Summary Memorandum – Potential Abatement Measures

Wastewater Treatment Facility No. 1 Collection System Exhaust

June 2020

San Jacinto River Authority

Summary Memorandum – Potential Abatement Measures
Wastewater Treatment Facility No. 1 Collection System Exhaust

Contents

Tables

Figures

Exhibits

STATE OF TEXAS
MARK A. PERKINS
60329
REGISTERED PROFESSIONAL ENGINEER

June 3, 2020
SUPERSEDES VERSION ISSUED 5/20/2020

1.0 Executive Summary

Perkins Engineering Consultants, Inc. (PECI) was retained to evaluate odors surrounding the San Jacinto River Authority's Wastewater Treatment Facility No. 1 (SJRA WWTF No. 1). One task in this evaluation is to assess costs and benefits of potential treatment and mitigation options for selected sources. This memorandum addresses a key specific point source of odors northwest of the facility site, where headspace air is mechanically withdrawn from upstream sewers to create a vacuum and thus control odors in upstream neighborhoods. This forced exhaust point, nicknamed the "Tin Man", has been determined to be a potential source of odors that could affect nearby neighborhoods.

This memorandum develops projected costs for recommended odor abatement improvements to the "Tin Man". Two alternatives were analyzed: Installation of an elevated stack to improve dispersion, and installation of a carbon adsorber to treat the discharged air and reduce the concentration of hydrogen sulfide (H_2S) and other odorants therein.

The elevated stack is expected to require less capital and maintenance cost than a carbon adsorber. However, dispersion modeling suggests that while an elevated stack would significantly improve conditions in the immediate vicinity of the manhole, it could contribute to lower-level odors potentially spreading farther onto neighboring properties. Treating the discharge air through carbon adsorption significantly reduces odor footprint in the model. Therefore, installation of a carbon adsorber is recommended.

2.0 Introduction

The "Tin Man", located west of the SJRA WWTF No. 1, is where incoming sewer headspace air is exhausted to maintain vacuum conditions in the upstream collection system. A photo of the existing structure is provided in Figure 1. This forced exhaust system has successfully helped maintain headspace vacuum conditions in upstream sewers for several years and was installed in response to complaints from residents along certain reaches of upstream interceptors. The location of the "Tin Man" with respect to the treatment facility is shown in **Exhibits 1-3**.

Figure 1: "Tin Man"

In March 2020, a H_2S monitor was placed at the discharge of the "Tin Man". The monitor recorded concentrations in parts per million (ppm) every three minutes and recorded measurements for approximately one week. The Acrulog® monitor used had a range of 0 to 200 ppm. The resulting data, displayed in **Figure 1**, shows a consistent diurnal pattern which sees high concentrations of about 8 to 12 ppm in the evening and low concentrations of about 2 to 4 ppm in the morning. The average measured concentration of H_2S in the discharged air was 6.4 ppm. The exhaust fan is reportedly operating at a discharge rate of approximately 6600 cubic feet per minute (cfm).

