January 23, 2015

Kathrina M. Donegan
Supervisor, Air Pollution Control Program
St. Louis County Health Department
74 Clarkson Wilson Center
Chesterfield, MO 63017

Kendall Hale
Permits Section Chief
Air Pollution Control Program
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Re: Sulfur Removal Technology Evaluation, Stage 2
Bridgeton Landfill, LLC

Dear Ms. Donegan and Mr. Hale;

Enclosed for your review is a document, referred to as the Stage 2 report, from SCS Engineers outlining the evaluation of sulfur removal technologies which expands upon the Stage 1 evaluation report dated November 21, 2014.

The enclosed submission further satisfies the requirement set forth in paragraph 27.E. of the Second Amendment to the First Agreed order of Preliminary Injunction and Appendix C to that document. Appendix C is a memorandum from Daniel Brennan with SCS Engineers and provides that if the pilot treatment system testing with MVT is unsuccessful, alternate technologies will be reviewed for appropriateness to the Bridgeton landfill gas constituents. The MVT system was successful in removing hydrogen sulfide and mercaptans; however, the MVT system demonstrated limited removal of DMS. As such, Bridgeton Landfill has continued their "review" of available technologies and documented their findings in this Stage 2 report.

The Stage 1 evaluation recommended that Bridgeton conduct a detailed evaluation of specified vendors to include: i) prior experience and performance, ii) ability to provide a complete package/solution, and 3) byproducts. The November 21, 2014 report also indicated that Bridgeton would select a vendor/technology to develop a protocol for a pilot test on site, and implement the pilot test. Based upon the pilot test results Bridgeton Landfill would be able to develop bid documents to procure design and construction services for the selected system.

Based upon SCS Engineer's detailed Stage 2 evaluation of sulfur removal technologies, it was determined that chemical scrubbing and liquid solvent are two technologies which are potentially viable solutions. The enclosed Stage 2 report provides protocols for pilot testing of chemical scrubbing and liquid solvent technologies. Bridgeton is prepared to move forward with implementation of the pilot tests immediately. It is estimated that procurement and setup of the necessary equipment in the field will begin within the next one to two weeks and the actual field pilot testing will likely occur in March/April of 2015 but may be potentially sooner if lead time on equipment and weather conditions are cooperative.

As recommended in the Stage 2 report, Bridgeton Landfill plans to develop bid documents for design and construction services of a full scale system based on results of the pilot tests and any additional evaluations, if applicable.

As referenced immediately above, Bridgeton Landfill intends to initiate pilot testing of the proposed sulfur removal technologies as soon as practical. For your review and consideration, general work plans for pilot testing are included in attachment 6 (chemical scrubber) and attachment 7 (liquid solvent). We request confirmation from the St. Louis County Air Pollution Control Program that an air program construction permit is not required for the installation of the pilot test equipment.

Should you have any questions on my letter or the enclosed Stage 2 report, please contact me at 314.744.8165.

Sincerely,

Bridgeton Landfill, LLC

Brian J. Power

Brian Power
Environmental Manager

cc: Laura Yates
Solid Waste Management Program
St. Louis County Department of Health
41 South Central
Clayton, MO 63105

Chris Nagel
Program Director
Solid Waste Management Program
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Environmental Consultants
4 Executive Boulevard
Suite 303
Suffern, New York 10901
845-357-1510
FAX 845 357-1049
www.scsengineers.com

SCS ENGINEERS

January 22, 2015
File No. 23211003.19

Privileged and Confidential, Attorney-Client Privileged

Mr. James Getting
Bridgeton Landfill, LLC
13570 Saint Charles Rock Road
Bridgeton, Missouri 63044

Subject: Sulfur Removal Technology Evaluation, Stage 2
Bridgeton Landfill

Dear Jim:

SCS Engineers (SCS), in collaboration with Nexo Solutions, prepared this letter to document our detailed evaluation of select sulfur removal technologies to treat the landfill gas (LFG) at the Bridgeton Landfill (Landfill). This detailed evaluation is considered the Stage 2 evaluation of sulfur removal technologies, which relies on and expands on SCS' Stage 1 evaluation. The Stage 1, concept-level evaluation was documented in a letter to you, dated November 21, 2014.

Items included in this letter are as follows:

- Preliminary design basis
- Stage 1 summary
- Chemical scrubbing
- Liquid solvent
- Solid media
- Pilot testing
- Summary
- Recommendations

PRELIMINARY DESIGN BASIS

The preliminary design basis for the sulfur removal system is summarized in Tables 1 and 2.

Privileged and Confidential, Attorney-Client Privileged

Table 1. Preliminary Design Basis

Parameter	Value	Units
Total reduced sulfur concentration in LFG (see detail in Table 2)	1,231	ppmv
Sulfur removal goal	90	percent
LFG flow rate	7,500	scfm
Methane (CH_4)	10	percent
Carbon dioxide (CO_2)	41	percent
Oxygen (O_2)	8	percent
Nitrogen N_2)	31	percent
Hydrogen (H_2)	9	percent
LFG temperature	100	°F
LFG moisture content	100	%, saturated
LFG pressure	10	in-w.c. gauge

Dimethyl sulfide (CH_3-S-CH_3 or DMS) is present in the LFG in addition to other sulfur compounds, as shown in Table 2. Approximately 83 percent, by weight, of the sulfur is DMS. Hydrogen sulfide (H_2S) and mercaptans are about 13 percent, by weight, of the sulfur loading. In order to meet the sulfur removal goal of 90 percent, H_2S and mercaptans must be at least partially removed, in addition to DMS.

Methods for removing sulfur components can vary, and single stage approaches do not often have the capability to remove all of the different forms of sulfur due to differences in their physical and chemical characteristics. H_2S is generally one of the easiest sulfur components to remove due to its higher reactivity, polarity, and acidic character. H_2S can be removed by a number of chemical agents and physical sorbents. Mercaptans are comparatively more stable, less reactive, and more difficult to remove. Organic sulfur compounds, such as DMS, are even more stable because of their minimal polarity and acid character. DMS also has a relatively stable C-S-C bond array. As such, DMS is one of the least reactive and most difficult to remove of the sulfur compounds in the Bridgeton LFG stream.

The data contained in Tables 1 and 2 are the best available data at this time. However, the data is highly variable, due to continuing changes in site conditions, and includes data derived from non-representative samples collected during the recent on-site pilot test. Further review and analysis of additional data is needed prior to selecting design criteria for a full-scale sulfur removal system. For the purposes of this detailed evaluation, the data in Tables 1 and 2 were shared with prospective vendors to gauge the ability of the vendors to treat a gas stream with flow and gas constituents within the order of magnitude shown in Tables 1 and 2.

Privileged and Confidential, Attorney-Client Privileged

Table 2. Sulfur Compounds

Sulfur Compound	Concentration							Mass Flow
	9/25/14[1]	9/11/14[1]	8/27/14[1]	8/14/14[1]	8/5/14[1]	7/31/14[2]	Average	
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	lb/day
Dimethyl sulfide (DMS)	1,050	902	979	1,079	736	944	948	1,676
Ethyl mercaptan	1.14	1	0.40	2	2	1	1	2
Diethyl sulfide	0.04	0.07	0.40	0.04	0.44	0.20	0	0.2
Dimethyl disulfide (DMDS)	42.4	15	128	87	41	55	61	82
Methylethyl sulfide	0.04	0.07	0.40	0.04	5	6	2	4
Hydrogen sulfide (H_2S)	18.9	30	4	19.0	33	0.2	17	17
Isopropyl mercaptan	0.5	1	0.4	0.7	0.4	0.2	1	1
Methyl mercaptan	170	221	101	250	199	107	175	239
Subtotal [3][4]	1,283	1,170	1,214	1,418	1,016	1,113	1,202	2,021
Total [5][6]	1,299	1,184	1,285	1,472	1,033	1,113	1,231	1,123

1. Samples collected during August and September were taken at the blower discharge as part of the MVT Pilot test study which was concluded on October 3rd, 2014
2. Sample collected on July 31 was taken at the blower discharge as part of the Stantec sampling event as required as part of the second amendment to the consent order, dated June 2014
3. For concentrations, total of listed compounds, expressed in terms of H_2S.
4. For mass flow rate, total is sum of mass flow for the listed compounds.
5. For concentrations, total of listed compounds plus unidentified sulfur, expressed in terms of H_2S (does not include COS and SO_2, if any).
6. For mass flow rate, total is expressed as pounds per day of elemental sulfur.

Privileged and Confidential, Attorney-Client Privileged

STAGE 1 SUMMARY

Our Stage 1 evaluation identified three general process technologies that could be potentially viable solutions for sulfur removal at the landfill. The following seven vendors were identified that could provide a potentially viable technology:

Table 3. Stage 1 Summary

Vendor	Technology	Comments
HydroCat	Solid media	Good DMS removal data provided. However, data applicable to gas stream that differs from the Bridgeton gas. Site-specific removal data needed.
TDA	Solid media	Good DMS removal data provided. However, data applicable to gas stream that differs from the Bridgeton gas. Site-specific removal data needed.
MV Technologies	Solid media	Demonstrated on-site success with removal of H_2S and mercaptans. MVT could be part of a two-stage system.
Hydros	Chemical scrubber	Oxidation of DMS appears feasible using a liquid oxidizer. Process chemistry needs to be confirmed.
AAT	Chemical scrubber	Oxidation of DMS appears feasible using a liquid oxidizer. Process chemistry needs to be confirmed.
Duall	Chemical scrubber	Oxidation of DMS appears feasible using a liquid oxidizer. Process chemistry needs to be confirmed.
Nrgtek	Liquid solvent	Solubility of DMS in solvent is documented. Ability to regenerate solvent needs to be confirmed.

Our Stage 1 recommendations were as follows:

1. Conduct detailed evaluation of the following vendors/technologies: HydroCat, TDA, MV Technologies (2-stage system only), Hydros, AAT, Duall, and Nrgtek.

2. Select a vendor/technology; develop a protocol for a pilot test on site; and, implement the pilot test.

3. Based on pilot test and any necessary further evaluation, develop bid documents to procure design and construction services for the selected system.

In addition to the above treatment methods, the feasibility of DMS removal via condensation (by cooling the gas) and then liquid-phase treatment of a condensed DMS stream was also considered in Stage 2. However, evaluation of this treatment concept found this to be technically infeasible, based on an engineering analysis of the vapor-liquid equilibrium of the LFG stream using the Deshmukh-Mather model. Refer to Attachment 1 for additional details on this evaluation and results of the Deshmukh-Mather model.

CHEMICAL SCRUBBING

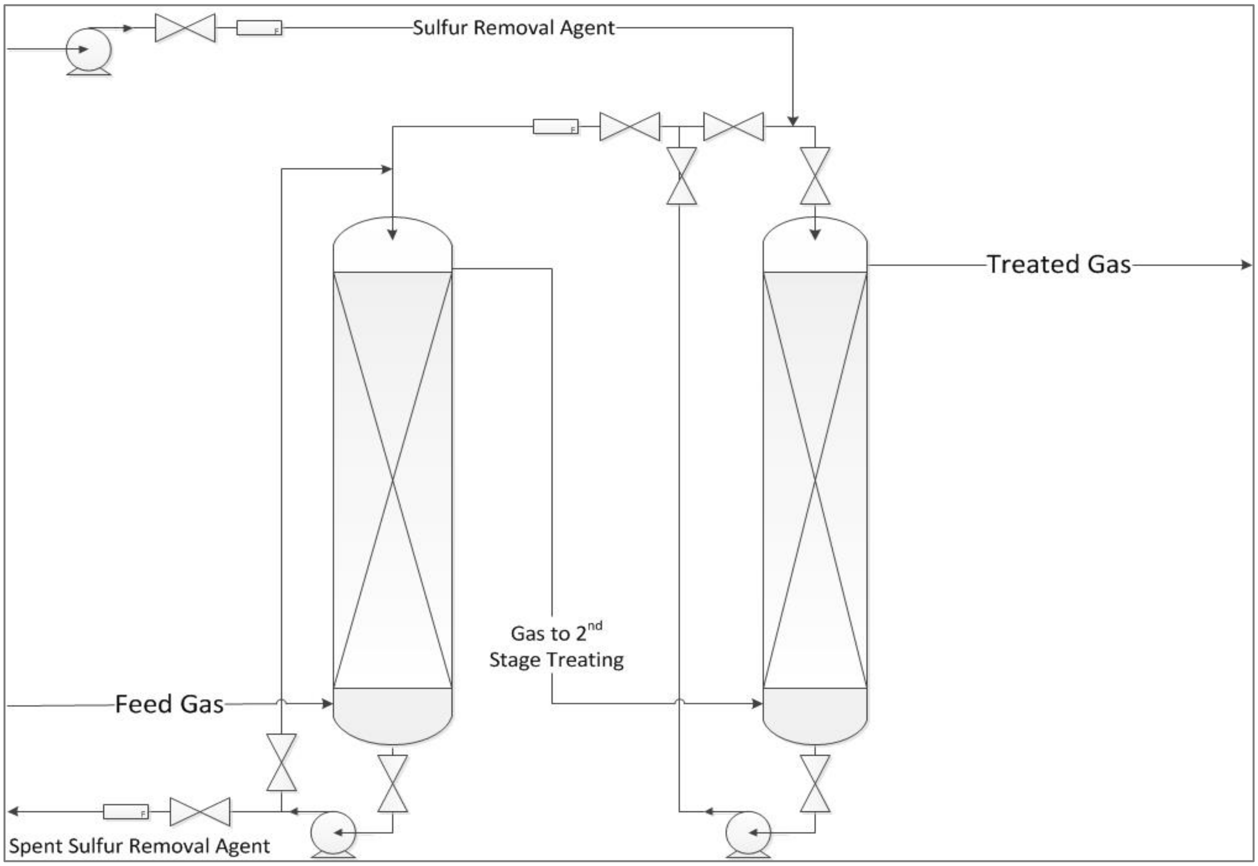
Chemical scrubbing (i.e., liquid phase absorption; wet scrubbers; liquid scavengers) encompass a variety of technologies, based on different chemical reactions and processes. Generally, chemical scrubbers cause sulfur compounds to be absorbed into the scrubbing liquid by maximizing contact between the gas and liquid. Liquid scrubbers typically utilize packed bubble towers, spray towers or venturi absorbers.

Three vendor systems rely on chemical scrubbing and include:

- Hydros
- Advanced Air Technologies
- Duall

Generally, each of these systems uses a scrubber, which is operated with the vendor's selected liquid removal agent (see generic schematic below). Further information on the above three vendors are discussed below.

Privileged and Confidential, Attorney-Client Privileged



Hydros

Hydros Environmental Diagnostics Inc. (Hydros) has developed a scrubber system, which utilizes oxidation/absorption using sodium hypochlorite (NaOCl) and sodium hydroxide (NaOH; caustic soda) to selectively remove sulfur compounds from LFG. NaOCl is used as on oxidizing agent and NaOH is used to regulate pH and promote efficient absorption of oxidized sulfur compounds. The process regulates pH and ORP (oxygen-reduction potential) to target removal of sulfur compounds, to limit use of chemicals.

The system produces an aqueous effluent with water-soluble, sulfur-based salt and oxidized DMS by-products in addition to sodium chloride. The reaction of sulfur compounds with NaOCl creates sulfoxides, sulfones and sulfates. These by-products are water-soluble, stable and treatable under the certain conditions.

A description of the scrubber operation is as follows:

1. Gas from the landfill enters the scrubber from the bottom and passes up through a matrix.

2. Blended reagents sodium hydroxide, sodium hypochlorite and water are sprayed from above into the matrix, and the sulfur compounds are converted from a gas to a liquid.

 Privileged and Confidential, Attorney-Client Privileged

3. The waste liquid from the reaction, which contains 95 percent water, is directed to treatment and disposal.

4. The treated gas exits the top of the scrubber and is directed to the flare.

A conceptual layout and isometric drawing of a proposed scrubber system are provided in Attachment 2. The drawings in Attachment 2 include a building for housing the pump skids and chemical storage tanks, but a building is not required (i.e., an outside installation is possible). The major equipment and components include scrubber vessels, chemical storage tanks, process piping, chemical pumps, and controls. A detailed list of system components is provided in Table 4.

Table 4. Detailed List of System Components

Item #	Item Name	Quantity	Material
1	Wet Scrubber Array	3	RFG
2	Packing Cartridges	mixed	PVC
3	Pumps (P-10 A/B/C and P-30 A/B)	5	viton/PVC
4	P-10 Ammeter Module	2	
5	Metering Pumps (P-40A/B, P-50A/B, 2 spares)	6	viton/PVC
6	Pressure Gauge with guard	5	PVC
7	Strainer single	5	PVC
8	Strainer duplex	2	PVC
9	Check valve	4	
10	Vacuum breaker	4	PVC
11	Nozzles	12	PVC
12	Vertical Nozzles	2	PVC
13	Ball Valves	18	PVC
14	Schedule 80 pipe and fittings	1	PVC
15	Hose coupling and hoses	3	Plastic and PVC
16	Water safety hoses	2	Plastic and PVC
17	Pump and skid frames coated	2	Steel
18	Yokogawa pH analyzer	1	Box
19	Yokogawa pH/ORP sensors	1	In line
20	Level gauge glass	2	Glass/steel
21	Controller gauge	2	
22	Controller switch	2	
23	Control Panel Nema 4	1	
24	Cold weather heating system	1	PEX and steel
25	Skid controls analyzer discharge	1	
26	Skid metering pumps for slurry	2	PVC
27	6630 gallon double wall insulated tank w/heater	1	PVCx

Privileged and Confidential, Attorney-Client Privileged

Table 4. Detailed List of System Components (Cont'd.)

