) Condensate build up in branch lines or vapor well connections	May lead to loss of vacuum influence	1	2	2	Piping is sloped 1% typical to collection point / treatment equipment	Inspect hose connections regularly, eliminate any low spots, piping supports must be spaced to prevent sagging		
	2) Material degradation	Potential vacuum leakage	1	1	1	FRP pipe temperature rating is in the 250 to 300F range, corrosion resistance rating is typically for the inner tube	Monitor VEW temperatures entering the FRP pipe, properly seal any penetrations made through the wall of the pipe. Properly seal any cuts through the pipe.		

VEW - Vapor Extraction Wells; SCR - Silicon Controlled Rectifier

HAZOP WORKSHEET
SRSNE Superfund Site HAZOP Review Date: 3/14/11 - 3/15/11
Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
2) Global Issues - Electrical									
2-1 Utility Power	1) Transformer Fans Malfunctions	Potential Damage to Transformer	2	1	2	Temperature Gauge / Readout	Periodic fan inspection once every month. Specify a temperature limit on the operator data sheet.		
	2) Transformer leaks oil	Overheating of Transformer due to lack of coolant. Environmental Release. Potential danger to personnel.	2	1	2	Liquid Level Gauge, Temperature Gauge. Personnel to wear appropriate PPE around equipment.	Containment and Periodic Inspection once every month		Evaluate the use of bio-degradable oil.
	3) Transformer Internal Faults	Power Interruption to site. Damage to equipment	2	1	2	Standby Generator and Automatic Transfer Switch to provide power to critical equipment. Fuses and circuit breaker to limit damage for equipment.	Transformer to be tested prior to connecting to the grid.		
	4) Low Voltage Cable Failure	Electrical Equipment damage.	2	1	2	Fuses and breakers to protect equipment	Consider installing spare conduit for emergency cable run. Have spare cable on site for emergency repair		
2-2 Standby Generator	1) Diesel Fuel Leak	Environmental Release. Insufficient fuel to run generator	2	1	2	Secondary containment, subsequent start-ups and monthly inspection		YES	
	2) Failed Battery / Failed block heater	Generator fail to start. Unable to provide power to critical equipment	1	1	1	Once a week generator test		YES	
	3) Automatic Transfer Switch fail to transfer load	Unable to provide power to critical equipment during outage	1	1	1	Manual transfer.		YES	
	4) Generator internal faults	Generator Damage. Unable to provide power to critical equipment during outage.	2	1	2	None		YES	
2-3 Switchgear	1) Breaker fail to trip	Additional equipment damage may result	2	1	2	Upstream breaker will operate. More loads may be taken offline as a result			
	2) Switchgear internal bus fault	Switchgear damage and equipment damage. Possible danger to personnel. Potential ignition source	3	1	3	Upstream breaker will operate. More loads may be taken offline as a result. Proper PPE for personnel. Good Housekeeping around equipment. Ensure that a second person checks inside the cabinet before re-energizing to minimize the likelihood of having loose wires or tools left in cabinet.	Switchgear to be tested at shop and site prior to startup	YES	
2-4 Phone Line	1) Phone line cut	No outside communication to site system	1	1	1	Operator schedule to limit downtime.	Have an automatic dial out to check connection once a day.		

HAZOP WORKSHEET
SRSNE Superfund Site HAZOP Review Date: 3/14/11 - 3/15/11
Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
3) P&ID 102 Sheet 6 - Treatment System Utilities									
3-1 Cooling Tower W-101	1) High W-101 Cooling Tower level	Overflow of cooling water onto ground	1	1	1	High level switch LS-601	Install an overflow line to the ground.	Yes, water.	
	2) Low W-101 Cooling Tower level	Starve cooling water pump P-101A/B, loss of cooling for E-101	1	1	1	TIT-101 on inlet to moisture separator S-101 will indicate high temperature	Add high temperature alarm on TIT-101		
	3) Fan motor burns up	Smoke, possible electrical short	1	1	1	Circuit breakers	Identify back-up motor.		
	4) Cooling tower freezes up	Starve cooling water pump P-101A/B, loss of cooling for E-101	1	2	2	Immersion heater			
	5) Biological or mineral fouling of tower	Starve cooling water pump P-101A/B. Clog cooling water packing. Diseases, loss time for illness.	2	1	2	Bioagent, chlorine duck, periodic maintenance, check water quality periodically.			
	6) Low water hardness	Starve cooling water pump P-101A/B. Clog cooling water packing. Diseases, loss time for illness.	2	1	2	Water is already soft enough.			
3-2 Air Compressor Z-104, Air Receiver Z-105, Air Dryer Z-106	1) High air pressure in Receiver Z-105	Potential property damage and injury	1	1	1	Pressure relief valve PRV-601 is designed to relieve at 125 psig. Receiver tank is a code-rated tank. Piping should be pressure tested beyond pressure relief valve setting.			
	2) Low air pressure in Receiver Z-105	Loss of control valves	1	1	1	PSL-601 on air receiver and PSL-602 on instrument air provide early warning. Critical valves are all spring loaded to their safe position.	Install alarms on PSL-601 and PSL-602		
	3) Air Compressor Z-104 shuts down on internal fault	Loss of compressor oil causes contained spill	1	1	1	Low oil pressure would shut down compressor			
	4) Air Dryer Z-106 failure	Loss of pressure due to clogging with oil	1	1	1	None.	Keep spare dessicant modules in TerraTherm warehouse.		
	5) PCV 601 failure	High pressure downstream	1	1	1	PSH-602			
	6) PRV 601 failure	High pressure downstream	1	1	1	PSH-602			

HAZOP WORKSHEET
SRSNE Superfund Site HAZOP Review Date: 3/14/11 - 3/15/11
Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
4) P&ID 102 Sheet 1 - Gas Conditioning									
4-1 Vapor Cooler E-101A/B	1) High incoming vapor temperature	Potential damage to expansion joints and gaskets	1	1	1	Interlock 101. Shutdown wellfield block valve to prevent additional damage.	Expansion joints should be rated for at least 250 deg F. Add high temperature alarm to TIT-101.	Yes	
	2) High incoming vapor pressure	No Hazard	N/A	N/A	N/A	None required.			
	3) High vacuum	No Hazard	N/A	N/A	N/A	S-101 is equipped with vacuum relief valve.			
	4) P-102A/B shutdown on motor overload or other problem	Back liquid up into vapor path	2	1	2	LAH-101 will alarm. Manually start the spare pump. Interlock 101 shuts down wellfield block valve to prevent additional damage.			
	5) High cooling water temperature	Lose adequate cooling for vapor	1	1	1	TI-103, TI-104 and TI-105 provide indication of inlet and outlet cooling water temperature. TI-102, TI-106, and TI-107 provide local indication of inlet and outlet vapor temperature	Add high temperature alarm on TIT-101		
	6) Cooling water leak in heat exchanger tubes due to corrosion/cracking	Lose adequate cooling for vapor, additional liquid in condensate system	1	1	1	Pre-installation pressure test.	Monitor operational data in water usage.		
	7) Gasket leak in ducts due to material of construction	Exposure to fugitive vapors	1	1	1	Expanded teflon material of construction	Conduct preventive visual inspection daily.		
	8) High pressure drop	Plugged tubes, fugitive vapors	1	1	1	Monitor pressure gauges PI-110, PI-105		Yes	
4-2 Moisture Separator S-101	1) High high liquid level	Back liquid up into vapor path	1	2	2	LSH-101 turns on P-102A/B. Add interlock to shutdown vacuum blowers to avoid pulling water into blowers on high-high level (LSHH-101) of S-101. Additionally wellfield block valve would shut. Equipment specification sheet specifies as a standard item to keep sensors on stilling well.	Add an additional port for a pipe connection for overflow on S-101.		
	2) Low liquid level	Potential vacuum leak, damage to P-102A/B	1	2	2	Check valves CK-101 and CK-102 will prevent vacuum leak.	Add LSLL to S-101 shut down pumps P-102A/B.		
	3) P-102A/B high discharge pressure / dead-head	Damage pump, piping	1	1	1	Centrifugal pumps are used.	Plan to test piping at 1.5 x max. operating pressure or max. available, whichever is less		
	4) P-102A/B shutdown on motor overload or other problem	Back liquid up into vapor path	1	1	1	LAH-101 will alarm on high-high level. Shutdown wellfield block valve to stop additional liquid build-up.	Add manual valve with a tee under the motorized valve for dilution air upstream of E-101A/B		
	5) High vapor temperature	Potential damage to expansion joints	1	1	1	Automatic dilution air	Expansion joints should be teflon-lined and rated for high vapor temperature.		
		Failure of tank liner	1	1	1	Automatic dilution air	Add high temperature alarm on TIT-101		
	6) High vacuum	Implode vessel	2	1	2	PI-110 after extraction well; VRV-101 on S-101	Vessel should be designed for 1.5x higher vacuum than the blower.		