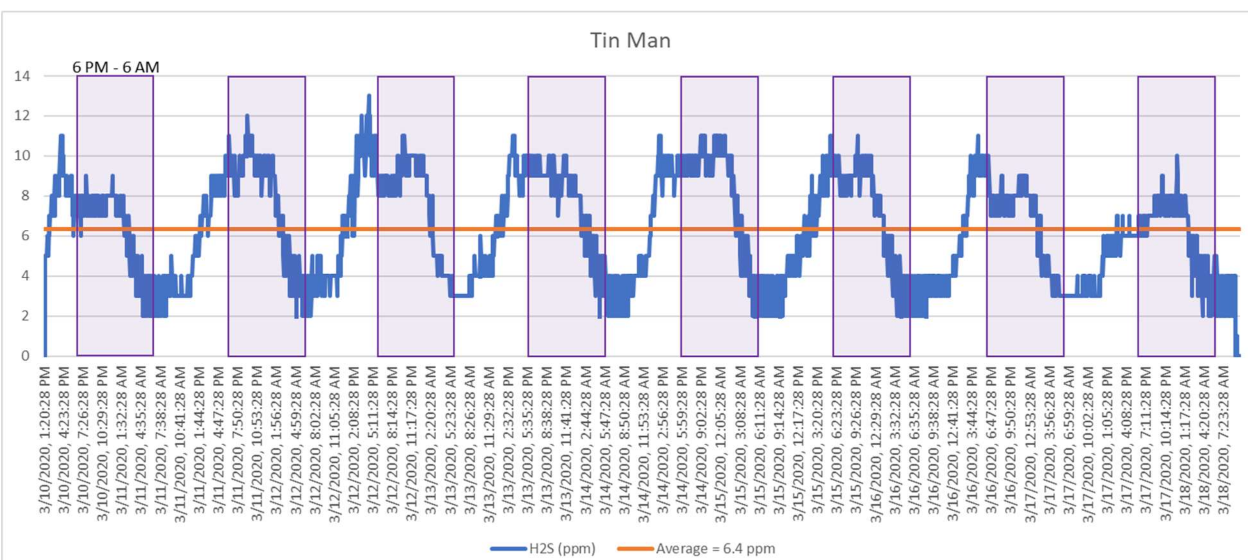


Figure 2: "Tin Man" H_2S Concentrations

Table 1: "Tin Man" Data Summary

Acrulog® SN	Date Start	Time Start	Date Stop	Time Stop	Number of Concentration Measurements	Max Instantaneous H_2S Measurement (ppm)	Average H_2S (ppm)
0605	3/10/20	1:30 pm	3/18/20	10:00 am	3,775	13	6.4

The Texas Commission on Environmental Quality (TCEQ) has two standards for treatment facility odors:

> **30 TAC 112.31** – Prohibits hydrogen sulfide on downwind residential, business, or commercial properties from exceeding a "…net ground level concentration of 0.08 parts per million [or 80 parts per billion] averaged over any 30-minute period…"
>
> **30 TAC 101.4** – Prohibits "…air contaminants or combinations thereof, in such concentration and of such duration as are or may tend to be injurious to or adversely affect human health or welfare, animal life, vegetation, or property, or as to interfere with the normal use and enjoyment of animal life, vegetation, or property."

Individual sensitivity determines the level at which one can detect a smell, and different researchers have suggested varying recognition thresholds for H_2S. For the purposes of this evaluation, 7 parts per billion (ppb) is adopted as the level at which a person having "normal" olfactory senses can detect H_2S.

3.0 Odor Dispersion Modeling

To understand how the "Tin Man" may be affecting H_2S concentrations in the surrounding area, PECI created an odor dispersion model with AERMOD. The model output for the "Tin Man" displayed in **Exhibit 1** at the end of this memorandum represents H_2S concentrations that can be expected for a 5-minute period once per year for existing conditions. Isopleths, which indicate the H_2S concentration, are represented by a color gradient. It should be noted that the locations of the isopleths cannot be interpreted as absolutes, especially for an area this small. This model suggests that the "Tin Man" alone can produce significant odors in its immediate vicinity. If all sources within the plant could be modeled together, a greater "reach" might be demonstrated. Typically, a full plant model shows a different area of influence than its individual components.

3.1 Dispersion Modeling Software

The American Meteorological Society (**A**MS)/Environmental Protection Agency (**E**PA) **R**egulatory **Mod**el (AERMOD) was specially designed to support the EPA's regulatory modeling programs. AERMOD was designed for short-range dispersion, up to 50 kilometers, of air pollutant emissions from stationary industrial sources. AERMOD is a steady-state plume dispersion model which simulates transport and dispersion of multiple point (scrubber stacks or vents), area (uncovered process units) or volume (open doors, etc.) emission sources. AERMOD incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

The AERMOD meteorological pre-processor (AERMET) provides AERMOD with the information it needs to construct vertical profiles of required meteorological variables. The user provides surface characteristics in the form of albedo, surface roughness, and Bowen ratio. The TCEQ Air Dispersion Modeling Team (TCEQ ADMT) has processed meteorological data for all counties in Texas with minimum, average, and maximum surface roughness characteristics. In 2012, the TCEQ ADMT updated the preprocessed meteorological data for each county in response to revisions made to the EPA's AERMET program. Surface level meteorological data for the model was from the Conroe-North Houston Regional Airport. Upper air data was from the Lake Charles Regional Airport, which is used by TCEQ for 17 counties in the region.