Item #	Item Name	Quantity	Material
28	6630 gallon Double wall for bleach	1	PVCx
29	Water supply tank with sub pumps	1	Steel
30	Pipe heating system for NaOH	1	PEX and steel
31	Office trailer	1	
32	Mobile Container Units	1	

The 3-vessel system proposed by Hydros utilizes 2 vessels on-line at a time, operating in series. The scrubbing solutions are circulated individually through each vessel. There is a connection however, that allows transfer of a portion of the second scrubber recirculating solution to the first scrubber recirculating solution. This configuration essentially allows the second scrubber to maintain a fresh solution for polishing without wasting any solution, as the remaining activity of the solution is used at the first scrubber. This also allows fresh solution to be fed at only one location, directly to the second scrubber. Spent solution should also be discharged at only one location; i.e., from the first vessel recirculating line.

This configuration is recommended as the first vessel can provide bulk sulfur removal, while the second can provide polishing of any remaining sulfur compounds in order to consistently meet the removal goal. It is recommended that this configuration be used for any chemical scrubbing system.

The materials selected for fabrication of the system are not expected to have compatibility issues. The instrumentation and associated equipment proposed by Hydros were reviewed and appears to be fairly comprehensive. Sizing calculations and vessel design have not been provided. Hydros prefers that the scrubber system be located on the vacuum side of the blower system. Hydros estimates the head loss as 12 to 18 inches of water column (in-w.c.), but adjustments to the design can reduce the head loss, as necessary.

Hydros estimates a chemical usage of 14 gallons per hour (GPH) for both NaOCl and NaOH, and water usage at 3000 to 5000 gallons per day.

Our primary concern with the proposed Hydros system is the dosage estimate for the oxidizing chemical (NaOCl). At optimal conditions, 1 mole of NaOCl can theoretically remove a maximum of 1 mole of a sulfur-based compound. This stoichiometry assumes, however, that only the dimethyl sulfoxide (DMSO) product is created. The actual stoichiometry is expected to be higher, due to a number of other reactions that can take place.

At high enough molar ratios and alkaline pH, NaOCl will further oxidize DMSO to dimethyl sulfone at a 1:1 mole ratio. In addition, a number of other reactions may take place that produce formaldehyde, methanesulfonyl chloride, and several other by-products. As high molar ratios and alkaline pH will be necessary to promote efficient reaction kinetics and mass transfer, it is expected that more than 2 moles of NaOCl will be required to remove 1 mole of sulfur. Given

Privileged and Confidential, Attorney-Client Privileged

the amount and type of sulfur contaminants present, it is conservatively estimated that 4 to 5 grams of NaOCl will be required to remove 1 gram of sulfur.

Given this criteria, it is estimated that about 300 GPH of NaOCl will be needed. Thus, the 14 GPH dosage indicated by Hydros is far lower than our estimate. More information is needed from Hydros pertaining to the reasoning behind the dosage recommendations provided. Sizing and design should then be re-evaluated, if necessary.

Spent solution disposal needs to be evaluated based on the requirements for wastewater disposal (e.g., pH, chlorine, sulfur).

Advanced Air Technologies (AAT)

Advanced Air Technologies (AAT) can also provide a scrubber system for sulfur removal utilizing NaOCl as an oxidizing agent and NaOH to regulate pH and promote efficient reaction of sulfur compounds. The system produces an aqueous effluent with water-soluble, sulfur-based salt by-products and sodium chloride. The reaction of sulfur compounds with NaOCl creates sulfoxides, sulfones and sulfates. These by-products are water-soluble, stable and readily treatable at the correct conditions.

AAT proposes a single-scrubber system (30-foot tall vessel on 11-foot by 11-foot pad; see Attachment 3). Gas is directed from the blower discharge to the scrubber. The scrubber uses a vertical counter-flow packed column to bring the gas into intimate contact with a recirculating scrubbing solution. The scrubbing solution is NaOH and NaOCl, whose levels are maintained by monitoring pH and ORP, respectively. Water is continuously added, producing a gravity overflow to a floor drain.

The scrubber uses two (2) operating 10-hp recirculation pumps. AAT estimates water usage at 1 to 2 gpm and scrubber pressure drop at 4 in-w.c. These estimates need to be refined during the testing and design phase.

AAT estimates a chemical usage of 280 GPH for NaOCl (12.5% vol.) and 25 GPH for NaOH (50% vol.). The chemical dosage is much higher in comparison to Hydros' estimate. Our estimates for chemical usage are closer to AAT than Hydros. More realistic estimates for chemical dosage have to be developed based on an on-site pilot test.

Spent solution disposal needs to be evaluated based on requirements for water disposal (e.g., pH, chlorine, sulfur).

Duall

Duall Air can also provide a scrubber vessel for sulfur removal utilizing any desired additive for sulfur removal and pH control agent. Limited information was provided by Duall to date, but, if a chemical scrubber system is selected, a quote could be solicited from Duall.

Privileged and Confidential, Attorney-Client Privileged

Alternative Scrubber Reagents and On-site Generation

Nexo investigated use of alternative scrubber reagents (hydrogen peroxide and ozone) and on-site generation of necessary chemicals (using chlorine gas or solid calcium hypochlorite). These are process concepts suggested by Nexo, not by the vendors.

Hydrogen peroxide (H_2O_2) and ozone (O_3) can be used separately or in combination with one another (peroxone). The reaction of sulfur compounds with H_2O_2 and/or O_3 creates sulfoxides, sulfones and sulfates. These by-products are water-soluble, stable and readily treatable under correct conditions. A chemical usage requirement of 8.7 GPH for H_2O_2 (50% vol.) alone and 25 GPH for NaOH (50% vol.) is projected. If O_3 is utilized, a generator would need to be installed to convert oxygen in air to O_3. This ozone gas would then be dissolved into water using an ozone injection system.

A summary of chemical usage for various alternatives is provided in Table 5.

Table 5. Summary of Chemical Usage

	NaOCl	$Ca(OCl)_2$	Cl_2	H_2O_2	O_3	H_2O_2/O_3
lbs (100%) / lb Sulfur	5	4	4	0.9	1.3	0.4/1.0
lbs (100%) / day	5,835	4,668	4,668	1,050	1,500	467/1,154
gallons (12.5%) / day	4,661	--	--	--	--	--
gallons (50%) / day	--	--	--	210	--	--

The dosage estimates in Table 5 are conservative for all options. The dosage estimate for H_2O_2/O_3 is even more conservative than other options. In combination, H_2O_2 and O_3 oxidize sulfur contaminants via a different mechanism than when added alone. The H_2O_2/O_3 combination produces hydroxyl radicals that have a much higher redox potential than H_2O_2 or O_3 by themselves. The stoichiometry required for sulfur contamination removal is lowered as well, and hence a smaller amount of each chemical is required. The total amount (and ratio) of chemicals required may in fact be much less. For this reason, it is recommended that the optimal dosage of H_2O_2/O_3 be estimated through field testing and compared to that required for hypochlorite solution. The efficiency of each oxidant should be compared during field testing.

We also recommend further evaluation relative to producing hypochlorite solution on-site using gaseous or solid chlorine. Gaseous chlorine dissolved in water produces hypochlorite solution. Another option for the creation of hypochlorite solution is the dissolution of solid calcium hypochlorite in water.

Chlorine gas (Cl_2) is the safest option for hypochlorite solution acquisition. Modern cylinder-mounted, gas feeding systems draw chlorine from the container with a vacuum, and failure of any system component results in an automatic and immediate shut-off of the chlorine. Chlorine gas (Cl_2) is also a safer option than H_2O_2/O_3, as H_2O_2 is a strong and reactive oxidant.

Summary of Chemical Scrubbing

From a technical standpoint, the most effective solution is a scrubbing system with hypochlorite solution, as proposed by Hydros and AAT. This option has proven and demonstrated efficacy for this application, and has been used previously.

The peroxone-based system is also expected to carry low risk from a technical standpoint. Reliability should not be an issue, as the equipment and operation is relatively simple to maintain. The potential for unexpected maintenance or failure is low. The risk of inadequate performance is low, as the chemistry and system are demonstrated, proven, and extensively used for similar applications. The only technical concern with this option is the rate of reaction. It is possible that the reaction of peroxone with sulfides may require a larger contact time (and hence scrubber volume) for effective conversion and removal. Field testing can address this concern. The peroxone solution can have varying degrees of activity in different applications. At the right conditions, the solution can be recirculated with minimal make-up addition of hydrogen peroxide. This aspect can also be confirmed via field testing.

LIQUID SOLVENT

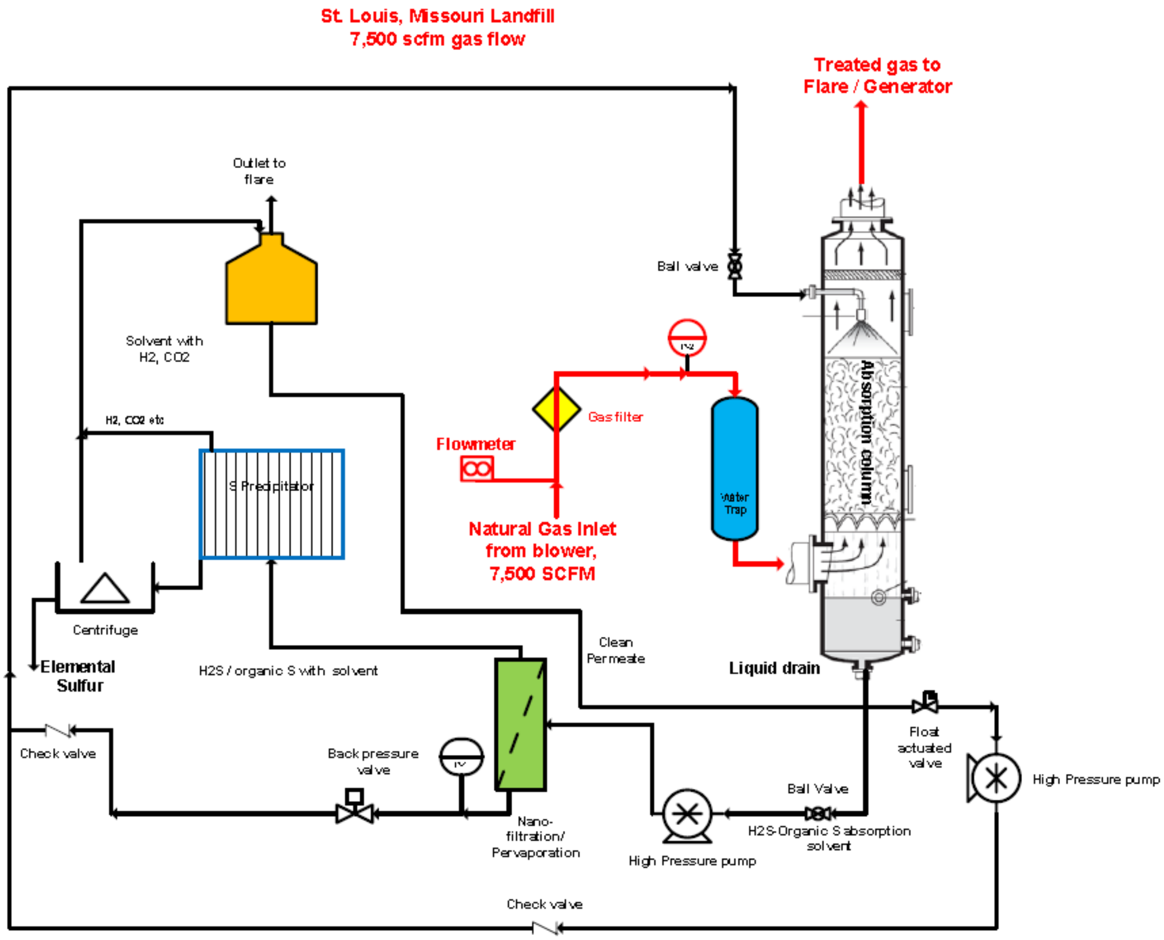
A number of physical solvents are available for use in gas treating processes, including dimethyl ether of polyethylene glycol (DEPG), propylene carbonate (PC), N-methyl-2-pyrrolidone (NMP), and methanol (MeOH). The selection of a physical solvent process depends on process objectives and characteristics of the solvents. Of note, DMS has a relatively high solubility in NMP.

Nrgtek, Inc. (technology to be licensed under Technip Engineering) proposes to provide a multi-stage removal system for DMS. A 2-stage system is proposed in which each system operates in parallel with a design flow rate of 4,000 SCFM per system. A conceptual layout and section-view drawing is provided in Attachment 4. Further design details of the proposed system were not provided by Nrgtek. Material compatibility, packing and solvent selection, operating conditions, and sizing parameters need to be assessed.

The system utilizes 3 techniques to accomplish sulfur removal. The first stage of this process consists of a liquid scrubber with a solvent selected for preferential absorption of hydrogen sulfide and other organic sulfur species present in LFG. The solvent that is enriched with sulfur species in the scrubber is then passed through an organophilic pervaporation membrane element (or nano-filtration). This allows for the sulfur species, along with some entrained solvent, to permeate across the membrane and produce a stream that is highly concentrated with the sulfur-based contaminants. This stream is then processed in an electrochemical catalytic converter (ECC) that electro-chemically converts the sulfur species to either elemental sulfur or polysulfides (depending on Bridgeton's preference). The solid sulfur products are separated by centrifugation. The purified solvent is continuously recycled into the scrubber system for further removal of sulfur species from the LFG in a closed loop.

A conceptual process flow diagram of the Nrgtek process for sulfur removal is as follows:

Privileged and Confidential, Attorney-Client Privileged



Nrgtek's proposed sulfur treatment system is stated to be capable of reducing the sulfide levels (both H_2S and organic sulfur species) by at least 90 percent. The system would include all equipment and appurtenances, process control instrumentation, chemicals used in the initial runs, organophilic membranes, and a sulfur/polysulfide electrochemical catalytic converter/reactor with its constituents. Operating requirements include solvent replacement and electrical energy.

To demonstrate the system's potential efficacy at removing sulfide and disulfide components, Nrgtek fabricated and operated a lab-scale system, employing an in-house designed and fabricated electrocatalytic converter cell to demonstrate conversion into more benign forms that can be safely sequestered using traditional techniques. The system was configured and used for DMS and DMDS (dimethyl disulfide) removal. The laboratory results indicate that the technology is capable of reducing the sulfur levels below 100 ppmv. The process was performed at or near atmospheric pressure and without the addition of heat.

While it is a promising technology, the reliability of Nrgtek's proposed system and the amount of maintenance and labor required for its efficient operation is unknown at this stage, and the potential for unexpected shutdowns or poor performance is of concern. The lack of extensive case history for this technology in this application carries some risk. The theory of the system's

Privileged and Confidential, Attorney-Client Privileged

operation is proven and demonstrated, but the field performance of the system (especially for DMS removal) is not well known. Reliability issues are also of concern due to the process equipment. Inefficient absorption of sulfur contamination into the scrubbing solvent, fouling of the pervaporation membrane, and poor conversion or separation efficiency in the electrochemical catalytic converter are all potential challenges the system may encounter. Field testing of the system will help address the potential system reliability issues.

Our concerns with the limited performance record of this technology are alleviated somewhat by a proposed partnership with Technip Stone and Webster (www.technip.com). Technip has been evaluating and conducting due diligence of Nrgtek's gas separation technologies. At this time, Technip and Nrgtek have entered into an exclusive negotiation period where over the next 4 weeks they expect to have a formal technology alliance agreement, with Technip having full exclusivity of the technology and using Nrgtek as ongoing consultants to provide technology transfer and technical support for each new project. The fact that Technip Engineering is licensing the technology provides some level of security as the technology and system provided would have the backing of a large engineering firm.

Further, Technip wants to support a pilot test at Bridgeton to optimize the Nrgtek design to remove DMS. Technip has proposed a field test, with a 100 SCFM scrubber system, electro-catalytic converter, and a filter press to separate the solid by-products and recycle the solvent back to the liquid scrubber system.