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Revision date: 3/30/11

System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
4-3 Vacuum Blowers B-101A/B	1) Filter FX-102A/B plugs	Loss of vacuum in wellfield, fugitive emissions	1	1	1	Monitor PI-105, PI-106 at blower inlet.	Keep spare filters on site. Put a local DP with red line marking max DP that needs to be serviced.		
		Block or decreased vapor flow, damage to blower.	1	1	1	Monitor PI-105, PI-106 at blower inlet.	Maintain filter per manufacturer's instruction/recommendation. Put a local DP with red line marking max DP that needs to be serviced.		
	2) Water accumulation in FX-102A/B	Loss of blower and loss of vacuum in wellfield	1	2	2	Conduct preventive drain of filters as required.			
	3) High high liquid level in S-101	Back liquid up into vapor path	1	1	1	LSH-101 turns on P-102A/B. Add interlock to shutdown vacuum blowers to avoid pulling water into blowers on high-high level (LSHH-101) of S-101. Additionally block valve would shut.	Add an additional port for a pipe connection for overflow on S-101.		
	4) Low liquid level in S-101	Potential vacuum leak, damage to P-102A/B	1	2	2	Check valves CK-101 and CK-102 will prevent vacuum leak.	Add LSLL to S-101 shut down pumps P-102A/B.		
	5) High vacuum in S-101	Implode S-101	2	1	2	PI-110 after extraction well; VRV-101 on S-101	Vessel should be designed for 1.5x higher vacuum than the blower.		
	6) B-101A/B shutdown on motor overload or other problem	Unable to maintain vacuum at well field.	2	1	2	PI-110 on the inlet to E-101A/B. Interlocked with thermal oxidizer.	Start-up back up blower.		
	7) Sparks are caused by metal-on-metal contact	Potential deflagration	3	1	3	Because of high moisture content in the gas, LEL will be low.			
	8) High Temperature	Electrical short	1	1	1	Thermal protection on motor and VFD.			
	9) Oil leak	Slip and environmental hazard	1	1	1	Structure built within containment			
4-4 Caustic Tank T-102, Pump P-111	1) Liquid freezing	Unable to supply caustic to separator S-101	1	1	1	Use cold weather blend.	Switch to higher strength caustic during cold weather.		This drum will be too big to use drum heaters.
	2) Chemical metering pump P-111 unable to maintain pH level	Ineffective flow of caustic to separator S-101	1	1	1	pH gauge GE-101. Monitor/adjust/clean pH loop on a regular basis.	Decrease flow from wellfield operationally so that pump is sized correctly. Interlock I-103 and GC-103 should be removed. Remove BA-123 and install 3-way solenoid valve at intersection so that it is either re-circulating or discharging through FQIT-101.		
	3) Chemical addition line failure	Spray caustic	2	1	2	Conduct preventive visual inspection of the piping daily. Use proper PPE.			
	4) Low caustic level in drum	Unable to supply caustic to separator S-101. Potential leak at caustic drum.	2	1	2	Secondary containment. Daily inspection of drum is required.			
	5) Air in sensor	Incorrect reading from pH sensor, and no caustic added.	2	1	2	Proper installation to minimize air accumulation			
	6) Dirty pH probe	Incorrect reading from pH sensor, and no caustic added.	2	1	2	Periodic maintenance			

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
5) P&ID 102 Sheet 2 - Gas Conditioning									
5-1 Moisture Separator S-102	1) High high liquid level	Back liquid up into vapor path	1	2	2	LSH-201 turns on P-103A/B. Add interlock to shutdown vacuum blowers to avoid pulling water into blowers on high-high level (LSHH-201) of S-102. Additionally block valve would shut.	Add an additional port for a pipe connection for overflow on S-102.		
	2) Low liquid level	Potential vacuum leak, damage to P-102A/B	1	2	2	Check valves CK-201 and CK-202 will prevent vacuum leak.	Add LSLL to S-102 shut down pumps P-103A/B.		
	3) P-103A/B high discharge pressure / dead-head	Damage pump, piping	1	1	1	Centrifugal pumps are used.	Plan to test piping at 1.5 x max. operating pressure or max. available, whichever is less		
	4) P-103A/B shutdown on motor overload or other problem	Back liquid up into vapor path	1	1	1	LAH-201 will alarm on high-high level. Shutdown wellfield block valve to stop additional liquid build-up.			
	5) High vapor temperature	Potential damage to expansion joints	1	1	1	Automatic dilution air	Expansion joints should be teflon-lined and rated for high vapor temperature.		
		Failure of tank liner	1	1	1	Automatic dilution air	Add TIT and high temperature alarm on the inlet to S-102. Add TAH-202 on TIT-202 on outlet of S-102.		
	6) PRV-201 releasing vapors to atmosphere	Offsite release possible	2	1	2	Self-closing valve		Yes	
5-2 Duct Heater H-101	1) High vapor temperature on outlet of duct heater	Damage to heater coil.	1	1	1	TIC-203 is the control and TSH-201, I-203 will reduce the heater power input.			
	2) Low outlet temperature	Damage to oxidizer due to condensation	2	1	2	Monitor the temperature			
5-3 Dilution Air Blower B-102	1) Dilution air blower failure	Loss of LEL control	1	1	1	Perform periodic maintenance. Also, dilution valves throughout the system.	Remove PSL-201 and I-202 and do all the operations with butterfly valve BF-203.		

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
6) P&ID 102 Sheet 3 & 4 - Thermal Oxidizer									
6-1 Burner Z-101A/B	1) Loss of combustion air	Loss of burner, process upset, generation of carbon monoxide	1	1	1	NFPA Logic. If B-103A/B and B-106A/B fail, I-310 will shut down the burner. Both burners have an installed spare blower. If TCV-302 fails, TCV-301 will close.	Add check valves on outlet of each blower. Relocate PSL-302/402 and I-310/410 onto main line.		
	2) Natural gas high pressure	Possible burner blowout, loss of temp control, possible equipment damage	2	1	2	NFPA Logic, TCV-301, PSH-301, TCV-401, PSH-401. Will shut down the burner.	Add pressure regulator after BA-309 for each oxidizer.		
	3) Loss of natural gas pressure	Loss of burner, process upset	1	1	1	PSL-301, PSL-401 will shut down the burner.			
	4) Burner refractory damage	Hot gas exposure to metal	2	1	2	Inspection of refractory prior to start-up.	Monitor surface temperature on the shell of the reactor.		
	5) Pressure regulator leak	Release to the atmosphere	2	1	2	Periodic inspection; natural gas odor.		Yes	
6-2 Thermal Oxidizer F-101A/B	1) High LEL on inlet duct	High temperature vapor damages upstream piping and equipment. Release of COCs to the atmosphere.	2	1	2	No hazard because of high moisture content.			
	2) High process vapor heating value	Overheating of vapor	2	1	2	TE-301, TE-302, TE-401, TE-402	Investigate any NFPA requirements.		
	3) Reverse flow due to high back pressure	High temperature vapor damages upstream piping and equipment. Release of COCs to the atmosphere.	2	2	4	CK-301, CK-401 will prevent reverse flow.	Add check valves at blowers B-103A/B and B-106A/B discharge.	Yes	
	4) High exit vapor temperature	Damage of downstream equipment	2	1	2	TE-301, TE-302, TE-401, TE-402. Will provide indication and TAH alarms go off. B-105 will automatically open up when TE-501 indicates high T.	Work with vendor on oxidizer outlet valve placement and selection.	Yes	
	5) Low exit vapor temperature	Insufficient heating of vapor and low DRE. Release of COCs	2	1	2	TE-301, TE-302, TE-401, TE-402 will provide indication.			
	6) High pressure due to downstream equipment blockage.	Damage of downstream equipment	2	1	2	TRV-301 and TRV-401 opens up automatically. Wellfield block valve will be shut.			
	7) Scrubber packing melts	Increase in pressure in F-101A/B	2	1	2	Close wellfield block valve.	Interlock I-313 blocks the wellfield and opens TRV-301. Shuts down the process blower.		
	8) Flame failure	Unnecessary shutdown reducing system reliability. Release of COCs	2	1	2	Three redundant flame scanners installed for each oxidizer.		Yes	
	9) TE-301/TE-401 failure due to high temperature	Damage of downstream equipment.	2	1	2	Redundant thermocouples used. High temperature alarm on TI-302/402.			
	10) Free liquid carry over to Thermal Oxidizer	Loss of refractory in the thermal oxidizer	2	1	2	Moisture separator S-102 should prevent carry over			

