SESPE CONSULTING, INC.

468 Poli Street, Suite 2E • Ventura, California 93001

MEMORANDUM

Date: August 5, 2019

To: Santa Barbara West Coast Farms

From: Scott Cohen, P.E., C.I.H. and Andre Almeida, P.E.

Re: Cannabis Odor Modeling

Sespe was hired to perform independent air quality analysis to clarify relative odor impacts from the subject property (Figure 1) and provide expert testimony regarding methods that were used and findings of the analytical effort.

Methods used in preparing this memo are the same as those used for industrial projects that emit air pollutants. Air pollution engineering and analysis is one of Sespe's core services and staff has assessed many industrial projects for significance of air quality impacts and air quality health risk assessment impacts. Resumes for Sespe staff that performed this work and briefs describing similar air quality projects are provided in Attachment 3.

In order to determine the relative impact of odor on various locations surrounding the Santa Barbara West Coast Farms site, two major considerations were incorporated into this Memo:

1. Mitigation resulting from the application of the Byers Scientific Waterless Vapor-Phase Odor Control System utilizing Ecosorb odor neutralizer
2. A quantitative analysis of Surface and Profile Meteorological data obtained from Lakes Environmental for the subject site.

1.0 MITIGATION

The Byers Scientific & Manufacturing Waterless vapor-Phase Odor Control System is a vapor distribution system that disperses odor neutralizing vapor. The system will be utilized along the northern boundary of the facility, and will be aerosolizing an Ecosorb brand non-toxic essential oil surfactant blend. Per documentation provided in Attachment 1, essential oils can work to neutralize odors by bonding to gas molecules as a result of Van der Waals forces and by way of chemical reaction. In simple terms, the odor is neutralized and not simply masked.

Further documentation from OMI Industries includes a case study in which and Ecosorb product was found to reduce detectable cannabis odor at the fence line of a cannabis facility by 96%. Documentation in Attachment 1 also demonstrates Ecosorb's efficacy at significantly reducing detectable levels of Hydrogen Sulfide, Mercaptan, and Hydrocarbon odors. Ecosorb has also been utilized to abate odors emitted by landfills.

2.0 METEOROLOGICAL DATA

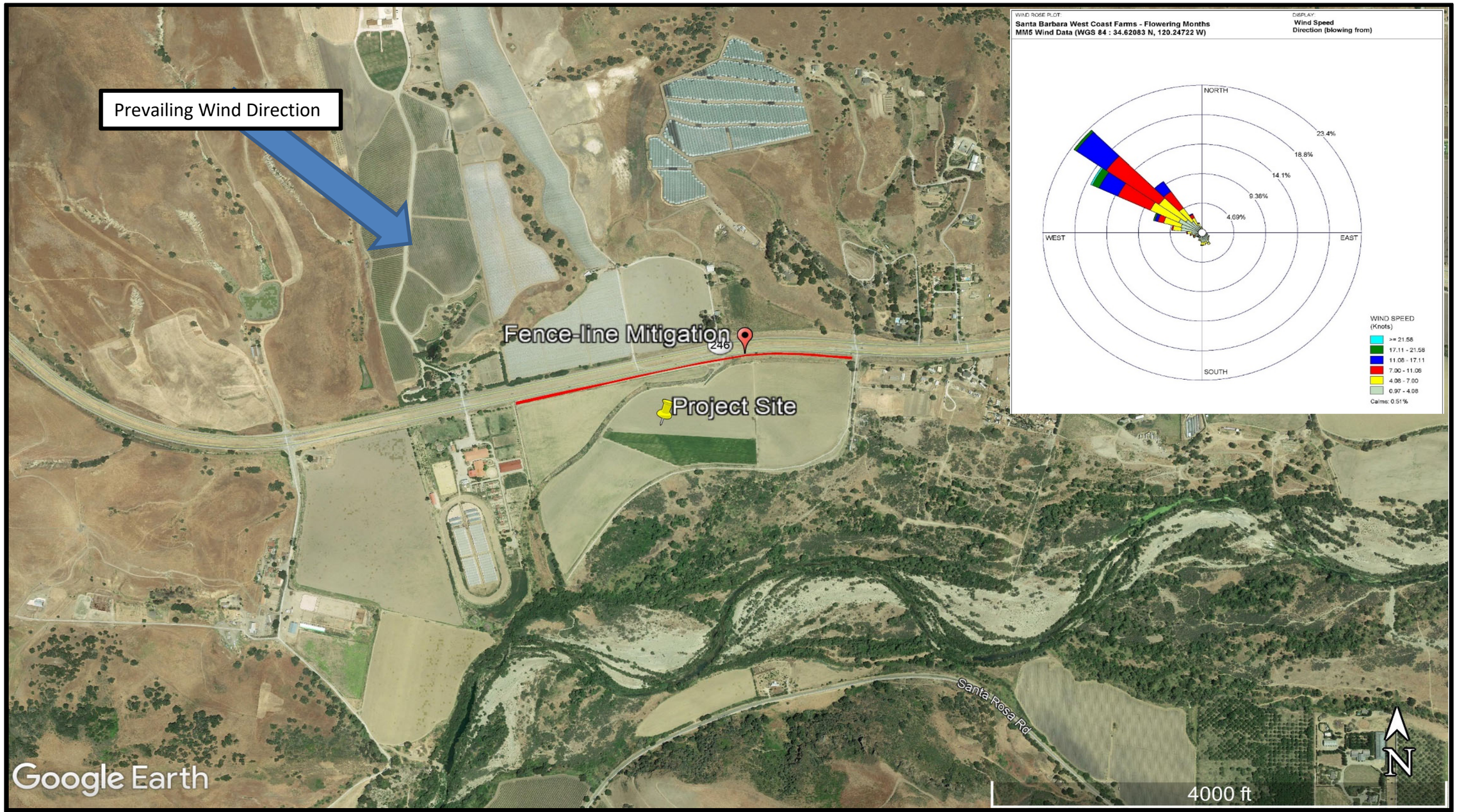
Site specific historically modeled meteorological data for the time period of Jan 1, 2014 to Dec 31, 2018 (Attachment 2) was purchased from Lakes Environmental. Lakes is a software company who's products includes a packaging tool used with the Air Dispersion model AERMOD, an EPA steady-state plume air quality model. The data incorporates both surface station and upper air station data pursuant to EPA guidelines and creates Surface and Profile meteorological data to be used in Pollutant Dispersion Modeling.

Flowering season for cannabis plants occurs during August and September. It is during this time that odor is a concern. Therefore, wind data was analyzed for this period. The following possible concerns were considered:

- Low wind speeds resulting in stagnation of odor; and
- Wind from the southeast resulting in high concentration of odor moving to occupied areas in the northwest.

In review of the data, it was determined that the frequency of Calm Winds (wind less than 0.97 Knots) was 0.51% of the 2 month flowering time period. This means that throughout the course of a year, calm winds and high odor output due to flowering will only occur simultaneously for 0.1% of the time.

With regards to wind direction, it was determined that during the flowering period, wind was blowing from the South East quadrant of the wind rose less than 20% of the time. When considering the context of the entire year, south-east originating winds and high odor output due to flowering will only occur simultaneously for less than 3% of the year. In other words, more than 97% percent of the year will either be outside of flowering season or have wind blowing from the north-west, in the direction of un-occupied areas (see Figure 1).



Source: Google Earth

SESPE CONSULTING, INC.

FIGURE	Site and Wind Direction		
1	Santa Barbara West Coast Farms 1800 W Highway 246, Buellton, CA Santa Barbara County, California		
PROJECT #:	SA16.19.01	DATE:	8/5/19
SCALE:	SHOWN	DRAWN BY:	ADA

ATTACHMENT 1
Mitigation Product Supporting Documentation

ECOSORB PRODUCT INFORMATION

Byers Scientific & Manufacturing
Industrial Odor Management

2332 W. Industrial Park Drive
Bloomington, IN 47404

(812) 269-6218
info@byers-scientific.com
www.byers-scientific.com

SECTION 1
ECOSORB ODOR NEUTRALIZER PRODUCT SECTION

ECOSORB® ODOR NEUTRALIZER PRODUCT SECTION

INTRODUCTION

Growing environmental concerns are creating questions regarding the quality of our soil, the water we drink, and the air we breathe. Of particular concern to many industries is the prevalence of odor emissions surrounding wastewater facilities, manufacturing plants, landfills, and other sites where malodorous gases collect. Odors are basically gaseous chemicals detected by the human olfactory organs and while the like or dislike of a particular smell is purely subjective, certain odors are generally agreed to be offensive or harmful to all.

As a result, many devices have emerged to satisfy the demand for better control of offensive odor emissions. Unfortunately, many solutions fall short in one of two categories, either they act as mere masking agents and do not address reactions with the malodorous gasses, or as they eliminate odors they may introduce hazardous compounds into the very areas they "clean."

Ecosorb® is an odor neutralizer, not a masking agent. It is applied most often via atomization as described in the "Methods of Application" section of this manual. The product is a proprietary formulation of several essential oils and a food grade surfactant. It is biodegradable and totally safe to people, animals, and plant life. Please see the various third party lab test reports included in Section 5.

Originally there was only one Ecosorb®, which consisted of the industrial strength version known as Ecosorb® 606 and its lesser strength derivatives known as Ecosorb® 505 and 404. These products contained the same active ingredients with varying intensities. Ecosorb® 606 and its derivatives are broad spectrum, applicable in multiple industries, and contain only the natural fragrance of the active ingredients.

Recently, OMI Industries responded to market requests by developing Ecosorb® 606AB (Apple Blossom) and Ecosorb® 606M (Magnolia). These "scented" versions of Ecosorb® provide the user with an odor neutralizer that also deposits a substitute odor into the process air. Instead of neutralizing the malodor thereby yielding no odor, these new products neutralize the malodor and leave a subtle floral scent behind. Little attention is given in this manual to Ecosorb® 606AB and 606M. The methods of delivery and neutralization mechanisms are the same as Ecosorb® 606.

A new Ecosorb® product was introduced in 1999. This product was developed specifically for application into the styrene market and is known as Ecosorb® 206. Testing shows this product to be an effective styrene odor neutralizer and to be more effective on organics similar to styrene than Ecosorb® 606. Attention will be given to Ecosorb® 206 herein. When this manual refers to mechanisms and application systems that pertain to both 606 and 206, we will refer to the product simply as Ecosorb®. When relating to topics specific to one product or the other, we will identify the appropriate product.

In 2001, OMI Industries embarked on a development program to create a new line of products, products that did not contain water and could be used as an additive into compounds that are not water tolerant. This successful development program yielded the Ecosorb® additive line of products, most notably the Asphalt Additive, but also products that are compounded into recycled rubber, machining cooling oils, various plastics and the like. Given this is an Engineering Manual, there is not a significant amount of engineering required for the additive. However, we do dedicate a small section to information relative to Ecosorb® Additive Products.

ESSENTIAL OILS

An essential oil is the predominately volatile material isolated by some physical process from an odorous single-species botanical. Over 3,000 oils are identified from the vast number of plant species and several hundred are commercialized. Of these, some are extremely rare and produced in only kilogram quantities, e.g., violet oil, concretes (flower extracts), and angelica root oil.

Essential oils are derived from various plant parts, such as leaves, fruit, bark, root, grass, wood, heartwood, gum, balsam, berries, seed, flowers, twigs, and buds. These plant parts are processed to yield their quintessence or essential oils, which are mostly devoid of cellulose, glycerides, starches, sugars, tannins, salts, and minerals, which also occur in these botanicals.

Essential oils are used as such for flavors and fragrances. But products derived from, or based on essential oils have large volume usage for specific applications. Essential oils are concentrated, rectified, extracted, or chemically treated to further isolate vital components, purify, adjust properties, or increase the concentration of significant flavor or fragrance components. The versatility of essential oils for odor control has made them an acceptable and effective technique.[i] The correct blending and selection of the oils are a science unto itself.