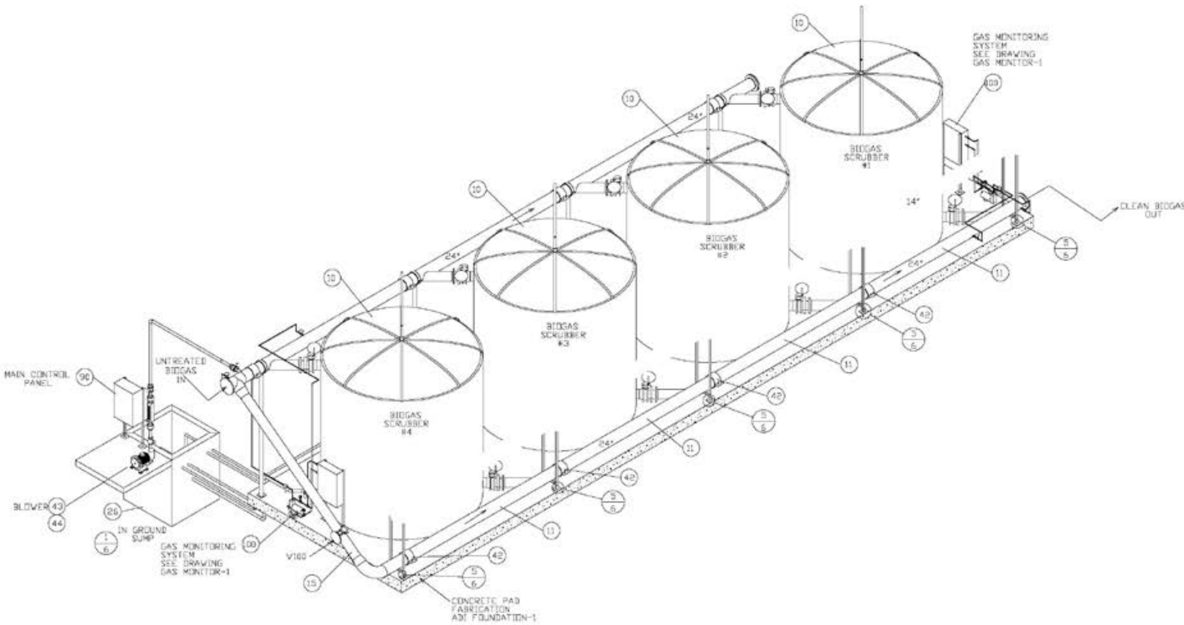
SOLID MEDIA

With solid chemical adsorption (i.e., solid media), there is a chemical interaction between the contaminant and the surface of the adsorbent which forms a new chemical compound. As a result, the chemical reactions are not easily reversed and spent adsorbent media often cannot be regenerated for reuse. Solid chemical adsorption processes are commonly referred to as "solid scavengers".

Solid scavengers typically use a hydrated metallic oxide or alkaline-based adsorbent media packed in a tower or vessel through which the raw gas passes to selectively remove sulfur compounds. The metallic oxide adsorbent media uses a variety of different metals including iron, nickel and zinc.

A typical installation includes a series of vessels, which are filled with the vendor's selected media (see below generic schematic).

 Privileged and Confidential, Attorney-Client Privileged



HydroCat Industries (HydroCat) can provide a solid bed media for sulfur removal comprising a mixture of iron oxides and other metal oxides on an inert base. An inorganic adsorption phase is also included in the solid bed system. The media (known as GTS2001) is granular and has high porosity, and it is stated to have a capacity as high as 20 percent, by weight, at optimal conditions. The media is designed for use in the removal of H_2S, mercaptans, and organic sulfides.

The reaction produces sulfur and stable iron sulfides. This reaction most optimally takes place at ambient temperature up to 140 F, in the presence of oxygen and high humidity. All of these conditions are met in the Bridgeton LFG, and the media is thus expected to be effective for H_2S and mercaptans removal.

The HydroCat media may not remove DMS, however. The media has not been demonstrated to remove sulfide components, such as DMS, at the high levels seen in this application. The media requires higher proportions of H_2S relative to mercaptans in order to activate the media and remove all sulfur components. Further, it is unknown whether or not DMS can effectively activate the media in a similar fashion. It is expected that the system will be able to remove less than 80 percent of the sulfur compounds at a reasonable sulfur capacity due to these conditions, as inefficient removal would be encountered prior to reaching capacity of the bed. It is further likely that sulfide compounds will not react efficiently with the mixed metal oxide media or inorganic adsorbent, nor will they activate the media as their reactivity is low compared to H_2S.

Systems provided by TDA and MVT are subject to the same limitations noted above.

The estimated sulfur concentration at the outlet of a solid media system is expected to be greater than 300 ppmv. As such, we recommend that this option not be considered further, as performance goals will not be met.

SITE CONSIDERATIONS

Site requirements for the sulfur treatment system were considered and initial review of the site was conducted. Site considerations included the following:

- The size/footprint required for the process equipment and ancillary equipment.
  - Nrgtek requires a footprint of about 20 feet by 25 feet.
  - A chemical scrubber requires a footprint of about 30 feet by 25 feet, not including chemical storage tanks.
- Utility services required for the system
  - Electrical power: 20 to 40 hp, depending on the technology. The need to upgrade electric service in the vicinity of the blower/flare station is unknown.
  - Water supply: 1 to 4 gpm, depending on the scrubber system.
  - Wastewater disposal/sewer connections for a chemical scrubber system.
- Vehicular access is required for equipment maintenance and chemical delivery
- A connection to and from the LFG header is required.

Water and wastewater utilities, and connections to the LFG header system are generally available in the blower/flare station.

A conceptual site plan is provided in Attachment 5.

PILOT TESTING

Pilot tests are recommended for both a chemical scrubber and a liquid solvent system, in order to validate each technology for DMS removal. The pilot tests would assess the performance of each technology and would also provide more accuracy relative to operational information and chemical handling. Other aspects may be identified during the pilot test, which may influence the final technology selection.

General work plans for pilot testing are included in Attachment 6 (chemical scrubber) and Attachment 7 (liquid solvent). For both tests, about 2 months will be needed to obtain equipment, and coordinate materials and labor for the tests.

For the chemical scrubber test, 5 to 7 days of field testing is expected. The pilot system will be sized for 100 to 500 scfm of LFG, depending on the actual scrubber used, although we anticipate use of the existing KCH scrubber. The existing KCH scrubber, previously purchased for a different application at Bridgeton, is currently located on-site, but is no longer in use. The following oxidants will be tested:

Privileged and Confidential, Attorney-Client Privileged

- NaClO
- H_2O_2/O_3
- H_2O_2/O_3 with an iron catalyst

For the Nrgtek system, a two-week field test period is expected, using one liquid solvent. The pilot system will be sized for 100 scfm of LFG. A filter press will be used in lieu of a centrifuge for the pilot test.

SUMMARY

Based on our detailed evaluation of sulfur removal technologies, two process technologies are potentially viable solutions for sulfur removal at the Landfill: chemical scrubbing and liquid solvent. Pilot testing is needed for both technologies to confirm sulfur removal efficiency and to identify process parameters for full-scale design.

RECOMMENDATIONS

Our recommendations are as follows:

1. Implement pilot testing for chemical scrubbing and liquid solvent technologies, in accordance with the pilot test work plans provided in Attachments 6 and 7.
2. Based on the pilot tests and any necessary further evaluation, develop bid documents for design and construction services for the selected system.

Please call with any questions.

Sincerely,

Erdal Gurten, P.E.
Project Engineer
SCS ENGINEERS

Gregory P. McCarron, P.E.
Task Manager
SCS ENGINEERS

cc: B. Power
R. Anderson

Attachment 1

Evaluation of DMS Treatment via Condensation

Attachment 1: Evaluation of DMS Treatment via Condensation

The potential for complete or partial removal of DMS from the LFG stream by condensation into the liquid phase (by cooling of LFG), with subsequent treatment of a separate concentrated liquid stream, was introduced as a concept during the Stage 1 evaluation. This concept was further investigated as part of the Stage 2 evaluation, summarized as follows.

Treatment of DMS in the liquid phase can be beneficial for a number of reasons. The concept is that by cooling the LFG to approximately 40 F, DMS would condense out of the gas stream forming a separate liquid phase stream of concentrated DMS. The majority of other components in the LFG stream have boiling points above the minimum cooling temperature for this application (40 F). The condensed liquid phase stream would be smaller in volume, thus allowing the design and sizing of smaller treatment options. Perhaps most importantly, the condensed liquid could feasibly be treated for sulfur removal via more effective and inexpensive methods, not applicable to the gas phase.

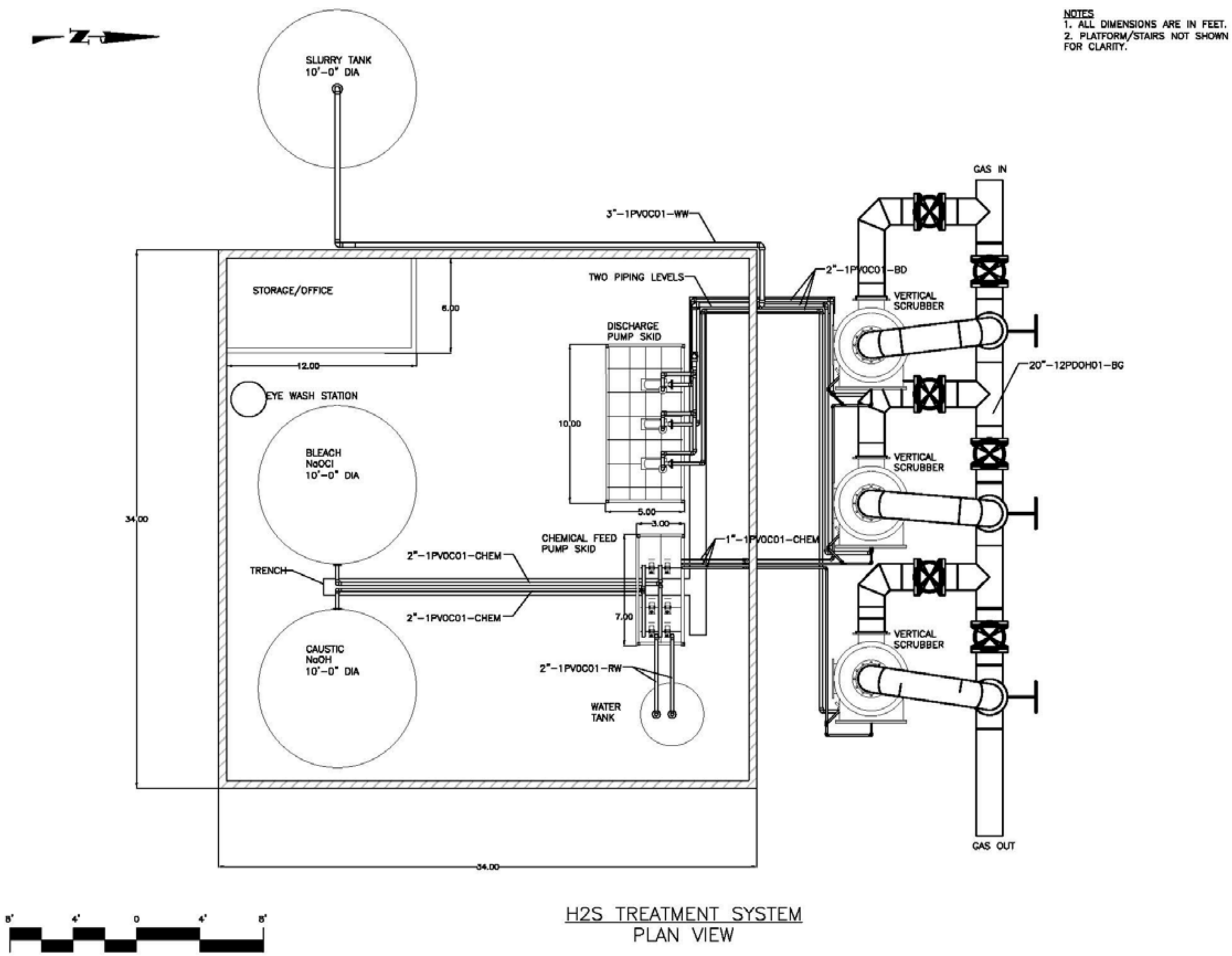
In order to determine the amount of DMS and other species in the LFG that would condense upon cooling from an assumed 100 F to 40 F (i.e. a typical range for conventional chiller-refrigeration technology used in LFG applications), the vapor-liquid equilibrium (VLE) of the LFG stream was modeled using the Deshmukh-Mather model. This model uses Henry's Law as a basis but also incorporates collected data for activity and fugacity coefficients of all components present in order to more accurately calculate equilibrium constants in the system. The results of this model in terms of VLE among all known components in the LFG stream are shown in **Table A1**.

Table A1. Calculated VLE of components in the LFG stream upon cooling to 40 F (Deshmukh-Mather model)

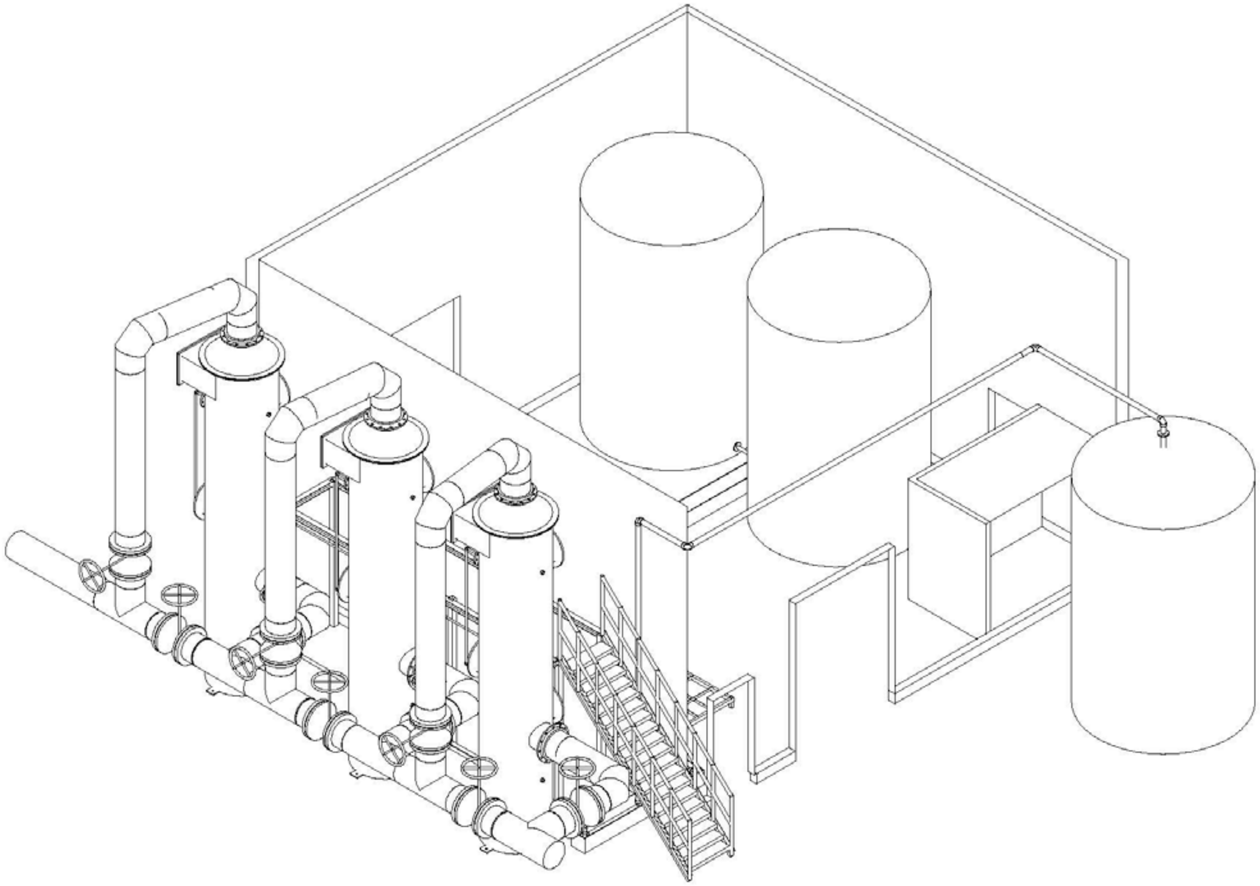
	Inlet Gas (100 F)		Gas After Cooling (40 F)		Liquids After Cooling (40 F)		
	kmol/s	Mol %	kmol/s	Mol %	kmol/s	Mol %	*% Condensed*
Water	9.33E-03	6.4492%	1.13E-03	0.8283%	8.20E-03	99.9512%	*87.8854%*
Dimethyl Sulfide	1.29E-04	0.0895%	1.29E-04	0.0947%	1.78E-07	0.0022%	*0.1372%*
Methyl Mercaptan	2.39E-05	0.0165%	2.39E-05	0.0175%	3.12E-08	0.0004%	*0.1307%*
Hydrogen Sulfide	2.32E-06	0.0016%	2.32E-06	0.0017%	4.79E-10	0.0000%	*0.0206%*
Carbon Dioxide	5.60E-02	38.6987%	5.60E-02		3.68E-06	0.0449%	*0.0066%*
Methane	1.37E-02	9.4387%	1.37E-02	10.0061%	3.36E-08	0.0004%	*0.0002%*
Oxygen	1.09E-02	7.5510%	1.09E-02	8.0049%	2.32E-08	0.0003%	*0.0002%*
Nitrogen	4.23E-02	29.2600%	4.23E-02	31.0189%	4.40E-08	0.0005%	*0.0001%*
Hydrogen	1.23E-02	8.4948%	1.23E-02	9.0055%	1.25E-08	0.0002%	*0.0001%*

As can be seen in the table, the only component in the stream that condenses in a significant proportion is water. This is expected as the stream is expected to be fully saturated at 100 F. The proportion of DMS that condenses is less than 0.1 percent of the total amount present at the original temperature. It is thus expected that the concept of cooling the LFG stream to remove DMS into a separate liquid phase for removal and treatment is not a technically feasible option.

