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September 24, 2018

Scott Miller
Lawrence Bean, DEQ, AQD and WMRPD
Jackson District
301 E. Louis Glick Highway
Jackson, MI 49201

Re: Advanced Disposal Services Arbor Hills Landfill, Inc.
Response to Violation Notice
SRN: N2688, Washtenaw County

Dear Scott:

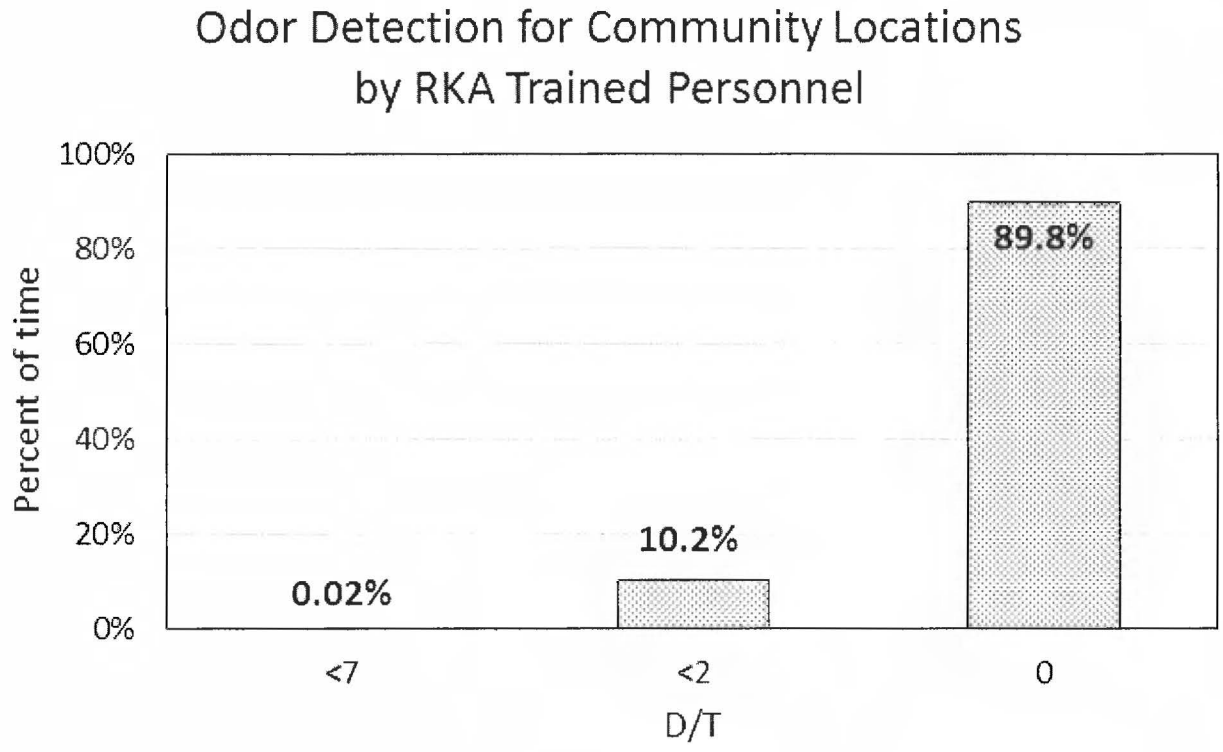
This letter responds to the Violation Notice dated August 31, 2018 issued to Advanced Disposal Services Arbor Hills Landfill, Inc. ("ADS"). The NOV states that the AQD staff detected a "distinct and definite objectionable landfill garbage odor" in a residential area on the south side of Napier Road "downwind of the facility" during an inspection on August 23, 2018. The NOV alleges that the odor detected is a level 3 on the MDEQ-AQD Odor Scale, and constitutes a violation of Rule 901(b) and violation of Rule 433(1). ADS fundamentally disagrees with the allegations contained in the NOV.

In this letter, we provide both ADS's technical and legal positions to advance these discussions toward a resolution. ADS operates a necessary and lawful business that meets or exceeds industry standards. The landfill and compost business, just like many other industrial operations (such as airports, wastewater treatment facilities, chemical plants, and a host of others), will have some incidental impacts upon neighboring property owners that are a natural and unavoidable consequence of operating the business. ADS implements all reasonable and practical measures to minimize the extent of these impacts upon the surrounding community, but it is not possible to eliminate them completely. In sum, we do not believe an NOV should be issued based upon the incidental effects of simply running a business.

Despite ADS's fundamental disagreement with the DEQ in issuing the NOV, ADS is committed to reaching common ground with the DEQ on how to measure odors, how to respond to potential odorous conditions, and how to ensure compliance. In this letter we set out in some detail the basis of ADS's position.

I. TWO-YEARS OF ODOR MONITORING DEMONSTRATE THAT OFF-SITE LANDFILL ODORS ARE DE MINIMUS AND WELL BELOW ACTIONABLE LEVELS IN OTHER STATES

We are aware of only one device with an ASTM for measuring odors, the Scentometer. (See Attachment A, ASTM Standard). As the DEQ is aware, ADS, over the past two years, has conducted what to our knowledge is the most extensive odor monitoring programs ever conducted at a landfill, or for that matter any industrial operation. Between November 2016 and August 2018, RK & Associates took a total of 10,512 odor readings at community locations. As depicted in the chart below, 89.3% or 9,437 of these readings were zero or no odors; 10.2% or 1,072 were less than 2; and only *3 readings* were less than 7 dilutions. To provide some additional perspective on the strength of odors measured at the site, the last time an odor measurement of <7 was detected at a community point was the morning of February 18, 2017 at C-7 and C-15 where the odor detected was compost and landfill gas, respectively. The site did not receive one odor complaint that day.



We understand that the state of Michigan, unlike a number of other states, does not currently have an objective odor nuisance standard or require the Scentometer to measure the level of odors.

Nevertheless, looking to the regulatory programs of other states and localities that do rely upon the Scentometer (or similar device) to measure odors helps put the Arbor Hills data in context:

State or Locality	Source of Standard	Determination Criteria
Colorado	5 CCR 1001-4: Odor Emission	7:1 D/T (2 samples over 1-hour period)
Connecticut	Sec. 22a-174-23: Control of Odors	(a) Nuisance standard; (b) 7:1 D/T (3 samples over 1-hour period); and (c) Ambient air limits for certain substances in Table 23-1 (e.g. Hydrogen sulfide: 0.0045 ppm (15-minute average))
Illinois	Section 9(a) of the Act and 35 IAC 245.121: Objectionable Odor Nuisance Determination	Nuisance standard. 8:1 D/T (Scentometer)
Kentucky	401 KAR 53:010: Ambient Air Quality Standards	7:1 D/T (Nasal Ranger/Scentometer)
Missouri	10 CSR 10-6.165: Restriction of Emission of Odors	7:1 D/T (Nasal Ranger) (2 samples over 1-hour)
North Dakota	Section 33-15-16: Restriction of Odorous Air Contaminants	Objectionable odors prohibited. 7:1 D/T (Scentometer)
San Francisco Bay Area Air Quality District		5 D/T applied after at least 10 complaints within 90 days.[1]
State of Massachusetts	Draft policy and guidance for composting facilities	5 D/T
City of San Diego WWTP		5 D/T average over 5 minutes
City of Seattle WWTP		5 D/T average over 5 minutes