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
6-2 Thermal Oxidizer F-101A/B	11) TE-302/TE-402 failure due to high temperature	Damage of downstream equipment.	2	1	2	Redundant thermocouples used. High temperature alarm on TI-302/402.			
	12) Thermal oxidizer internal installation falls off	Carbon steel shell overheats.	3	1	3	Proper conditioning of the refractory done during start-up. Inspection prior to start-up. Follow the correct refractory curing procedure from the vendor.			
	13) False flame signal	High natural gas flow into oxidizer	2	1	2	TE-301, TE-302, TE-401, TE-402 on oxidizer outlet.			
6-3 Thermal Relief Valve	1) Relief valve does not open	Damage to downstream equipment, high pressure	2	1	2	Wheel and chain assembly included. PIT-301 and PIT-401 will shut down the process system.			

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
7) P&ID 102 Sheet 5 - Quench/Scrubber System									
7-1 Cooling Air Blower B-105	1) Loss of flow from B-105	Hot vapor enters scrubber	2	1	2	TIC-501 indicates higher temperature.	Add an interlock to shut down burners. Add check valve between CV-501 and piping inlet line to quench.		
	2) B-105 shutdown on motor overload or other problem	May burn the FRP A-101 and melt packing.	1	1	1	TIC-501 indicates high temperature. Interlock TRV on oxidizer. Kynar packing and FRP shell.			
7-2 Reserve Water Tank T-108	1) High liquid level	Overflow tank within containment	1	1	1	Tank level normally maintained by P-110 on/off control.			
	2) Low liquid level	Damage P-110	1	1	1	Equipment specification sheet includes mechanical float in the tank.	Add level switch so that tank low level permissively disables P-110. Recommend daily visual inspection/periodic testing.		
	3) Loss of power	No emergency water to quench.	1	1	1	All pumps feeding T-103 (quench) as well as P-110 are backed up by standby generator.			
	4) P-110 discharge high pressure / dead head	Damage pump, piping	1	1	1	Piping design/testing pressure should be higher than pump dead head pressure.			
	5) SV-502 doesn't open	No emergency water to quench	2	1	2	None.	Provide a manual bypass to solenoid valve.		
	6) Frozen reserve water line	No flow to quench	2	2	4	Primary plant water line enters reserve tank and flows to pump.	Make P-110 a primary booster pump. Add bypass line with solenoid valve around tank in case pump fails.		
7-3 Quench/ Scrubber A-101	1) High liquid level	Water carry over to atmosphere. Excess back pressure to upstream equipment.	1	1	1	LIH-501 will alarm. LIHH will shutdown the entire system. Increase blowdown to POTW. Existing safeguards in thermal oxidizer.	Add overflow line to scrubber.		
	2) No liquid flow to demister	Possible build up of solids on top of tower	1	1	1	Not applicable.			
	3) Scrubber loop stops	Loss of scrubbing, loss of cooling, loss of pH	1	1	1	Back up pump P-105B will start manually. FE-501 on pump discharge recirculation will indicate no flow.			
	4) Recirculation pump line break	Personnel injury, chemical injury, damage to equipment, scrubber failure	3	1	3	Personnel training, administration controls. Spill is contained in secondary containment. Periodic inspection. CPVC material of construction.			
7-4 Caustic Tank T-101	1) Liquid freezing	Unable to supply caustic to scrubber A-101	1	1	1	Use drum heaters and cold weather blend.	Switch to higher strength caustic during cold weather.		
	2) Chemical metering pump P-106 unable to maintain pH level	Ineffective use of caustic to scrubber A-101	1	1	1	pH gauge GE-501. Monitor/adjust pH PID loop on a regular basis.	Decrease flow from wellfield operationally so that pump is sized correctly. Interlock I-501 and GC-501 should be removed. Remove BA-526 and install 3-way solenoid valve at intersection so that it is either re-circulating or discharging through FE-501.		
	3) Low caustic level in drum	Unable to supply caustic to scrubber A-101. Potential leak at caustic tank.	2	1	2	Secondary containment. Daily inspection of tank is required.			
	4) Chemical addition line failure	Spray caustic	2	1	2	Conduct preventive visual inspection of the piping daily. Use proper PPE.			

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
8) P&ID 102 Sheet 7 - Liquid Treatment System									
8-1 Oil Water Separator S-103, Pumps P-108A/B	1) High liquid level	Overflow tank within containment	1	1	1	LAH-701 will alarm. Tank level normally maintained by P-108A/B on/off control based on LSH-701 and LSL-701.	Include on overflow pipe to S-103 to the containment. Show high level on LNAPL and DNAPL tanks. Remove level switches on P-107, except HS-701.		
	2) Low liquid level	Damage P-108A/B	1	1	1	None.	Add interlock on LSL-703 to shut down P-108A/B.		
	3) P-108A/B discharge high pressure / dead head	Damage pump, piping	1	1	1	Centrifugal pump. Piping design/testing pressure should be higher than pump dead head pressure.			
	4) P-108A/B discharge pipe breaks	Spills liquid within containment	1	1	1	Piping design/testing pressure should be higher than pump dead head pressure. Use proper construction procedure when installing pipe.			
	5) High temperature water on inlet to S-103	Evaporation of COC vapors	1	1	1	TE-701, TIT-701, I-703. Release is into contained vent line.			
8-2 DNAPL Tank T-104, Discharge Tank T-105, LNAPL Tank T-106	1) High liquid level in DNAPL Tank T-104	Spill of DNAPL within containment	1	1	1	None.	Add high LAH and high level switch to tank.		
	2) High liquid level in Discharge Tank T-105	Overflow tank within containment	1	1	1	LAH-703 will start P-108.			
	3) High liquid level in LNAPL Tank T-106	Spill of LNAPL within containment	1	1	1	None.	Add high LAH and high level switch to tank.		
8-3 Bag Filter FX-101A/B	1) High differential pressure	Reduced flow rate in liquid treatment system	1	1	1	Inlet PI-702, PI-703 and outlet PI-704, PI-705 will show on-set of condition. FIT-701 will indicate reduced flow.	Install differential pressure gauges around each filter.		
	2) High inlet pressure	Damage to filter	1	1	1	PI-702 and PI-703 on inlet to the filters. Filter bags are designed for higher than pump discharge pressure.			
	3) Bags require changing during operation	Potential personnel exposure	1	3	3	Parallel filters and isolation valving allow for on-line bag change-out. Wear proper PPE and discard filters in hazardous waste drums.			
	4) Clogged Filter	Damage to filter	2	1	2	FQIT-701 will indicate flow. Monitor on regular basis.			
8-4 Air Stripper Z-103, Pumps P-109A/B	1) High liquid level	High liquid level of Z-103 may block vapor path	1	1	1	LAH-702 will alarm and shut down P-108.			
	2) Low liquid level	Damage P-109A/B	1	1	1	None.	Add LSLL-702 to shut down P-109A/B on low low liquid level.		
	3) Loss of power to pumps P-109A/B	P-108 and P-109A/B stop.	1	1	1	High point of liquid nozzle in tower will not allow gravity flow of liquid.			
	4) P-109A/B discharge high pressure / dead head	Water will enter B-104A/B. Damage blower, piping	1	1	1	LSHH-702. Piping design and testing pressure should be higher than pump dead head pressure.			