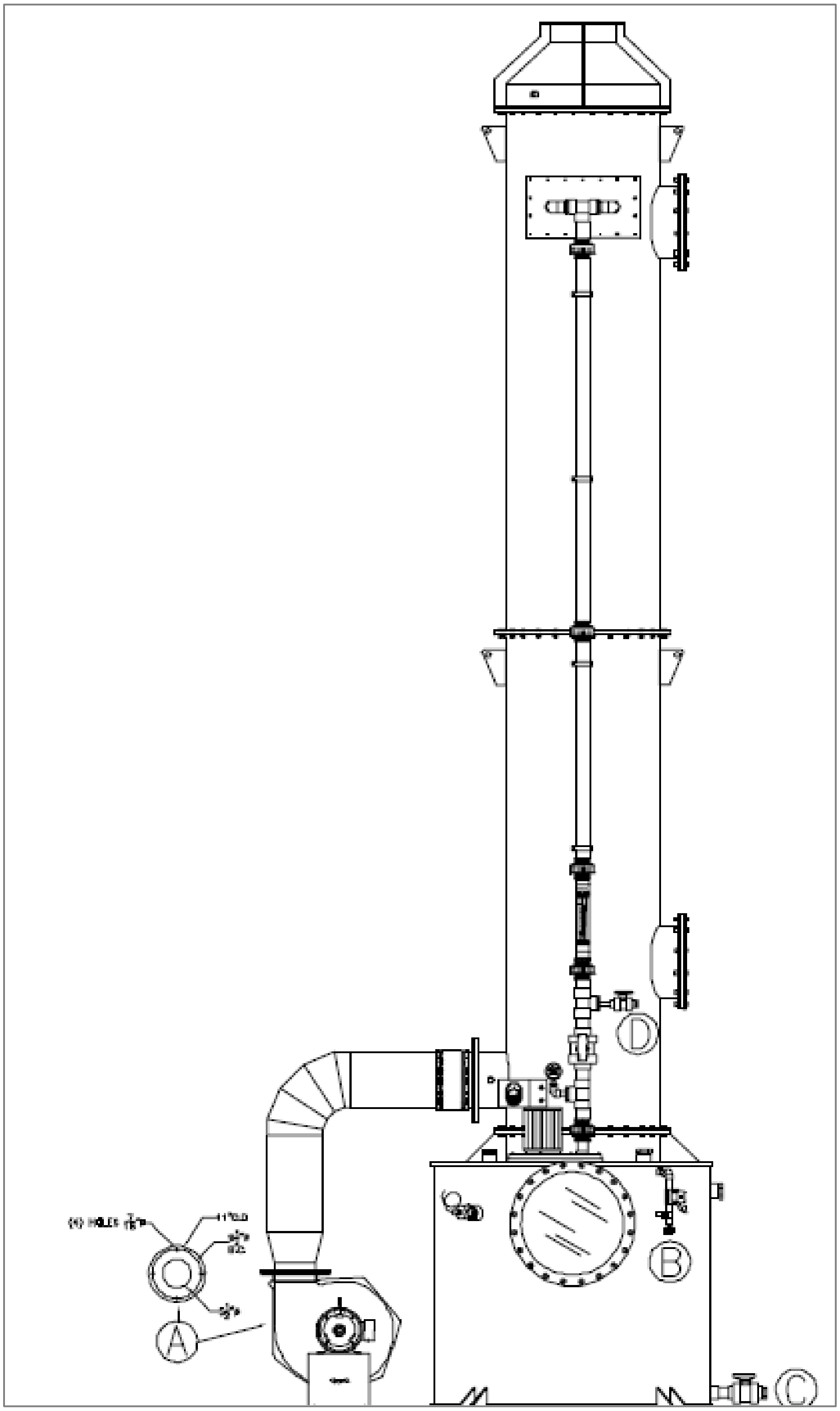
Attachment 2
Hydros Drawings



H2S TREATMENT SYSTEM
PLAN VIEW

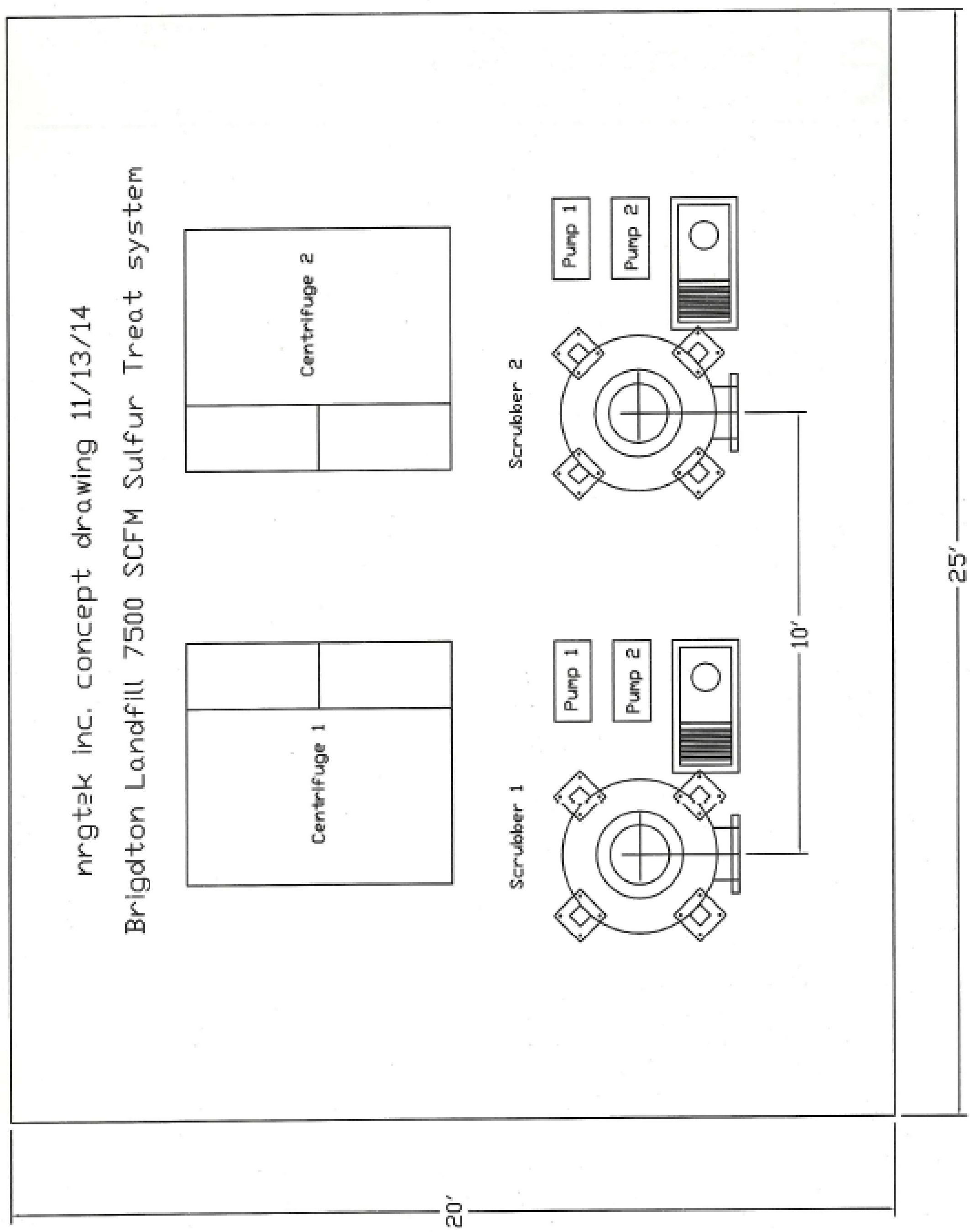


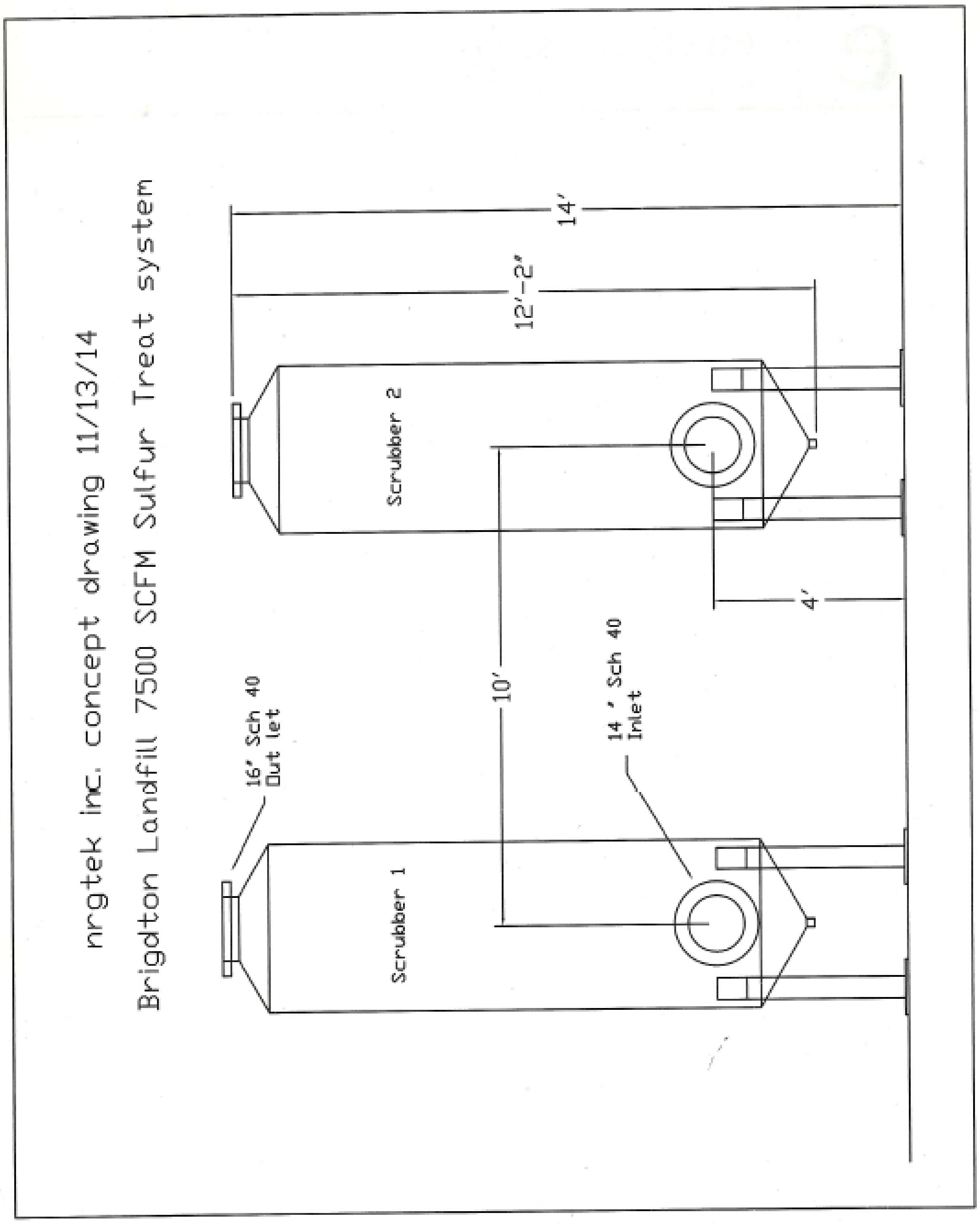
Attachment 3
AAT Drawings


A
B
C
D

Attachment 4
Nrgtek/Technip Drawings

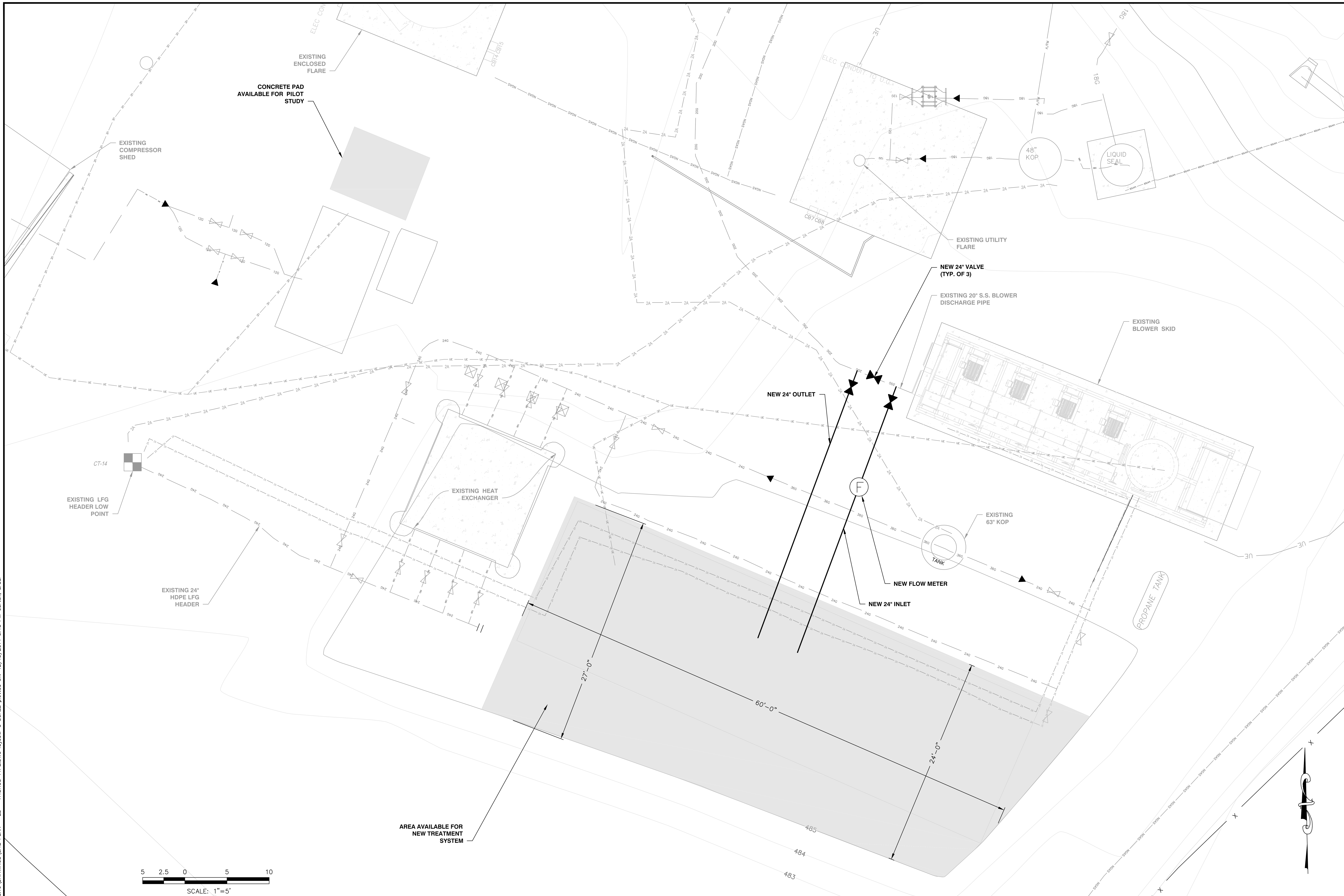
Privileged and Confidential, Attorney-Client Privileged




nrgtek Inc. concept drawing 11/13/14
Brigdton Landfill 7500 SCFM Sulfur Treat system
16" Sch 40
Out let
14 " Sch 40
Inlet
Scrubber 1
Scrubber 2
14'
12'-2"
10'
4'

Attachment 5

Conceptual Site Plan, Full-scale System



PRELIMINARY (12/15/2014)

L:\PROJECTS\FY11\23211003.19\DRAWINGS\SITE PLAN - 2D - HYDROS TYPE.DWG layout: 5 SCALE plotted on: 12/15/2014 3:18 PM Gurten, Erdal

NO.	REVISION	DATE
1		
2		
3		
4		
5		

SHEET TITLE

SITE PLAN

PROJECT TITLE

SULFUR TREATMENT
BRIDGETON LANDFILL

CLIENT

BRIDGETON LANDFILL, LLC

13570 SAINT CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS, INC.
4 EXECUTIVE BLVD. SUITE 303, SUFFERN, NY 10901
PH. (845) 357-1510 FAX. (845) 357-1049

PROJ. NO. 23211003.19	DWN. BY: EG	Q/A RVW BY: GPM
DSN. BY: GPM	CHK. BY: GPM	APP. BY: GPM

CADD FILE: SITE PLAN

DATE: 12/15/14

SCALE: 1" = 5'

DRAWING NO. 1 of 1

Attachment 6

Chemical Scrubber Pilot Test Work Plan

CHEMICAL SCRUBBER PILOT TEST WORK PLAN

A pilot test of a chemical scrubber will be undertaken in order to validate this technology for DMS removal. The pilot test will assess the performance of chemical scrubber technology and will also provide more accuracy relative to operational information and chemical handling. Other process and operational aspects may be identified during the pilot test, which may influence the final technology selection and configuration.

Items covered in this pilot test work plan are as follows:

- Site Preparation
- Major Equipment
- Required Chemicals
- Test Schedule
- Sampling Plan
- Decommissioning of Test Equipment
- Data Evaluation and Analysis

SITE PREPARATION

The pilot system will be located, and the test will be conducted, in the main flare yard (see site plan in Attachment 6-1). The test equipment will located on an existing concrete pad and an existing metal frame foundation, located to the south of the existing enclosed flare.