[1] Thomss Mahin, *Measurement and Regulation of Odors in the USA*, 64

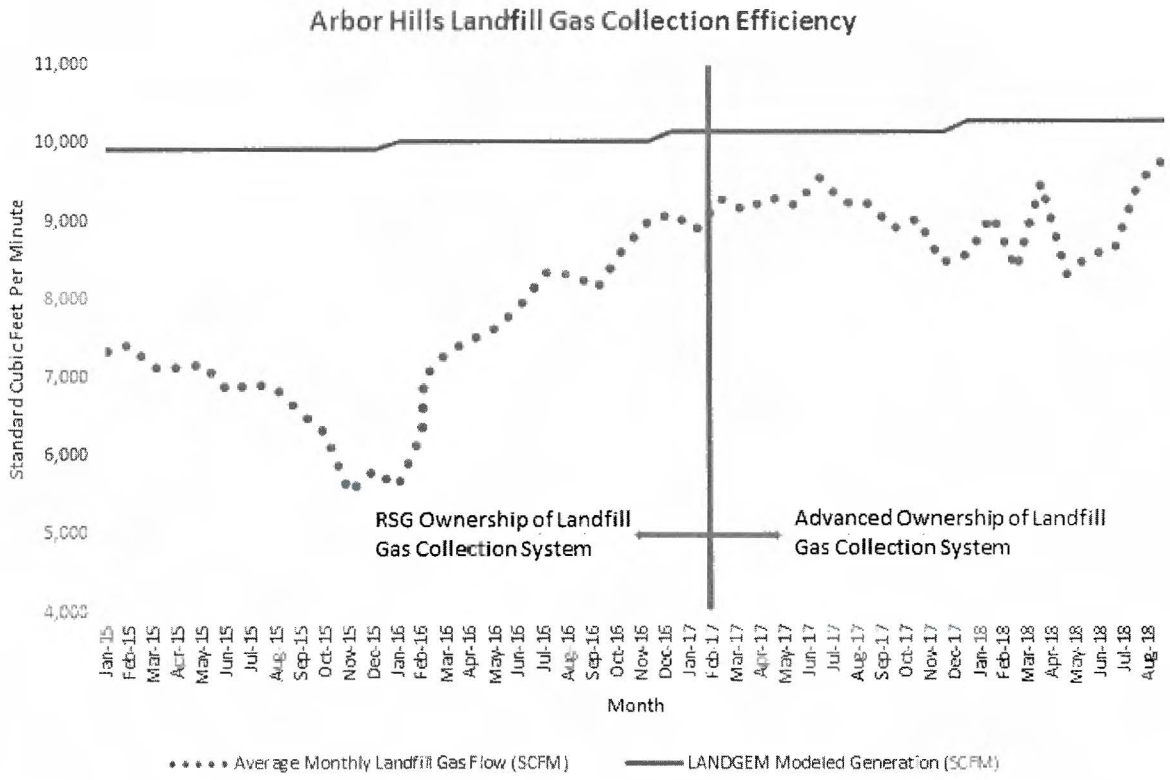
Thomas Mahin, in his paper *Measurement and Regulation of Odors in the USA,* references a study conducted for the California Air Resources Board that itself reviewed six published studies related to the recognizability, unpleasantness and annoyance associated with a variety of odors. The study found that for unpleasant odors the threshold of annoyance is about five times the threshold of detection. He also reports that the California's South Coast Air Quality Management District found that at 5 D/T people become aware of an odor and that at 5 to 10 D/T odors may be strong enough to trigger complaints.[2]

Evaluating the extensive RK data in light of the published scientific data demonstrates that the Arbor Hills Landfill is not generating odors exceeding any reasonable standard. The data even easily meets the standard set by the San Francisco Bay Area Air Quality District. No state law or legal principle of which we are aware equates the mere detection of an odor by any one person as constituting either a regulatory violation or a common law nuisance.

II. THE EFFICIENCY OF THE LANDFILL GAS SYSTEM HAS GREATLY IMPROVED SINCE EARLY 2017 WHEN ADS TOOK OVER CONTROL OF THE SYSTEM

It cannot be ignored that the current attention given to odors at the Arbor Hills Landfill began in 2015 when landfill gas collection efficiency declined during a period when Republic Services owned and operated landfill Gas Collection and Control System. As the Department is aware, since taking ownership of the GCCS in February 2017 from Republic Services, ADS has invested millions of dollars in upgrading the conveyance and control component of the GCCS. The graph below illustrates the success of ADS's efforts:

[2] *Id.*



The data illustrates that ADS has corrected the original source of the odor complaints – deficiencies in the infrastructure of the landfill gas collection and control system. This has left incidental odors from waste disposal operations and composting as the remaining potential sources for any detectable odors. In addition to the improvement in landfill gas collection efficiency, Arbor Hills Landfill has also aggressively implemented measures to mitigate odors associated with waste disposal operations as well as its compost operation.

We attach the RK Scentometer odor measurements for the morning and evening of August 23, 2018, the day the DEQ detected the "landfill garbage odor." (Attachment B). The results show two ">2" readings, one for compost and one for "fresh garbage." In further investigating the DEQ's detection of odors on this day, ADS traced the odors to waste disposal operations (trash odors). In light of the RK data and the site's own investigation, it is our opinion that the odors detected were neither strong enough nor of sufficient duration to be classified as a nuisance justifying the issuance of a Notice of Violation. But ADS is not just measuring odors. It has also taken numerous measures to further mitigate these odors. A summary of these measures is set forth on Attachment C. As noted, the odors from these operations are those associated with the normal operation of a landfill or composting operation and do not warrant the issuance of an NOV. Accordingly, we are requesting that the August 31, 2018 NOV, as well as the one issued February 6, 2018, be rescinded.

III. THE REGULATORY BASIS FOR THE NOTICE OF VIOLATION

The DEQ has cited two regulations supporting the NOV: R. 336.1901(b) and R. 299.4433(1)(c). To begin, Rule 433 relates to landfill gas, not to garbage odors and is therefore inapplicable. Rule 433(1)(c) states that the operator of a landfill shall ensure, among other things, that the "**gases** generated by the facility do not create a nuisance and are not otherwise in violation of part 55 of the act at the property boundary." (emphasis added.). As shown above, Arbor Hills is collecting landfill gas at peak efficiency and the Scentometer readings do not indicate a gas odor problem.

Rule 901, in turn, generally prohibits the emission of an air contaminant in quantities that cause, among other things, an "unreasonable interference with the comfortable enjoyment of life and property." This standard essentially restates the common law definition of "nuisance" and, therefore, must be considered in light of Michigan case law elucidating that concept. A nuisance is a non-trespassory invasion of another's interest in the private use and enjoyment of land. *See Adkins v. Thomas Solvent Co.*, 440 Mich. 293, 302 (1992). A defendant is not subject to liability in nuisance unless the plaintiff proves each of the following elements:

1. the other has property rights and privileges in respect to the use or enjoyment interfered with;

2. the invasion results in ***significant harm***;

3. the actor's conduct is the legal cause of the invasion; and

4. the invasion is either (i) intentional and ***unreasonable***, or (ii) unintentional and otherwise actionable under the rules governing liability for negligent, reckless, or ultrahazardous conduct.

Id. at 304 (emphasis added).

To properly establish a Rule 901 violation, there must be showing not only of "significant harm" resulting from the odor but also a showing that ADS acted ***unreasonably*** in its operation of the landfill. Further, under Michigan common law, an actionable nuisance exists only to the extent that defendant's conduct was "unreasonable" in light of a public-policy assessment of the conduct's overall value to society. *See Adams v. Cleveland-Cliffs Iron Co.*, 237 Mich. App. 51, 67 (1999). Accordingly, any intrusion of odors into residential areas must be balanced against the degree to which the Arbor Hills landfill is socially valuable.

Moreover, Michigan law accepts a certain amount of noise and odor as a consequence of modern living:

> No one is entitled, in every location and circumstance, to absolute quiet, or to air utterly uncontaminated by any odor whatsoever, in the use and enjoyment of his property; but when noises are unreasonable in degree, considering the neighborhood in which they occur and all the attending circumstances, or when stenches contaminate the atmosphere to such an extent as to substantially impair the comfort or enjoyment of adjacent premises, then an actionable nuisance may be said to exist; and in applying these tests the question presented is one of fact rather than law.

DeLongpre v. Carroll, 331 Mich. 474, 476, 50 N.W.2d 132 (1951).

This practical approach also recognizes that owners and operators of lawful businesses, such as ADS, have the right to operate their businesses in a reasonable manner without being subject to liability for nuisance. *See Waier v. Peerless Oil Co.*, 265 Mich. 398, 401, 251 N.W. 552 (1933) (holding that homeowners in an industrial district cannot complain of noise and odor arising in the ordinary and proper conduct of legitimate business so long as their health is not injured); *McMorran v. Cleveland-Cliffs Iron Co.*, 253 Mich. 65, 69, 234 N.W. 163 (1931) (stating that whether the operation of a fuel dock is a nuisance depends on plaintiffs' showing that "the dust, noise, and vibration are more than merely incident to the proper and skillful operation of the business").