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System ID	What If	Hazard & Consequences	S	L	RR	Existing Safeguards	Recommendations	Offsite Release?	Comments
8-4 Air Stripper Z-103, Pumps P-109A/B	5) Air Stripper high differential pressure	Reduced air flow, poor air stripper performance. Possible damage to blower B-104A/B	1	1	1	None.	Add DP gauge on air stripper. Add moisture separator between air stripper and blowers, with water gravity draining to separator S-101. Add pressure indicator on inlet and outlet and a pressure differential gauge.		
	6) High air stripper vacuum	Increased evaporation and water vapor loading	1	1	1	None.			
	7) P-109A/B discharge pipe breaks	Spills liquid within containment	1	1	1	Use proper construction procedure when installing pipe.			
8-5 Air Stripper Induced Draft Blowers B-104A/B	1) Low pressure	Untreated water	1	1	1	PSL-701 indicates low pressure.	Add interlock to PSL-701 to shut down upstream process.		
	2) B-104A/B shutdown on motor overload or other problem	No vapor flow to S-102	2	1	2	FIT-702 indicates flow. PSL-701 indicates low pressure.			
8-6 Carbon Cells C-101A/B	1) High water pressure	Damage vessel	1	2	2	PI-708, 709, 710 and PI-711 will indicate high pressure. Design vessel for higher pressure than pump dead head.			
	2) High differential pressure	Impede flow, limit system throughput	1	2	2	Each cell is equipped with inlet and outlet pressure indicators, PI-708, 709, 710, 711.	None		
	3) TCE or PCE breakthrough occurs between carbon adsorbers	Exceed allowable discharge limit of each COC	2	2	4	Check for breakthrough using PID meter.	Add manual valves on both sides of the hose connection to the carbon cells and sample ports with the PI gauges.	Yes	
	4) Change-out of carbon is required	Personnel exposure	1	2	2	Operating and maintenance procedure should be in place. PPE must be used.			
	5) Problems occur during backwash	Improper / incomplete backwashing may hinder performance and removal efficiency	1	1	1	Initial backwash of cells should be addressed in operations and maintenance plan.			

Appendix D

The P&ID's, Wellfield, and Electrical Designs

THERMAL TREATMENT ZONE

SURFACE COVER

N

ISTR-2 ISTR-3 ISTR-4 ISTR-5 ISTR-6 ISTR-7

THERMAL TREATMENT ZONE

PRELIMINARY

APPROX. SCALE

0 20' 40' 60' 80'

LEGEND

- VAPOR EXTRACTION WELL – 550
- HORIZONTAL VAPOR EXTRACTION WELL – 260 LINEAR FEET
- THERMAL TREATMENT ZONE
- SURFACE COVER
- VAPOR EXTRACTION PIPING ZONE A
- VAPOR EXTRACTION PIPING ZONE B
- HORIZONTAL VAPOR EXTRACTION PIPING ZONE C
- GROUNDWATER MONITORING WELL
- TEMPERATURE MONITORING WELL
- PRESSURE MONITORING WELL

REVISIONS						
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
A	3/11/11	DB			3/7 ISSUED FOR REVIEW, 3/11 UPDATED 6" TO 4" BRANCHES	

TERRATHERM

SRSNE SUPERFUND SITE

PIPING AND EQUIPMENT DETAIL

SIZE	FILE NO.	DWG NO.	REV
D	SRS-5102	SRS-5102	A

SCALE: AS SHOWN | DNS | SHEET 1 OF 1

NOTES:

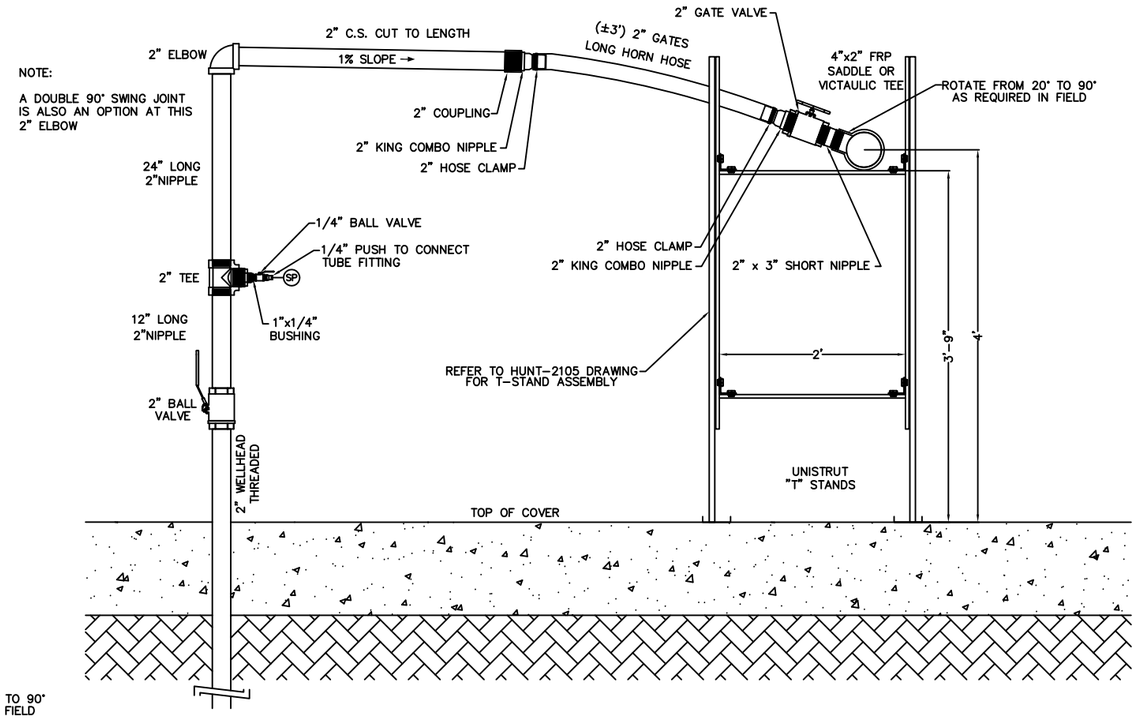
1.THE HEIGHT OF THE TOP CROSSBAR WILL CHANGE TO ACCOMODATE THE DIFFERENCE IN ELEVATION ALONG THE MANIFOLD PIPE.