The LFG test flow rate is expected to range between 100 to 500 scfm. For LFG supply, we propose to use the existing 2-inch connection to the blower skid outlet piping (pressure condition), which was installed as part of the MV Technologies test. The discharge from the test equipment will be connected to an existing above-grade 12-inch HDPE pipe (vacuum condition). Therefore, all gas (treated and untreated portions) will be kept within the closed loop piping system, and eventually combusted at flares. No gas, treated or untreated, will be vented the atmosphere.

The following piping and utilities need to be extended to the test equipment:

- 4-inch HDPE pipe to supply raw LFG to the test equipment. We propose to use the existing 2-inch connection to the blower skid outlet piping (pressure condition), which was installed as part of the MV Technologies test, with a 2-inch by 4-inch reducer.

- 4-inch HDPE pipe to return treated LFG to the existing system, with required reducers to connect to an existing 12-inch HDPE pipe.

- A new flow meter will be installed on the LFG supply line.

- ¾-inch HDPE pipe to supply water to the test equipment. We propose to connect to the existing water line at the nearest liquid seal. Water requirements are expected to be less than 200 gallons per day.

- 1-inch HDPE pipe as a drain for wastewater. Alternatively, or in combination, an existing 275-gallon tote may be used to collect wastewater to allow for composite sampling of the wastewater. We propose to connect the drain line to CT-13. Wastewater generation will generally match water usage; i.e., less than 200 gallons per day.

- Electric power. Three (3), 15-hp motors are expected to be used, requiring a 20 amp breaker for each (3 phase, 480 volt).

MAJOR EQUIPMENT

Subject to further detailed review, we plan to use the existing KCH scrubber, currently located on-site (see drawings in Attachment 6-2). The existing KCH scrubber was originally designed and installed as part of an odor control system associated with the interim leachate management system. With the permanent leachate management systems now fully in place at the Landfill, the KCH system is permanently disconnected and is no longer in use. The KCH system is sized for 2,000 scfm gas flow. We need to confirm the low flow limit of the scrubber with KCH. Also, the vessel interiors should be inspected and the packing examined for potential solids accumulation and physical integrity.

The scrubber uses a 2-step process. The scrubber tower will be assembled on site and will allow the chemical solutions to be injected in a countercurrent mode (from the second scrubber to the first scrubber).

REQUIRED CHEMICALS

The following chemicals will be required for the test:

- $NaClO$
- $NaOH$ (for pH adjustment)
- H_2O_2/O_3; ozone will be generated on-site.
- H_2O_2/O_3 with an iron catalyst; ozone will be generated on-site.

We propose that the above chemicals be provided in existing totes and filled from on-site tanks at the leachate pre-treatment facility.

TEST SCHEDULE

Field testing is expected to require approximately 5 to 7 days over a two-week period. The specific testing interval and time required with the specific chemicals will be provided within a detailed test protocol.

SAMPLING PLAN

Samples of the gas feed and effluent gas will be collected on-site using a Tedlar bag. On-site analysis will provide real-time results for DMS removal and for process optimization purposes.

Process parameters will be recorded (flow, pressure, and temperature).

Gas samples from the inlet and outlet will also be taken periodically for extended sulfur speciation concentration (H_2S, DMS, and mercaptans). Samples will be taken using Tedlar bags.

Measurements of the process liquid will be continuously taken (flow, pH, and temperature).

Wastewater samples will be collected for laboratory analysis.

DECOMMISSIONING OF TEST EQUIPMENT

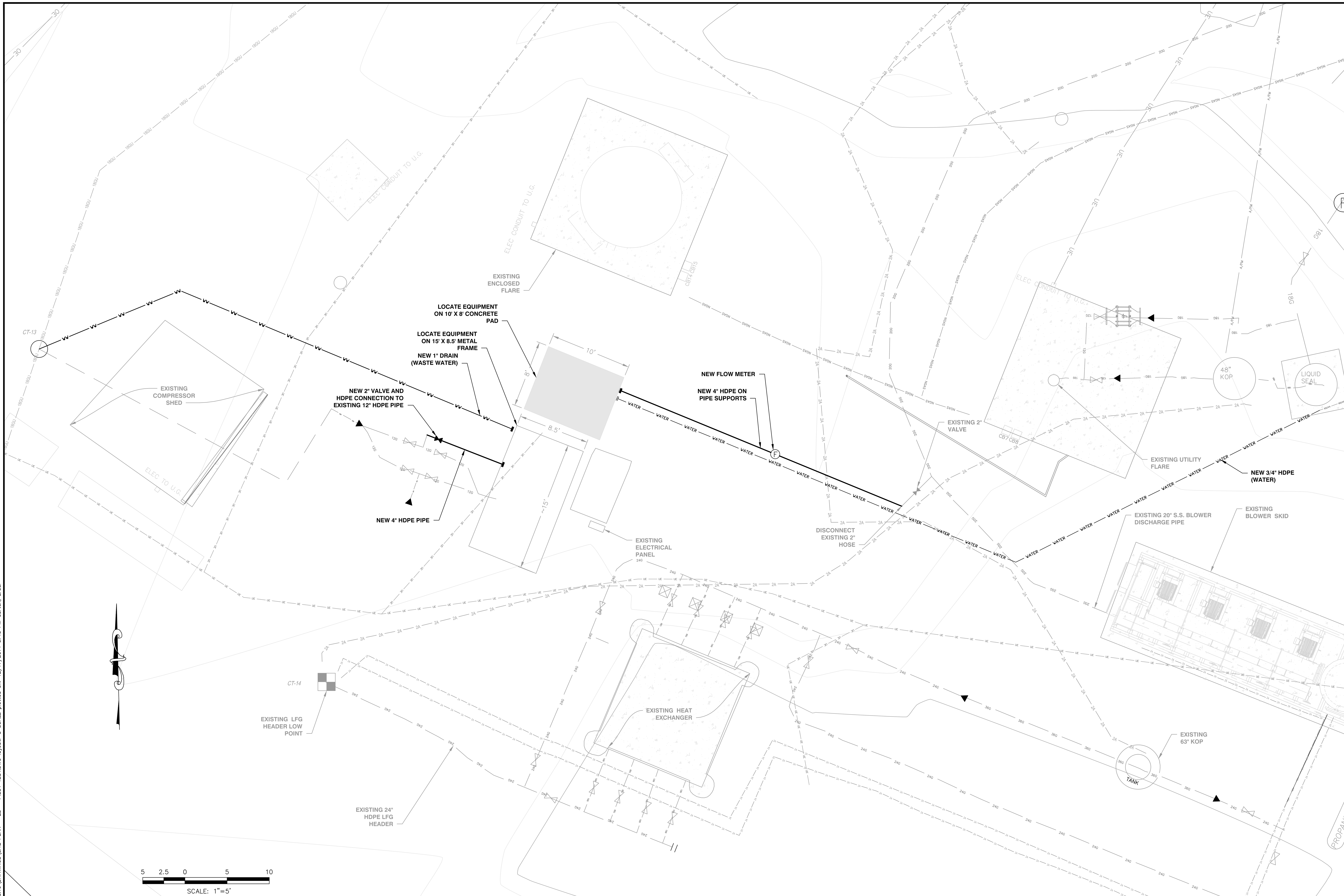
At the end of the test, the test equipment will be disassembled and stored on-site, as directed. Utilities will be terminated as directed.

DATA EVALUATION AND ANALYSIS

Following the field test, SCS/Nexo will compile all test data and prepare process calculations. Chemical injection rates and operating parameters, necessary to meet the sulfur removal goal, will be estimated for a full-scale facility.

Attachment 6-1

Conceptual Site Plan, Pilot System



PRELIMINARY (12/17/2014)

NO.	REVISION	DATE

SHEET TITLE: **PILOT TEST**

PROJECT TITLE: **SULFUR TREATMENT BRIDGETON LANDILL**

CLIENT: **BRIDGETON LANDFILL, LLC**
13570 SAINT CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS, INC.
4 EXECUTIVE BLVD, SUITE 303, SUFFERN, NY 10901
PH. (845) 357-1510 FAX. (845) 357-1049

PROJ. NO. 23211003.19 | DSN. BY: GPM | DWN. BY: EG | CHK. BY: GPM | Q/A RVW BY: GPM | APP. BY: GPM

CADD FILE: SITE PLAN

DATE: 12/17/14

SCALE: 1" = 5'

DRAWING NO. **1** of **1**

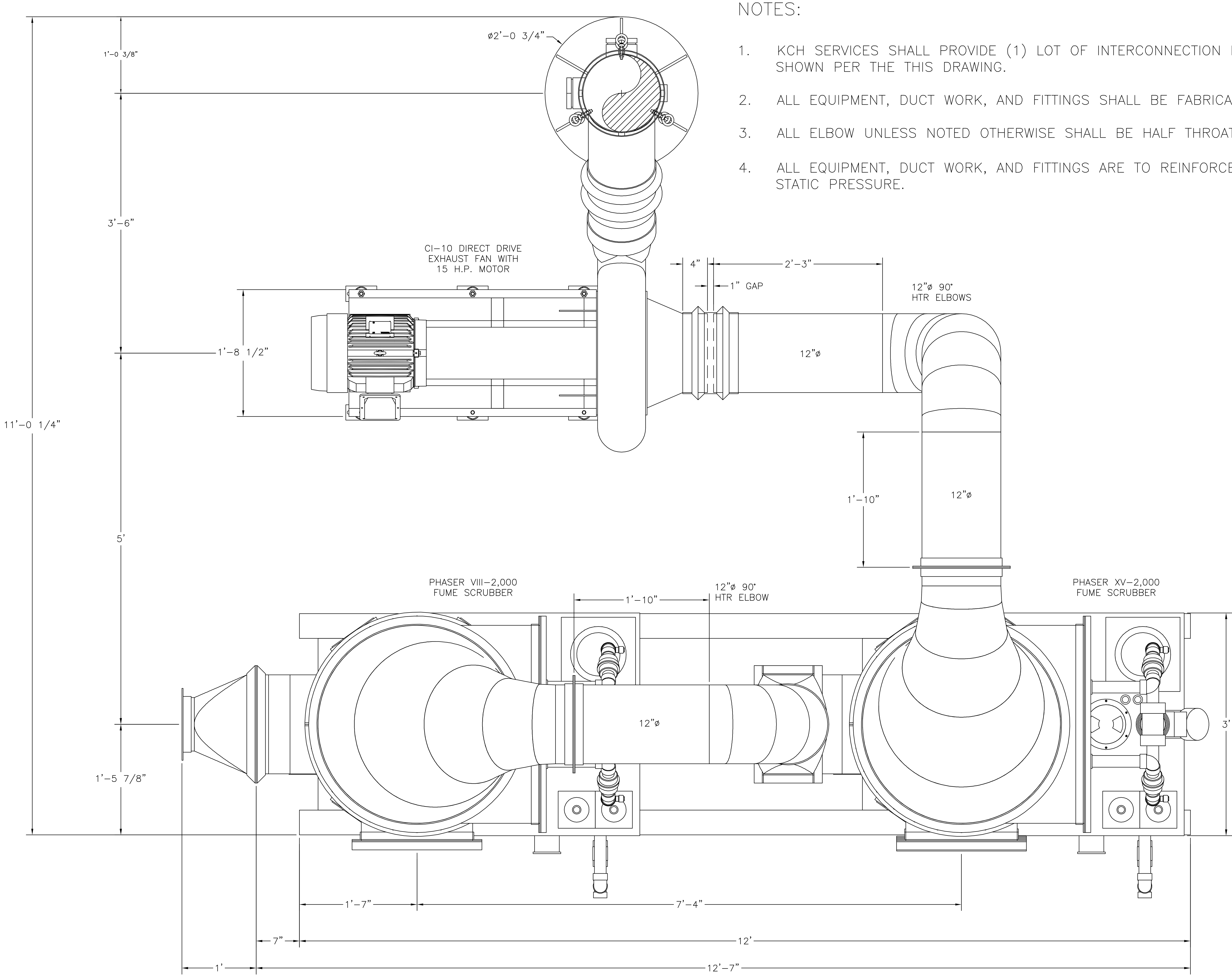
L:\PROJECTS\Y11\23211003.19\DRAWINGS\SITE PLAN – 2D – PILOT TEST.DWG layout: 5 SCALE plotted on: 12/17/2014 5:45 PM Gurten, Erdal

Attachment 6-2

Existing KCH Scrubber Drawings

NOTES:

1. KCH SERVICES SHALL PROVIDE (1) LOT OF INTERCONNECTION DUCT WORK AND FITTINGS AS SHOWN PER THE THIS DRAWING.
2. ALL EQUIPMENT, DUCT WORK, AND FITTINGS SHALL BE FABRICATED FROM TYPE II WHITE PVC.
3. ALL ELBOW UNLESS NOTED OTHERWISE SHALL BE HALF THROAT RADIUS.
4. ALL EQUIPMENT, DUCT WORK, AND FITTINGS ARE TO REINFORCED FOR A MINIMUM OF 18" STATIC PRESSURE.



PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DESCRIPTION: PLAN VIEW OF VENTILATION EQUIPMENT

PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
J.C.	J.C.			9/25/13	0	PHASER XV 2,000
J.C.	J.C.			9/30/13	1	CHANGED THE STYLE OF THE INLET

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

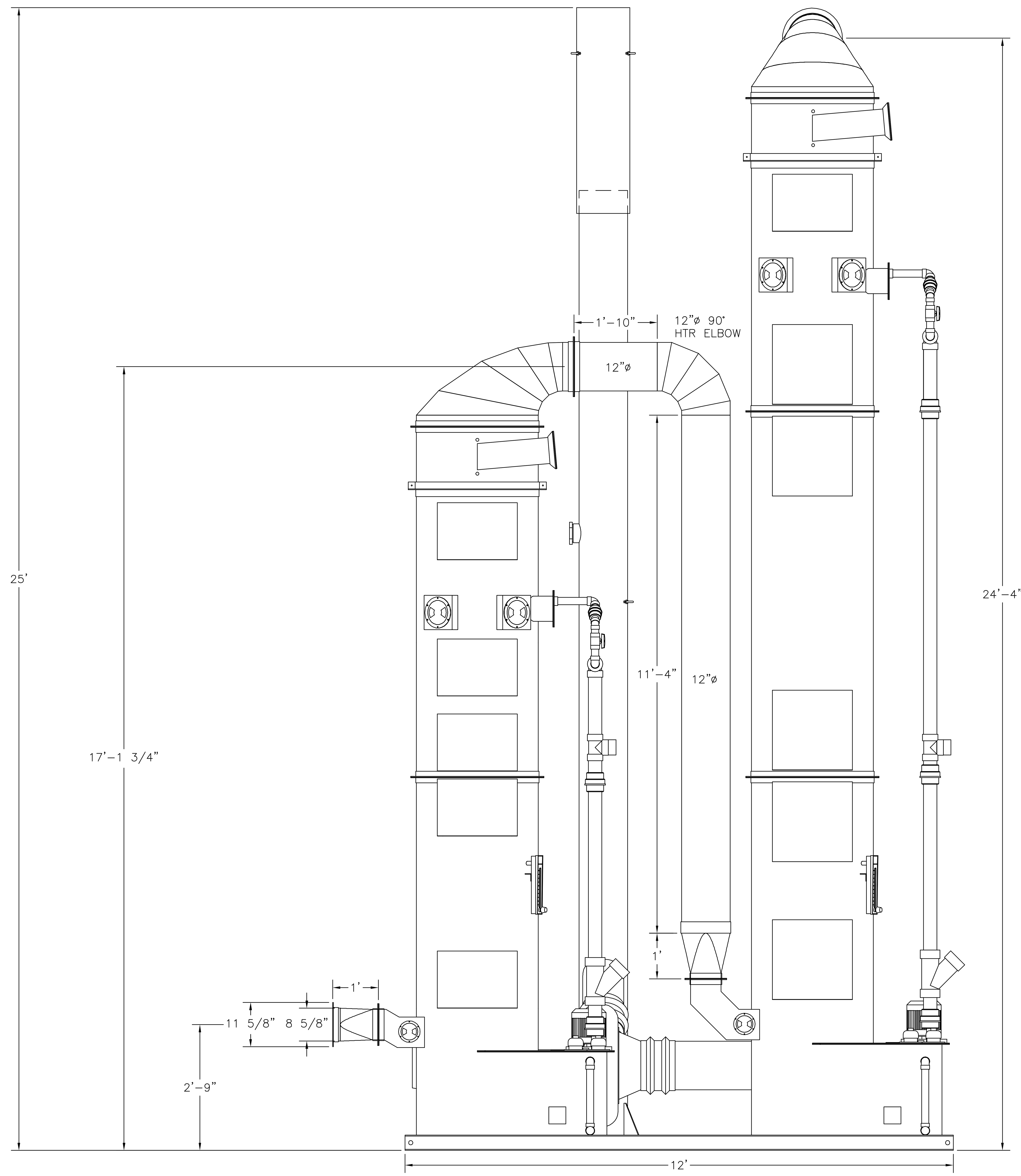
SCALE: 1-1/2" = 1'-0"

CAD FILE NO: 30030 M-1 R-1

REVISION: 1

JOB NUMBER: 30030

DRAWING NUMBER: 30030 M-1



NOTES:

1. KCH SERVICES SHALL PROVIDE (1) LOT OF INTERCONNECTION DUCT WORK AND FITTINGS AS SHOWN PER THE THIS DRAWING.
2. ALL EQUIPMENT, DUCT WORK, AND FITTINGS SHALL BE FABRICATED FROM TYPE II WHITE PVC.
3. ALL ELBOWS UNLESS NOTED OTHERWISE SHALL BE HALF THROAT RADIUS.
4. ALL EQUIPMENT, DUCT WORK, AND FITTINGS ARE TO REINFORCED FOR A MINIMUM OF 18" STATIC PRESSURE.