The point of these cases is the same one we have emphasized in the beginning of this response: legal liability cannot attach, consistent with due process, to a person that is simply carrying out a lawful business in accordance with industry standards. Inherent in the concept of nuisance is that the interference must be *unreasonable*, which means that the DEQ must show that ADS is operating the landfill contrary to its permit or outside industry standards. *ADS should not be subject to a regulatory violation simply for the transient, incidental effects of running its business, which cannot be demonstrated to rise to a nuisance actionable under Michigan law.*

IV. THE MDEQ'S RELIANCE UPON A VAGUE, SUBJECTIVE AND UNPUBLISHED ODOR STANDARD VIOLATES DUE PROCESS

As explained below, the DEQ's reliance upon the "AQD Odor Scale" to base the NOV against Arbor Hills is fundamentally flawed.

A. MDEQ's Interpretation of Rule 901(b) Violates Due Process Because the Arbor Hills Landfill Has Not Been Given "Fair Notice" of A Discernible Standard to Achieve Compliance.

MDEQ's interpretation of Rule 901(b) as warranting a violation when a "Level 3 on the MDEQ-AQD Odor Scale" is detected *violates due process*. It is a fundamental principle of due process that government bodies that attempt to enforce statutes and regulations are required to give fair, adequate notice of the specific conduct required to conform to the standard. *See e.g. Ohio Cast Products v. Occupational Safety & Health*, 246 F.3d 791, 798 (6th Cir. 2001). "Fair notice" requires

that a regulated party, acting in good faith, be able to determine with "ascertainable certainty" the standards with which the agency expected it to conform by reviewing the regulations and other public statements issued by the agency. *See General Elec. Co. v. USEPA*, 53 F.3d 1324, 1328-29 (D.C. Cir. 1995); *see also Adkins v Dep't of Civil Service*, 140 Mich. App 202, 213-214 (1985) (noting that due process requires the existence of reasonably precise standards to be employed by administrative agencies in performing their delegated legislative tasks). If the regulator does not provide fair warning of its interpretation of the regulations, the regulated party is not "on notice" and cannot be punished. *General Elec. Co.*, 53 F.3d at 1333-34.

In this case, not only did MDEQ fail to provide notice of its intention to use the "MDEQ-AQD Odor Scale" in evaluating Rule 901(b) violations, but it ***is no easy task even finding the odor scale and ADS still has doubts over what it is.*** Moreover, the "MDEQ-AQD Odor Scale" is so vague and indecisive that the Arbor Hills Landfill has not been given "fair notice" of a discernible standard to achieve compliance. The "MDEQ-AQD Odor Scale," in fact, is an arbitrary rule that fails to (1) identify when an odor is classified as a "distinct and definite objectionable odor" and (2) provide a precise standard regarding when an odor causes an unreasonable interference with the comfortable enjoyment of life and property. Such a secretive, subjective guideline prevents the Arbor Hills Landfill from being able to identify, with ascertainable certainty, the standards with which MDEQ expects it to conform. The Arbor Hills Landfill, therefore, cannot be cited for a violation of Rule 901(b) under MDEQ's interpretation without violating due process.

B. MDEQ Is Barred from Enforcing The "MDEQ-AQD Odor Scale" Against the Arbor Hills Landfill Because the Rule Was Not Promulgated in Accordance With APA Notice And Comment Provisions.

The "MDEQ-AQD Odor Scale" is also an invalid administrative rule because it was not promulgated in accordance with the Administrative Procedures Act (the "APA") notice-and-comment rule making provisions. An administrative rule is an "agency regulation, statement, standard, policy, ruling, or instruction of general applicability that implements or applies law enforced or administered by the agency…" MCLS § 24.207. If by its action the agency intends to create new law, rights, or duties, the rule is properly considered to be a rule subject to notice and comment rule making. *See First Nat'l Bank v. Sanders*, 946 F.2d 1185, 1188 (6th Cir. 1991) (quoting *General Motors Corp. v. Ruckelshaus*, 742 F.2d 1561, 1565 (D.C. Cir. 1984), *cert. denied*, 471 U.S. 1074 (1985).); *see also Clonlara, Inc. v. State Bd. Of Educ.*, 442 Mich. 230, 239-40 (1993) (stating that rules having the force and effect of law are subject to notice and comment procedures). The APA provides that a rule is not valid unless promulgated in accordance with its notice and comment provisions. *Greenfield Constr. Co. v. Dep't of State Hwys*, 402 Mich. 172, 215 (1978); MCLS § 24.243. An agency is barred from attempting to enforce against a citizen a rule not so promulgated. *Greenfield*, 402 Mich. at 215; MCLS § 24.243[3]

[3] Similarly, the MDEQ-AQD Odor Scale cannot be employed as a "guideline" because it has not been subjected to notice and comment as required under MCL 2.224-228.

Here, the "MDEQ-AQD Odor Scale" is an invalid administrative rule because it is a policy or instruction created by MDEQ with the intention to impose a duty on the public to limit odors to a level that MDEQ deems reasonable. As such, MDEQ was required to promulgate the rule in accordance with APA notice-and-comment rule making provisions. MDEQ's failure to do so deprived ADS of notice of the rule and an opportunity to participate in the rulemaking process. The "MDEQ Odor Scale," therefore, is an invalid administrative rule and MDEQ is barred from attempting to enforce the rule against the Arbor Hills Landfill.

V. CONCLUSION

ADS has devoted significant resources to complying with environmental standards applicable to the Arbor Hills landfill. But it cannot comply with a vague, imprecise standard that depends only upon the subjective senses of an individual inspector. It is evident that what is needed is a protocol for objectively measuring odors. This will provide the DEQ with a firm and ascertainable basis to enforce compliance and at the same time give ADS confidence in knowing the conduct required to comply with the law.

ADS representatives will be meeting with Washtenaw County as soon as possible to determine whether the county is willing to participate in the program conceptually outlined during discussions in the meeting on September 12th. If the county is willing to participate we will supplement this letter with a more detailed plan for odor monitoring, odor assessments based on the Best Management Practices requested by (and already submitted to the DEQ), and the corrective action process that would be adopted by the landfill. We look forward to further discussions on this topic.

Very truly yours,

Philip L. Comella

PLC/mk

cc: Mr. Jay Warzinski, Vice President LF Operations, ADS
Mr. Anthony Testa, Advanced Disposal Services
Mr. Nathan Frank, USEPA
Mr. Kenneth Ruffatto, USEPA
Ms. Mary Ann Dolehanty, DEQ
Mr. Craig Fitzner, DEQ
Mr. Chris Ethridge, DEQ
Ms. Jenine Camillari, DEQ
Ms. Diane Kavanaugh Vetort, DEQ
Mr. Jack Schinderle, DEQ
Mr. Lonnie Lee, DEQ
Ms. Alex Clark, DEQ

EXHIBIT A

Designation: E 679 – 04

Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits[1]

This standard is issued under the fixed designation E 679; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The obtaining of odor and taste thresholds requires the sensory responses of a selected group of individuals called panelists. These thresholds may be determined in order to note the effect of various added substances on the odor and taste of a medium. They may also be determined in order to characterize and compare the odor or taste sensitivity of individuals or groups.

It is recognized that precise threshold values for a given substance do not exist in the same sense that values of vapor pressure exist. The ability to detect a substance by odor or taste is influenced by physiological factors and criteria used in producing a response by the panelist. The parameters of sample presentation introduce further variations. Thus, the flowrate of a gaseous, odorous sample has an influence on the detectability of an odor. However, a concentration range exists below which the odor or taste of a substance will not be detectable under any practical circumstances, and above which individuals with a normal sense of smell or taste would readily detect the presence of the substance.