Fluctuations in the cost and availability of natural oils and the high cost of some oils have induced users to seek substitutes. Nonetheless, there is a trend away from synthetic oils because complete duplications are in most cases not technically, aesthetically, or economically possible.[ii]

Science once believed essential oils were only good as masking agents and had no potential to actually neutralize odor. However, testing indicates that certain essential oils have the ability to cancel out particular malodors. For example, oil of wintergreen will neutralize rank tobacco odors and juniper oil cancels the odor of rancid butter and milk fats.

Not only is the type of oil (juniper versus wintergreen) important but also where that oil is produced since similar oils do not necessarily have the same chemical content. Melaleuca Alternifolia (tea tree oil), for example, is found on three continents. However, the therapeutic effect needed for the production of pharmaceuticals is only found in the oils produced in the Lismore area of New South Wales, Australia. It has becoming evident that this is true of many essential oils used in odor control.

The full mechanics of how essential oils work is quite complex. However, they basically operate through the use of weak electrostatic bonding, gas phase solubility, and acid base reactions. The oils are mixed with water and sprayed into the air. The mix in these droplets separate and the oils form a thin film over the water droplet itself and inside the droplet. The exterior "skin" formed by the oils creates an electrostatic charge over its outer surface. This charge attracts the odor molecules onto and into the droplet. Although the water droplet is quite minute, it is still large enough to capture the malodor molecules, and affect the neutralization process.

[i] "Odor and VOC Control Handbook", Harold J. Rafson, 1998, McGraw Hill, p. 8.20

[ii] "Concise Encyclopedia of Chemical Technology", Kirk-Othmer, 1985, John Wiley & Sons, Inc.

ECOSORB® THE PRODUCT

Ecosorb® is carried into an atmosphere where it attracts, or is attracted to, whatever is in the atmosphere; whether it is a pleasant odor, malodor, or particulate. Some studies claim that essential oils work by either:

1. Van der Waals forces
2. Zwaardemaker pairing
3. Reaction / neutralization
4. A combination of any two above

Ecosorb® tests indicate that all three phenomena take place in various areas. The oils collect and bond onto the gas molecule (Van der Waals forces). In each case, the odor is eliminated (possible occasional presence of Zwaardemaker pairs). And, the subject gases are drastically reduced in content because of a chemical reaction (reaction/neutralization).

Additionally, Ecosorb® has the unique ability to bond onto particles that do not have dipoles such as chlorine gas and carbon dioxide. This is achieved by creating a momentary unevenness in the electron cloud around a particle. Once this unevenness is created, bonding takes place.

The essential oils in Ecosorb® operate as a cluster and bond onto gases in the atmosphere. The cluster continues to operate until it saturates and falls to ground or is otherwise removed.

Extensive laboratory testing shows that reactions between Ecosorb® 606 and malodor compounds occur. Ecosorb® 606, being a blend of essential oils, develops into an "acid buffer." This buffer can react with both weak acids and bases. The reaction varies with the gas. In the case of basic gases such as amines, lab tests identified an acid base reaction. In the case of acidic gases, an acid-base reaction was observed and there is evidence of ion transfer with additions across double bonds within the product. In both cases, the result is a non-volatile organic salt. For a more in-depth look at these reactions, please refer to the technical paper provided in Section 5 entitled, "Control of Malodors Using Ecosorb®." For independent laboratory evidence of reactions causing gas reduction, refer to the Southern Petroleum Laboratory test reports in Section 5.

Using the blend of essential oils in Ecosorb® is an advantage because we can control the full spectrum of odors and not leave any peripheral odors or odorous by-products. Although essential oils are capable of working on most gases, there are instances where they may not be economically feasible for use as an odor control. These situations include atmospheres where the gases contain heavy aromatics, strong acids, and strong alkalis. The weight and solubility of heavy aromatics sometimes make it difficult to control their odor in high contamination levels. Atmospheres containing large doses of strong acids and alkali also appear to reduce the effectiveness of the oils by destabilizing the bonding between the oil particles.

Because of the various specific gravities and flash points of the oils, the oils will begin to separate at high temperatures. This marginally reduces their effectiveness. However, we have situations where Ecosorb *has been* successfully injected into exhaust flues where the gas emissions are measured at *approximately* 425°F *and an amazing 1100°F*.

There are many factors, which will affect the amount of Ecosorb® required to control a situation. To measure the potential effectiveness of Ecosorb® on a particle you have to look at:

1. Parts per million (ppm)
2. Air Flow
3. Solubility
4. Molecular Weight
5. Molecular Density
6. Make up (organic/inorganic)

SOLUBILITY

Reaction is not the only mechanism through which Ecosorb® controls odors. In fact, it is not the first mechanism. Before Ecosorb® can react with gasses, the malodor gases must be dissolved into the atomized droplet containing Ecosorb®. The first mechanism in odor control using Ecosorb® is solubility. Industrial malodor gasses vary in terms of solubility in water. This variation ranges from "very slightly soluble" such as styrene to "very soluble" such as ammonia. Generally speaking, Ecosorb® increases the solubility of most malodor gasses.

Once the gas is dissolved (absorbed) into the atomized droplets, "Henry's Law" takes affect and a percentage of the gas wants to leave the droplet and form a state of equilibrium. We refer to the ability of the liquid to hold the gas as the "distribution constant." It was proven in the laboratory that Ecosorb® enhances the ability of an aqueous solution to hold liquid, thereby favorably affecting the distribution constant. Therefore, Ecosorb® increases the solubility of the gas into the aqueous solution and increases the ability of the liquid to contain the gas.

Laboratory testing relative to the solubility of a few common industrial gasses was performed under the direction of OMI. Section 5, Reference Materials, contains reports that address the solubility effects of the product. The report, "Control of Malodors Using Ecosorb®," addresses acidic and basic gasses in Ecosorb® 606. The subject of styrene solubility and its distribution constant can be found in the report entitled "The Use of Ecosorb® 206 in Controlling Styrene Odors." Finally, a study specific to the solubility of benzene is reported in "Effect of Ecosorb® 206 on the Solubility of Benzene."

ECOSORB® 206, STYRENE, AND OTHER NEUTRAL HYDROCARBONS

ECOSORB® 206 was developed specifically with the solubility of styrene in mind. Styrene odors associated with the composites industry and regulatory pressure within that industry influenced Odor Management, Inc. to develop a product targeted specifically for control of styrene odors.

Ecosorb® 206 differs slightly from Ecosorb® 606 in oils that make up the blend. It is slightly more volatile and acidic than 606. The toxicity, health, and safety characteristics are equivalent to 606; it is safe. The product has a noticeably different natural fragrance while still remaining similar in fragrance. Application methods of the two products are identical.

Ecosorb® 206 was designed to enhance the solubility of styrene in an aqueous solution. It was not designed to react with styrene. Since reactions are only a piece of the odor control puzzle, we believed that if we could absorb and adsorb more styrene into an atomized aqueous solution of the new Ecosorb® product, then we could affect odor control by removing the atomized droplets from the air. This concept proved true; however, we also discovered that a reaction with styrene does exist. Further investigation determined that the oxidation reaction takes place between styrene and water, but that styrene does not readily dissolve in water. By measurably increasing the amount of styrene that dissolves into water containing Ecosorb® 206, we can capture and hold significant amounts of styrene and react it causing identifiable byproducts. For more details, please refer to "The Use of Ecosorb® 206 in Controlling Styrene Odors" located in Section 5.

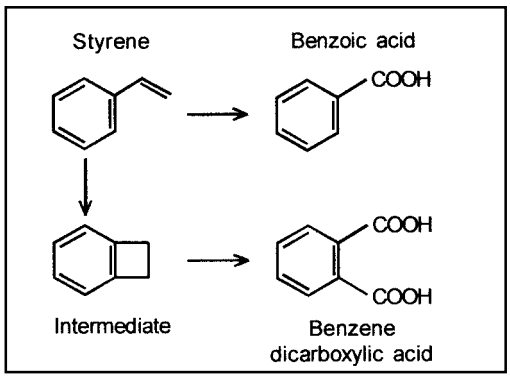


Figure 1.1: Degradation of Styrene in Ecosorb® 206 solution

Even though Ecosorb® 206 was designed for styrene applications, we also found it is more effective on compounds with which 606 has the most trouble, such as the BETX series. Generally speaking, when dealing with neutral hydrocarbon compounds, Ecosorb® 206 is the product of choice.

Because of its acidity, Ecosorb® 206 is not recommended for applications involving acidic gasses.

MATERIAL SAFETY DATA SHEET (MSDS)

Independent laboratories *have* examined *all of the* Ecosorb® products to provide the information for our MSDS. The criterion to which Ecosorb® was tested is the OSHA Federal Hazard Communications Standard, 29 CFR 1910-1200, which does not allow OMI to make any disclaimers on the product testing.

Having the product tested to these standards, OMI can state "*All constituents are not considered hazardous according to the Federal Hazard Communication Standard."* (MSDS Section II – Hazardous ingredients / Identity information). OMI can also point to the fact that Ecosorb® does not contain any hazardous Volatile Organic Compounds (VOCs). The "Percent Volatile" section of MSDS Section III "Physical / Chemical Characteristics" shows the percent volatile measures approximately 1.4%, but our corroborative testing by Pace Laboratories and Chemical Waste Management to EPA Guidelines 8260 and 624 show that none of the volatiles tested for are in Ecosorb®.

HUMAN TOXICITY

Industry is more aware of personal and environmental dangers from the use of chemicals. OMI had studies completed to assure our clients that Ecosorb® is safe to use personally and for the environment. These reports can be found in Section 5, Reference Materials.

Tox Monitor Laboratories in Chicago tested Ecosorb® 606 to the following EPA Guidelines:

EPA Guideline 81-1	Acute Oral Toxicity
EPA Guideline 81-2	Acute Dermal Toxicity
EPA Guideline 81-3	Acute Inhalation Toxicity
EPA Guideline 81-4	Acute Eye Irritation
EPA Guideline 81-5	Primary Dermal Irritation
EPA Guideline 81-6	Sensitization

Tox Monitor Laboratories also tested Ecosorb® 206 for toxicity. The test protocol was nearly identical to the previous tests but the regulating agency (EPA Office of Prevention, Pesticides, and Toxic Substances (OPPTS)) and protocol designators changed as follows:

OPPTS 885.3050 Guideline	Acute Oral Toxicity Study
OPPTS 885.3100 Guideline	Acute Dermal Toxicity Study
OPPTS 870.1300 Guideline	Acute Inhalation Toxicity Study
OPPTS 870.2400 Guideline	Acute Eye Irritant/Corrosion Study
OPPTS 870.2500 Guideline	Acute Dermal Irritation/Corrosion Study
OPPTS 870.2600 Guideline	Dermal Sensitization Study

In all cases, Ecosorb® received the safest possible classification.

FISH TOXICITY

T.R. Wilbury Laboratories conducted fish toxicity testing on Ecosorb® in April 1993. These tests were performed to establish any potential problems from the spillage or use of Ecosorb® in an exposed water stream.

The tests performed included:

EPA Method 72-2	Daphnia Magna
EPA Method 72-1	Fathead Minnow
EPA Method 72-1	Rainbow Trout
EPA Method 797-1300	Daphnia Magna
EPA Method 797-1400	Fathead Minnow
EPA Method 797-1400	Rainbow Trout

These tests proved that Ecosorb® was completely non-toxic to marine life. The letter associated with this report can be found in Section 5, Reference Materials.

VOC ANALYSIS

EPA and state regulatory bodies are becoming more and more stringent relative to Volatile Organic Compounds (VOC) emissions. Ecosorb® was tested to EPA Method 8260 and EPA Method 624. In both tests, there were no harmful VOCs detected.

However, Ecosorb® contains natural active ingredients that are organic and volatile. Ecosorb® 206 and 606 were tested according to United States Environmental Protection Agency (US EPA) Method 24, in part "Determination of Volatile Matter Content." It was determined that undiluted Ecosorb® 606 contains about 1.42% volatile matter content and Ecosorb® 206 contains about 1.5% volatile matter content. In application, these products are usually diluted thereby reducing these percent contents.