DESCRIPTION: ELEVATION VIEW OF VENTILATION EQUIPMENT

PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
J.C.	J.C.			9/25/13	0	ELEVATION VIEW
J.C.	J.C.			9/30/13	1	CHANGED THE STYLE OF THE INLET

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

SCALE: 3/4" = 1'-0"

CAD FILE NO: 30030 M-1 R-1

REVISION: 1

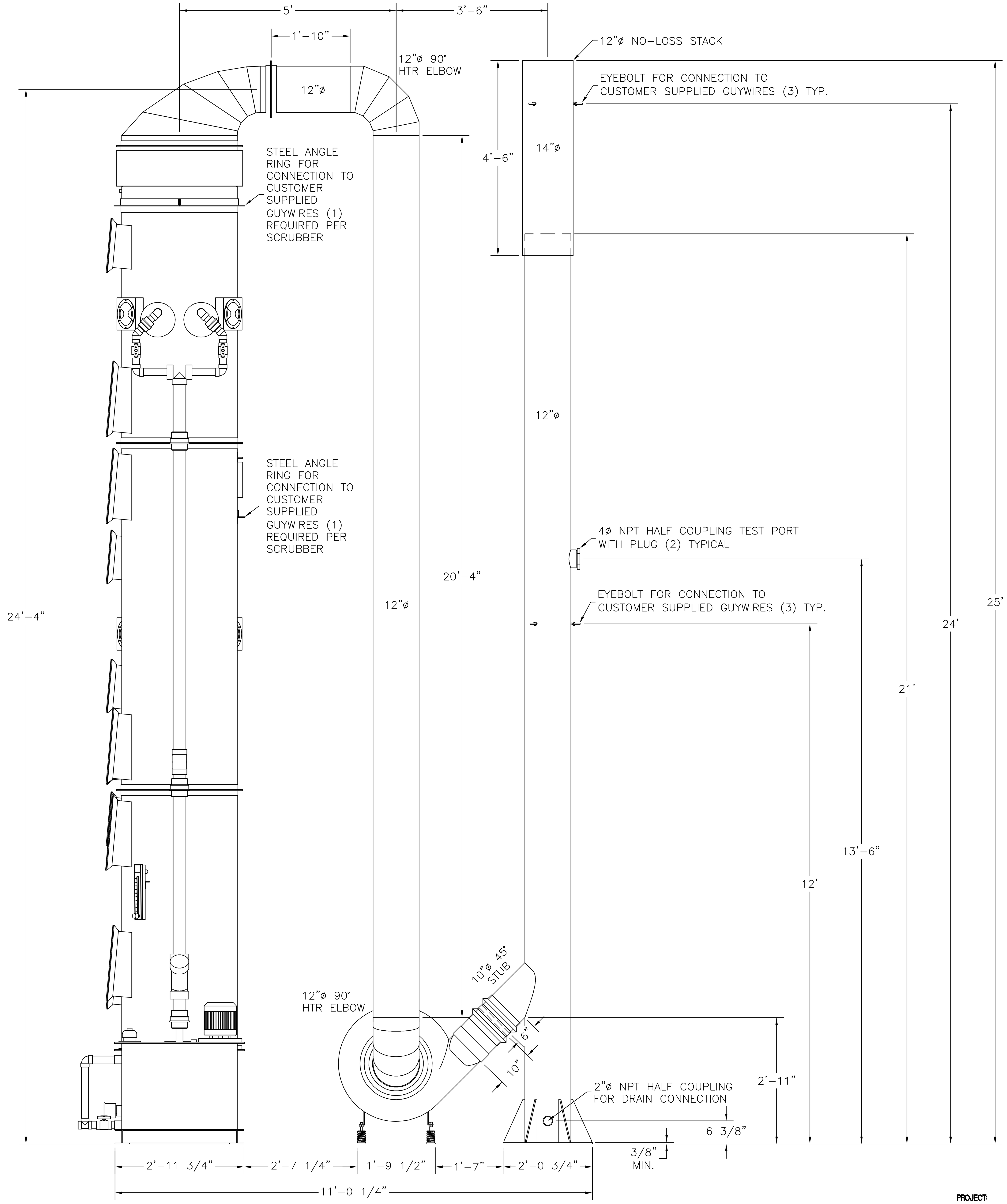
JOB NUMBER: 30030

DRAWING NUMBER: 30030 M-2

PROJECT: REPUBLIC SERVICES
BRIDGETON, MO

NOTES:

1. KCH SERVICES SHALL PROVIDE (1) LOT OF INTERCONNECTION DUCT WORK AND FITTINGS AS SHOWN PER THE THIS DRAWING.
2. ALL EQUIPMENT, DUCT WORK, AND FITTINGS SHALL BE FABRICATED FROM TYPE II WHITE PVC.
3. ALL ELBOWS UNLESS NOTED OTHERWISE SHALL BE HALF THROAT RADIUS.
4. ALL EQUIPMENT, DUCT WORK, AND FITTINGS ARE TO REINFORCED FOR A MINIMUM OF 18" STATIC PRESSURE.



PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DESCRIPTION: END ELEVATION VIEW OF EXHAUST SYSTEM DETAIL DRAWING

PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
J.C.	J.C.			9/25/13	0	END ELEVATION VIEW
J.C.	J.C.			9/30/13	1	CHANGED THE STYLE OF THE INLET

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

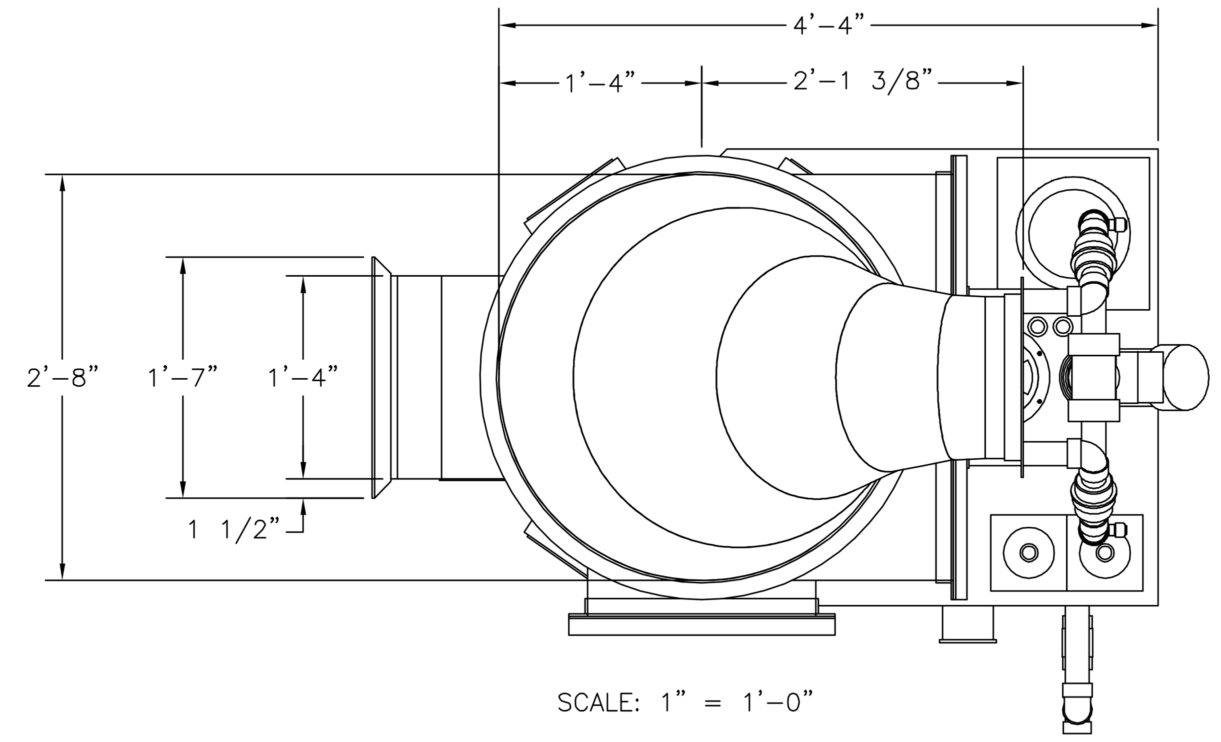
SCALE: 3/4" = 1'-0"

CAD FILE NO: 30030 M-1 R-1

REVISION: 1

JOB NUMBER: 30030

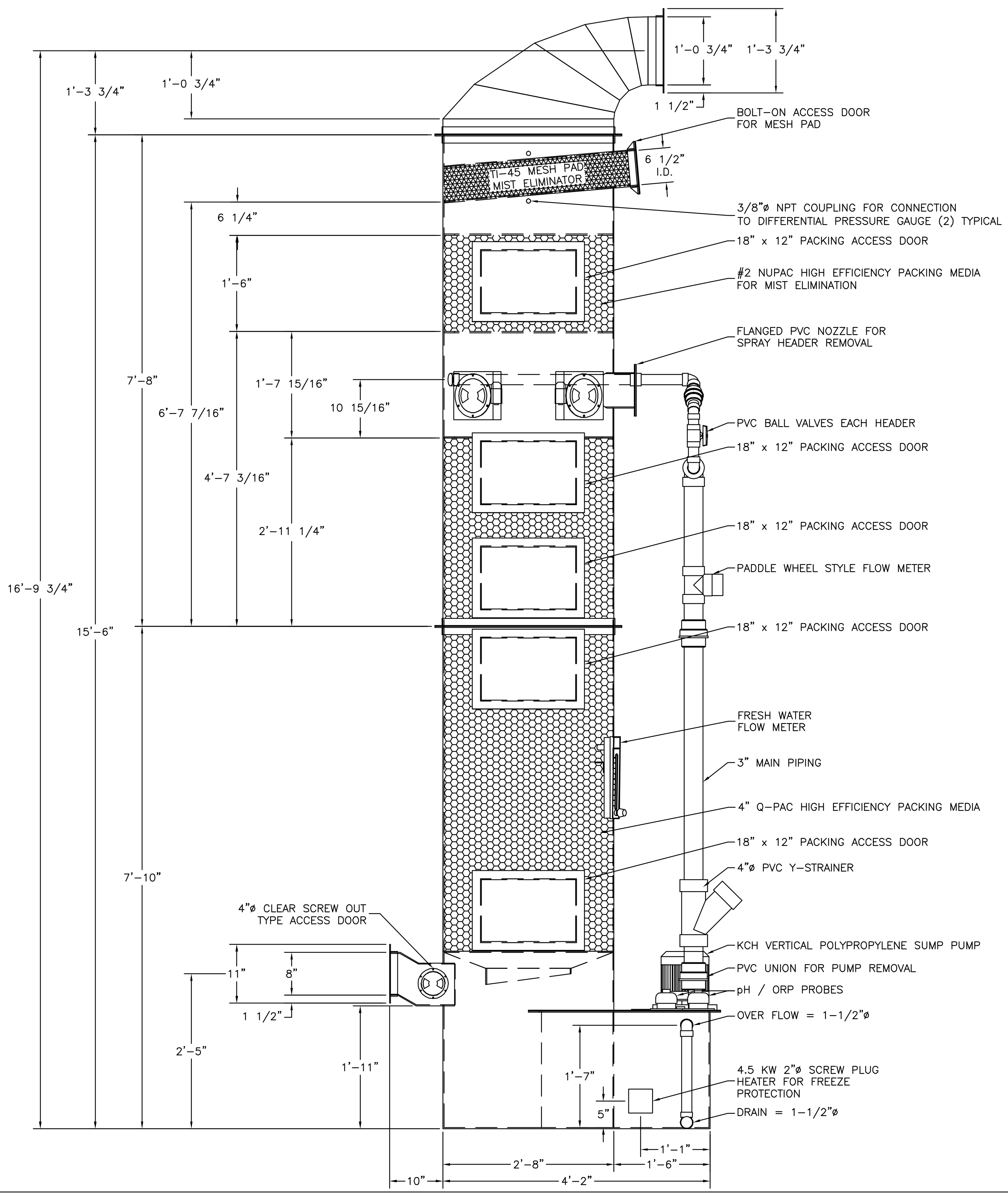
DRAWING NUMBER: 30030 M-3

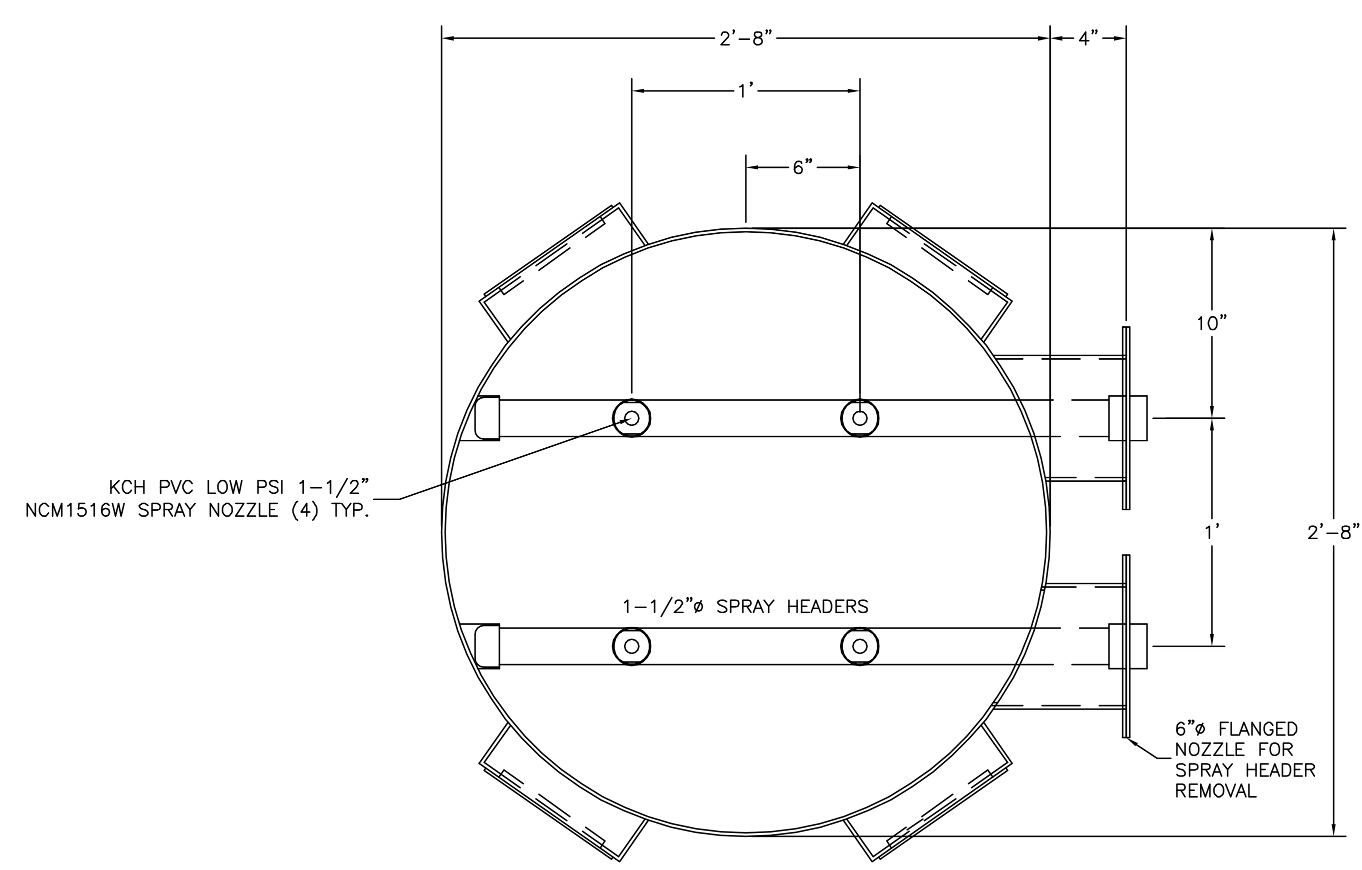


GENERAL NOTES:

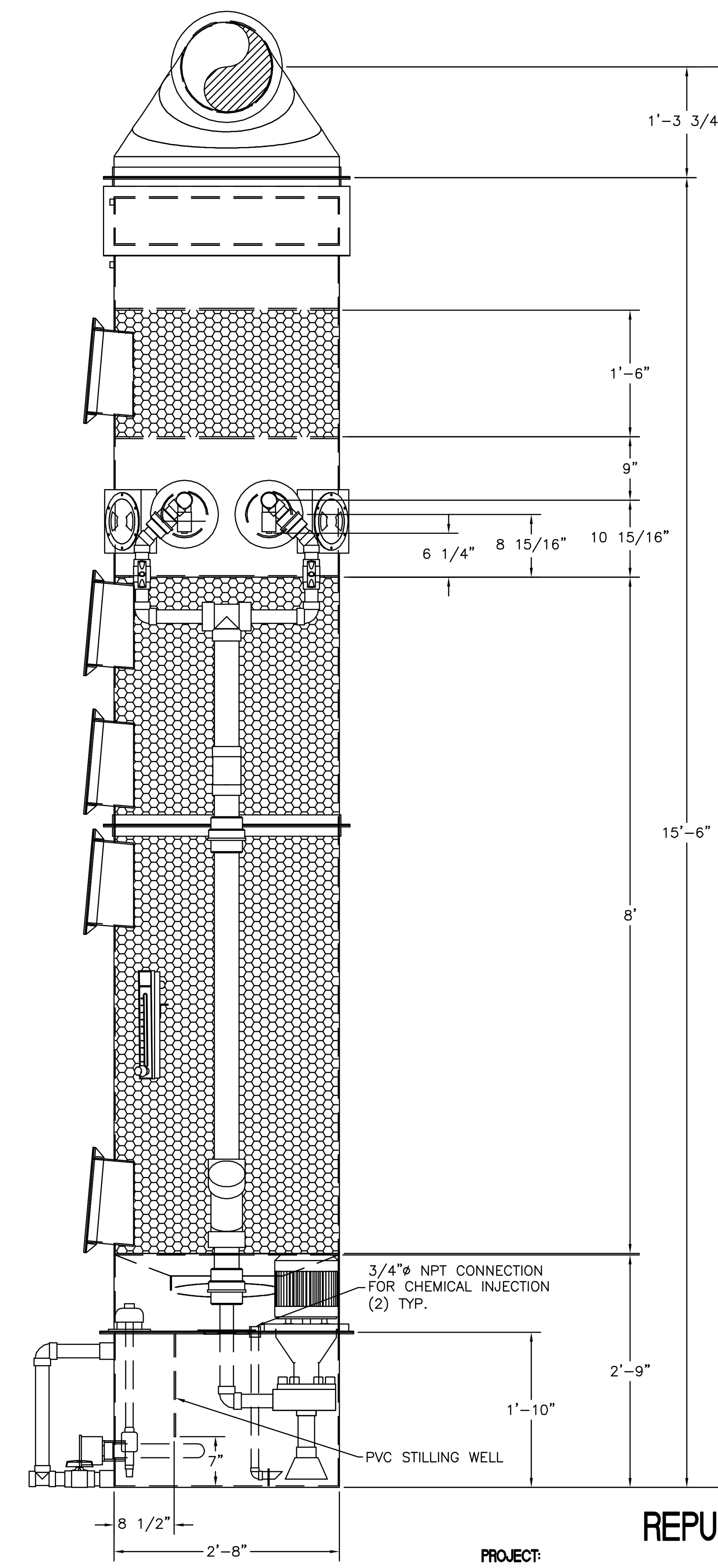
Recirculation Pump: 5HP 230/460 Volt - 3 Phase - 60 Cycle Motor
Pump Full Load Amps: 11.70 / 5.85
Sump Heater: 4.5 KW 480 Volt - 3 Phase - 60 Cycle
Heater Full Load Amps: 5.4
Recirculation Flow Meter Analyzer: GF SIGNET 3-9900-1P (BY CUSTOMER)
pH / ORP Controller: 120 Volt - 1 Phase - 60 Cycle
pH Chemical Metering Pump: 120 Volt - 1 Phase - 60 Cycle
ORP Chemical Metering Pump: 120 Volt - 1 Phase - 60 Cycle

PHASER VIII - 2,000 FUME SCRUBBER	
KCH FOREST CITY, N.C.	
EXTENDED PACK W/ SELF CONTAINED RECIRCULATION	
USER: REPUBLIC SERVICES	
PURCHASER: SAME	
DATE: 9/25/13	JOB NUMBER: 30030
C.F.M.: 2,000	VENTING: LEACHATE TANK
STATIC PRESSURE: 3" W.C.	MAT'L TYPE: TYPE II WHITE
PUMP G.P.M.: 45 TO 55	FLOW METER: RMC143-SSV
FRESH WATER G.P.M.: .5 TO 2.5	
PUMP MODEL: KP1.5X2IM5F.5-H5 V. 230/460 PH. 3 CYC. 60	





SPRAY HEADER AND NOZZLE DETAIL
SCALE: 1-1/2" = 1'-0"



PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DESCRIPTION: PHASER VIII - 2,000 FUME SCRUBBER DRAWING
PROJECT: REPUBLIC SERVICES, INC BRIDGETON, MO

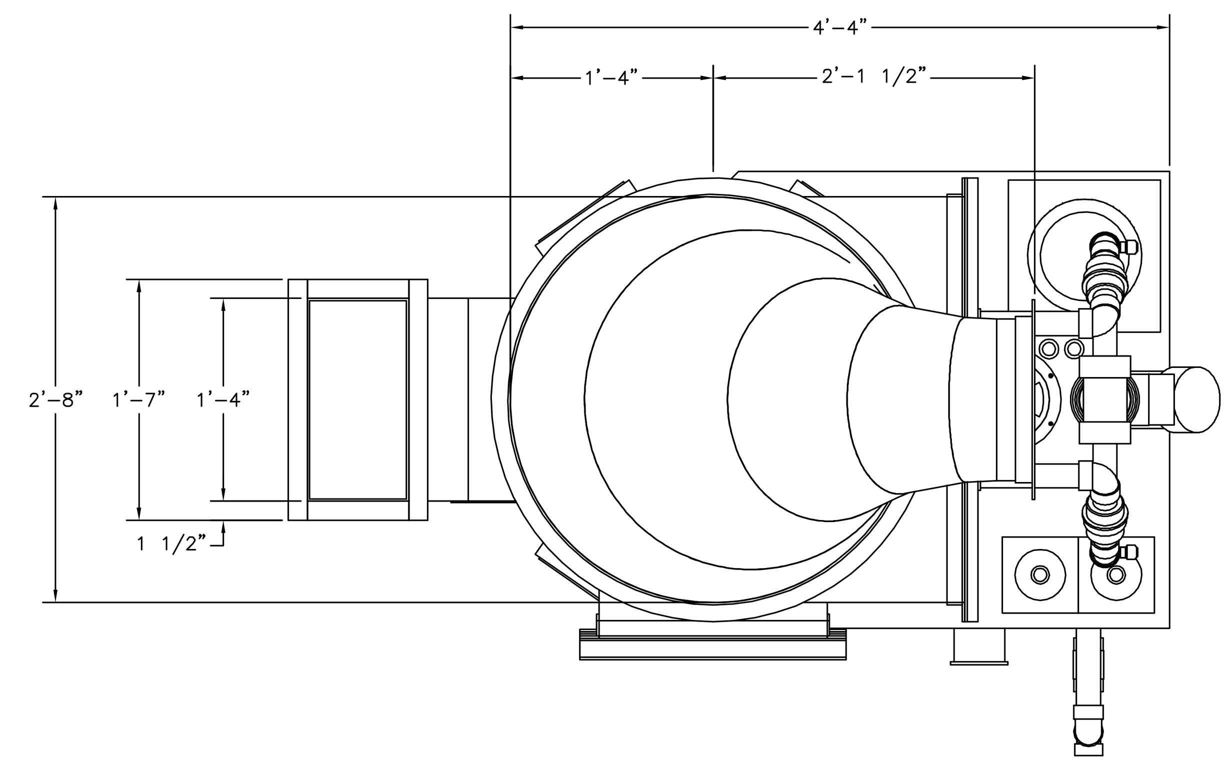
DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
J.C.	J.C.			9/25/13	0	PHASER VIII 2,000
J.C.	J.C.			9/30/13	1	CHANGED THE STYLE OF THE INLET

CONFIDENTIAL
THIS PRINT IS THE PROPERTY OF KCH SERVICES, INC. IT MUST NOT BE REPRODUCED IN ANY MANNER, NOR SHALL IT BE SUBMITTED TO OUTSIDE PARTIES FOR EXAMINATION WITHOUT OUR WRITTEN CONSENT. IT SHALL BE USED ONLY AS A MEANS OF REFERENCE TO WORK DESIGNED OR FURNISHED BY KCH SERVICES, INC.

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

SCALE: 3/4" = 1'-0"
CAD FILE NO: 30030 SD-1 R-1
REVISION: 1
JOB NUMBER: 30030
DRAWING NUMBER: 30030 SD-1



SCALE: 1" = 1'-0"

GENERAL NOTES:

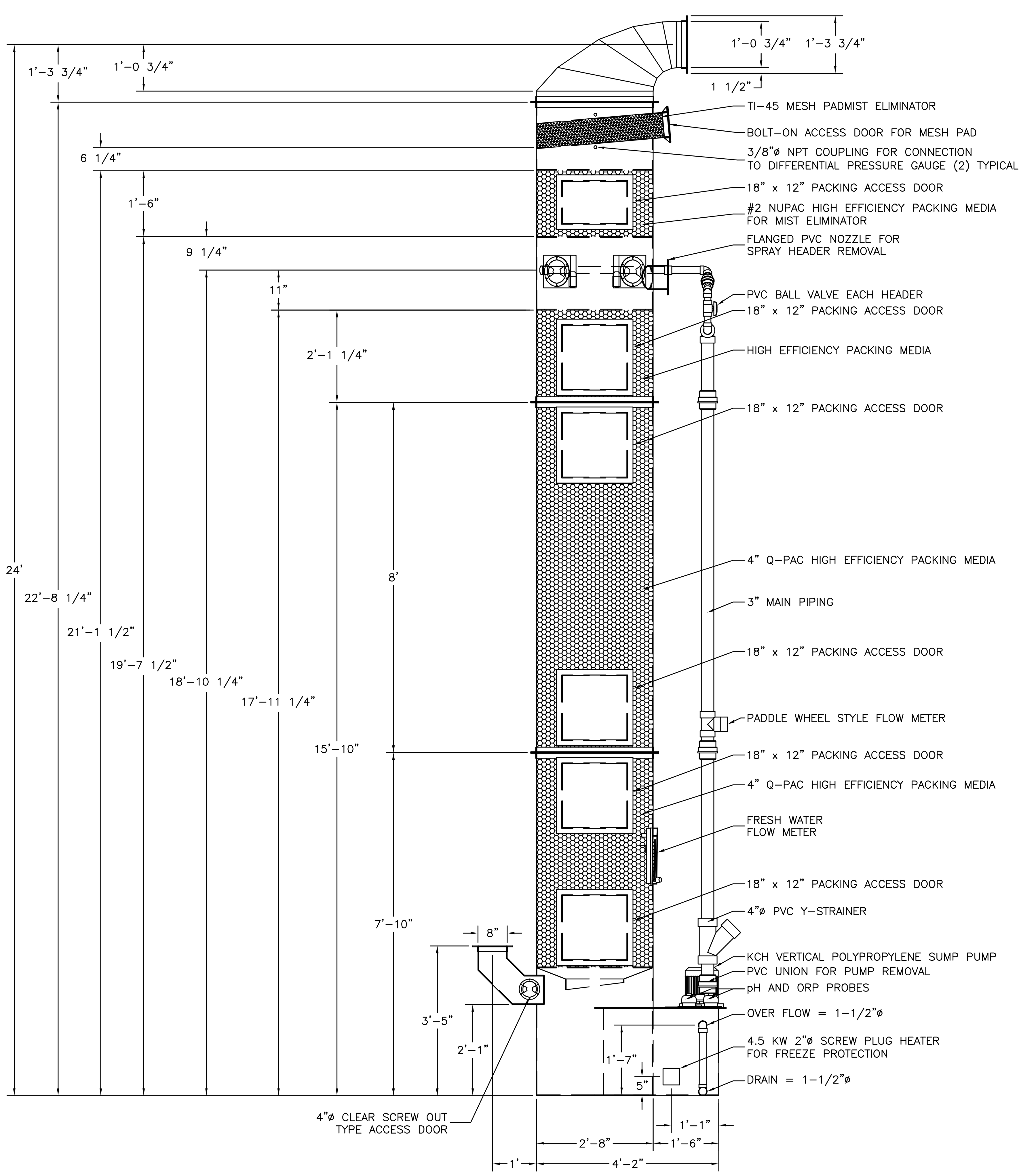
Recirculation Pump: 5HP 230/460 Volt - 3 Phase - 60 Cycle Motor
Pump Full Load Amps: 11.70 / 5.85
Sump Heater: 4.5 KW 480 Volt - 3 Phase - 60 Cycle
Heater Full Load Amps: 5.4
Recirculation Flow Meter Analyzer: GF SIGNET 3-9900-1P **(BY CUSTOMER)**
pH / ORP Controller: 120 Volt - 1 Phase - 60 Cycle
pH Chemical Metering Pump: 120 Volt - 1 Phase - 60 Cycle
ORP Chemical Metering Pump: 120 Volt - 1 Phase - 60 Cycle

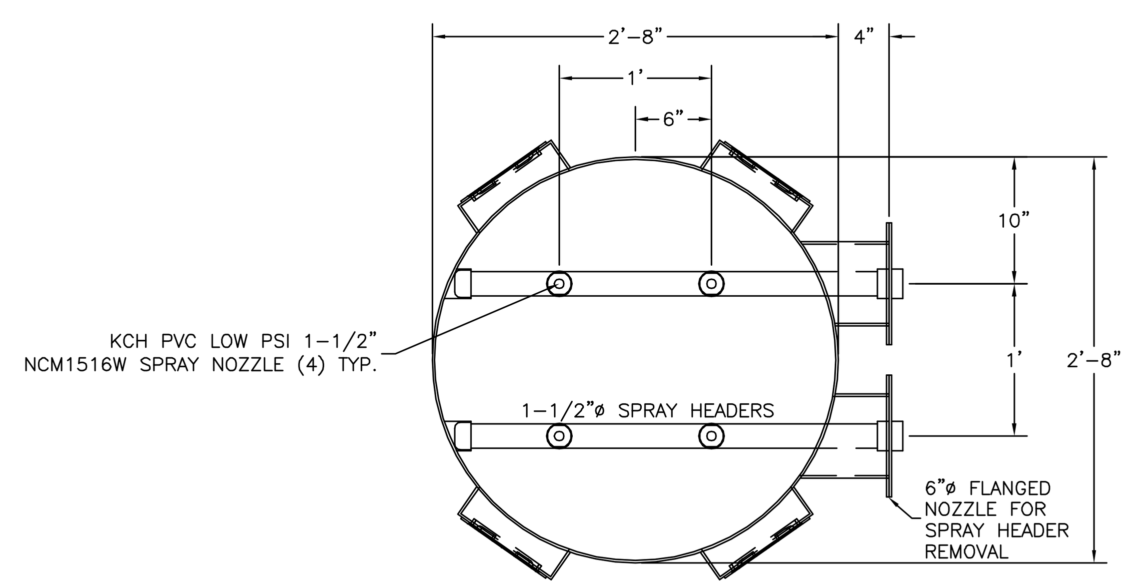
PHASER XV - 2,000 FUME SCRUBBER

KCH FOREST CITY, N.C.

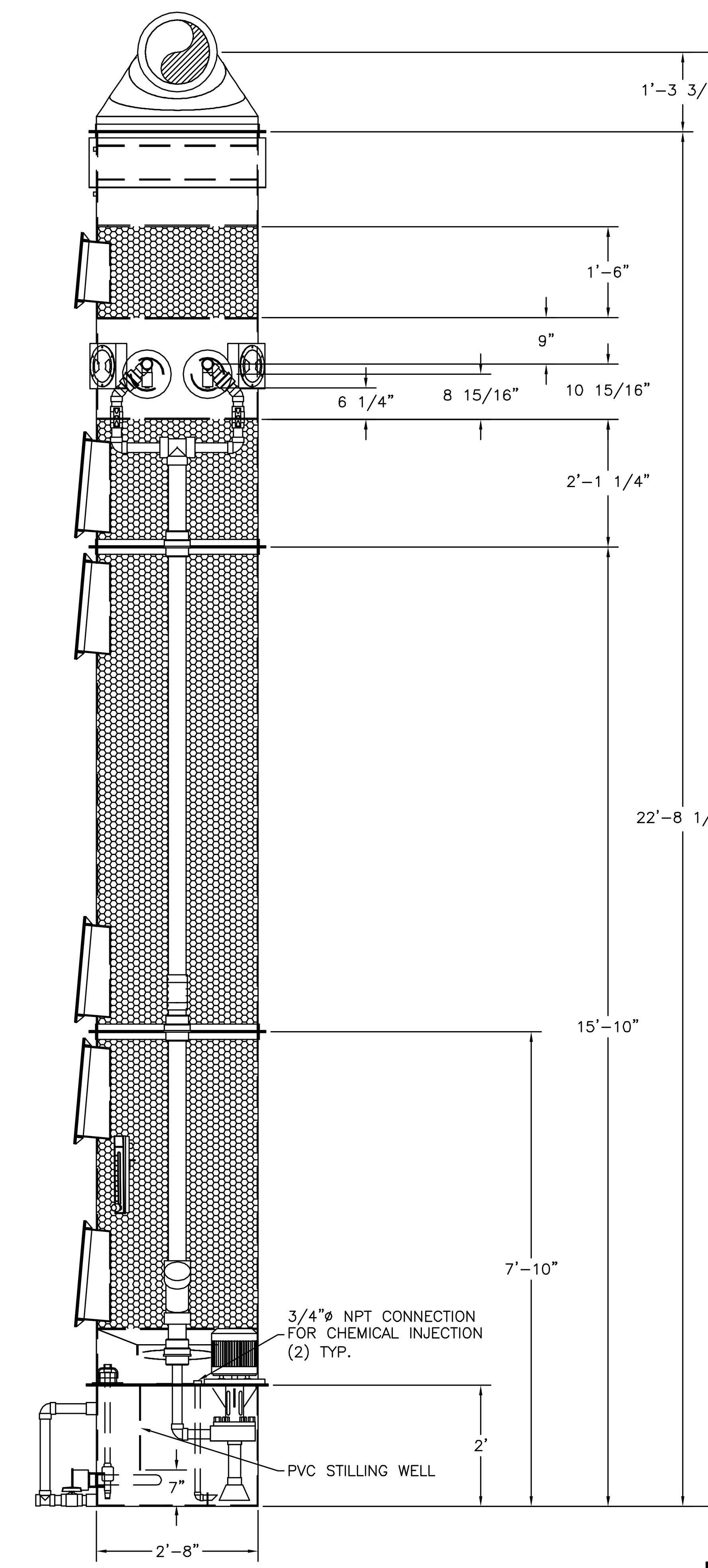
EXTENDED PACK W/ SELF CONTAINED RECIRCULATION