The threshold determined by this practice is not the conventional group threshold (the stimulus level detectable with a probability of 0.5 by 50 % of the population) as obtained by Practice E 1432, but rather a best estimate not far therefrom. The bias of the estimate depends on the concentration scale steps chosen and on the degree to which each panelist's threshold is centered within the range of concentrations he or she receives. The user also needs to keep in mind the very large degree of random error associated with estimating the probability of detection from only 50 to 100 3-AFC presentations.

1. Scope

1.1 This practice describes a rapid test for determining sensory thresholds of any substance in any medium.

1.2 It prescribes an overall design of sample preparation and a procedure for calculating the results.

1.3 The threshold may be characterized as being either (*a*) only *detection* (awareness) that a very small amount of added substance is present but not necessarily recognizable, or (*b*) *recognition* of the nature of the added substance.

1.4 The medium may be a gas, such as air, a liquid, such as water or some beverage, or a solid form of matter. The medium may be odorless or tasteless, or may exhibit a characteristic odor or taste per se.

1.5 This practice describes the use of a multiple forced-choice sample presentation method in an ascending concentration series, similar to the method of limits.

1.6 Physical methods of sample presentation for threshold determination are not a part of this practice, and will depend on the physical state, size, shape, availability, and other properties of the samples.

1.7 It is recognized that the degree of training received by a panel with a particular substance may have a profound influence on the threshold obtained with that substance **(1)**.[2]

1.8 Thresholds determined by using one physical method of presentation are not necessarily equivalent to values obtained by another method.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

D 1292 Test Method for Odor in Water

E 544 Practice for Referencing Suprathreshold Odor Intensity

[1] This practice is under the jurisdiction of ASTM Committee E18 on Sensory Evaluation of Materials and Products and is the direct responsibility of Subcommittee E18.04 on Fundamentals of Sensory.

Current edition approved April 1, 2004. Published April 2004. Originally approved in 1979. Last previous edition approved in 1997 as E 679 – 91 (1997).

[2] The boldface numbers in parentheses refer to the list of references at the end of this practice.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E 1432 Practice for Defining and Calculating Individual and Group Sensory Thresholds from Forced-Choice Data Sets of Intermediate Size

2.2 *CEN Standards:*[4]

EN 13725 Air Quality—Determination of Odour Concentration Using Dynamic Dilution Olfactometry

2.3 *ISO Standards:*[5]

ISO 13301 Sensory Analysis—Methodology—General Guidance for Measuring Odour, Flavour and Taste Detection Thresholds by a Three Alternative Forced Choice (3–AFC) Procedure

3. Terminology

3.1 *Definitions:*

3.1.1 *sample*—a material in any form that may or may not exhibit an odor or taste, depending on the amount of odorous or sapid components that it may contain.

3.1.2 *medium*—any material used to dissolve, disperse, or sorb odorous or sapid material whose threshold is to be measured.

3.1.3 *blank sample*—a quantity of the medium containing no added odorous or sapid material.

3.1.4 *test sample*—the medium to which an odorous or sapid material has been added at a known concentration.

3.1.5 *detection threshold*—the lowest concentration of a substance in a medium relating to the lowest physical intensity at which a stimulus is *detected* as determined by the best-estimate criterion.

3.1.6 *recognition threshold*—the lowest concentration of a substance in a medium relating to the lowest physical intensity at which a stimulus is *recognized* as determined by the best-estimate criterion.

3.1.7 *best-estimate criterion*—an interpolated concentration value, but not necessarily the concentration value that was actually presented. In this practice it is the geometric mean of the last missed concentration and the next (adjacent) higher concentration.

3.1.8 *panelists*—individuals whose odor or taste thresholds are being evaluated, or who are utilized to determine the odor or taste threshold of the substance of interest.

3.1.9 *ascending scale of concentrations*—a series of increasing concentrations of an odorous or sapid substance in a chosen medium.

3.1.10 *scale steps*—discrete concentration levels of a substance in a medium, with concentrations increased by the same factor per step throughout the scale.

3.1.11 *3-alternative forced choice (3-AFC) presentation*—a set consisting of one test sample and two blank samples (as applied to this practice).

3.1.12 *geometric mean*—the *n*th root of the product of terms. In this method, the terms are concentration values.

[4] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

4. Summary of Practice

4.1 A series of test samples is prepared by dispersing the substance whose threshold is to be determined in the medium of interest. This concentration scale should increase in geometric increments so that any two adjacent concentration steps are separated by a constant factor. At each concentration step, two blank samples consisting of the medium only are made available to the panelist. The blank and test samples are encoded so that there is no visual, audible, tactile, or thermal difference between the samples other than code designators **(2)**.

4.2 The panelist starts at the lowest concentration step, which should be two or three concentration steps below the estimated threshold. Each sample within the set of three is compared with the other two.

4.3 The panelist indicates which of the three samples is different from the other two. A choice must be made, even if no difference is noted, so that all data can be utilized.

4.4 Individual best-estimate values of threshold are derived from the pattern of correct/incorrect responses produced separately by each panelist. Group thresholds are derived by geometrical averaging of the individual best-estimate thresholds.

5. Significance and Use

5.1 Sensory thresholds are used to determine the potential of substances at low concentrations to impart odor, taste, skinfeel, etc. to some form of matter.

5.2 Thresholds are used, for example, in setting limits for air pollution, in noise abatement, in water treatment, and in food systems.

5.3 Thresholds are used to characterize and compare the sensitivity of individual or groups to given stimuli, for example, in medicine, in ethnic studies, and in the study of animal species.

6. Preparation of Concentration Scale

6.1 The concentration levels of the test substance in a medium should begin well below the level at which the most sensitive panelist is able to detect or recognize the added substance, and end at (or above) the concentration at which all panelists give a correct response.

6.2 The increase in concentration of the test substance per scale step should be by a constant factor. It is desirable to obtain a scale step factor that will allow the correct responses of a group of nine panelists to distribute over three to four concentration steps (see Appendix X1-Appendix X3). This will allow more accuracy in determining the group threshold value based on the geometric mean of the individual panelists.

6.3 Good judgment is required by the person in charge in order to determine the appropriate scale step range for a particular substance. This might involve the preparation of an approximate threshold concentration of the odorous or sapid substance in the medium of choice. The concentration of the substance may be increased two to three times for odorants or 1.5 to 2.5 times for sapid substances depending on how the perceived intensity of odor or taste varies with the concentration of the substance providing the sensory response. For

example, if x represents an approximate odor threshold concentration, then a series of concentration steps would appear as follows if a step factor of "3" were used:

$$\ldots x/27, x/9, x/3, x, 3x, 9x, 27x \ldots$$

6.4 In actual practice, the various concentrations are obtained by starting at the highest concentration and diluting three times per step, thus providing a series of dilution factors, "V_i" being the initial volume:

$$\ldots 729V_i, 243V_i, 81V_i, 27V_i, 9V_i, 3V_i, V_i, \ldots$$

6.5 At each selected concentration or dilution, a 3-AFC sample set consisting of one test and two blank samples is presented to panelists in indistinguishable fashion **(3)**. It is desirable to have all samples prepared and ready for judging before the evaluation session begins. (Reference **(2)** contains sound practices for coding the samples, rotating the positions of these test and blank samples as the test proceeds, etc.)

6.6 If the samples are arranged in a left-center-right, or an above-center-below order, care must be taken that the test sample is presented in one third of the presentations in the left (top) position, one third in the center position, and one third in the right (bottom) position to eliminate positional bias.

6.7 If only one sample at a time is available, the test and blank samples may be presented one after another in units of three presentations, with the test sample being randomized to be the first, the second, and the third, and requesting the response after all three samples in the set have been presented. Better results, however, are obtained if the test and the two blank samples are available for a direct comparison, so that the panelist may sniff or taste back and forth at ease until a decision is reached.

7. Judgment Procedure

7.1 The panelist begins judging with that set which contains the test sample with the lowest concentration (highest dilution) of the odorous or sapid substance, takes the time needed to make a selection, and proceeds systematically toward the higher concentrations.

7.2 Within each set, the panelist indicates that sample which is different from the two others (detection threshold) or which exhibits a recognizable odor or taste of the substance (recognition threshold). If the panelist cannot readily discriminate, a guess must be made so that all data may be utilized.