2. A MINIMUM 1% SLOPE TO TREATMENT EQUIPMENT CONNECTION IS REQUIRED.

3. THE DETAIL IS A REPRESENTATION OF A TYPICAL CONNECTION.

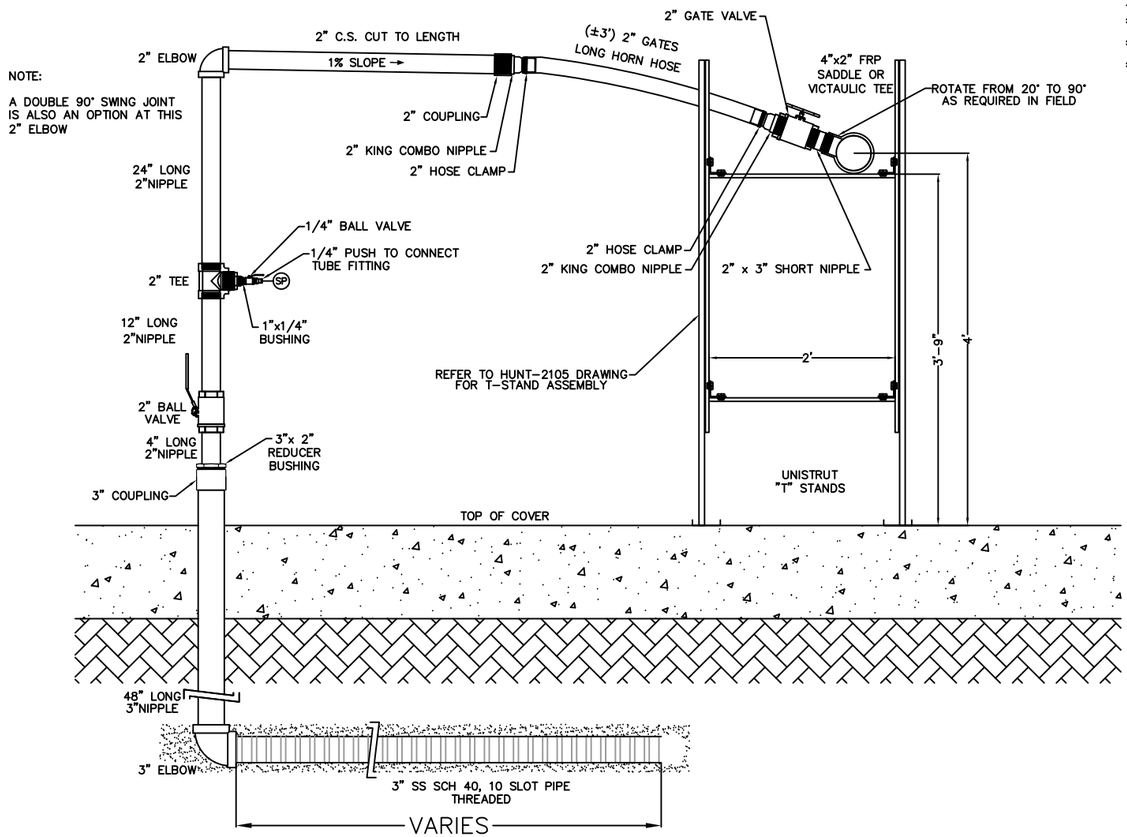
TYPICAL VERTICAL VAPOR EXTRACTION WELL DETAIL

SCALE: NTS



TYPICAL HORIZONTAL VAPOR EXTRACTION WELL DETAIL

SCALE: NTS



PRELIMINARY

REVISIONS						
B	3/07/11	BC			REVISED DETAILS	
A	2/18/10	PT	RS	JL	ISSUED FOR REVIEW	
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED

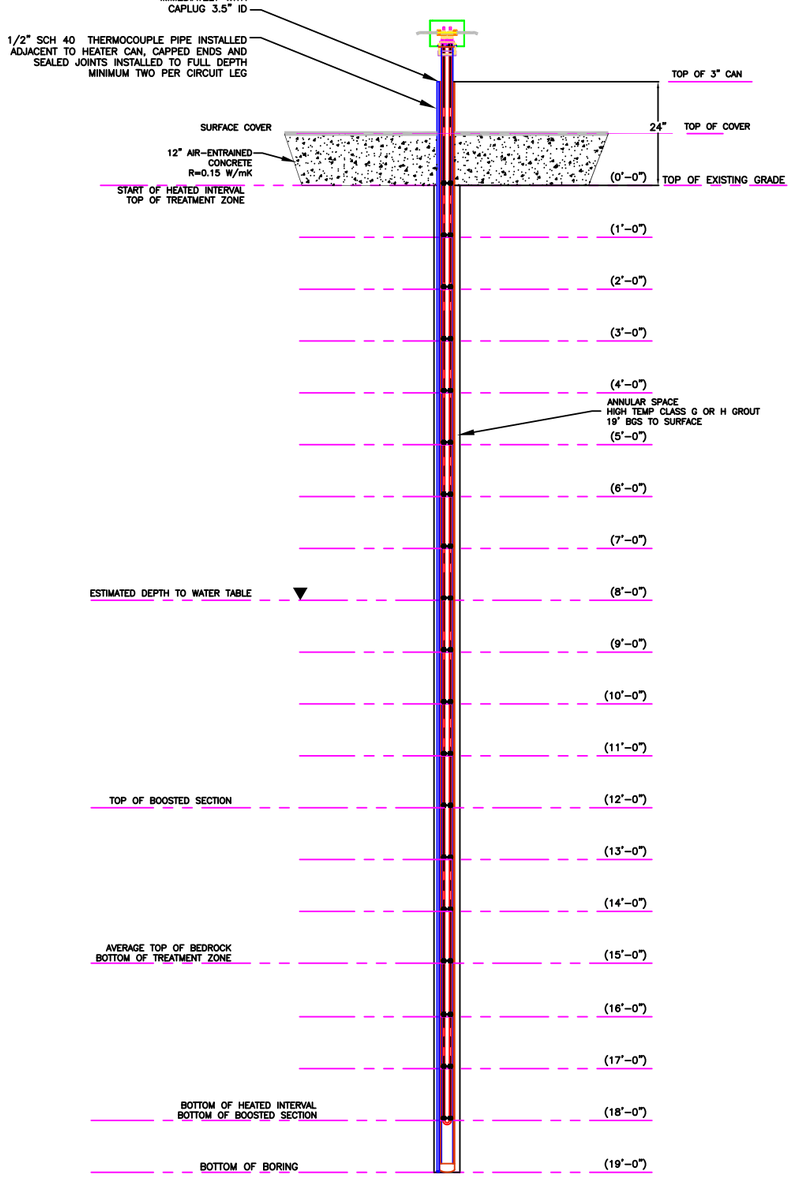
TERRATHERM

SRSNE SUPERFUND SITE
TYPICAL VAPOR EXTRACTION
WELL CONNECTION DETAIL

SIZE	FILE NO.	DWG NO.	REV
D	C109	C109	B

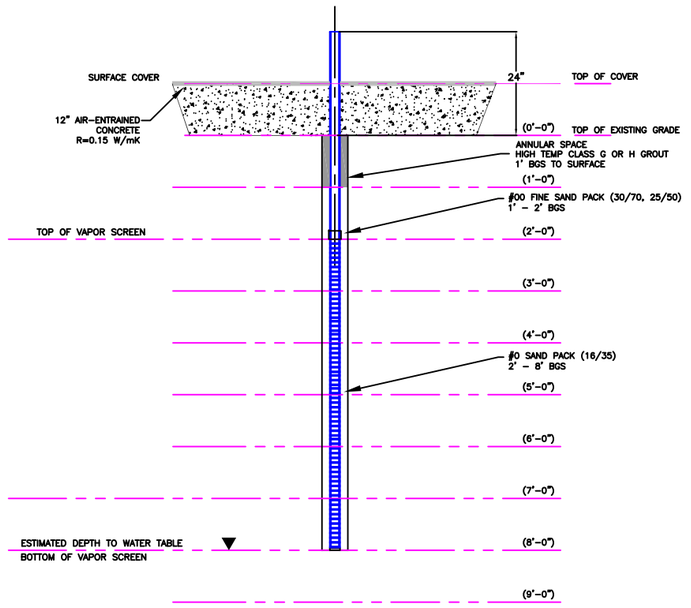
SCALE: AS SHOWN | DNS | SHEET 1 OF 1

ZONE B
THERMAL CONDUCTION HEATER WELL DETAIL
QTY (263) – 2 5/8" OR 2 3/4" OD X .065 WALL, 304SS SLEEVE
INSTALLED WITHIN A 3" SCH 80, C.S. HEATER CAN
EACH HEATER DELIVERS APPROXIMATELY 300 W/FT
IN NON-BOOSTED SECTION (0-12' BGS)
AND 435 W/FT IN BOOSTED SECTION (12-18' BGS)



WELL INSTALLATION
3" SCH 80 C.S. CAN INSTALLED TO 19' BGS
MINIMUM 6" BOREHOLE

ZONE B
VAPOR EXTRACTION WELL (VEW) DETAIL
QTY (263)
6'L X 2" WELL SCREEN, .010 SLOT W/PLATE BOTTOM, SS
2" SCH 80, C.S. RISER W/THREADED END



WELL INSTALLATION
MINIMUM 6" DIA BOREHOLE

PRELIMINARY

REVISIONS						
B	3/30/11	DC			UPDATED DETAILS	
A	3/15/10	PT	RS	JL	ISSUED FOR REVIEW	
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED

TERRATHERM

SRSNE SUPERFUND SITE
ZONE B – THERMAL CONDUCTION HEATER & VAPOR EXTRACTION WELLS

SIZE	FILE NO.	DWG NO.	REV
D	C107	C107	B
SCALE: AS SHOWN	DNS	SHEET 1 OF 1	

PHASE 1

PHASE 2

N

APPROX. SCALE

0 20' 40' 60' 80'