GAS TESTING

OMI has tested a range of gases that are found to be common nuisance odors in industry. These gases include:

- Hydrogen sulfide
- Sulfur dioxide
- Ammonia
- Ethyl mercaptan
- Methyl mercaptan

Ecosorb® exhibited a dramatic effect on each gas. Most notably sulfur dioxide, ethyl mercaptan and methyl mercaptan were reduced by over 97% on contact.

The results of current testing are shown in Table 1.1. Since there were no established testing procedures for our requirements, OMI developed our own methods.

The method of testing is best described as:

- The subject gas is introduced, using a pure gas permeation tube, into a constant air stream flowing into and out of a reaction chamber. Once a constant gas rate is maintained in and out of the reaction chamber, a brief spray of Ecosorb® is introduced.

- Exit samples are taken immediately upon the introduction of Ecosorb® and periodically thereafter. Samples are analyzed using gas chromatography, except in the case of ammonia where a colorimetric sensor is used.

- The reader will note a gradual increase in hydrogen sulfide, sulfur dioxide, and ammonia after the introduction of Ecosorb®. This is caused by a residual effect of the brief product introduction on the constant incoming gas.

Table 1.1: Ecosorb® contact testing with identified gases

	ppm/vol. Perm Tube	ppm/vol. Reactor Out	Contact	4 minutes	18 minutes
Hydrogen sulfide	36	36	20.04	36	
Sulfur dioxide	26	26	< 0.01	4.4	
Ammonia	97	97	68	8	38
Ethyl mercaptan	3.92	3.92	< 0.1		< 0.1
Methyl mercaptan	3.2	3.2	< 0.01		< 0.1
Testing completed by independent laboratories. Full test methods and results are provided in Section 5.					

PRODUCT SPECIFICATIONS ECOSORB® 606

The odor-neutralizing product shall meet or exceed the following requirements:

1. Shall be a food grade, water based formulation designed to neutralize malodors associated with wastewater treatment, composing, landfills and lechate, industrial processes, refinery and petrochemical processing, and other related or similar odors.

2. All constituents shall be non-hazardous according to Federal Hazard Communication Standard (29 CFR 1910-1200).

3. Shall function as an atmospheric odor neutralizer and contain no disinfectants or other ingredients designed for contact anti-bacterial activity.

4. Shall have non-descript odor and shall not be a masking agent and shall not depend on a heavy scent to cover up.

5. Shall be documented to reduce malodorous compounds such as hydrogen sulfide and ammonia by 95% and sulfur dioxide, ethyl mercaptan, and methyl mercaptan by 97% on contact.

6. Will have been demonstrated on site at the subject facility and approved by the appropriate management.

7. Shall contain no volatile organic compounds as determined by EPA Methods 8260 and 624.

8. Shall be non-toxic according to the following test procedures.

Acute Eye Irritation	EPA Guideline 81-4
Primary Dermal Irritation	EPA Guideline 81-5
Acute Oral Toxicity	EPA Guideline 81-1
Acute Inhalation Toxicity	EPA Guideline 81-3e
Dermal Toxicity	EPA Guideline 81-2
Sensitization	EPA Guideline 81-6
Daphnia Magna	EPA Guideline 72-2
Fathead Minnow	EPA Guideline 72-1
Rainbow Trout	EPA Guideline 72-1
Daphnia Magna	EPA Guideline 797-1300
Fathead Minnow	EPA Guideline 797-1400
Rainbow Trout	EPA Guideline 797-1400

9. Shall have no flash point.

10. Shall have compound authorization by the USDA.

11. Shall have a

    - Boiling point of approximately 210 °F (99 °C)
    - Specific gravity of 0.96
    - pH of 5.5 to 6.8
    - Shall be less than 1.5% volatile per US EPA Method 24
    - Shall be water soluble

12. Shall not contain any nitrogenous substances.

13. Shall contain no more than 0.50% non-toxic, food-grade emulsifiers and/or surfactants.

Ecosorb 607

Safety Data Sheet
according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations
Date of issue: 09/01/2016 Revision date: 09/01/2016 Version: 1.0

SECTION 1: Identification

1.1. Identification

Product form : Mixture
Product name : Ecosorb 607

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended use : Odor Neutralizer
Restrictions on use : None known

1.3. Details of the supplier of the safety data sheet

Manufacturer
OMI Industries
One Corporate Drive, Suite 100
Long Grove, IL 60047 - U.S.A
T 1-847-304-9111

1.4. Emergency telephone number

Emergency number : 1-800-662-6367, Monday - Friday 8 am to 5 pm CST

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification
Not classified

2.2. Label elements

2.3. Other hazards

Other hazards not contributing to the classification : None under normal conditions.

2.4. Unknown acute toxicity (GHS US)Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substance

3.2. Mixture

This mixture does not contain any substances to be mentioned according to the criteria of section 3.2 of HazCom 2012

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Call a poison center/doctor/physician if you feel unwell.
First-aid measures after inhalation : Remove person to fresh air and keep comfortable for breathing.

First-aid measures after skin contact : Wash skin with plenty of water.

First-aid measures after eye contact : Rinse eyes with water as a precaution.

First-aid measures after ingestion : Call a poison center/doctor/physician if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries : Not expected to present a significant hazard under anticipated conditions of normal use.

Symptoms/injuries after inhalation : No effects known.

Symptoms/injuries after skin contact : No effects known.

Symptoms/injuries after eye contact : No effects known.

Symptoms/injuries after ingestion : No effects known.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Dry powder. Foam. Carbon dioxide.

Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : Not flammable.

Reactivity : The product is non-reactive under normal conditions of use, storage and transport.

5.3. Advice for firefighters

Protection during firefighting : Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment : Gloves. Safety glasses.

Emergency procedures : Ventilate spillage area.

6.1.2. For emergency responders

Protective equipment : Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment. Prevent liquid from entering sewers, watercourses, underground or low areas.

6.3. Methods and material for containment and cleaning up

For containment : Collect spillage.

Methods for cleaning up : Take up liquid spill into absorbent material.

Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13. For further information refer to section 8: "Exposure controls/personal protection".

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Ensure good ventilation of the work station. Wear personal protective equipment.

Hygiene measures : Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures : Does not require any specific or particular technical measures.

Storage conditions : Store in a well-ventilated place. Keep cool.

Incompatible products : Oxidizing agent. Strong acids.

Incompatible materials : Keep away from strong acids and strong oxidizers.

Storage temperature : 4 - 29 °C 40°F and 85°F Allowing product to freeze may cause layering.

Prohibitions on mixed storage : KEEP SUBSTANCE AWAY FROM: (strong) acids. oxidizing agents.

Storage area : Keep container in a well-ventilated place. Store in a cool area. Keep out of direct sunlight. Store in a well-ventilated place.

Special rules on packaging : Keep only in original container.

SECTION 8: Exposure controls/personal protection

8.1. Control parametersNo additional information available

8.2. Exposure controls

Appropriate engineering controls : Ensure good ventilation of the work station.

Personal protective equipment : Gloves. Safety glasses.

Hand protection : Protective gloves.

Eye protection : Safety glasses.

Skin and body protection : Wear suitable protective clothing.

Respiratory protection : In case of insufficient ventilation, wear suitable respiratory equipment.

Thermal hazard protection : Not applicable.

Environmental exposure controls : Avoid release to the environment.

Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Liquid

Appearance : White liquid.

Color : White

Odor : Citrus

Odor threshold : No data available

pH : ≈ 6.2 (5.5 - 8)

Melting point : Not applicable

Freezing point	: < 0 °C
Boiling point	: 99 °C
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Not applicable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: 0.99
Solubility	: Soluble in water.
Partition coefficient n-octanol/water	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: ≈ 1 cSt
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No dangerous reactions known under normal conditions of use.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Oxidizing agent. Strong acids.

10.6. Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure	: Skin and eye contact
Acute toxicity	: Not classified
Skin corrosion/irritation	: Not classified pH: ≈ 6.2 (5.5 - 8)
Serious eye damage/irritation	: Not classified pH: ≈ 6.2 (5.5 - 8)

Respiratory or skin sensitization	: Not classified.
Germ cell mutagenicity	: Not classified
Carcinogenicity	: Not classified
Reproductive toxicity	: Not classified
Specific target organ toxicity (single exposure)	: Not classified
Specific target organ toxicity (repeated exposure)	: Not classified
Aspiration hazard	: Not classified
Potential Adverse human health effects and symptoms	: No other effects known.
Symptoms/injuries after inhalation	: No effects known.
Symptoms/injuries after skin contact	: No effects known.
Symptoms/injuries after eye contact	: No effects known.
Symptoms/injuries after ingestion	: No effects known.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment.

12.2. Persistence and degradability

ECOSORB 607	
Persistence and degradability	Biodegradability in water: no data available.

12.3. Bioaccumulative potential

ECOSORB 607	
Bioaccumulative potential	No bioaccumulation data available.

12.4. Mobility in soil

ECOSORB 607	
Ecology - soil	The product is predicted to have high mobility in soil. Soluble in water.

12.5. Other adverse effects

Effect on the global warming	: No known effects from this product.
GWPmix comment	: No known effects from this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste)	: Disposal must be done according to official regulations.
Waste treatment methods	: Dispose of contents/container in accordance with licensed collector's sorting instructions.
Waste disposal recommendations	: Avoid release to the environment.
Ecology - waste materials	: Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Not regulated

TDG

Not regulated

Transport by sea

Not regulated

Air transport

Not regulated

SECTION 15: Regulatory information

15.1. US Federal regulations

ECOSORB 607
Not listed on the United States TSCA (Toxic Substances Control Act) inventory

15.2. International regulations

CANADA

No additional information available

EU-Regulations

No additional information available

National regulations

No additional information available

15.3. US State regulations

No additional information available

SECTION 16: Other information

Revision date	:	09/01/2016
Data sources	:	This document has been prepared in accordance with the SDS requirements of the OSHA Hazard Communication Standard 29 CFR 1910.1200.
Training advice	:	Normal use of this product shall imply use in accordance with the instructions on the packaging.
Other information	:	None.

ABBREVIATIONS AND ACRONYMS:	
ATE	Acute Toxicity Estimate
BCF	Bioconcentration factor
CLP	Classification Labelling Packaging Regulation; Regulation (EC) No 1272/2008

DMEL	Derived Minimal Effect level
DNEL	Derived-No Effect Level
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IMDG	International Maritime Dangerous Goods
LC50	Median lethal concentration
LD50	Median lethal dose
LOAEL	Lowest Observed Adverse Effect Level
NOAEC	No-Observed Adverse Effect Concentration
NOAEL	No-Observed Adverse Effect Level
OECD	Organisation for Economic Co-operation and Development
NOEC	No-Observed Effect Concentration
PBT	Persistent Bioaccumulative Toxic
SDS	Safety Data Sheet

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product

Control of Malodors using Ecosorb® "A Natural Product"

Sulfur Dioxide, Hydrogen Sulfide, and Ammonia Mechanisms for their removal

Ying Zhang, M.S.
R.W. Hurd, M.S.
Donald R. Wilkinson, Ph.D.

Delaware State University
March 1997

ABSTRACT

Ecosorb removes many malodors, including sulfur dioxide, hydrogen sulfide and ammonia, from the environment. It is made up of a combination of essential oils consisting of an equilibrium of neutral organic compounds and organic buffers. Its pH ranges from 4.0 to 6.8.

Acidic malodors such as hydrogen sulfide and sulfur dioxide are removed by at least four mechanisms including solubility, oxidation/reduction, neutralization and addition across double bonds. Basic malodors such as ammonia and other amines are removed by at least three mechanisms including solubility, addition and neutralization. In all cases the final products consist of organic salts, newly formed organic compounds, very weak natural organic acids (those that were present in the original essential oil mixture), and malodors dissolved in the water/oil mixture. Resulting organic compounds are frequently subjected to oxidation or reduction when in solution. In the case of sulfur dioxide and hydrogen sulfide these reactions result in the formation of free sulfur, or higher oxidation states including SO2 and SO3.

The removal efficiency is related to the interaction of the above-mentioned mechanisms, the atomizing efficiency (size and speed of droplets), humidity, temperature and reaction time.