7.3 The judgments are completed when the panelist either (*1*) completes the evaluation of all sets of the scale, or (*2*) reaches a set wherein the test sample is correctly identified, then continues to choose correctly in higher concentration test sample sets.

8. Data Evaluation

8.1 The series of each panelist's judgments may be expressed by writing a sequence containing (0) for an incorrect choice or (+) for a correct choice arranged in the order of judgments of ascending concentrations of the added substance.

8.2 If the concentration range has been correctly selected, all panelists should judge correctly within the range of concentration steps provided. Thus, the representation of the panelists' judgments as in 8.1 should terminate with two or more consecutive plusses (+).

8.3 Because there is a finite probability that a correct answer will occur by chance alone, it is important that a panelist continues to take the test until there is no doubt by that person of the correctness of the choice.

8.4 The best-estimate threshold concentration for the panelist is then the geometric mean of that concentration at which the last miss (0) occurred and the next higher concentration designated by a (+).

8.5 The panel threshold is the geometric mean of the best-estimate thresholds of the individual panelists. If a more accurate threshold value of an individual panelist is desired, it may be obtained by calculating the geometric mean of the best-estimate threshold of all series administered to that person.

9. Report

9.1 Successful completion of the foregoing procedure provides either the detection or recognition threshold of the substance in the medium of interest in accordance with this practice.

9.2 The threshold value is in concentration or dilution units appropriate for the substance tested **(4)**.

9.3 For enhanced understanding of the threshold results, the following information is recommended:

Threshold of:
Procedure: ASTM Practice E 679 (Rapid Method)
Presentation:
Number of scale steps:
Dilution factor per step:
Temperature of samples:
Panelist selection:
Number of times test given:
Type of threshold (detection or recognition):
Best-estimate threshold:
  Individual:
  Panel:

9.4 Refer to Appendix X1-Appendix X3 for examples of the calculations and reporting requirements.

10. Precision and Bias

10.1 Because sensory threshold values are functions of sample presentation variables and of individual sensitivities, interlaboratory tests cannot be interpreted statistically in the usual way, and a general statement regarding precision and bias of thresholds obtained by this practice cannot be made. However, certain comparisons made under particular circumstances are of interest and are detailed below.

10.2 When 4 panels of 23 to 35 members evaluated butanol in air **(5)**, the ratio of the highest to the lowest panel threshold was 2.7 to 1; when the same panel repeated the determination on 4 days, the ratio was 2.4 to 1. For 10 panels of 9 members evaluating hexylamine in air, the ratio was 2.1 to 1.

10.3 When 26 purified compounds were tested for threshold by addition to similar beers by 20 brewery laboratories (each compound was tested by 2 to 8 laboratories), the ratios of the highest to the lowest panel threshold varied from less than 2.0 to 1, to 7.0 to 1 or more **(6)**. The lowest variability was found with simple compounds of high threshold (sugar, salt, ethanol), and the highest with complex compounds of low threshold (eugenol, hop oil, geosmin).

10.4 When 14 laboratories determined the threshold of purified hydrogen sulfide in odorless air **(7)**, the ratio of the highest to the lowest laboratory threshold was 20 to 1. Interlaboratory tests with dibutylamine, isoamyl alcohol, methyl acrylate and a spray thinner for automobile paint gave somewhat lower ratios. Although the methods used vary somewhat from this practice, the results are comparable.

10.5 A discussion of the likely bias of results by this practice compared to a true threshold can be found in references **(5)**, **(8)** and **(9)**.

11. Keywords

11.1 air pollution; ascending method of limits; odor; panel; sensory evaluation; taste; threshold; water pollution

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE NO. 1—DIFFERENCE THRESHOLD OF ETHYL ACETATE ADDED TO BEER

X1.1 The difference threshold of purified ethyl acetate added to a bland reference beer was to be determined. The reference beer contained 20 mg/L endogenous ethyl acetate.

X1.2 The purest commercial ethyl acetate obtainable was further purified by passage through columns of selected absorbants. Ten concentrations of the purified compound were prepared by addition to the reference beer. Sixteen panelists experienced in threshold testing each received five or six sets of 3-AFC presentations spaced by a factor of 2.0. The sets had been chosen by preliminary testing aimed at finding an optimal range of concentrations, such that the panelists would be able to easily detect the highest concentration, but unable to detect the lowest concentration. The preliminary testing also served to familiarize the panelists with the flavor of added ethyl acetate. Each panelist performed the test a minimum of two times after their optimal range had been established.

X1.3 The results listed in Table X1.1 were obtained.

X1.4 Details of calculation are as follows:

X1.4.1 For panelist 01, the best-estimate threshold is: $\sqrt{60 \times 120} = 84.8$ mg/L added ethyl acetate. For panelist 02, the best estimate threshold is $\sqrt{20 \times 40} = 28.3$ mg/L. All other values follow these same calculations.

X1.4.2 In Table X1.1, different panelists received different concentration sets. Not all concentrations were spaced at a constant factor of 2.0. The best estimate thresholds were calculated per 8.4 above using the exact concentrations received by each panelist.

X1.5 *Report*—The report shall include the following information:

Difference threshold: Purified ethyl acetate added to a bland beer containing 20 mg/L endogenous ethyl acetate

Procedure: Practice E 679

Presentation: three-glass 3-AFC presentations (two identical controls and one glass containing the added substance). Weakest concentrations were presented first

TABLE X1.1 Example of Difference Threshold for an Added Substance

Panelist	Judgments[A]											
	Concentrations of ethyl acetate presented, mg/L										Best-Estimate Threshold (BET)	
	10	15	20	30	40	60	80	120	160	240	Value	$\log_{10}$ of value
01	...	0	...	+	...	0	...	+	...	+	84.8	1.93
02	+	...	0	...	+	...	+	...	+	...	28.3	1.45
04	0	...	0	...	+	...	+	...	+	...	28.3	1.45
07	+	...	+	...	0	...	+	...	+	...	56.5	1.75
09	+	...	+	...	+	...	+	...	+	...	7.1	0.85
10	...	0	...	+	...	0	...	+	...	+	84.8	1.93
11	...	+	...	0	...	0	...	+	...	+	84.8	1.93
12	...	...	...	0	...	+	...	...	...	...	42.4	1.63
13	+	...	0	...	0	...	+	...	+	...	56.5	1.75
17	...	0	...	+	...	+	...	+	...	+	21.2	1.33
18	0	...	0	+	...	0	...	+	...	+	84.8	1.93
19	+	...	0	...	0	...	0	...	+	...	113	2.05
20	0	...	+	...	+	...	+	...	+	...	14.1	1.15
23	0	...	+	...	0	...	+	...	+	...	56.5	1.75
24	...	+	...	0	...	+	...	+	...	+	42.4	1.62
27	...	0	...	+	...	0	...	0	...	+	169.7	2.23
Group BET = geometric mean, mg/L ethyl acetate											$\Sigma\log_{10} \rightarrow$	26.73
											46.8 ←	1.67
Log Standard deviation												0.36

[A] "0" indicates that the panelist selected the wrong sample of the set of three. "+" indicates that the panelist selected the correct sample.

Number of scale steps: ten available, five or six used for each panelist
Dilution factor per step: two
Temperature: samples at 15°C, room at 23°C
Panelist selection: brewery panelists experienced in threshold determinations by the Practice E 679 method
Number of panelists: 16 - each panelist continued testing until convinced of the correctness of his or her choice: "added compound present" or "I am guessing"
Type of threshold: difference
Best-estimate threshold:

$BET = 46.8$ mg/L
$\log_{10} BET = 1.67$
Log standard deviation = 0.36

X2. EXAMPLE NO. 2—ODOR THRESHOLD DETERMINATION

X2.1 The odor threshold of an odorous air sample was to be determined.

X2.2 Six different concentrations of the odorous sample in air were prepared. Each of these was presented in conjunction with two samples of nonodorous air. The concentrations were increased by a factor of three per concentration step. Nine randomly selected panelists participated. Each proceeded from the lower to higher concentrations. At each concentration level, panelists compared the three samples—two blanks and one diluted odorous sample—and indicated which sample was different from the other two.