LEGEND

- HEATER WELL 15' – 80
- HEATER WELL 18' – 262
- HEATER WELL 24' – 251
- THERMAL TREATMENT ZONE
- SURFACE COVER

REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
A	02/25/11	DC			3/2: ADDED SUBSTATION	

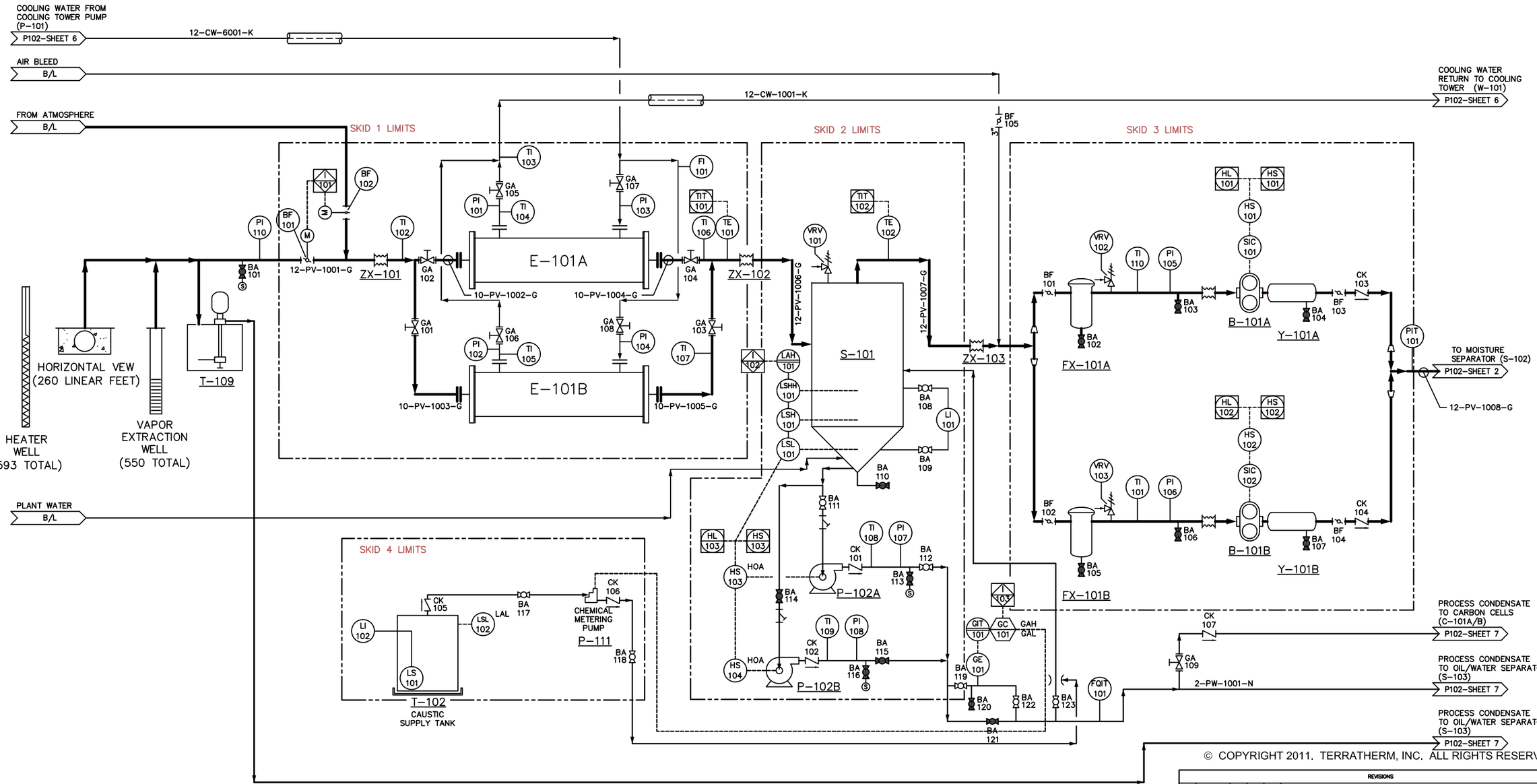
TERRATHERM

SRSNE SUPERFUND SITE

WELLFIELD LAYOUT

SIZE	FILE NO.	DWG NO.	REV
D	E102	E102	A

SCALE: AS SHOWN | DNS | SHEET 1 OF 1



B-101A/B	VACUUM BLOWER
E-101A/B	VAPOR COOLER
FX-101A/B	FILTERS
P-102A/B	MOISTURE SEPARATOR 1 PUMP
P-111	CAUSTIC PUMP
S-101	MOISTURE SEPARATOR 1
T-102	CAUSTIC TANK
T-109	CONDENSATE SUMP
Y-101A/B	SILENCER
ZX-101	EXPANSION JOINT
ZX-102	EXPANSION JOINT
ZX-103	EXPANSION JOINT

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA RS

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
GAS CONDITIONING SYSTEM 1

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 1 OF 7

PRELIMINARY

VAPOR FROM AIR STRIPPER (Z-103)
P102-SHEET 7

6-PV-7002-G

VAPOR FROM VACUUM BLOWER (B-101A/B)
P102-SHEET 1

12-PV-1008-G

SKID 6 LIMITS

TIT 202
FIT 201
TI 207
PRV 201
TE 202
FE 201
BA 206
12-PV-2005-G
12-PV-2007-G
S-102
LAH 201
LSHH 201
LSH 201
LSL 201
BA 208
LI 202
BA 209
BA 204
BA 202
HL 201
HS 201
TI 208
PI 206
CK 202
BA 210
HS 201
HOA
BA 207
P-103A
BA 201
TI 209
PI 207
CK 201
BA 205
HS 202
HOA
BA 203
FQIT 201
P-103B

ZX-105

SKID 7 LIMITS

TSH 201
TIC 203
TE 203
PI 205
TI 210
H-101
12-PV-2008-G
12-PV-2009-G
TO THERMAL OXIDIZERS (F-101A/B)
P102-SHEET 3
BF 203
CK 203
PI 208
PSL 201
8-AA-2002-G
B-102

2-PW-2001-N

PROCESS CONDENSATE TO OIL/WATER SEPARATOR (S-103)
P102-SHEET 7

DILUTION AIR
ATMOSPHERE

8-AA-2001-G

B-102	DILUTION AIR BLOWER
H-101	DUCT HEATER
P-103A/B	MOISTURE SEPARATOR 2 PUMP
S-102	MOISTURE SEPARATOR 2
ZX-105	EXPANSION JOINT

REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA RS

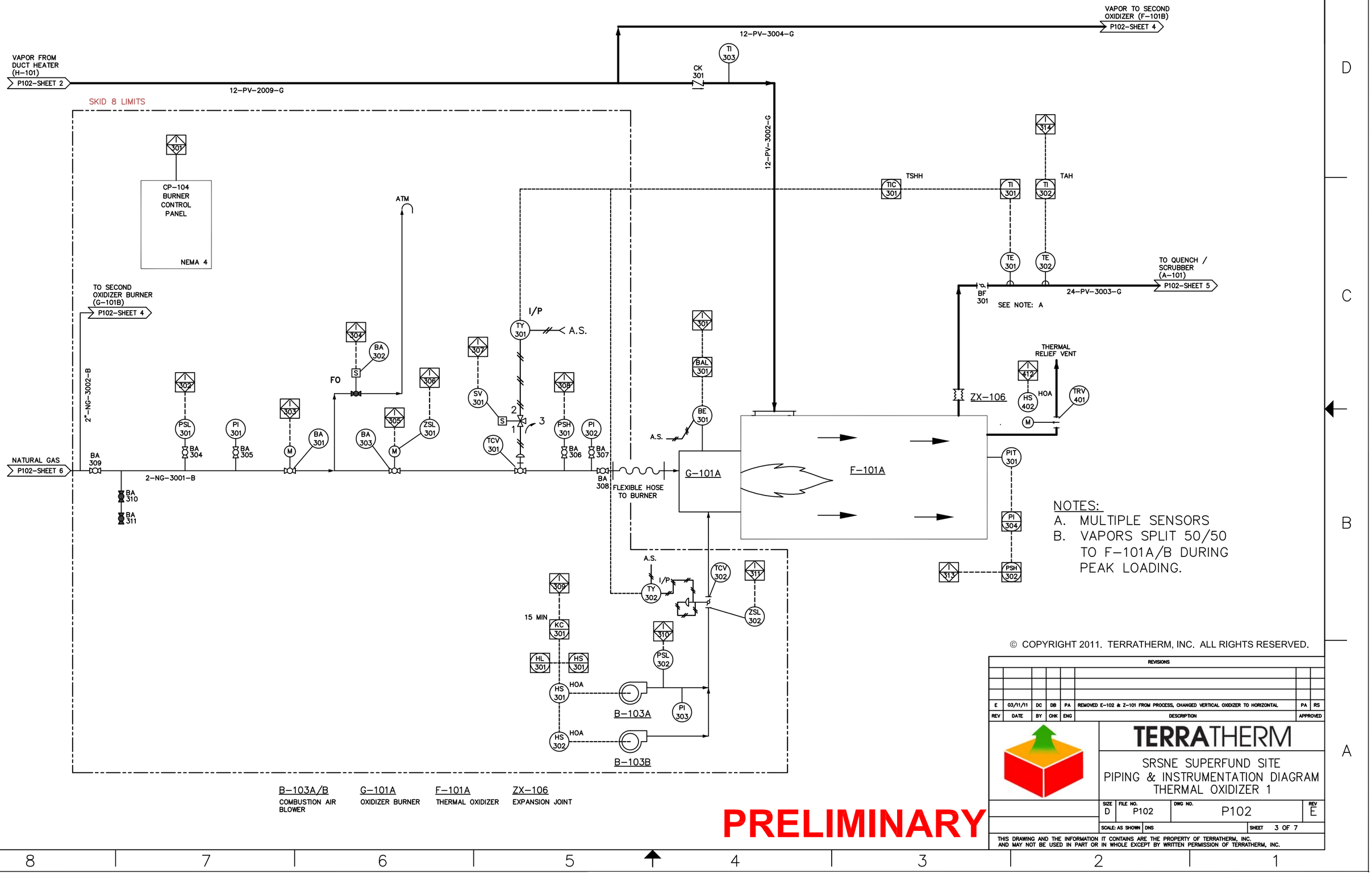
TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
GAS CONDITIONING SYSTEM 2

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 2 OF 7

PRELIMINARY



B-103A/B COMBUSTION AIR BLOWER

G-101A OXIDIZER BURNER

F-101A THERMAL OXIDIZER

ZX-106 EXPANSION JOINT

REVISIONS							
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA	RS
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED	

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
THERMAL OXIDIZER 1

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 3 OF 7

PRELIMINARY

VAPOR FROM DUCT HEATER BRANCH (H–101)
P102–SHEET 3
12–PV–3002–G
CK 401
TI 403
SKID 9 LIMITS
CP–105 BURNER CONTROL PANEL
NEMA 4
ATM
FO
I/P
A.S.
TSHH
TIC 401
TI 401
TI 402
TAH
TE 401
TE 402
TO QUENCH / SCRUBBER (A–101)
P102–SHEET 5
24–PV–4001–G
BF 401
SEE NOTE: A
THERMAL RELIEF VENT
ZX–107
HOA
HS 402
TRV 401
NATURAL GAS
P102–SHEET 3
2–NG–3002–B
BA 409
BA 410
BA 411
PSL 401
PI 401
BA 404
BA 405
BA 401
BA 402
BA 403
ZSL 401
SV 401
TY 401
TCV 401
PSH 401
PI 402
BA 406
BA 407
BA 408
BAL 401
BE 401
FLEXIBLE HOSE TO BURNER
G–101B
F–101B
PIT 401
PI 404
PSH 402
NOTES:
A. MULTIPLE SENSORS
15 MIN
KC 401
HL 401
HS 401
HS 402
B–106A
B–106B
TY 402
TCV 402
ZSL 402
PSL 402
PI 403

B–106A/B COMBUSTION AIR BLOWER
G–101B OXIDIZER BURNER
F–101B THERMAL OXIDIZER
ZX–107 EXPANSION JOINTS

PRELIMINARY

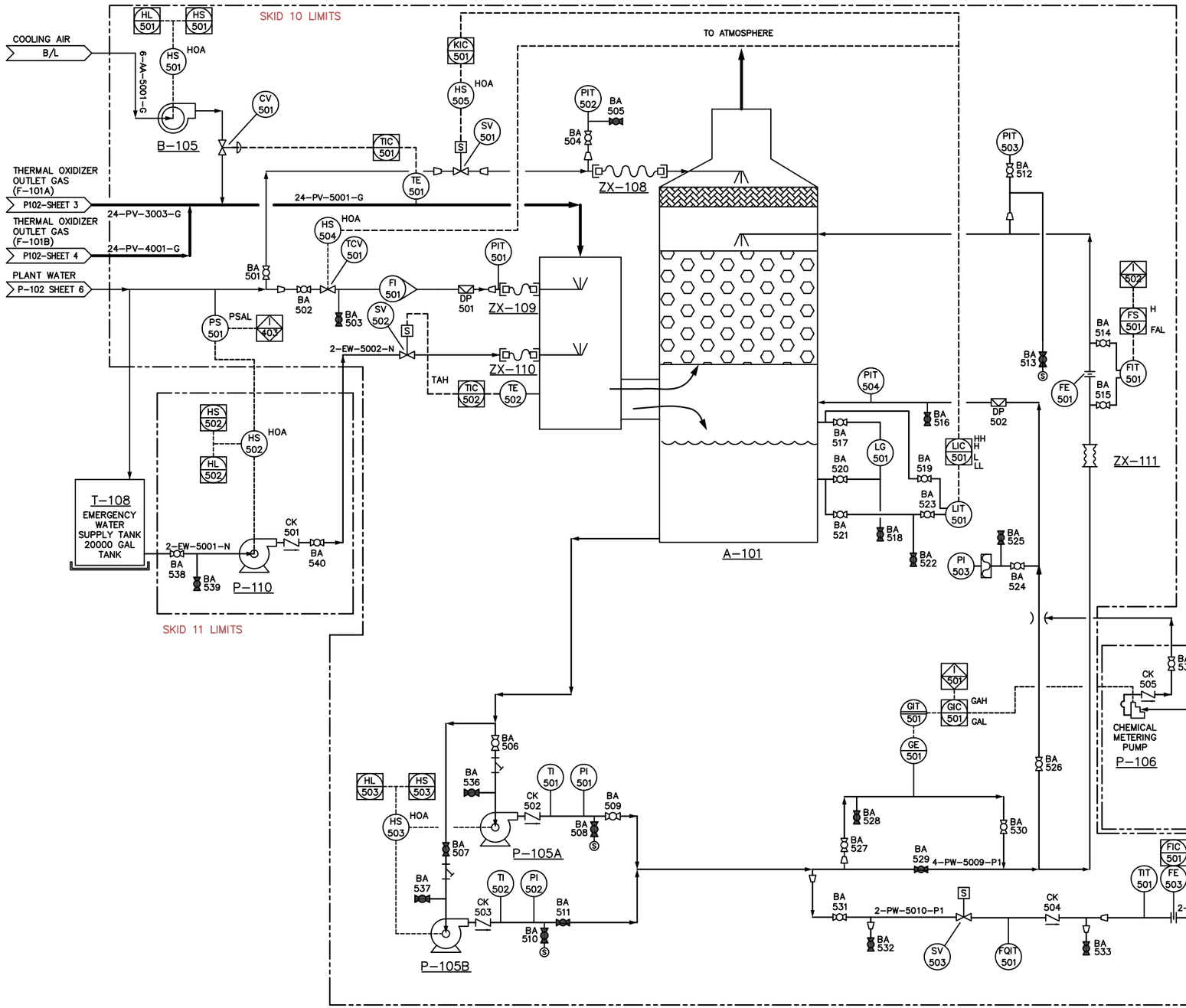
REVISIONS							
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED	
E	03/11/11	DC	DB	PA	REMOVED E–102 & Z–101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA	RS