3.2 Dispersion Modeling Inputs

Factors impacting odor dispersion include:

- Odor intensity of sources
- Flux and discharge air flow rates
- Meteorological conditions (especially wind speed, wind direction and atmospheric stability)
- Surrounding topography and building obstructions
- Water surface elevations and stack heights
- Stack discharge velocities

The odor intensity of the "Tin Man" discharge was determined through sampling with the H_2S monitor placed at the discharge. Meteorological data was taken from the TCEQ and topography data was taken from the USGS. The discharge air flow rates, stack heights and discharge velocities used for the "Tin Man", FRP stack and carbon adsorber were the site-specific design parameters.

3.3 Dispersion Modeling Outputs

Odor dispersion model output, or odor isopleths, show the spatial extent at which specified levels are predicted to be perceived. Odor isopleths show the areas impacted by odors at the level corresponding to the legend for a defined duration once per year.

AERMOD employs hourly sequential preprocessed meteorological data to estimate concentrations for averaging time from one hour to one year. Because the nose can detect odors very quickly, the averaging period of one hour can be converted to a shorter averaging period using the power law relationship detailed in the equation below.

$$C_{new} = C_{1\text{-hour}} (T_{1\text{-hour}}/T_{new})^q$$

Where:

C_{new} = Concentration for the shorter period
$C_{1\text{-hour}}$ = One-hour concentration
T_{new} = Shorter average period in minutes
$T_{1\text{-hour}}$ = 60 minutes (for 1-hour average period)
q = 0.17 (power law exponent, dependent on atmospheric stability class)

The calculated emission peaking factor used for the current project, to convert from one hour to 5-minute averaging times using a power exponent of 0.2, is a multiplier of 1.64.

First, the model was run to match the existing conditions of the structure. A discharge height of 10 feet was assumed. The result from the model, shown in **Exhibit 1** at the end of this memorandum, suggests that the “Tin Man” alone can produce significant odors in its immediate vicinity. These odors lessen with distance but can still be perceived on neighboring properties.

4.0 Odor Abatement Alternatives

Two odor abatement alternatives are compared in this report. The first is a fiberglass reinforced plastic (FRP) stack designed to discharge the foul air 55 feet above ground. This alternative would not treat the foul air but would aid in the dispersion of H_2S and other odorants. The second alternative would be to install a carbon adsorber to treat the foul air and reduce the odorant concentration discharged to the atmosphere.

4.1 FRP Discharge Stack

The model was run for the situation of installing a 55-foot discharge stack. This height was chosen because the tree line height was estimated to be about 50 feet through Google Earth®. Results of testing the model for different discharge heights showed that better dispersion was achieved once the elevation was raised above the tree line. The tree line height should be verified before design. The output, shown in **Exhibit 2** at the end of this memorandum, suggests that the H_2S concentrations are lowered significantly in the immediate area, but the footprint of the low-level isopleths stretch further.

Table 2 summarizes the opinion of probable construction cost (OPCC) for the FRP discharge stack.

Table 2: Opinion of Probable Construction Cost – FRP Stack

Description	OPCC
Earthwork, Concrete Slab, etc.	$20,000
FRP Fan, Ductwork, and Stack	$100,000
Fencing, Misc.	$19,000
Tree Allowance, Restoration	$50,000
Electrical and Instrumentation	$40,000
SUBTOTAL	**$229,000**
Mobilization, Demob., Bonds, Insurance @ 5%	$12,000
Contractor's Overhead and Profit @ 15%	$37,000
Contingency @ 30%	$84,000
TOTAL CAPITAL CONSTRUCTION COST	**$370,000**

This estimate does not include any access roadway improvements. The current roadway, shown in **Figure 3**, may need to be graded and filled during the construction process. Before design is initiated on such improvements, a decision would need to be made as to whether the stack should be guyed or free-standing. At this location, the floodplain elevation is 117 ft. Thus, all electrical and mechanical equipment would need to be raised approximately four feet above ground.