INTRODUCTION

Malodors include acids, bases, and neutral compounds. Several of these are polar compounds and are water-soluble, others are non-polar and are soluble in other non-polar organic solvents. An example of using this solubility would be the scrubbing of ammonia gas from the atmosphere by misting it with water. Although this method can remove ammonia, the reaction is temperature dependent, reversible and not very efficient. The same statement could be made when applied to other soluble bases, soluble acids and even to some neutral compounds.

Some malodors, including sulfur compounds, can be oxidized by air when the compounds are in solution. During this process sulfur compounds can produce sulfur. This procedure is slow, not very efficient, and dependent on moisture content, temperature and mixing with air.

These mechanisms for odor removal can and will take place naturally, although inefficiently. Ecosorb contains a mixture of selected essential oils that can facilitate the efficient removal of many malodors.

Wilkinson and Zhang have broken the malodors down into four main groups which include bases, acids, neutrals and those that will not react with essential oils. A summary of this breakdown of 37 common malodors is shown in Table 1.

MALODORS			
	Group	**Reactions**	**Number of Compounds**
A.	Bases	React by acid/base mechanism 13 compounds plus CH3S, TME, and DMEA.	16
B.	Acids	(If they contain relatively small anions) 10 compounds including HCN and phenol, SO2, Cl2 react by addition to a double bond and by neutralization.	10
C.	Neutrals	Includes styrene, CO, CO2, acetaldehyde, ozone.	5
D.	Will not react	Possibly will not react with Ecosorb due to steric hindrance caused by large anion.	6
Total number of malodors			37

Table 1: Malador Breakdown

The groups include the following malodors:

Group A: ammonia, butylamine, cadaverine, dibutylamine, diisopropylamine, dimethylethylamine, diphenyl sulfide, ethylamine, indole, methylamine, putrescine, pyridine, skatole, triethylamine, trimethylamine

Group B: ethyl mercaptan, hydrogen sulfide, methylmercaptan, propylmercaptan, hydrogen cyanide, chlorophenol, sulfur dioxide, phenol and sulfurous acid

Group C: acetaldehyde, chlorine, ozone, carbon monoxide, dioxide, and styrene

Group D: allyl mercaptan, amyl mercaptan, crotyl mercaptan, tert-butyl mercaptan, thiophenol (Contain large anions, which cause steric hindrance. These are not as common or as volatile as other compounds in Group A and B.)

Dr. Sylvain Savard, a chemist and Project Leader of the Center of Industrial Research for Quebec, Canada, prepared a report on "The Operating Principles of the Ecosorb System to Neutralize Odors". He pointed out that Ecosorb is a combination of volatile essential oils that are selected for their ability to neutralize odors. The composition of these essential oils can vary because of many factors including:

1. Type of soil in which the plant is cultivated.
2. Time of year of harvest.
3. Part of the plant used.
4. Amount of water in the plant.
5. Amount of exposure to the sun during growth process.
6. Storage conditions before distillation.

The solution contains approximately 30 major chemical compounds, and numerous minor compounds (major and minor in terms of concentration).

Dr. Savard reports that the solution can react through three mechanisms including: Van der Waals Forces, Zwaardemaker pairing and chemical reactions. The solution is mixed with water and sprayed into small droplets, which are in the form of a mist or fog and remain airborne for long periods of time. These small droplets represent a large surface area, which are covered, or partially covered with a film of essential oils. The electrostatic charges on the droplet surface attract gas molecules. When in contact, removal by one of three mechanisms can occur. Sometimes this reaction is slow and other times it is fast. Once captured, the odor is gone. The droplets can cluster, increase in mass and condense.

[1] Dr. Sylvain Savard, a chemist and Project Leader of the Center of Industrial Research for Quebec, Canada, "The Operating Principles of the Ecosorb System to Neutralize Odors".

Wilkinson and Zhang have studied possible chemical reactions between selected essential oils and hydrogen sulfide, sulfur dioxide and ammonia. The essential oils being studied contain three types of substances: weak organic acids, weak organic bases and neutral organic compounds. The acids and bases react and end up as a buffer solution. The oil mixture has a pH of approximately 4.5. When diluted the pH is approximately 6.0. This final buffer like solution is fairly stable, but can change pH with time depending on its environment and how well it is sealed from its environment. We have found the mixture of essential oils to have a pH between 4.0 and 6.0 in the concentrated form.

Based on experimental data already discussed, malodors can be classified into one of three categories: acids, bases and neutrals. Compounds such as hydrogen sulfide, sulfur dioxide, amine, ethyl amine, etc. are bases. Compounds such as styrene are neutral. Acids and bases will react with essential oil buffers in a normal acid/base reaction forming organic salts and water. Many of these acids and some bases will react with the selected essential oils by addition across conjugated double bonds. This has been shown to be the case with hydrogen sulfide. The question of neutral compounds is still to be studied. Whatever the chemical mechanism or mechanisms involved, the amount of malodor reacting with the essential oils (the bulk kinetic prediction) is much less than the amount of malodor removed (recalculated amount) because of oils.

Previous reports have shown the particular mixture of oils to be very efficient in removing hydrogen sulfide, sulfur dioxide, ammonia, mercaptans, and alkylamines.

Dr. Davidovits of Boston College has studied the effects of pH and Van der Waals' forces on sulfur dioxide.[1] His work is extremely important. He shows how pH greatly affects the amount of sulfur dioxide that remains dissolved in water droplets. He observed as much as a 300% increase in the amount of sulfur dioxide that remained in water if the pH was increased from 3.0 to 6.0. He further concluded that the size and speed of the droplet greatly affected the effectiveness of removing sulfur dioxide from the atmosphere. He also discusses the tremendous effect pH has on the distribution constant of sulfur dioxide in water.

If the work of Dr. Savard, Carter Laboratories, Dr. Davidovits, Boston College and Dr. Wilkinson and Ms. Zhang, Delaware State University are combined, overall mechanisms for the effectiveness of selected essential oils in removing malodors from the environment develops.

Of primary importance in odor removal is the formation of very small droplets with an initial high velocity. This will ensure a large surface area and increased opportunity for collisions with gas molecules. If we are using only water, then the efficiency of removing gas molecules now depends on the solubility of each individual gas in water. The more soluble the gas, the more readily it will dissolve. Once dissolved, the gas will begin to

[1]Davidovits, P. and Jayne, J.T., Department of Chemistry, Boston College, Chestnut Hill, Massachusetts and D.R. Worsnop, M.S. Zahniser, and C.E. Kolb of Aerodyne Research, Inc., Billerica, Massachusetts "Uptake of SO_2 (gas) by Aqueous Surfaces as a Function of pH: The Effect of Chemical Reaction at the Interface," Journal of Physical Chemistry 1990, 94, 6041-6048.

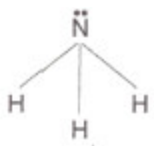
leave the droplet and establish an equilibrium (according to Henry's Law) between its concentration in the gas phase and its concentration in the aqueous phase. The pH of the droplet will greatly affect this solubility by a factor of as much as 300. Some gases are readily soluble, and others only slightly soluble. When selected essential oils are added to the mix the droplets are covered, or partially covered with a thin layer of essential oils. These oils attract most gases to the droplet surface where chemical reactions and pH effects come into play. The oils greatly influence the initial attraction of gas molecules, the pH greatly influences the solubility (gas uptake), and chemical reactions "irreversibly" remove some of the gas molecules by forming new, less volatile compounds. The change in the organic content of the droplet and a resulting change in its polarity all cause a large increase in the distribution constant between gas molecules in the vapor and aqueous phases. This increase indicates that more of the gas remains trapped in the aqueous layer than would normally be trapped at a given temperature.

EXPERIMENTAL RESULTS

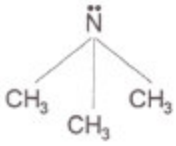
Mechanisms for Basic Malodors:

There are many amines that have been classified as malodors including triethylamine (TEA), and dimethylethylamine (DMEA), ammonia, and trimethylamine. These gaseous amines stimulate nerve endings in the nose and are irritants. They can lead to cell necrosis (cells swell and disintegrate) and increased permeability of the alveolar walls. They can cause flooding of the alveoli and produce a delayed pulmonary edema that may be fatal.

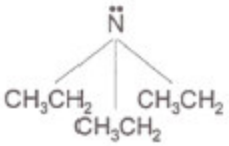
Ammonia is extremely soluble in water and will rapidly dissolve. The oils will have some effect on increasing the attraction of gas molecules to the droplet. A chemical reaction occurs between essential oil buffers and ammonia forming organic ammonium salts. Ammonia, which would normally easily leave the droplet, will now remain to a larger extent in the aqueous layer. This change in the distribution constant will keep the ammonia trapped in the water droplet until condensation occurs, affecting a very efficient removal of this gas from the environment. Since ammonia is a base, the oil mixture should be adjusted to a pH of approximately 4.0 to 6.2 to more effectively remove the gas. This would be true for any basic malodor (alkylamines, etc.). The pH of the essential oil mixture is typically in this range when used.



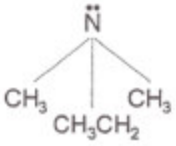
ammonia
Figure 1



trimethylamine
Figure 2



triethylamine
Figure 3



dimethylethylamine
Figure 4

Ammonia (Fig. 1) is the most basic amine. It possesses a nitrogen atom containing a non-bonded electron pair. Its ability to donate this pair to other chemical compounds gives it the characteristic of a base. Notice that this is also true for trimethylamine (Fig. 2), as well as triethylamine (Fig. 3) and dimethylethylamine (Fig. 4).

Amines, being basic, will react with organic acids present in essential oils forming organic salts. The ease and rate of reaction is, in part, a function of the strength of the base. The strength of these bases can be measured by their equilibrium constant (K_b). The larger the value of K_b the more basic is the amine. Ammonia has a K_b of 1.8×10^{-5} (very weak), TME has a K_b of 6×10^{-1} (much stronger), DMEA has a K_b of approximately 2.3 (stronger than TME) and TEA has a K_b of 5.6 (slightly stronger than DMEA). Amines will readily react with the weak organic acids present in the selected essential oils. These weak organic acids are naturally occurring acids, which have proven **not** to be toxic or carcinogenic.[3,4]

DMEA	+	H^+A^-	=	$DMEAH^+A^-$
amine	+	organic acid	=	an organic salt
$(CH_3)_2(CH_3CH_2)N$:	+	H^+A^-	=	$(CH_3)_2(CH_3CH_2)N:H^+A^-$
TEA	+	H^+A^-	=	$TEAH^+A^-$
amine	+	organic acid	=	an organic salt
$(CH_3CH_2)_3N$:	+	H^+A^-	=	$(CH_3CH_2)_3N:H^+A^-$

Figure 5: Chemical Reactions

Ammonium salts formed with essential oils are non-crystalline solids, have a low melting point, are yellow in color, are thermally unstable, are subject to air oxidation, and can undergo rearrangement to form more stable organic amines. The salts are formed by the reaction of the base with the acidic portion of the buffers, e.g. ammonium eugenolate, or ammonium acetate.

Ammonia has been found to be virtually 100% removed within 15 minutes after treatment with the oil mixture both in a laboratory and in actual situations. The oil mixture is more efficient in removing stronger bases such as TEA and DMEA, which may be present as malodors. Their concentration levels may be reduced to less than 0.1 ppm on contact. The essential oil mixture was titrated versus a standard solution of ammonia. It was found that 1 mL of the oil mixture was needed to neutralize 0.00012 g. of NH_3. Because of the solubility and distribution factors mentioned previously, the total amount of NH_3 removed from the environment would be much larger than the amount predicted from chemical reactions alone. The number of g. of NH_3 removed by 1 mL of the oils may be as high as 0.012 g.