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
THERMAL OXIDIZER 2

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 4 OF 7



A-101 SCRUBBER	P-105A/B SCRUBBER RECIRC PUMPS	P-110 EMERGENCY WATER SUPPLY PUMP	T-103 QUENCH	ZX-108 FLEXIBLE CONNECTION	ZX-110 FLEXIBLE CONNECTION
B-105 COOLING AIR BLOWER	P-106 CAUSTIC PUMP	T-101 CAUSTIC TANK	T-108 EMERGENCY WATER SUPPLY	ZX-109 FLEXIBLE CONNECTION	ZX-111 FLEXIBLE CONNECTION

PRELIMINARY

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA RS

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
QUENCH/SCRUBBER/STACK

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 5 OF 7

NATURAL GAS
B/L

FIT 601
BA 601
BA 602
FE 601

TO OXIDIZER BURNER (Z-101A)
P102-SHEET 2

SKID 13 LIMITS

W-101

HS 601
HL 601
HS 601
HOA
Y-101

FROM VAPOR COOLER (E-101A/B)
P102-SHEET 1

12-CW-1001-K

LV 601
GA 601
BA 603
DW-4010-1"-D
W-101

ZX-112
BF 601
ZX-113
BF 602
P-101

HS 601
HL 602
HS 602
HOA

TE 601
TIT 601
TAL
TALL
PI 601
BA 604
BA 605
FQIT 601
FQIT 602
GA 602

FSL 601
FAL 601

12-CW-6001-K

TO VAPOR COOLERS (E-101A/B)
P102-SHEET 1

2-PW-6001-G

BLOWDOWN TO POTW
B/L

PLANT WATER
B/L

BFP-1
GA 603
BA 607
BA 608
BA 606
1½"x1"

2-UW-6001-N

PI 602
FQIT 603

BA 609

TO QUENCH/ SCRUBBER (T-103)
P102-SHEET 5

TO MOISTURE SEPARATOR 1 (S-101)
P102-SHEET 1

SKID 15 LIMITS

AMBIENT AIR
HS 602
Z-104
BA 617
BA 616
PSL 601
PAL
PI 605
BA 618
BA 619
PRV 601
TI 602
Z-105
PA-4014-4"-E
SV 601
BA 629
BA 630
BA 631
KIC 601
S

BA 620
PCV 601
BA 621
Z-106
BA 623
BA 622
PI 606
BA 624
BA 625
PSL 602
PAL
BA 626
PI 607
BA 627
BA 628
TO INSTRUMENTS

UTILITY POWER
B/L
UTILITY POWER
UTILITY PHONE
B/L

CP-101
POWER DISTRIBUTION PANEL(S)

CP-102
CALLOUT

VENDOR PACKAGE
DAY TANK
DIESEL GENERATOR BACKUP FOR PROCESS EQUIPMENT

CP-103
AUTOMATIC TRANSFER SWITCH

P-101 COOLING TOWER PUMP
W-101 COOLING TOWER
Y-101 COOLING FAN MOTOR
Z-104 AIR COMPRESSOR
Z-105 AIR RECEIVER
Z-106 AIR DRYER
ZX-112 FLEXIBLE CONNECTION
ZX-113 FLEXIBLE CONNECTION

PRELIMINARY

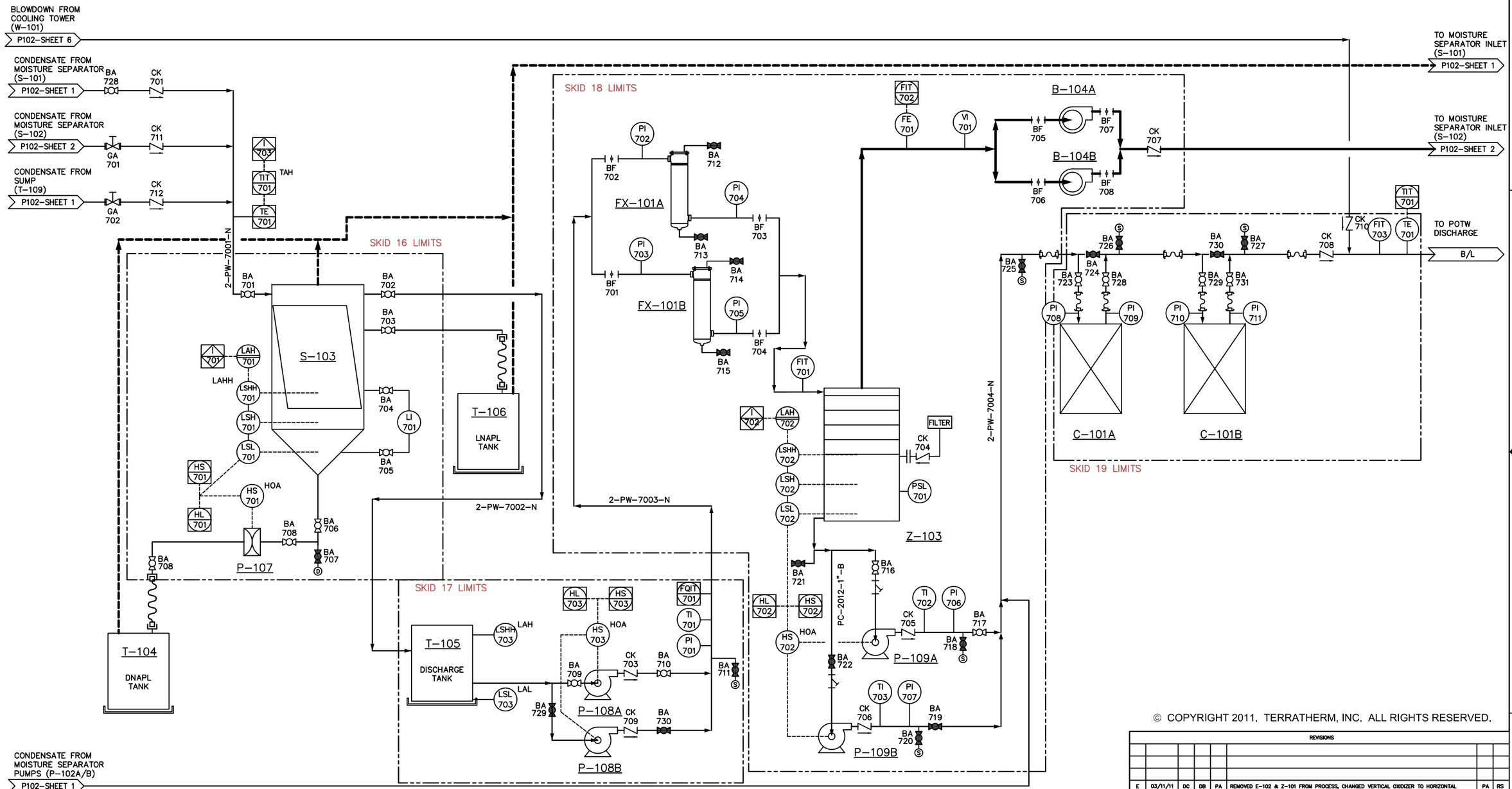
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA RS

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
UTILITIES

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 6 OF 7



B-104A/B AIR STRIPPER VACUUM BLOWER

FX-101A/B BAG FILTER

P-108A/B OIL /WATER SEPARATOR WATER DISCHARGE PUMP

S-103 OIL / WATER SEPARATOR

T-105 DISCHARGE TANK

Z-103 AIR STRIPPER

C-101A/B CARBON CELLS

P-107 DNAPL PUMP

P-109A/B AIR STRIPPER DISCHARGE PUMP

T-104 DNAPL TANK

T-106 LNAPL TANK

PRELIMINARY

REVISIONS							
E	03/11/11	DC	DB	PA	REMOVED E-102 & Z-101 FROM PROCESS, CHANGED VERTICAL OXIDIZER TO HORIZONTAL	PA	RS
REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED	

TERRATHERM

SRSNE SUPERFUND SITE
PIPING & INSTRUMENTATION DIAGRAM
LIQUID TREATMENT SYSTEM

SIZE	FILE NO.	DWG NO.	REV
D	P102	P102	E

SCALE: AS SHOWN | DNS | SHEET 7 OF 7