Figure 3: "Tin Man" Access Road

4.2 Carbon Adsorption

Adsorption systems, such as carbon adsorbers, are a well-established odor control technology. A vessel is filled with activated carbon (or proprietary dry media) and foul air is passed through the media. Odorants such as H_2S and mercaptans, as well as volatile organic compounds (VOCs), are adsorbed onto the surface of the carbon or oxidized by proprietary media. Maintenance is generally limited to replacing media once the adsorptive capacity has been exhausted.

Because of the frequent carbon replacement needed at higher H_2S loadings, carbon adsorbers are best suited for low concentrations of H_2S (typically below 10 ppm). Dry media adsorbers are also well suited for “polishing” the airstream after treatment by another odor control unit and for removing non- H_2S compounds. In a carbon adsorber with fresh carbon, H_2S removal can exceed 99%. Some contaminants show a lower removal rate; these contaminants may see improved removal with other types of media. Due to the average H_2S concentration in the discharge air being only 6.4 ppm, carbon adsorption is the recommended vapor phase odor control technology. Other vapor phase odor control technologies, such as biofilters and chemical scrubbers, are better suited for higher H_2S concentrations and may not remove other odor-causing compounds as well as carbon adsorption.

Numerous configurations are available for dry media adsorbers, including but not limited to single bed, dual bed, radial and horizontal adsorbers. A primary design parameter, face velocity, is the air flow divided by the cross-sectional area of the vessel. Face velocities should be less than 100 feet per minute, with recommended design values ranging from 40 to 60 feet per minute.

Empty bed contact time (EBCT), another primary design parameter, is defined as the total volume of the media bed divided by the airflow rate. EBCTs typically range from two to ten seconds for wastewater odor control applications. The design EBCT depends on the type and concentration of the contaminants to be treated as well as the targeted replacement frequency. The more adsorptive media in the system, the less frequent replacement is required. An EBCT of about four seconds is recommended for this application, with further refinement to be conducted as part of design.

Although low profile designs may be preferred for aesthetic purposes, a taller discharge (nominal 15 feet plus) will assist with air dispersion of the discharge if difficult to treat compounds are encountered or if the adsorptive media is not replaced as frequently as needed. If a lower profile scrubber design is selected, a taller discharge stack could be incorporated to increase the height of discharge.

Condensate from the odor control system may be acidic and corrosion resistant drain piping is recommended. The ventilation manhole should be lined for corrosion protection if it is not already. Care could be exercised to extend the discharge of the condensate drain to mix with the wastewater flow before contacting any existing concrete, or a condensate storage with pH adjustment system could be provided.

The model was run for the situation of installing a carbon adsorber to treat the foul air. It was assumed that the carbon was not spent, so it would be able to reduce H_2S concentrations by more than 99%. The output, shown in **Exhibit 3** at the end of this memorandum, is based on anticipated odor units (OU) from the carbon vessel not exceeding 100 OU. The model suggests that the H_2S concentrations are lowered beyond perception for the entire area, as no ground-level odor units were predicted at any significate distance from the carbon adsorber discharge. The maximum of 1.35 OU/m^3 was only predicted around the immediate vicinity of the structure. For reference 1 OU can be perceived by half of the population. It is noted that other odorants may be present and occasionally detectable.

An opinion of probable construction cost was prepared to compare the FRP discharge stack and carbon adsorber in this application. It is noted that at this level of analysis, prior to commencing detailed design, assumptions were made for size of the carbon adsorber unit, structural, electrical, and civil site requirements. **Table** 3 provides a summary of the cost opinion for treatment with carbon adsorption. Once again, access roadway improvements are not included in the cost opinion.