In the case of NH_3 we are dealing with a substance that is very soluble in water, and is very reactive at lower pH values. We therefore would expect the difference between the bulk prediction and recalculated

[3]Ecosorb was tested for toxicity in accordance with EPA Regulations and was found to have no positive eye irritation reactions, had a zero dermal irritation score, (Toxicity Category IV for skin effects), not to be toxic by6 oral ingestion at the 5 g/kg level (Toxicity Category IV), not toxic by dermal application (Toxicity IV), had no positive Buehler tests for skin sensitization, tested, not detected, for halogenated hydrocarbons and tested, not detected, for harmful volatile organics (protocol 624). [4]Results available on request.

values, which would correct for gas-phase diffusion neutralization due to NH_3 uptake, to be more pronounced. The increase in gas uptake would be a much larger factor, possibly as much as 20 or 100 times as great. In an attempt to visually see this effect a theoretical chart of expected values for NH_3 was constructed and is shown in Figure 6.

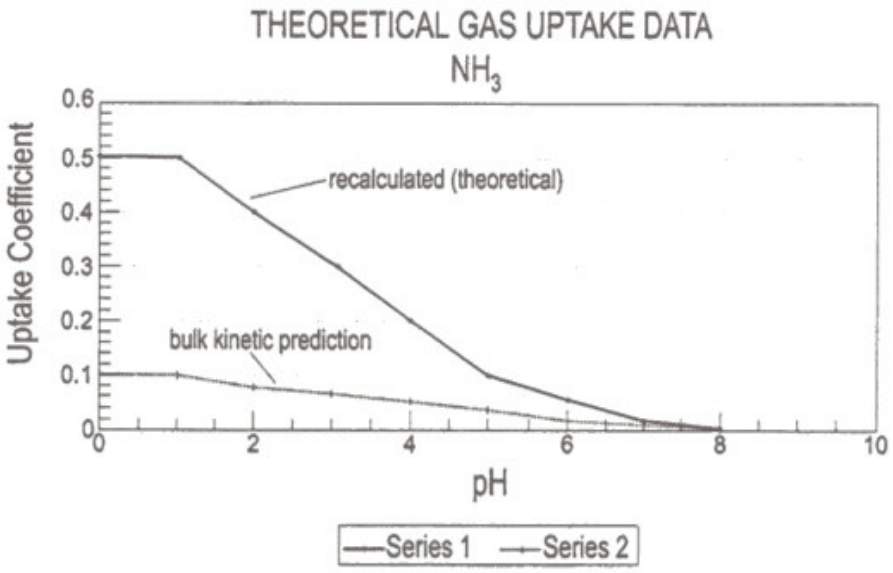


Figure 6: Theoretical Gas Uptake

It would seem that the efficiency of essential oils in holding onto gaseous substances such as SO_2, H_2S, and NH_3 is a function of the misting efficiency (size and speed of the droplet), the solubility of the substance in water (which is facilitated by the organic nature of the essential oils%a variable not studied in the above mentioned paper), and the chemical reactions (chemisorption) taking place between active ingredients in the oils and the gas.

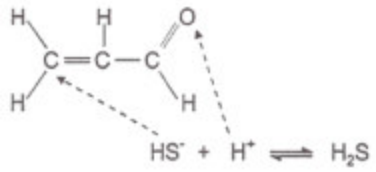
Summary: Selected essential oils will effectively remove the basic malodors NH_3, TEA and DMEA by a combination of mechanisms including an acid-base reaction, increased solubility due to pH factors, and changes in distribution constants. A portion of the amine forms a non-crystalline solid ammonium salt, which is readily removed from the air during the scrubbing process. The remaining amine dissolves in the essential oil/water droplet and is strongly held in the droplet due to changes in its solubility and distribution constant. Amines have been shown to be virtually removed within fifteen minutes after contact with the mixture.

Mechanisms for Acidic Malodors:
Acidic malodors include hydrogen sulfide, sulfur dioxide, chlorine, alkyl mercaptans, phenols and other volatile acids. An essential oil mixture will have the same general mechanism for attracting these acids as it does for ammonia. In this case the pH of the mixture should be adjusted to 6.0 - 6.2. The higher the pH will more greatly affect the absorption of hydrogen sulfide, and other acidic gases. The gases will chemically react with the oil buffersw forming organic salts, and by adding accross double bonds in conjugated components of the

oils, forming new, derivitized essential oils. The chemical reactions and pH adjustment will greatly increase the efficiency of removing acidic gases from the atmosphere. The pH of the essential oil mixture is typically at a pH of 6.0 when used.

Sulfur dioxide is an oxidant gas and exposure to it alters pulmonary immunologic responses and increases the host's susceptibility to bacterial infection. The gas reacts readily with water and forms sulfurous acid, which is an irritant.

The above-mentioned compounds are acids, or will form acids when in contact with water. The compound H_2S has been tested and believed to react with Ecosorb by addition across a double bond as well as by a neutralization mechanism. Several compounds in the mixture contain double bonds, which can react with acidic malodors.1 Compounds containing a conjugated system of double bonds, one of them being an electron-withdrawing group such as a carbonyl (C=O), which facilitates the addition, will more readily react with these acids. A solution of H_2S underwent a pH change from approximately 4.0 to 6.0 when it came in contact with the oils, indicating the elimination of this acid. Infrared studies of the reaction of H_2S with a conjugated aldehyde show loss of one of the aldehyde's double bonds. Experimental data indicates the H_2S is removed by the reaction shown in the following reaction. When the double bonds were removed through the addition of Br_2, the oils proved to be less effective in removing these malodors.



Hydrogen sulfide, when in an aqueous media, can also be air oxidized to form free sulfur. This may also happen to organic sulfides. Mercaptans react using the mechanism illustrated above. Ionization of these compounds is shown below. Malodors, such as hydrogen sulfide, that have not reacted chemically, but have dissolved in water droplets, will oxidize over a period of time. The oxidation products will be less volatile and therefore will no longer produce an odor problem.

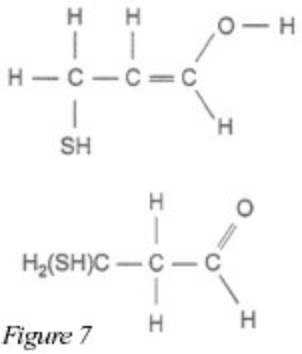


Figure 7

$$CH_3CH_2SH \sim CH_3CH_2S^- + H^+$$

$$CH_3SH \sim CH_3S^- + H^+$$

$$SO_2 + H_2O \sim H_2SO_3$$

$$H_2SO_3 \sim H^+ + HSO_3^-$$

Figure 8: Ionization

[1] Yet unpublished research by Wilkinson and Zhang.

Molecular models were constructed for Phenol, H_2S, H_2SO_3, C_2H_5SH, and CH_3SH. These models were added on to a double bond in a model of a conjugated aldehyde. No steric hindrance was noted in the case of Phenol, H_2S, H_2SO_3, and CH_3SH, and only slight hindrance in the case of C_2H_5SH. Models of higher molecular weight mercaptans showed considerable steric hindrance indicating difficulty in reacting by the suggested mechanism.

Acidic malodors will also react with the aforementioned buffers forming organic salts. It was found that 1 mL of Ecosorb reacted with 0.000118 g. of SO_2, and as in the case of NH_3 this value could be as high as 0.0118 g. There are three major factors effecting the removal of an acidic gaseous malodor from the environment: (a) uptake as a function of pH, (b) modeling of the gas uptake (Henry's Law), and (c) interaction at the interface. The following chart was used to discuss the uptake of the gas SO_2 by fast moving water droplets.

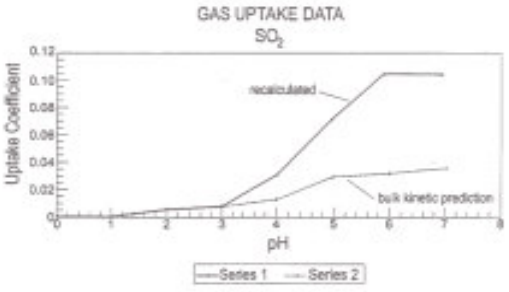


Figure 9: SO_2 Uptake Data

The lower curve represents the bulk kinetics prediction, or the amount of SO_2 we anticipate being removed by liquid water. The Y-axis (uptake coefficient) relates to the relative amount of the gas being removed. Under normal conditions we would anticipate SO_2 dissolving into the droplets of water more efficiently at a pH of 4.0 to 7.0, since the gas is an acid anhydride and will react chemically much better as the pH increases. This lower curve considers primarily the solubility of SO_2 at the pH listed. The upper curve is what we actually find when studying removal of the gas under fast-moving droplet conditions. We observe a 4 fold increase in removal efficiency caused by a combination of the above listed factors:

a) SO_2 is more soluble in water that is less acidic, reaching a maximum at a pH of 5.0. The fact that the droplets are small and fast moving causes more collisions, and increased surface resulting in a more efficient removal of the gas when using a mist.

b) Because of the limited solubility of SO_2 in water, re-evaporation of the gas due to Henry's Law is important. A portion of the gas would be lost due to this equilibrium. However, it is believed that $SO_2(g)$ enters the liquid droplet not as $SO_2(aq)$, but via a surface complex. Under these conditions, since there is increased surface area, surface complex formation would be increased in the presence of a second chemical substance. This leads to:

c) Interactions at the interface. This constitutes a chemisorption process in which, in the present case, $SO_2(g)$ collides with a water molecule at the interface and forms a complex such as HSO_3^-. The effect of fast moving, extremely small droplets combined with the above mentioned three factors make the removal of SO_2 more efficient when the sample is misted with small droplets of water than when we look at reactions of water solutions (H_2SO_3) of the gas. In the article we find that the recalculated gas uptake values are greater than the bulk kinetic prediction by a factor of 4.

Wilkinson and Zhang determined hydrogen sulfide levels in a field test using an MDA Zellweger monitoring device. This instrument produced higher readings at high humidity versus low humidity using identical concentrations of hydrogen sulfide. Hydrogen sulfide levels apparently remained constant when sprayed with a water solution of essential oils when measured with the MDA device. However, when a filter containing silica gel was attached to the instrument's intake line hydrogen sulfide levels decreases from 15.7 ppm to approximately

1 ppm in twelve minutes. It is apparent that if one is interested in determining hydrogen sulfide gas alone and not in hydrogen sulfide dissolved in water, then a water-removing filter must be added to the system. For proper analysis of hydrogen sulfide gas in a gaseous sample an instrument must be used that: (a) does not use heat to vaporize the sample, (b) is specific for the gas only, and/or (c) contains a hydrophobic filter to prevent hydrogen sulfide dissolved in water from being analyzed as hydrogen sulfide gas.

Summary:
Selected essential oils have been shown to be effective in removing the malodors Phenols, H_2S, SO_2, C_2H_5SH, and CH_3SH from a contaminated atmosphere. Sulfur dioxide, methyl mercaptan, and ethyl mercaptan were reduced to less than 0.1 ppm on contact with Ecosorb. Hydrogen sulfide took as long as 15 minutes for removal. Selected phenols were also effectively removed. Acidic compounds capable of ionizing in water, and not having bulky anions which would cause steric hindrance, will react with specific compounds contained in the product. Compounds listed in this section meet these criteria. Acidic malodors will also react with the natural buffers to produce organic salts.

Mechanisms for Neutral Malodors:
Neutral compounds such as benzene and styrene are less soluble in water than acids and bases. They are also less chemically reactive with most essential oils. At the present time little research has been done on these compounds. It would seem that pH would have less of an effect on solubility and on the distribution constant. The electrostatic oil film around droplets would still act to facilitate the removal of these gases, but the overall effectiveness in removing the gases would be much less than with the aforementioned compounds. Styrene can react with itself under basic conditions to form polystyrene. There are compounds in the essential oil mixture that have a conjugated system similar to styrene. It is proposed that the mixture's pH be adjusted to levels of 8.0, 9.0, 10.0 to study the effect of these higher pH's on the removal of styrene. Additional modification of the scrubber and the oils will be made to increase the efficiency of removing styrene from the environment.