X2.3 The results listed in Table X2.1 were obtained.

X2.4 Details of calculation are as follows:

X2.4.1 For Panelist 1, the best-estimate threshold is $\sqrt{135 \times 45} = 78$, or at a dilution by a factor of 78 (one volume of the odorous air sample diluted with nonodorous air to occupy 78 volumes in total). For Panelist 2, the threshold is at $\sqrt{1215 \times 405} = 701$.

X2.4.2 Panelist 4 missed at the highest concentration, where the dilution is only by a factor of 15. It is assumed that he would have been correct at a higher concentration level, where the dilution would have been a factor 15/3 = 5.

X2.4.3 Consequently, an estimate of his threshold is $\sqrt{15 \times 5} = 9$. The underlying assumption is that since the thresholds of the other panelists were within the presented scale range, his threshold should not be far away from the range if he belongs to the same statistical population. If the test were to establish the sensitivity of the panelists, this panelist would have been retested, with a scale range extended to the right of the results in Table X2.1.

X2.4.4 Panelist 6 represents the opposite extreme. The estimate is based on the assumption that a miss would have occurred at a dilution of $3 \times 3645 = 10\ 935$; the best-estimate threshold is then $\sqrt{10\ 935 \times 3645} = 6313$.

X2.4.5 In Table X2.1, dilutions change exactly by a factor of three per scale step. Experimentally, small deviations from such equal spacing occur, and the actual dilutions or concentrations should be used in calculating the best-estimate thresholds from two adjacent values in the table.

TABLE X2.1 Example of Odor Threshold

NOTE 1—This example has been selected to represent both extremes. Panelist 4 missed even at the highest concentration. Panelist 6 was correct even at the lowest concentration and continued to be correct at all subsequent higher concentrations.

Panelists	Judgments[A]							
	Dilution Factors (concentrations increase →)						Best-Estimate Threshold (BET)	
	3645	1215	405	135	45	15	Value	$\log_{10}$ of Value
1	0	+	+	0	+	+	78	1.89
2	+	0	+	+	+	+	701	2.85
3	0	+	0	0	+	+	78	1.89
4	0	0	0	0	+	0	9	0.94
5	+	0	0	+	+	+	234	2.37
6	+	+	+	+	+	+	6313	3.80
7	0	+	+	0	+	+	78	1.89
8	+	0	0	+	+	+	234	2.37
9	+	0	+	+	+	+	70	2.85
Group BET geometric mean							$\Sigma\log_{10}$ →	20.85
							209 ←	2.32
Standard deviation								0.81

[A] "0" indicates that the panelist selected the wrong sample of the set of three. "+" indicates that the panelist selected the correct sample.

X2.5 *Report*—The report shall include the following information:
Odor threshold: Odorous Air Sample XX
Procedure: ASTM Practice E 679
Presentation: at 500 ml/min (dynamic dilution olfactometer)
Number of scale steps: six
Dilution factor per step: three
Temperature: 25°C (room and samples)
Panelist selection: random
Number of panelists: nine
Type of threshold: detection
Best-estimate threshold:

$Z_{OL} = 209$
$\log_{10} Z_{OL} = 2.32$
Standard log deviation = 0.81

NOTE X2.1— The symbol Z represents a dilution factor proposed to designate a dimensionless measure of sample dilution needed to reach some target effect **(10)**.[6] For threshold work, the subscript "OL" represents the dilution at which the odor reaches a limit that corresponds to the best-estimate threshold.

[6] The dilution factor, Z, is used in modest honor of H. Zwaardemaker, a Dutch scientist and early investigator in olfactometry. Alternate terminology in use: Dilution-to-Threshold Ratio (D/T or D-T); Odor Unit (OU); Effective Dose (ED).

X3. EXAMPLE NO. 3—ODOR THRESHOLD DETERMINATION

X3.1 The odor threshold of an odorous air sample was to be determined.

X3.2 Fourteen different concentrations of the odorous sample in air were prepared using a dynamic dilution olfactometer. Each of these was presented in conjunction with two samples of nonodorous air. The concentrations were increased by a factor of two per concentration step. Five panelists were selected at random from a pool of assessors who meet the selection criteria set forth in EN 13725. Each panelist proceeded from the lower to higher concentrations. At each concentration level, panelists compared the three samples (two blanks and one diluted odorous sample) and indicated which sample was different from the other two. Each panelist performed the test two times.

X3.3 The results listed in Table X3.1 were obtained.

X3.4 Details of calculation are as follows:

X3.4.1 For Panelist 1, the best estimate threshold is $\sqrt{4096 \times 2048} = 2896$, or at a dilution by a factor of 2896 (one volume of the odorous air sample diluted with nonodorous air to occupy 2896 volumes in total). For Panelist 2, the threshold is at $\sqrt{2048 \times 1024} = 1448$. All other values follow these same calculations.

X3.4.2 In Table X3.1, dilutions change exactly by a factor of two per scale step. Experimentally, small deviations from such equal spacing occur, and the actual dilutions or concentrations should be used in calculating the best-estimate thresholds from two adjacent values in the table.

X3.5 *Report*—The report shall include the following information:

Odor threshold: Odorous Air Sample XX
Procedure: Practice E 679 and EN 13725
Presentation: at 20 L/min (dynamic dilution olfactometer)
Number of scale steps: 14 available (five used)
Dilution factor per step: two
Temperature: 25°C (room and samples)
Panelist selection: random selection from pool of assessors who meet EN 13725 selection criteria
Number of panelists: five - each panelist observed each sample twice
Type of threshold: detection
Best-estimate threshold:

$$Z_{OL} = 2188$$
$$\log_{10} Z_{OL} = 3.34$$
$$\text{Log standard deviation} = 0.15$$

X3.6 *Additional examples*—References **(11-21)** contain examples of thresholds determined according to this practice or by equivalent methods.

TABLE X3.1 Example of Odor Threshold

NOTE 1—This example shows only six of the available fourteen dilution levels. All panelists observed the sample two times.

Panelists	Judgments[A] (Concentrations increase →)						Best-Estimate Threshold (BET)	
	3 16 384	4 8192	5 4096	6 2048	7 1024	8 512	Value	$\log_{10}$ of value
1	...	0	0	+	+	...	2896	3.46
2	...	0	0	0	+	+	1448	3.16
3	...	0	0	0	+	+	1448	3.16
4	...	0	0	+	+	...	2896	3.46
5	...	0	0	+	+	...	2896	3.46
1	...	0	0	+	+	...	2896	3.46
2	...	0	0	0	+	+	1448	3.16
3	...	0	0	+	+	...	2896	3.46
4	...	0	0	+	+	...	2896	3.46
5	...	0	0	0	+	+	1448	3.16
Group BET geometric mean							$\Sigma\log_{10}$ →	33.40
							2188 ←	3.34
Standard deviation								0.15

[A] "0" indicates that the panelist selected the wrong sample of the set of three. "+" indicates that the panelist selected the correct sample.

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EXHIBIT B

RK & Associates, Inc.