Table 3: Opinion of Probable Construction Cost – Carbon Adsorption

Description	OPCC
Earthwork, Concrete Slab, etc.	$29,000
6,600 cfm Adsorber, Fan, Ductwork, Installation	$182,000
Condensate Handling, Fencing, Misc.	$20,000
Tree Allowance, Restoration	$50,000
Electrical and Instrumentation	$40,000
SUBTOTAL	**$321,000**
Mobilization, Demob., Bonds, Insurance @ 5%	$17,000
Contractor's Overhead and Profit @ 15%	$51,000
Contingency @ 30%	$117,000
TOTAL CAPITAL CONSTRUCTION COST	**$510,000**

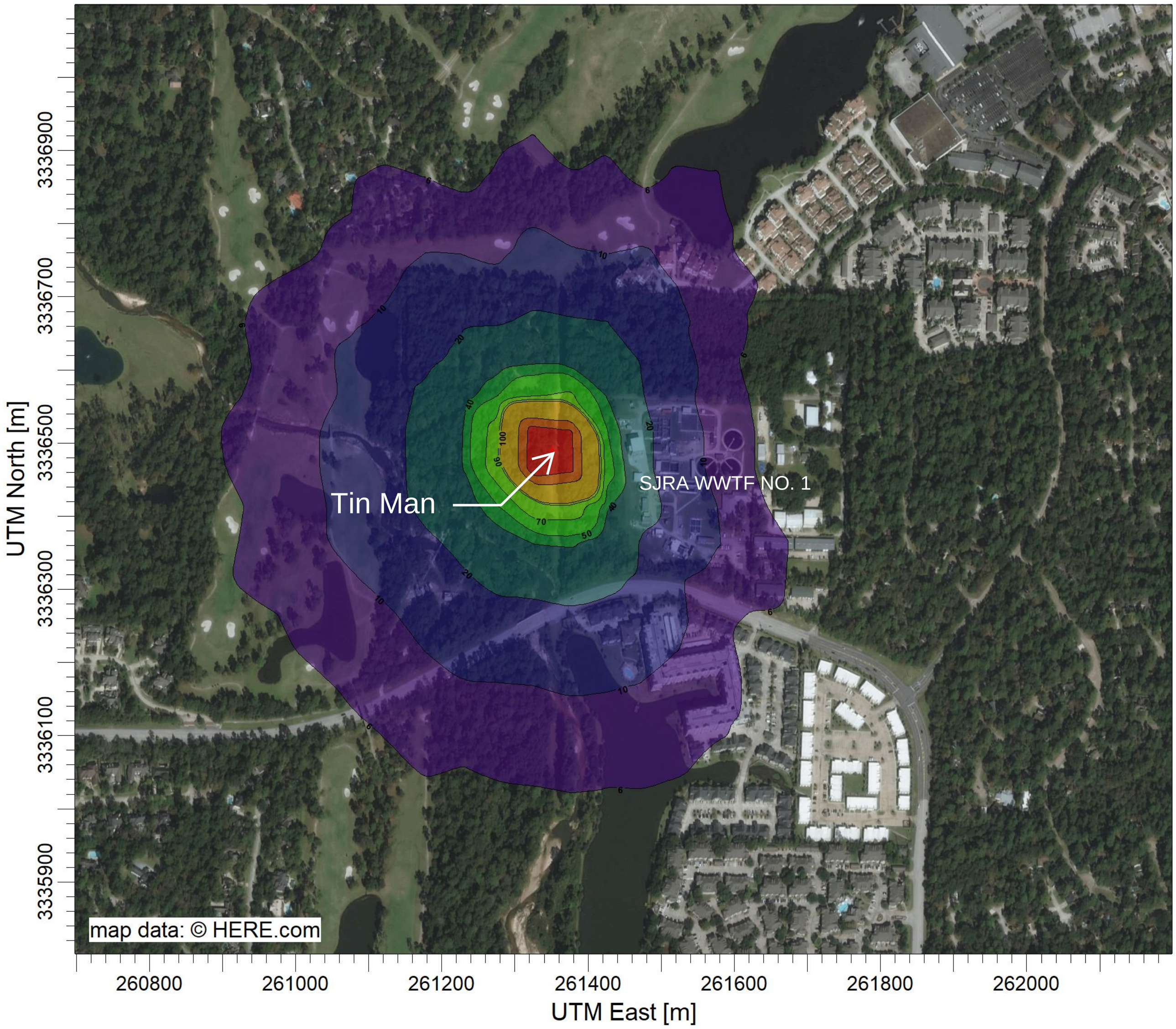
Due to the presence of a high-pressure gas transmission line, running a buried duct into the plant site may not be desirable. If the duct would be required to go beneath the gas line, a condensate pumping system would be needed. It is thus anticipated that the carbon adsorber would need to be placed near the current site of the “Tin Man”. The system would require approximately 750 square feet. The electrical service would also need to be routed above ground to avoid burying lines over a gas transmission main. Once again, the equipment would need to be raised above the floodplain elevation. There are options for how to elevate the carbon adsorber. Earth fill can be provided to raise the ground elevation around the equipment, or an elevated platform can be provided. We would most likely suggest an elevated platform rather than earth fill to minimize the volume displaced below the flood elevation.