CONCLUSIONS

The most universal scrubber for malodors is water. However, water offers some disadvantages including its rapid loss of dissolved gases. The uptake of a gas into water is a function of (a) pH, (b) gas phase diffusion, (c) re-evaporation due to Henry's Law, (d) change in polarity of water due to polarity modifiers and (e) interactions at the interface. Ecosorb facilitates the removal of malodors by chemically reacting with the gas itself, by changing the pH and affecting the solubility of the gas in water, by increasing the organic makeup of droplets of water, and by possibly increasing the distribution constant between the gas and water. The effectiveness of Ecosorb in removing high concentrations of malodors is measured more by its influence in solubility and the distribution constant of malodors in water than in its specific chemical reactions. The effectiveness of the product in removing low concentrations of malodors is related primarily to the chemical reactions involved, and less to pH and atomizing characteristics.

Examination of the Effect of Ecosorb 606 on Selected Sulfur Compounds

Testing Completed by

Southern Petroleum Laboratories, Houston, Texas.

METHOD

The analytical methods for the project were chosen based upon SPL's many years of experience with the analysis of sulfur compounds in hydrocarbons.

The gas to be tested would be supplied using permeation tubes manufactured by GC Industries, Chatsworth, CA.

Measurements would be monitored using flame photometric detection gas chromatography (FPD).

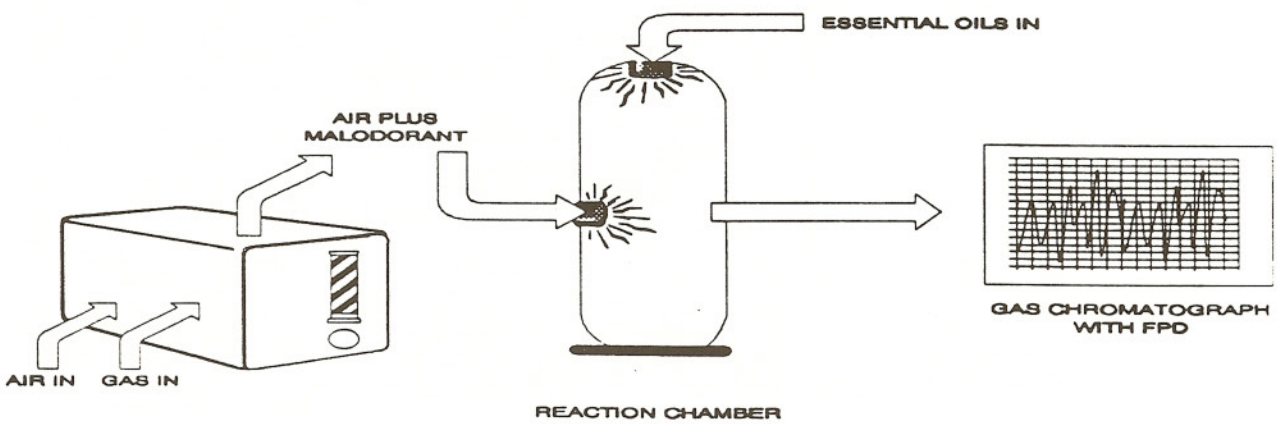
The FPD was selected over using length of stain tubes as it has been our experience that these strips do not always accurately register the reduction in sulfur compounds.

The testing would be conducted using Ecosorb 606 (2% by volume Ecosorb concentrate in water).

A glass container/reactor was chosen as the reaction vessel for all tests, its volume was approximately ten liters (see Figure 1). Air from the permeation tube calibrator containing the contaminant was charged to the reactor near the bottom, Ecosorb 606 was charged into the reactor from the top using an air aspirated nozzle misting unit in a 10 second time burst presenting the Ecosorb 606 to the gas in 5-15micron particles (75% efficient).

FIGURE 1.

ESSENTIAL OIL CONTACT TESTING PROCESS



When the gas levels (ppm) at the inlet and outlet sample points were constant the Ecosorb 606 was charged. Exit samples were taken immediately after application of the Ecosorb, a second sample was taken after 4 minutes, and the final sample was taken at 18 minutes. Exit samples were taken from the side of the reactor at the top of a small cyclone separator.

The pollutant concentration and the flow rate of the contaminants were maintained at a constant level until the final samples were taken at 18 minutes.

In some cases, because the odor bodies were so completely destroyed we rechecked the permeation tube inlet to be sure that the malodorant was still being fed to the reactor.

Since all of the materials being tested were toxic, we felt that for the experiment to be a success the malodorant had to be lowered to a value at or below the eight hour Time Weighted Average (TWA in ppm). Table I lists the TWA and the Threshold Limit Value. GC Industries' permeation tubes easily achieve these levels.

Table I

Exposure Limits to Various Malodorants

Malodorant	8 Hr. TWA (ppm)	TLV (ppm)
Sulfur Dioxide	5.0	3.0
Hydrogen Sulfide	10.0	-
Methyl Mercaptan	0.5	10.0
Ethyl Mercaptan	0.5	10.0

Table II

Permeation Tube Properties

Tube	Serial No.	Shipment Date	Wt. @ Shipment	Empty Weight	Perm Rate @ 25 C. (P)	Wt. @ Run End	Air Flow Rate (F)	K	ppm Mal-odorant
Sulfur Dioxide	930	11/25/92	184.92930	176.57	14,500	184.2	200	0.382	25.78
Hydrogen Sulfide	933	11/25/92	309.06800	284.02	40,100	305.7	800	0.718	36.00
Methyl Mercaptan	932	11/25/92	150.10950	149.52	1,260	150.0	200	0.509	3.20
Ethyl Mercaptan	757	10/27/92	181.84943	175.36	11,350	181.8	400	0.394	3.97

Concentration ppm vol = (K x P) / F

All of the permeation tubes were obtained from:

GC Industries, Inc.
8967 OSO Avenue
Chatsworth, CA 91311
Phone 510/226-1329

The solubility of the various malodorants should also be considered in evaluating the effects of the ECOSORB 606. Table III lists the solubility of the various gasses tested.

Table III

Solubility in Water of Various Malodorants

Malodorant	Solubility in Water
Sulfur Dioxide	10.2 Wt. % @ 20 Deg. C.
Hydrogen Sulfide	2.6 Vol. Gas/Vol. Water @ 20 Deg. C.
Methyl Mercaptan	2.4 Wt. % @ 15 Deg. C.
Ethyl Mercaptan	1.3 Wt. % @ 15 Deg. C.

RESULTS

The various permeation tubes were adjusted for flow rates to produce the desired concentration of odor level. Several reactor volumes were passed through the reactor and samples were withdrawn to check for the malodorant by GC using FPD (Sulfur Specific) detection.

The inflow of gas into the reaction chamber was kept constant for the duration of the test and the gas levels were measured on contact with Ecosorb, again after four minutes and once more at 18 minutes. The dilution effect from the air nozzle having dissipated the results now show that any continuing reduction of the gas indicates the residual oils still present in the chamber were continuing to act on the contaminants being presented.

The results of these examinations are contained in Table IV following:

Table IV

Component	ppm/vol Perm Tube	ppm/vol Reactor Out	ppm/vol - Concentration after treatment Immed.	4 min.	18 min.
Hydrogen Sulfide	36.00	36.00	20.04	36.00*	
Sulfur Dioxide	26.00	26.00	< 0.01	4.40*	
Methyl Mercaptan •	3.20	3.20	< 0.01		< 0.1*
Ethyl Mercaptan •	3.92	3.92	< 0.1		< 0.1*

• Disulfides were present that were also removed.

**** Note: The gradual increase of the contamination level after the injection of the Ecosorb reflects the residual effect of the Ecosorb on the constant incoming gas.***

Sincerly

Fred DeAngelo
Director Houston Hydrocarbon Services
Southern Petroleum Laboratories, Inc.

TDH
FLUID SYSTEMS INC

9439 - 47 STREET
EDMONTON, ALBERTA T6B 2R7
PHONE (403) 465-5447
FAX (403) 465-5667

The oil and gas industry in Western Canada has many pieces of equipment requiring annual servicing, cleaning, inspection and certification. This equipment includes treaters, separators and storage tanks. Before service personnel can enter these vessels, the LEL must be met. This is accomplished by purging vessel gases to atmosphere. As many of the wells in Western Canada are sour, H2S is another problem in addition to hydrocarbon odours. Many wells are also located close to residential areas.

Odor complaints were a very big issue with the residents. ECOSORB 606 was introduced with steam before opening equipment or venting gases.

Case Study #1

A 35 cubic metre treater was injected with steam and 20 litres of ECOSORB 606. Vessel was opened 2 hours later. No odours were detected and H2S reading was zero. In this case, no reading was taken for H2S before process started.

Case Study #2

A service company was contracted to clean two storage tanks, 3,000 barrels and 1,000 barrels. 1,800 ppm H2S was recorded before ECOSORB 606 was intoduced with steam. Twelve litres of ECOSORB 606 were injected into 3,000 barrel tank and six litres into the 1,000 barrel tank. Tanks were left overnight. H2S reading next morning was zero. Service company was able to safely vent tanks and complete their work. No odour complaints were received.

Case Study #3

A service company was about to work on a 90 cubic metre treater. H2S concentration was 6,600 ppm. Twenty litres of ECOSORB 606 were introduced with steam. A reading was taken after 15 minutes and showed H2S down to 30 ppm. Odours were gone. After 5 more minutes, H2S was down to 8 ppm.

Results of these tests confirm that ECOSORB 606 eliminates H2S, Mercaptan and Hydocarbon odours. The big plus is the reduction of dangerous H2S levels thus enabling workers to enter sooner without harmful discharges to the atmosphere.

Byers Scientific & Manufacturing
Industrial Odor Management

2332 W. Industrial Park Drive
Bloomington, IN 47404
Ph: (812) 269-6218

ECOSORB® CNB 100 TECHNICAL DATA SHEET

Ecosorb® CNB 100 is an odor neutralizer designed specifically for the control of cannabis odors. It was designed to remove the odorous chemicals that are produced when growing cannabis. Ecosorb® CNB 100 is effective on the main groups of odor causing chemical compounds found in cannabis including but not limited to the cannabinoids, terpenes, and sesquiterpenes groups.

Ecosorb® CNB 100 can be diluted with water or used neat depending on the application and delivery equipment. Dilution with water ranges from roughly 1 part in 10 of water to 1 part in 100 of water, depending on the type of delivery system and odor intensity. This product is a blend of plant oils, food grade surfactant, and purified water.

Ecosorb® CNB 100 should never be applied in a manner that would allow it to come in direct contact with the cannabis plant, water or soil.

FEATURES

- True odor neutralized
- Biodegradable and non-toxic
- Environmentally friendly
- No measurable flash point
- Scientifically proven

ADVANTAGES

- No masking of odors
- Usually no permits required
- Safe for employees and neighbors
- Safe for all environments
- It performs as advertised

PHYSICAL PROPERTIES

pH:	~6.0
Specific Gravity:	~0.99
Boiling point:	~208° F
Appearance:	Milky White
Odor:	Slight Citrus

HMIS CLASSIFICATION

Health: 0 Flammability: 0 Reactivity: 0 Protective Equipment: B

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ECOSORB® CNB 100 TECHNICAL DATA SHEET

ECOSORB® Odor Control Solutions

ALL INGREDIENTS CAN BE FOUND LISTED ON THE FOLLOWING CHEMICAL SUBSTANCE INVENTORIES:

United States: TSCA
Canadian: DSL
European: EINECS
Australian: AICS
South Korea: ECL and KECI
China: IECSC
Japan: ENCS
New Zealand: NZIoC

REGULATORY

- Ecosorb® CNB 100 is non-hazardous by OSHA Hazard Communication Standard 29 CFR 1910.1200
- This product does NOT contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm.
- Not subject to reporting requirements of the United States SARA Section 313.
- Uncontrolled product according to WHMIS classification criteria.

HANDLING AND PACKAGING

Ecosorb® CNB 100 is shipped in HDPE containers. It is recommended to store the product in the original container. The product should be stored in a well-ventilated place, in a cool area, out of direct sunlight, and tightly sealed. Store the product above 35°F and below 85°F. Allowing the product to freeze is especially damaging and will disrupt the emulsion. Extended exposure to higher temperatures may cause separation. Ecosorb® CNB 100 is incompatible with oxidizing agents and strong acids. This product does not burn. Always shake or mix before using.