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Perimeter & Community Locations

Date 8/22/18 PM Field Person Kevin VanDod

Locations		Wind Direction	Wind Speed	Scentometer Reading	Time	Odor Description
Perimeter Locations	#					
Napier Rd & Entrance to GLR	P-1	WNW	5-10	0	20:15	
5 Mile Rd & Entr to Energy Ctr.	P-2	WNW	5-10	0	20:09	
5 Mile Rd & Utility Corridor	P-3	WNW	5-10	0	20:06	
6 Mile Rd & NW Corner of LF	P-4	WNW	5-10	0	20:36	
6 Mile Rd & Old LF Office	P-5	WNW	5-10	0	20:38	
6 Mile Rd & Napier Rd	P-6	WNW	5-10	<2	20:40	D
Napier & Private Road	P-7	WNW	5-10	<2	20:25	E
Napier & Railroad	P-8	WNW	5-10	<2	20:17	E
Napier & Entr to Composting	P-9	WNW	5-10	0	20:27	
Community Receptors	#					
Mulberry Ct. & Mulberry Way	C-1	WNW	5-10	0	21:03	
Boulder & Parkside Dr.	C-2	WNW	5-10	0	21:07	
Entrance to Steeplechase	C-3	WNW	5-10	0	21:31	
Ridgewood Elementary School	C-4	WNW	5-10	0	20:44	
Waterway Park on Ridgeway Dr.	C-5	WNW	5-10	0	20:58	
Bayberry Way & Rose Terrace	C-6	WNW	5-10	0	21:16	
NW Corner of Briar Ridge Ln.	C-7	WNW	5-10	0	21:29	
Brier Ridge Ln. & Trail Entrance	C-8	WNW	5-10	0	21:24	
SW Corner of Ridgeway Dr.	C-9	WNW	5-10	0	21:26	
Napier & Last Drive	C-10	WNW	5-10	0	20:12	
Salem Rd. & Jessica J Ln	C-11	WNW	5-10	0	20:03	
6 Mile & Pearl Street	C-12	WNW	5-10	0	20:34	
Tamarack Trail	C-13	WNW	5-10	0	21:27	
Starlite Run	C-14	WNW	5-10	0	21:29	
Northstar Way	C-15	WNW	5-10	0	21:22	
Northville High School	C-16	WNW	5-10	0	20:49	
Briar Ridge	C-20	WNW	5-10	0	21:18	
Seven Mile and Ridge Road	C-21	WNW	5-10	0	20:56	
Seven Mile and Napier Road	C-22	WNW	5-10	0	20:38	
Ridgewood Ct & Mulberry Way	C-23	WNW	5-10	0	21:05	

A* = Perfume Odor
B* = Perfume and LF Odor
C = Landfill Gas
D = Compost
E = Fresh Garbage
F = Leachate
G= Other (explain; e.g. fresh cut grass)
H= Garbage Pickup Date in the Community

* When masking agent spray system comes to play

Note: Monitoring locations C-17, C-18, C-19 are removed from daily odor monitoring effective 8/28/17

RK & Associates, Inc.

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Perimeter & Community Locations

Date 08/23/18 AM

Field Person Alex Watzek

Locations		Wind Direction	Wind Speed	Scentometer Reading	Time	Odor Description
Perimeter Locations	#					
Napier Rd & Entrance to GLR	P-1	W	5-10	0	06:53	
5 Mile Rd & Entr to Energy Ctr.	P-2	W	5-10	0	06:55	
5 Mile Rd & Utility Corridor	P-3	W	5-10	0	07:00	
6 Mile Rd & NW Corner of LF	P-4	W	5-10	0	06:48	
6 Mile Rd & Old LF Office	P-5	W	5-10	0	06:42	
6 Mile Rd & Napier Rd	P-6	W	5-10	0	06:51	
Napier & Private Road	P-7	W	5-10	<2	07:13	C
Napier & Railroad	P-8	W	5-10	<2	07:10	C
Napier & Entr to Composting	P-9	W	5-10	<2	07:20	D
Community Receptors	#					
Mulberry Ct. & Mulberry Way	C-1	W	5-10	0	06:35	
Boulder & Parkside Dr.	C-2	W	5-10	0	06:24	
Entrance to Steeplechase	C-3	W	5-10	0	06:39	
Ridgewood Elementary School	C-4	W	5-10	0	06:19	
Waterway Park on Ridgeway Dr.	C-5	W	5-10	0	06:15	
Bayberry Way & Rose Terrace	C-6	W	5-10	0	07:27	
NW Corner of Briar Ridge Ln.	C-7	W	5-10	0	07:32	
Brier Ridge Ln. & Trail Entrance	C-8	W	5-10	0	07:43	
SW Corner of Ridgeway Dr.	C-9	W	5-10	<2	07:40	D
Napier & Last Drive	C-10	W	5-10	0	07:04	
Salem Rd. & Jessica J Ln	C-11	W	5-10	0	06:58	
6 Mile & Pearl Street	C-12	W	5-10	0	06:46	
Tamarack Trail	C-13	W	5-10	0	07:37	
Starlite Run	C-14	W	5-10	0	07:36	
Northstar Way	C-15	W	5-10	0	07:33	
Northville High School	C-16	W	5-10	0	06:05	
Briar Ridge	C-20	W	5-10	0	07:30	
Seven Mile and Ridge Road	C-21	W	5-10	0	06:12	
Seven Mile and Napier Road	C-22	W	5-10	0	07:24	
Ridgewood Ct & Mulberry Way	C-23	W	5-10	<2	06:27	E

A* = Perfume Odor
B* = Perfume and LF Odor
C = Landfill Gas
D = Compost
E = Fresh Garbage
F = Leachate
G= Other (explain; e.g. fresh cut grass)
H= Garbage Pickup Date in the Community

* When masking agent spray system comes to play

Note: Monitoring locations C-17, C-18, C-19 are removed from daily odor monitoring effective 8/28/17

RK & Associates, Inc.

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Perimeter & Community Locations

Date 8/23/18 PM Field Person M. Dzielan

Locations		Wind Direction	Wind Speed	Scentometer Reading	Time	Odor Description
Perimeter Locations	#					
Napier Rd & Entrance to GLR	P-1	SW	5-10	0	2027	
5 Mile Rd & Entr to Energy Ctr.	P-2	SW	5-10	0	2030	
5 Mile Rd & Utility Corridor	P-3	SW	5-10	0	2037	
6 Mile Rd & NW Corner of LF	P-4	SW	5-10	0	2021	
6 Mile Rd & Old LF Office	P-5	SW	5-10	0	2017	
6 Mile Rd & Napier Rd	P-6	SW	5-10	<2	2024	C
Napier & Private Road	P-7	SW	5-10	0	2044	
Napier & Railroad	P-8	SW	5-10	0	2043	
Napier & Entr to Composting	P-9	SW	5-10	0	2052	
Community Receptors	#					
Mulberry Ct. & Mulberry Way	C-1	SW	5-10	0	2007	
Boulder & Parkside Dr.	C-2	SW	5-10	0	2004	
Entrance to Steeplechase	C-3	SW	5-10	<2	2012	C
Ridgewood Elementary School	C-4	SW	5-10	0	2000	
Waterway Park on Ridgeway Dr.	C-5	SW	5-10	0	1958	
Bayberry Way & Rose Terrace	C-6	SW	5-10	0	2057	
NW Corner of Briar Ridge Ln.	C-7	SW	5-10	0	2103	
Brier Ridge Ln. & Trail Entrance	C-8	SW	5-10	0	2107	
SW Corner of Ridgeway Dr.	C-9	SW	5-10	0	2108	
Napier & Last Drive	C-10	SW	5-10	0	2040	
Salem Rd. & Jessica J Ln	C-11	SW	5-10	0	2034	
6 Mile & Pearl Street	C-12	SW	5-10	0	2019	
Tamarack Trail	C-13	SW	5-10	<2	2110	G laundry detergent
Starlite Run	C-14	SW	5-10	<2	2114	C
Northstar Way	C-15	SW	5-10	0	2104	
Northville High School	C-16	SW	5-10	0	1950	
Briar Ridge	C-20	SW	5-10	0	2102	
Seven Mile and Ridge Road	C-21	SW	5-10	0	1956	
Seven Mile and Napier Road	C-22	SW	5-10	0	2054	
Ridgewood Ct & Mulberry Way	C-23	SW	5-10	0	2006	

A* = Perfume Odor
B* = Perfume and LF Odor
C = Landfill Gas
D = Compost
E = Fresh Garbage
F = Leachate
G= Other (explain; e.g. fresh cut grass)
H= Garbage Pickup Date in the Community

* When masking agent spray system comes to play

Note: Monitoring locations C-17, C-18, C-19 are removed from daily odor monitoring effective 8/28/17

RK & Associates, Inc.