The unit would be designed to provide a minimum of three years of media life. A maintenance cost of $35,000 is estimated for each media replacement. Due to issues with degradation and compaction, a replacement frequency greater than about five years is not recommended. Once the adsorptive media becomes spent and requires changeout, most fresh media suppliers can provide a complete turnkey replacement service including removal, transport, and disposal of spent media.

For conventional design-bid-build delivery, bid documents for the odor control system could be completed in three to six months after authorization to proceed. Delivery of a 6,600-cfm dry media adsorber typically takes 24 weeks from contract execution. Delivery timeframes may be negatively impacted by supply chain issues associated with the ongoing COVID epidemic. The construction period will depend on the site development, submittal and permitting requirements. Construction would be dependent on delivery times for the fan and carbon adsorber but could proceed relatively quickly after they are delivered. It is anticipated that, barring permitting delays, the system could be operational 13 to 14 months after engineering is initiated.

Alternative delivery methods are available. There are carbon vendors that will furnish a vessel as part of a term commitment for furnishing and replacing carbon. Some will even operate and maintain the system under a “lease” agreement. If this option is pursued, the only needed capital improvements would be electrical, foundation work, and sitework. The long-term cost may be higher under a “lease” agreement, but the maintenance effort could be lower, and the delivery time might be shortened significantly.