USER: CIVIL AND ENVIRONMENTAL CONSULTANTS	
PURCHASER: SAME	
DATE: 9/25/13	JOB NUMBER: 30030
C.F.M.: 2,000	VENTING: LEACHATE TANK
STATIC PRESSURE: 3" W.C.	MAT'L TYPE: TYPE II WHITE
PUMP G.P.M.: 55 TO 65	FLOW METER: RMC143-SSV
FRESH WATER G.P.M.: .6 TO 3	
PUMP MODEL: KP1.5X2IM5F.5-H5 V. 230/460 PH. 3 CYC. 60	





SPRAY HEADER AND NOZZLE DETAIL
SCALE: 1-1/2" = 1'-0"



PROJECT: REPUBLIC SERVICES
BRIDGETON, MO

DESCRIPTION: PHASER XV-2,000 FUME SCRUBBER DRAWING

PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
J.C.	J.C.			9/25/13	0	PHASER XV 2,000

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

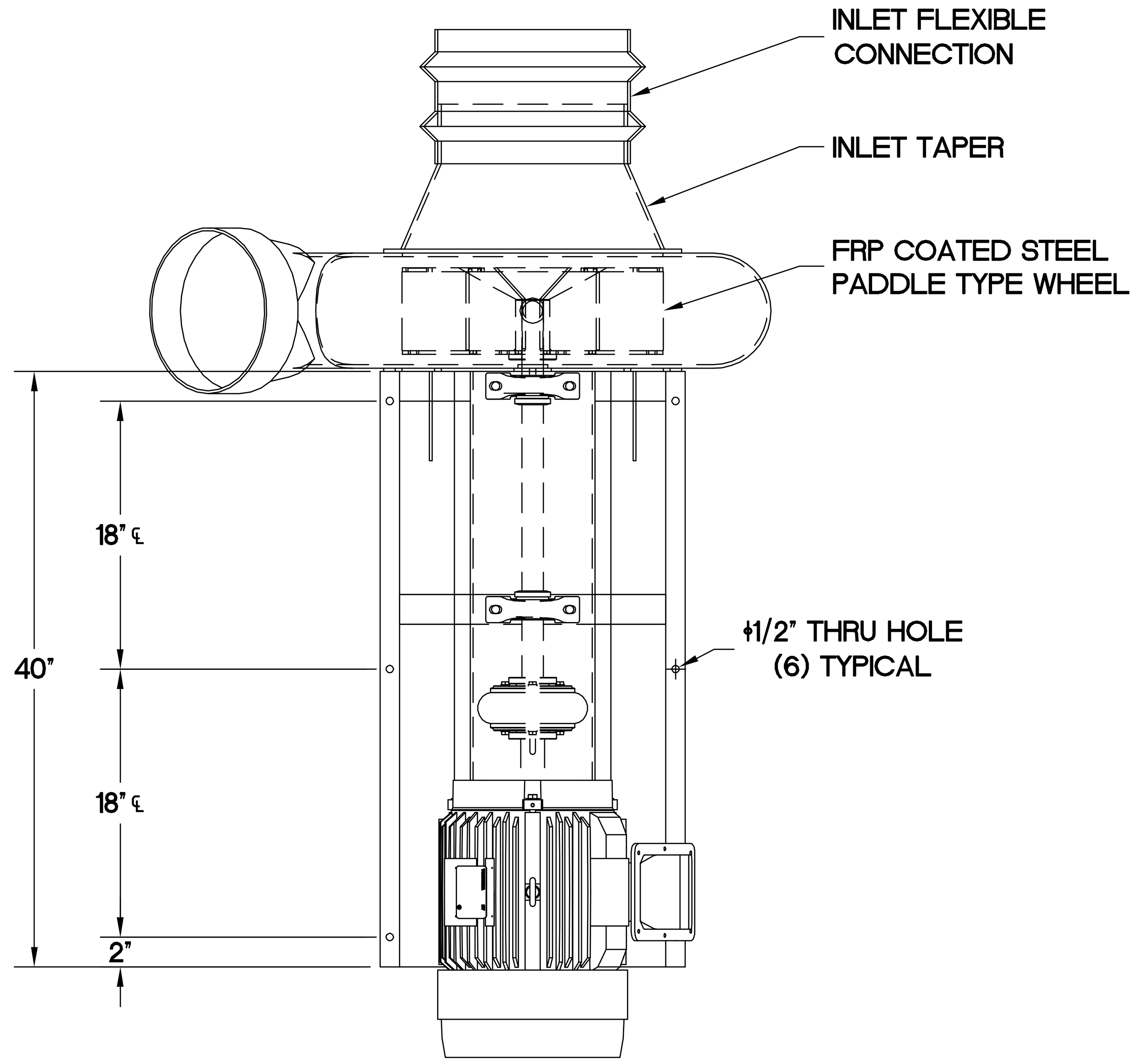
SCALE: 1/2" = 1'-0"

CAD FILE NO: 30030 SD-2

REVISION: 0

JOB NUMBER: 30030

DRAWING NUMBER: 30030 SD-2



CENTRIFUGAL CI BLOWER NO. 10

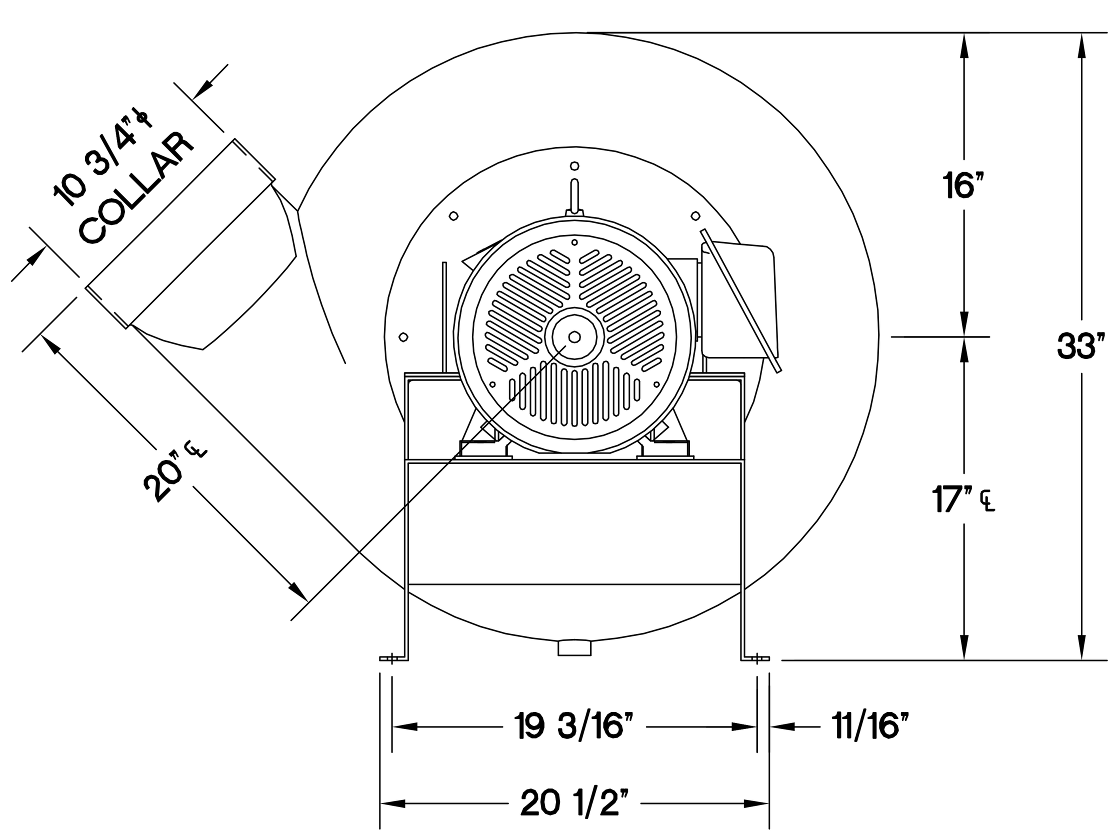
KCH services, inc. — FOREST CITY, N.C.

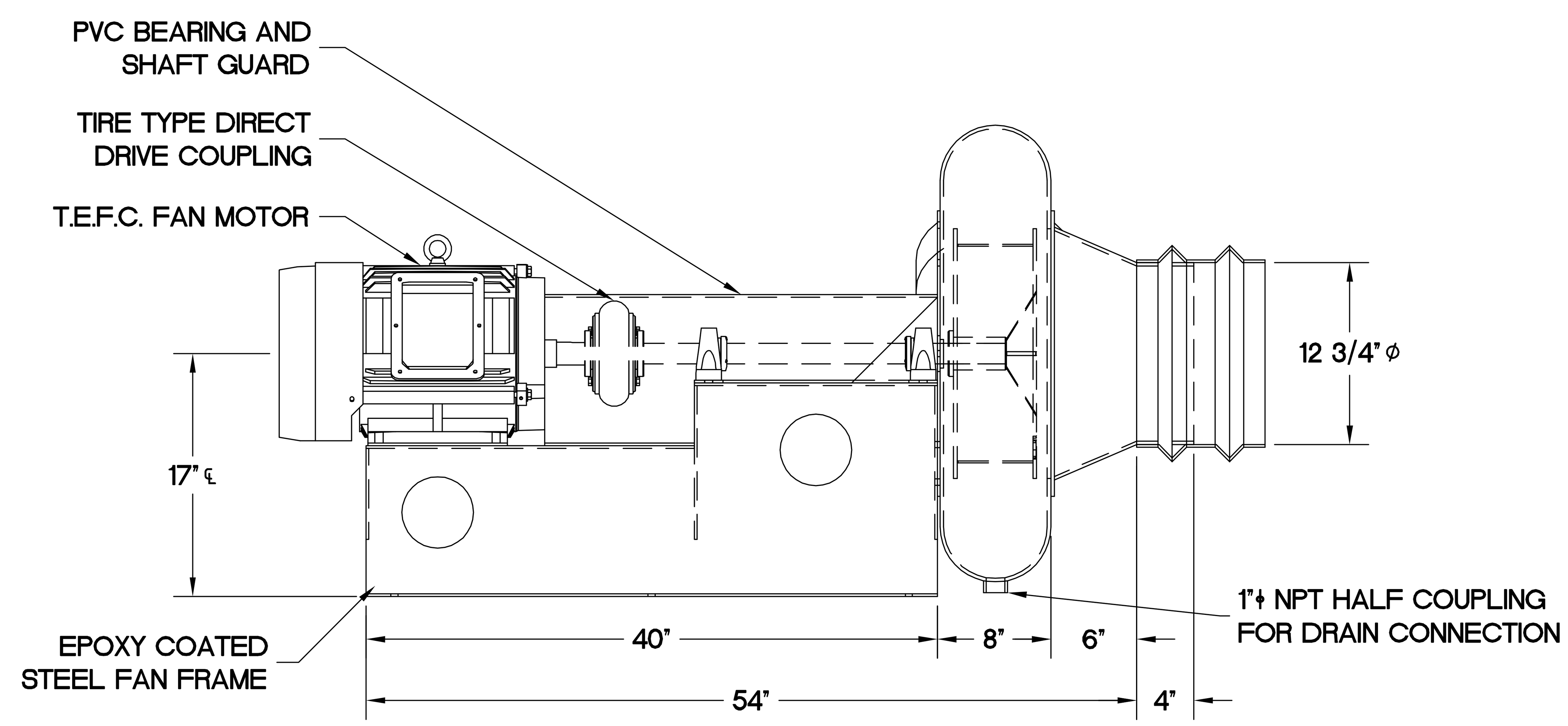
USER: REPUBLIC SERVICES	
PURCHASER: SAME AS ABOVE	
DATE: 9/27/13	JOB NUMBER: 30030
☐ PROVIDING PUSH AIR	■ PROVIDING EXHAUST
C.F.M.: 2,000	VENTING: LEACHATE TANK
STATIC PRESSURE: 8" w.c.	MAT. TYPE: TYPE II WHITE PVC
CLASS: S.S.	ARRANGMENT: 4 DIRECT DRIVE
ROTATION: CLOCKWISE	DISCHARGE: BOTTOM ANGULAR 45
BHP: 14.01	FAN RPM: 3,264
MOTOR H.P.: 15	MOTOR RPM: 3,450
VOLTAGE: 230 460 VOLT - 3 PHASE - 60 CYCLE	
COUPLING: MX70SDS	BEARINGS: SY 1-7/16 PF/AH
DRIVER BUSHING: SDS x 1-5/8"	DRIVEN BUSHING: SDS x 1-7/16"
SHAFT LENGTH: 27"	

DESCRIPTION: CI-10 DIRECT DRIVE EXHAUST FAN DETAIL DRAWING

PROJECT: REPUBLIC SERVICES, INC BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
G.L.	G.L.			9/27/13	0	DIRECT DRIVE CI-10 FAN CERTIFIED





144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH services, inc. ENGINEERED SYSTEMS

SCALE: 3/4" = 1'-0"

CAD FILE NO: 30030 FD-1

REVISION: 0

JOB NUMBER: 30030

DRAWING NUMBER: 30030 FD-1

PROJECT: REPUBLIC SERVICES, INC
BRIDGETON, MO

Attachment 7

Liquid Solvent Pilot Test Work Plan

LIQUID SOLVENT SYSTEM PILOT TEST WORK PLAN

A pilot test of a liquid solvent system will be undertaken in order to validate this technology for DMS removal. The pilot test will assess the performance of liquid solvent technology and will also provide more accuracy relative to operational information and chemical handling. Other process and operational aspects may be identified during the pilot test, which may influence the final technology selection and configuration.

Items covered in this pilot test outline are as follows:

- Site Preparation
- Major Equipment
- Required Chemicals
- Test Schedule
- Sampling Plan
- Decommissioning of Test Equipment
- Data Evaluation and Analysis

SITE PREPARATION

The pilot system will be located, and the test will be conducted, in the main flare yard (see site plan in Attachment 6-1). The test equipment will located on an existing concrete pad, located to the south of the existing enclosed flare.

The LFG test flow rate is expected to range between 10 and 100 scfm. For LFG supply, we propose to use the existing 2-inch connection to the blower skid outlet piping (pressure condition), which was installed as part of the MV Technologies test. The discharge from the test equipment will be connected to an existing above-grade 12-inch HDPE pipe (vacuum condition). Therefore, all gas (treated and untreated portions) will be kept within the closed loop piping system, and eventually combusted at flares. No gas, treated or untreated, will be vented the atmosphere.

The following piping and utilities need to be extended to the test equipment:

- 4-inch HDPE pipe to supply raw LFG to the test equipment. We propose to use the existing 2-inch connection to the blower skid outlet piping (pressure condition), which was installed as part of the MV Technologies test, with a 2-inch by 4-inch reducer.

- 4-inch HDPE pipe to return treated LFG to the existing system, with required reducers to connect to an existing 12-inch HDPE pipe. A back-pressure valve and flow meter will be installed on the LFG discharge line.

- Electric power. Three (3) 20-amp breakers for each (1 phase, 220 volt).

- 4-cubic yard container.

MAJOR EQUIPMENT

The major equipment will include the following:

- Scrubber
- ECC
- Filter press.

REQUIRED CHEMICALS

The following chemicals will be required for the test:

- 25 gallons of solvent

Nrgtek will supply the above chemicals.

TEST SCHEDULE

Two weeks of field testing is expected. LFG flow rates will include 10, 20, 40, 60 and 100 scfm. Testing will be conducted at varying gas flow rates to estimate the kinetics of sulfur removal and optimal liquid solvent volumes needed for sulfur removal.

Based on initial test results at varying LFG flow rates (and hopefully, varying sulfide levels), solvent volumes and the amperage requirements of the electrocatalytic converter (ECC) will be adjusted to optimize sulfide removal to meet the removal goal. The entire field testing program is expected to take 2 to 3 weeks, after installation and verification of LFG flow rates and initial LFG analysis test results. The specific testing intervals will be provided within a detailed test protocol.

SAMPLING PLAN

Samples of the gas feed and effluent gas will be collected on-site using a Tedlar bag. On-site analysis will provide real-time results for DMS removal optimization purposes.

Process parameters will be recorded (flow, gas composition, pressure, and temperature).

DECOMMISSIONING OF TEST EQUIPMENT

At the end of the test, the test equipment will be disassembled and removed from the site. Utilities will be terminated as directed.

DATA EVALUATION AND ANALYSIS

Following the field test, Nrgtek will compile all test data and prepare process calculations. Liquid solvent volumes and operating parameters, necessary to meet the sulfur removal goal, will be estimated for a full-scale facility.