DISPOSAL AND CLEANUP

Wash with water or soap and water. The product is not hazardous to humans, animals, or the environment. Dispose of in accordance with local, regional, and national and/or international regulations.

CONTAINERS

Ecosorb® CNB 100 is available in the following sizes:

5 Gallon Pails
55 Gallon Drums
275 Gallon Containers

DISTRIBUTOR OF

Ecosorb® ***Remarkably effective. Surprisingly simple.***

OMI INDUSTRIES

One Corporate Drive, Suite 100
Long Grove, IL 60047, USA
Phone: 800.662.6367 Fax: 847.304.0989
www.omi-industries.com

MEMORANDUM

TO: **Marc Byers, Byers Scientific & Manufacturing**
FROM: **Sarah Foster, CPF Associates, Inc.**
DATE: **December 8, 2017**
RE: **Screening Health Assessment of Waterless Vapor Phase Odor Control Technology**

INTRODUCTION AND SUMMARY

Byers Scientific & Manufacturing has developed a waterless vapor phase odor control technology which releases an Ecosorb® odor control product in gaseous form. Byers requested CPF Associates to conduct a health assessment of this system to evaluate its potential air impacts relative to inhalation criteria derived to be protective of public health. This memo describes the health assessment and its conclusions.

The application scenario evaluated in this study was defined by Byers. It assumed that Ecosorb® CNB 100, a proprietary odor control product, would be fed into the vapor phase odor control technology at a rate of 2.5 gallons per day and, once volatilized, would be distributed as a gas through a pipe. Air flow through the pipe would be generated by a fan set at roughly 300 cubic feet per minute and the product would be released from upward-facing holes spaced at nine foot intervals along the length of the pipe. The pipe would be placed around the outside perimeter of a building at a height of 10-15 feet (3.0-4.6 m). The total pipe length would vary from about 575-3,150 feet (175-960 m), depending on the building's footprint. The composition of CNB 100 was provided to CPF by its manufacturer, OMI Industries, under the understanding that this is confidential business information.

The assessment was a screening-level evaluation that relied on conservative, health-protective assumptions. These assumptions are expected to overestimate potential air concentrations, exposures and risks associated with the evaluated scenario.

The assessment showed that operation of the Byers-defined application scenario would not be expected to pose public health concerns. Potential air concentrations calculated using a screening-level model in the immediate vicinity of the distribution pipe were below available health-protective inhalation criteria.

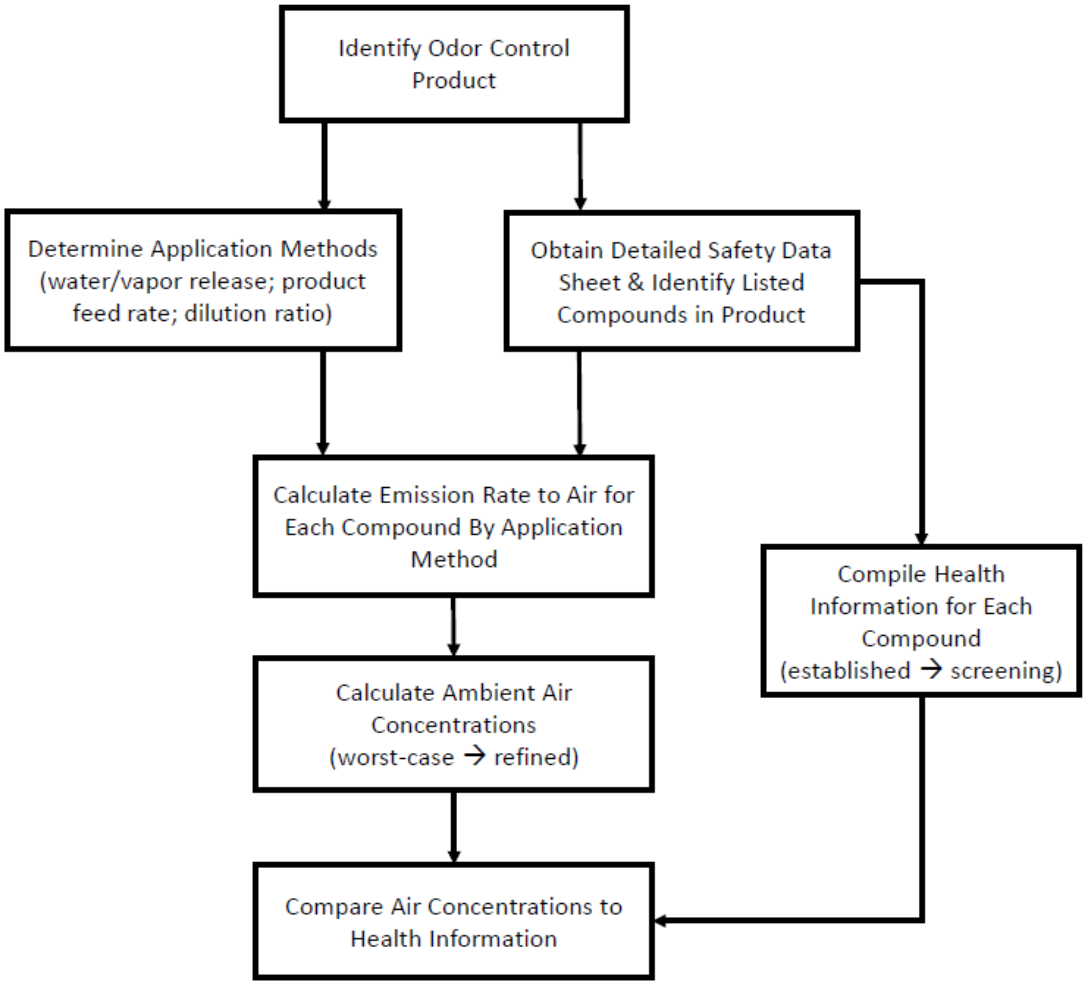
SCREENING HEALTH ASSESSMENT

Methodology

CPF has developed a methodology to evaluate odor control product use at landfills and other potentially odiferous facilities. This methodology is based on well-accepted health risk assessment principles and has been used to objectively assess more than one dozen odor control products delivered using a variety of application systems.

A flow chart of the methodology is provided in Figure 1. Broadly defined, the methodology combines information about odor control product composition, odor control application methods, health effects information and modeled ambient air concentrations to evaluate the potential for public health concerns via inhalation.

Figure 1
Overview of Odor Control Product Health Assessment Methodology



Consistent with standard health risk assessment practice, the methodology can be applied in a stepwise fashion of increasing refinement, as warranted. The initial screening-level evaluation employs conservative, health-protective assumptions which are intended to overestimate potential air concentrations, exposures and potential risks. If the screening-level evaluation does not demonstrate a potential for health concerns, then no further assessment is needed. If not, more refined evaluations can be performed to further evaluate an odor control system under more realistic conditions.

Assessment of Byers Vapor Phase Odor Control System

Application Method

In this assessment, a screening-level evaluation was conducted of an application setup defined by Byers. It was assumed that Ecosorb® CNB 100, an odor control product, would be fed into the vapor phase odor control technology at a rate of 2.5 gallons per day and, once volatilized, would be distributed as a gas inside a pipe of variable length, with air flow generated by a fan set at roughly 300 cubic feet per minute. The pipe would be placed around the outside perimeter of a building, close to but below the roof edge, at a height of 10-15 feet (3.0-4.6 m) and the total pipe length would vary from about 575-3,150 feet (175-960 m), depending on the footprint of the building. The vapor would be released from holes, each roughly 0.16 inch (4 mm) in diameter and facing upwards, placed every nine feet along the pipe length. Due to the pressure created by the fan, the vapor is expected to be emitted at a velocity of more than 100 ft/sec (>45 m/sec) from each hole.

Odor Control Product

The odor control product evaluated was Ecosorb® CNB 100. Its composition was provided to CPF by its manufacturer, OMI Industries, under the understanding that this is confidential business information. The product is comprised of two polysorbate surfactants and a blend of citrus and pine oils with the remainder being water.[1] Both polysorbate surfactants are widely used in hundreds of industrial, consumer, medicinal and personal care products. The Safety Data Sheet (SDS) for CNB 100 is provided in Attachment A. This SDS includes information about the product, its hazards and instructions for handling, disposal, transport, first-aid, fire-fighting and exposure control measures.

Emission Rates into Air

Emission rates into air for the product as a whole and its individual constituents were calculated based on the application setup described above and the Ecosorb® CNB 100 composition. The method for calculating emission rates was designed to ensure that potential air impacts would be overestimated in the interests of health protectiveness. First, it was assumed that 100% of the product would be volatilized in the odor control technology and transported down the distribution pipe. Second, each constituent in CNB 100 was assumed to be present at the maximum percentage provided by OMI. Third, the calculated emission rates from all holes were summed and the resulting cumulative emission rate was then assumed to be released from a shorter section of pipe on only one side of a building, rather than dispersed along the entire pipe surrounding all four building sides. Overall, these assumptions are expected to overestimate potential emission rates, and thus also air concentrations.

Ambient Air Concentrations

Potential air concentrations were calculated in the immediate vicinity of the distribution pipe using a screening method called a box model. This approach assumes that emissions are completely mixed in a

[1] The percentages of each polysorbate surfactant and the citrus/pine oil blend in Ecosorb CNB 100 are a proprietary trade secret, however, they were provided to CPF for the purposes of this analysis. In accordance with a Confidentiality Agreement, this composition is not specifically provided in this memo. The product's Safety Data Sheet is included in Attachment A.

box having a specified width and height through which wind is blowing.[2] It is generally considered more likely to overestimate than underestimate concentrations because the model does not take into account air mixing and dispersion outside the box, atmospheric reactions or settling (deposition). All of these processes, which naturally occur in the outdoor environment, would result in lower concentrations than those modeled. As a result, the air concentrations due to emissions are expected to be overestimated.

For this assessment, the box was defined to conservatively estimate potential air concentrations that might occur in the immediate vicinity of the distribution pipe (i.e., within roughly 15 feet). It was assumed to extend outward 15 feet (4.57 m) from the side of the building and upwards to a building height of 18 feet (5.5 m), with air flowing through this cross-section at a velocity of 1 mile per hour (0.447 m/sec), representative of a calm wind speed. Air concentrations would be lower if a larger box and higher wind speed were used.[3]

Health Criteria for Odor Control Product

The next step in the assessment involved compilation of available health criteria for the odor control product and its constituents. These criteria reflect concentrations in air (in mg/m^3) or average daily intakes (in mg/kg body weight/day) that are protective of public health. They are developed by regulatory agencies and public health scientists based on scientific information about the toxicity of chemical substances. When these values are derived, safety factors are generally incorporated to ensure that they are protective of human health.

Numerous information sources were searched to identify available health effects criteria.[4] Criteria were able to be identified for all constituents in Ecosorb® CNB 100 - either for the listed constituent itself (each polysorbate surfactant) or for a component in the constituent (citrus and pine oil blend). For example, for the blend of pine and citrus oils, dominant components in orange, lime, lemon, tangerine, grapefruit and pine oils were identified from published studies, and then acute short-term inhalation criteria were compiled as available for each of these. Among the dominant components, acute short-term inhalation criteria were available for limonene, α-terpineol, and α- and β-pinene. The lowest among these three criteria (59 mg/m^3) was selected to evaluate the entire oil blend.

In addition to identifying criteria for constituents in Ecosorb® CNB 100, the results from acute inhalation toxicity studies were used to derive an inhalation criterion for the product as a whole. Acute inhalation toxicity studies have been conducted for two Ecosorb® products that are used to

[2] American Society for Testing and Materials (ASTM). 1994. Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. Philadelphia, PA. ES 38-94.

[3] The equation for calculating air concentrations in the simple well-mixed box model is: Ca = (ER*1,000)/(H*W*V), where Ca = Air concentration (mg/m^3), ER = Emission rate (g/sec), 1,000 = Conversion factor (1,000 mg/g), H = Box height (5.5 m), W = Box width (4.57 m), and V = Air velocity through box (0.447 m/sec).