Exhibit 1
Odor Dispersion Model – Existing Conditions



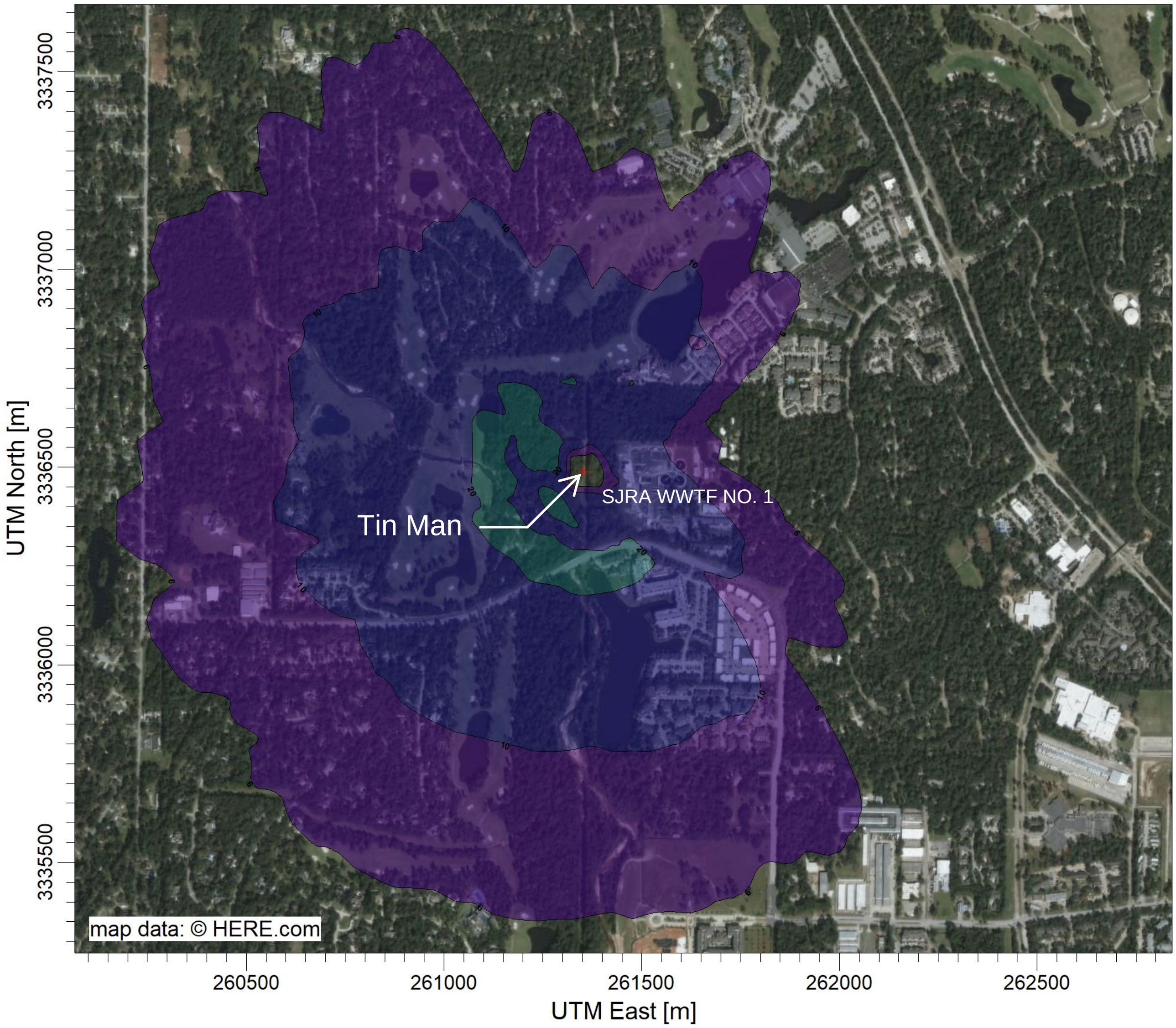
PLOT FILE OF HIGH 1ST HIGH 5.0-MIN VALUES FOR SOURCE GROUP: ALL PPB

Max: 289 [PPB] at (261325.84, 3336464.97)

6 10 20 40 50 70 90 100 200 250

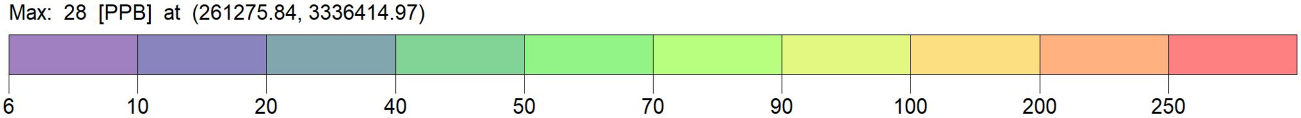
COMMENTS:	SOURCES: **1**	COMPANY NAME: Perkins Engineering Consultants, Inc.	
	RECEPTORS: **10000**	MODELER: Charlotte G. Smith, P.E.	PERKINS ENGINEERING CONSULTANTS, INC.
	OUTPUT TYPE: **Concentration**	SCALE: 1:9,438 0 — 0.3 km	
	MAX: **289 PPB**	DATE: **4/30/2020**	PROJECT NO.: SJR 20-001