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Perimeter & Community Locations

Date 8/24/18 AM Field Person M. Drickon

Locations		Wind Direction	Wind Speed	Scentometer Reading	Time	Odor Description
Perimeter Locations	#					
Napier Rd & Entrance to GLR	P-1	SSW	5-10	0	0718	
5 Mile Rd & Entr to Energy Ctr.	P-2	SSW	5-10	0	0720	
5 Mile Rd & Utility Corridor	P-3	SSW	5-10	0	0726	
6 Mile Rd & NW Corner of LF	P-4	SSW	5-10	0	0714	
6 Mile Rd & Old LF Office	P-5	SSW	5-10	<2	0706	C
6 Mile Rd & Napier Rd	P-6	SSW	5-10	0	0716	
Napier & Private Road	P-7	SSW	5-10	0	0734	
Napier & Railroad	P-8	SSW	5-10	0	0732	
Napier & Entr to Composting	P-9	SSW	5-10	<2	0737	C
Community Receptors	#					
Mulberry Ct. & Mulberry Way	C-1	SSW	5-10	0	0659	
Boulder & Parkside Dr.	C-2	SSW	5-10	0	0656	
Entrance to Steeplechase	C-3	SSW	5-10	0	0703	
Ridgewood Elementary School	C-4	SSW	5-10	0	0653	
Waterway Park on Ridgeway Dr.	C-5	SSW	5-10	0	0650	
Bayberry Way & Rose Terrace	C-6	SSW	5-10	0	0744	
NW Corner of Briar Ridge Ln.	C-7	SSW	5-10	0	0747	
Brier Ridge Ln. & Trail Entrance	C-8	SSW	5-10	0	0750	
SW Corner of Ridgeway Dr.	C-9	SSW	5-10	0	0751	
Napier & Last Drive	C-10	SSW	5-10	0	0729	
Salem Rd. & Jessica J Ln	C-11	SSW	5-10	0	0723	
6 Mile & Pearl Street	C-12	SSW	5-10	0	0712	
Tamarack Trail	C-13	SSW	5-10	0	0752	
Starlite Run	C-14	SSW	5-10	0	0754	
Northstar Way	C-15	SSW	5-10	0	0748	
Northville High School	C-16	SSW	5-10	0	0658	
Briar Ridge	C-20	SSW	5-10	0	0745	
Seven Mile and Ridge Road	C-21	SSW	5-10	0	0647	
Seven Mile and Napier Road	C-22	SSW	5-10	0	0741	
Ridgewood Ct & Mulberry Way	C-23	SSW	5-10	0	0658	

A* = Perfume Odor
B* = Perfume and LF Odor
C = Landfill Gas
D = Compost
E = Fresh Garbage
F = Leachate
G= Other (explain; e.g. fresh cut grass)
H= Garbage Pickup Date in the Community

* When masking agent spray system comes to play

Note: Monitoring locations C-17, C-18, C-19 are removed from daily odor monitoring effective 8/28/17

EXHIBIT C

Attachment C
Advanced Disposal Services Arbor Hills Landfill
Summary Report of Odor Mitigation Measures Implemented

Month/Year	Odor Mitigation Measure
January 2016	Republic initiates Phase 1 of an extensive expansion of the landfill gas collection and conveyance system
February 2016	Expansion of the Landfill Gas System continues
March 2016	Expansion of the Landfill Gas System continues
April 2016	Expansion of the Landfill Gas System continues
May 2016	Expansion of the Landfill Gas System continues
June 2016	Expansion of the Landfill Gas System continues – Phase 1 is effective to removing the excess landfill gas built up within the waste mass
July 2016	Republic Initiates Phase 2 of the expansion of the landfill gas collection and conveyance system.
August 2016	Phase 2 Landfill Gas Collection and Conveyance Expansion Continues. Installation of Caisson Wells in Cell 4 initiated that provides opportunity to extract landfill gas within the Cell 4 waste mass sooner and allows for vertical drainage of liquid to improve collection efficiency of the landfill gas system. Operational practices that were enhanced included an increase in the thickness of daily cover applied to the waste.
September 2016	Phase 2 Landfill Gas Collection and Conveyance Expansion Continues. Carbon Filters installed on leachate storage tanks.
October 2016	Phase 2 Landfill Gas Collection and Conveyance Expansion Continues
November 2016	RK Associates initiates odor monitoring. Arbor Hills employees trained in odor recognition by RKA.
December 2016	Republic, Fortistar, and Advanced submit the Compliance Plan to USEPA Region V associated with continued improvements to be Implement at the landfill to mitigate odors. The Compliance Plan focuses on the continued expansion and enhancements to the landfill gas collection and conveyance system, construction of temporary and final cover systems, and implementation of waste placement operational enhancements
January 2017	Advanced submits permit application for the installation of a temporary flare at the northwest corner of the landfill to improvement collection capability through increased vacuum distribution throughout the north portion of the landfill gas wellfield until modifications to the conveyance system and flare capacity can be completed.
February 2017	Advanced and Republic consummate an Agreement whereby Advanced takes ownership and control of the landfill gas collection and conveyance system. Existing Landfill Gas Sales and Operational Agreements with Fortistar are assigned to Advanced under the Agreement. Initial odor misting system line installation completed and put into operation.

Month/Year	Odor Mitigation Measure
March 2017	MDEQ issues the permit allowing the installation of the Temporary Flare at the Northwest Corner of the Landfill to improve collection efficiency and increase landfill gas vacuum to the northern portion of the landfill gas wellfield. Advanced meets with MDEQ to discuss structure of the permit application required for the installation of the 5,000 SCFM Flare. Temporary Flare operational on March 9th.
April 2017	Advanced initiates construction of an expansion of the landfill gas wellfield that include the installation of supplemental wells, replacement wells, construction of 18 inch and 24 inch perimeter conveyance header along the northern portion and western portion of the landfill that is a component of the increase in header capacity to the Blower Flare compound and the landfill gas to energy facility that will be completed in 2018. Advanced submits a revised Air Permit Application for the installation of the 5,000 SCFM candlestick flare.
May 2017	Advanced, Republic, and Fortistar enter into a Administrative Consent Order to memorialize the Compliance Plan that is being executed at the facility.
June 2017	Advanced Disposal installs 20 new or re-drilled wells and upgrades approximately 5000 feet of lateral and header piping to improve gas collection efficiency.
July 2017	Advanced submits the request to install the 36 inch header through the CSX railroad right of way to improve vacuum distribution to the landfill gas wellfield and landfill gas volume management to the Blower Flare Compound and Gas to Energy Facility.
August 2017	Advanced Disposal begins installation of 2000 ft of 24inch header on the north perimeter of the landfill.
September 2017	Advanced initiates construction of 20 acres of final cover on the southern slope of Arbor Hills West. Completion of 2017 Phase I Landfill Gas Wellfield Expansion. Operations begin applying Odor No More to the surface of the working face prior to placement of enhanced daily cover. Operations begins 30 day trial of Posi-shell applied as daily cover material. Results of the 30 day trial did not indicate an improvement in odor control from the active area. Installation of Carbon Filter on leachate sampling shed located in the southeast corner of the landfill property.
October 2017	Advanced initiates Cell 4E waste exhumation activities to allow for an expansion of the lined area of the landfill into unlined areas of the Arbor Hills East Landfill.
November 2017	Phase II of the Landfill Gas Expansion project is completed and includes the construction of 2000 Ft of 24inch perimeter header on the north side of the landfill. Operations also initiated connection of 12 caisson wells to the landfill gas extraction system.
December 2017	Advanced completes construction of 10 acres of temporary geomembrane cover on the north portion of the west slope of Arbor Hills West. This includes 8 under the cap horizontal collectors.

Month/Year	Odor Mitigation Measure
	Advanced disposal begins Phase II of gas construction by installing 2000 ft of 24 inch perimeter header on the west side of the landfill and completes connection of 12 caisson wells to permanent vacuum.
January 2018	Advanced Procures Vibratory Drum Compactor to compact daily cover to reduce permeability
April 2018	5,000 SCFM Flare Permit Issued by MDEQ
May 2018	Third Party Landfill Expert Facility Audit
May 2018	24 inch West Header Extended - 36 inch Header Beneath Railroad Line Installed
June 2018	Repiping of GCCS North Side of Blower Building
August 2018	5,000 SCFM Permanent Flare Installed
August 2018	Compost Site Management Plan by RRS
October 2018	Replacement of Existing Blowers/Installation of New Control System
December 2018	Procurement of Portable Misting System