Exhibit 2
Odor Dispersion Model – 55 FT Discharge Stack



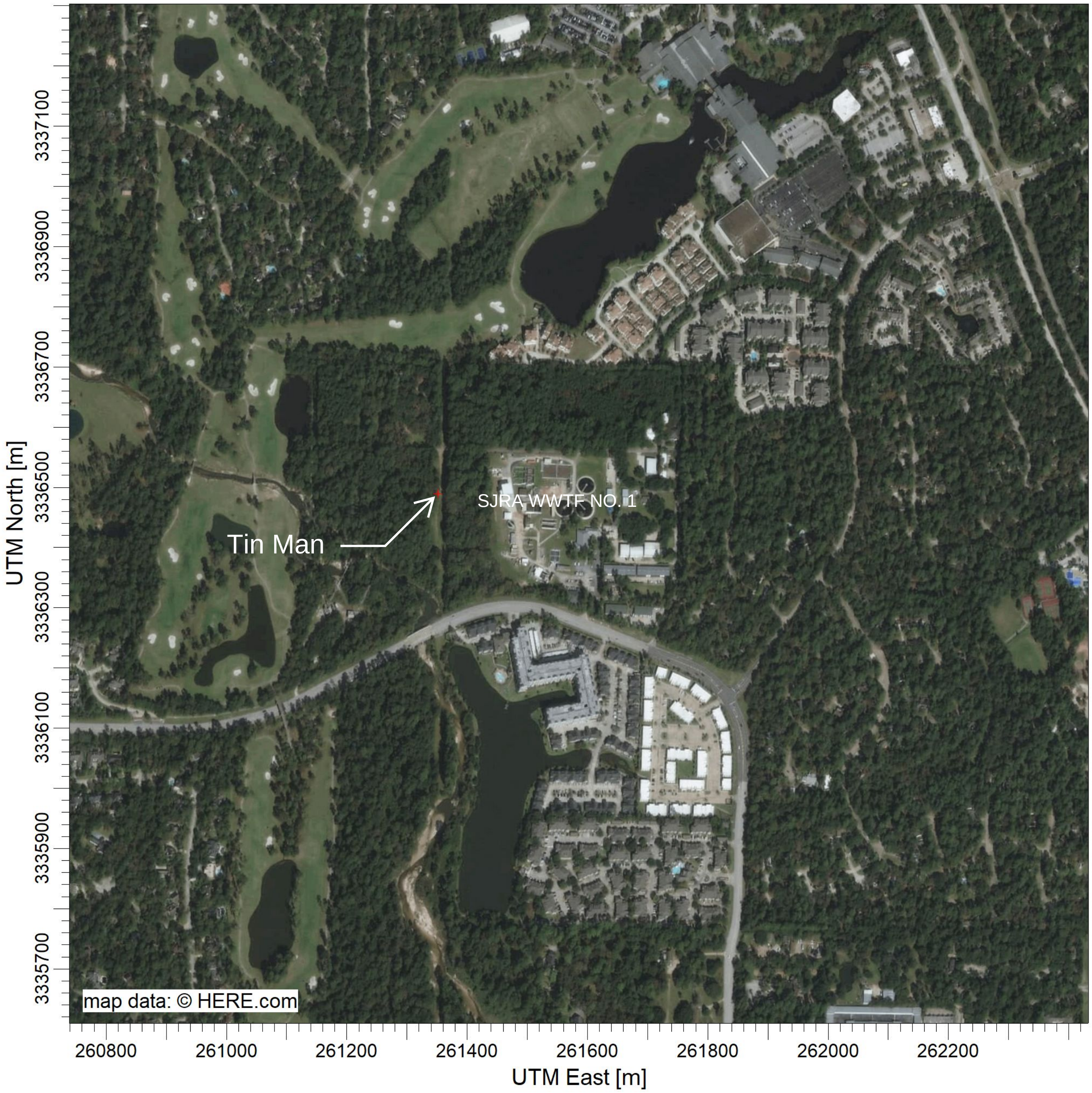
PLOT FILE OF HIGH 1ST HIGH 5.0-MIN VALUES FOR SOURCE GROUP: ALL   PPB

Max: 28 [PPB] at (261275.84, 3336414.97)



COMMENTS:	SOURCES: **1**	COMPANY NAME: Perkins Engineering Consultants, Inc.	
	RECEPTORS: **10000**	MODELER: Charlotte G. Smith, P.E.	PERKINS ENGINEERING CONSULTANTS, INC.
	OUTPUT TYPE: **Concentration**	SCALE: 1:17,451 (0 – 0.5 km)	
	MAX: **28 PPB**	DATE: **4/30/2020**	PROJECT NO.: SJR 20-001

Exhibit 3
Odor Dispersion Model – Carbon Adsorber



COMMENTS:	SOURCES:	COMPANY NAME:	
	1	Perkins Engineering Consultants, Inc.	
	RECEPTORS: **10000**	MODELER: Charlotte G. Smith, P.E.	PERKINS ENGINEERING CONSULTANTS, INC.
	OUTPUT TYPE: **Concentration**	SCALE: 1:10,650 (0 – 0.4 km)	
	MAX: **1.35 OU/M**3**	DATE: **4/30/2020**	PROJECT NO.: SJR 20-001