[4] Information sources searched included: California Environmental Protection Agency (CALEPA) Reference Exposure Levels (RELs), US Environmental Protection Agency's (USEPA) Risk-Based Screening Levels (RSLs), USEPA's Acute Exposure Guideline Levels (AEGLs), American Industrial Hygiene Association's Emergency Response Planning Guidelines (ERPGs), Temporary Emergency Exposure Limits (TEELs) developed by the DOE Office of Emergency Management, US National Library of Medicine PubChem databases, European Union and European Food Safety Authority assessments on food additives, Safety Assessments prepared by Cosmetic Ingredient Review Expert Panels, and Japan Food Safety Commission reports on food additives.

formulate CNB 100 (Ecosorb® 606 and Ecosorb® 206). The acute inhalation toxicity studies examined the occurrence of adverse effects on rats exposed to each product for four hours at a high concentration in aerosolized form (2,220 mg/m^3 for Ecosorb® 606 and 2,080 mg/m^3 for Ecosorb® 206). Observations of the test animals for 12 different health endpoints (ranging from lacrimation to tremors to death) were tabulated during the exposure period and for 14 days after the exposure ceased. No adverse effects were observed at either tested air concentration. The lowest of the two no observed adverse effect levels (NOAELs) was divided by an uncertainty factor of 100 to derive the criterion for this assessment (21 mg/m^3). [5]

Compare Air Concentrations to Health Information

The potential for a health concern was evaluated by comparing the calculated air concentrations to the health information. If the calculated air concentration for a compound or odor control product is lower than the corresponding inhalation health criterion, adverse public health effects would not be expected to occur under the assumed odor control application scenario. If an air concentration exceeds its criterion, this does not mean that adverse effects will occur among the general public because of the conservative assumptions included in both the derivation of the criterion and the calculation of air concentrations. Rather it indicates that further investigation may be warranted, using more refined and realistic assumptions, to help determine whether or not levels in air may present a potential public health concern.

In this analysis, the potential air concentrations calculated in the immediate vicinity of the distribution pipe were below the available health-protective criteria. As noted above, the air concentrations were calculated using a screening-level box model and assuming total emissions from a pipe around four sides of a building were all released from a shorter section of pipe along only one side of a building. The calculated air concentration of the product as a whole was two times lower than its criterion. The concentrations of the individual constituents in CNB 100 were lower than their respective criteria by factors of 370 to 1,760.

Discussion of Uncertainties

The results of health assessments inherently reflect some uncertainty because of the complexities involved in the analysis. In accordance with standard practice, key uncertainties affecting this assessment are discussed here. In general, uncertainties in health assessments, including this one, are addressed by using conservative (i.e., health protective) assumptions which collectively produce results much more likely to be overestimated than underestimated. This adds a margin of safety to the results.

Conservative assumptions used in this assessment have been noted above, such as concentrating all emissions from a pipe around four sides of a building into one pipe section along only one building side, assigning small dimensions (i.e., 15 feet by 18 feet) to the simple box model, assuming each constituent was present in the product at the maximum percent noted by OMI, and assessing the blend of citrus and pine oils using only the lowest available inhalation health criterion among those for dominant components of these oils. Deriving a health-protective criterion for the product as whole

[5] Consistent with screening-level methods for deriving reference air concentrations, the uncertainty factor of 100 incorporated one factor of 10 for animal to human extrapolation and another factor of 10 for human variability.

based on a NOAEL from a toxicity study that evaluated only one exposure level was another conservative assumption, because the actual NOAEL may be much higher. Some uncertainties were not explicitly addressed in this study, such as whether the form of emissions might vary in extremely cold temperatures (e.g., gas versus aerosols), whether the composition of volatilized constituents might vary after long periods of operation and the effect of buildings on dispersion and mixing of emissions. The modeling of air concentrations was conducted for one building using a simple screening-level model with conservative input assumptions; more refined calculations of potential air concentrations could be estimated using more sophisticated methods (e.g., refined air dispersion modeling, wind tunnel modeling or computational fluid dynamic modeling). Overall, these uncertainties are not expected to change the conclusions of this assessment.

This assessment addressed only the inhalation route of exposure with a focus on the general public. Not considering other exposure routes (e.g., dermal) is appropriate given that the general public would not be expected to come into contact with the odor control product in any manner other than through the air. With respect to occupational situations, which were not addressed here, this product should only be used in accordance with its SDS, any label instructions, and regulatory requirements of Cal/OSHA.

Conclusions

Based on the methods and assumptions used, this screening-level assessment showed that operation of the Byers-defined application scenario would not be expected to pose public health concerns. Potential air concentrations calculated using a screening-level model in the immediate vicinity of a distribution pipe were below available health-protective inhalation criteria. The calculated air concentration of the product as a whole was two times lower than its criterion. The concentrations of evaluated individual constituents in CNB 100 were lower than their respective criteria by factors of 370 to 1,760.

ABOUT CPF ASSOCIATES

CPF Associates, Inc. is an independent Maryland-based scientific and research consulting firm with in-depth experience and expertise in the health and environmental evaluation of air emission sources, waste management technologies, industrial facilities and waste sites. CPF applies state-of-the-art scientific tools - risk assessment, life-cycle analysis, epidemiology and environmental impact analysis - to address public health and environmental issues. In over 30 years of professional association, the CPF Principals have conducted hundreds of projects for energy-from-waste (EfW) facilities, landfills, incinerators, biosolids management facilities, recycling plants, transfer stations and other types of treatment units. The principal investigator for this assessment was Ms. Sarah Foster, a Principal with CPF Associates. Internal review was provided by Dr. Paul Chrostowski, also a Principal with CPF.

ATTACHMENT A

SAFETY DATA SHEET

ECOSORB CNB 100

Safety Data Sheet
according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations
Date of issue: 12/04/2017 Version: 1.0

SECTION 1: Identification

1.1. Identification

Product form : Mixture

Product name : ECOSORB CNB 100

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Odor Neutralizer

Recommended use : Odor Neutralizer

Restrictions on use : None known

1.3. Details of the supplier of the safety data sheet

Manufacturer
OMI Industries
1300 Barbour Way
Rising Sun, IN 47040 - U.S.A
T 1-847-304-9111

1.4. Emergency telephone number

Emergency number : 1-800-662-6367, Monday - Friday 8 am to 5 pm CST

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Not classified

2.2. Label elements

2.3. Other hazards

Other hazards not contributing to the classification : None under normal conditions. Keep out of reach of children.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substances

3.2. Mixtures

This mixture does not contain any substances to be mentioned according to the criteria of section 3.2 of HazCom 2012

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Call a poison center/doctor/physician if you feel unwell.

First-aid measures after inhalation : Move to fresh air if necessary.

First-aid measures after skin contact : Wash skin with plenty of water.

First-aid measures after eye contact : Rinse eyes with water as a precaution.

First-aid measures after ingestion : Call a poison center/doctor/physician if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects : None under normal use.

Symptoms/effects after inhalation : No effects known.

Symptoms/effects after skin contact : No effects known.

Symptoms/effects after eye contact : No effects known.

Symptoms/effects after ingestion : No effects known.

Symptoms/effects upon intravenous administration : No other effects known.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Dry powder. Foam. Carbon dioxide.

Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : Not flammable.

Reactivity : The product is non-reactive under normal conditions of use, storage and transport.

5.3. Advice for firefighters

Firefighting instructions : Cool tanks/drums with water spray/remove them into safety.

Protection during firefighting : Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Stop leak if safe to do so.

6.1.1. For non-emergency personnel

Protective equipment : Gloves and safety glasses recommended.

Emergency procedures : Ventilate spillage area.

6.1.2. For emergency responders

Protective equipment : Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment. Prevent liquid from entering sewers, watercourses, underground or low areas.

6.3. Methods and material for containment and cleaning up

For containment : Collect spillage.

Methods for cleaning up : Take up liquid spill into absorbent material.

Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13. For further information refer to section 8: "Exposure controls/personal protection".

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Ensure good ventilation of the work station. Wear personal protective equipment.

Hygiene measures : Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures : Does not require any specific or particular technical measures.

Storage conditions : Store in a well-ventilated place. Keep cool.

Incompatible products : Oxidizing agent. Strong acids.

Incompatible materials : Keep away from strong acids and strong oxidizers.

Storage temperature : 4 - 29 °C 40°F and 85°F Allowing product to freeze may cause layering.

Heat-ignition : KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.

Information on mixed storage : KEEP SUBSTANCE AWAY FROM: (strong) acids. oxidizing agents.

Storage area : Keep container in a well-ventilated place. Store in a cool area. Keep out of direct sunlight. Store in a well-ventilated place.

Special rules on packaging : Keep only in original container.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

8.2. Exposure controls

Appropriate engineering controls : Ensure good ventilation of the work station.

8.3. Individual protection measures/Personal protective equipment

Personal protective equipment : Gloves and safety glasses recommended.

Hand protection : Protective gloves. Recommended.

Eye protection : Safety glasses. Recommended.

Skin and body protection : None under normal use.

Respiratory protection : Respiratory protection not required in normal conditions.

Thermal hazard protection : Not applicable.

Environmental exposure controls : Avoid release to the environment.

Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance	: White liquid.
Color	: White
Odor	: Characteristic odour
Odor threshold	: No data available
pH	: 6 - 8.5
Melting point	: Not applicable
Freezing point	: No data available
Boiling point	: ≈ 99 °C
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Not applicable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: ≈ 0.99
Solubility	: Soluble in water.
Partition coefficient n-octanol/water	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: ≈ 1 cSt
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No dangerous reactions known under normal conditions of use.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Oxidizing agent. Strong acids.

10.6. Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure : Inhalation; Dermal

Acute toxicity : Not classified

Skin corrosion/irritation : Not classified
pH: 6 - 8.5

Serious eye damage/irritation : Not classified
pH: 6 - 8.5

Respiratory or skin sensitization : Not classified.

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity – single exposure : Not classified

Specific target organ toxicity – repeated exposure : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : No other effects known.

Symptoms/effects after inhalation : No effects known.

Symptoms/effects after skin contact : No effects known.

Symptoms/effects after eye contact : No effects known.

Symptoms/effects after ingestion : No effects known.

Symptoms/effects upon intravenous administration : No other effects known.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment.

12.2. Persistence and degradability

ECOSORB CNB 100	
Persistence and degradability	Biodegradability in water: no data available.

12.3. Bioaccumulative potential

ECOSORB CNB 100	
Bioaccumulative potential	Not established.

12.4. Mobility in soil

ECOSORB CNB 100	
Ecology - soil	The product is predicted to have high mobility in soil. Soluble in water.

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste)	: Disposal must be done according to official regulations.
Waste treatment methods	: Dispose of contents/container in accordance with licensed collector's sorting instructions.
Sewage disposal recommendations	: Disposal must be done according to official regulations.
Product/Packaging disposal recommendations	: Avoid release to the environment.
Ecology - waste materials	: Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Not regulated

Transportation of Dangerous Goods

Not regulated

Transport by sea

Not regulated

Air transport

Not regulated

SECTION 15: Regulatory information

15.1. US Federal regulations

ALL COMPONENTS OF THIS PRODUCT ARE LISTED, OR EXCLUDED FROM LISTING, ON THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY TOXIC SUBSTANCES CONTROL ACT (TSCA) INVENTORY

15.2. International regulations

CANADA

ECOSORB CNB 100
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

ECOSORB CNB 100
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

National regulations

ECOSORB CNB 100
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Korean ECL (Existing Chemicals List) Listed on INSQ (Mexican National Inventory of Chemical Substances)

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

SECTION 16: Other information

Training advice : Normal use of this product shall imply use in accordance with the instructions on the packaging.

Other information : None.

ABBREVIATIONS AND ACRONYMS:	
ATE	Acute Toxicity Estimate
BCF	Bioconcentration factor
IATA	International Air Transport Association
IMDG	International Maritime Dangerous Goods
LC50	Median lethal concentration
IARC	International Agency for Research on Cancer
OECD	Organisation for Economic Co-operation and Development
LD50	Median lethal dose
SDS	Safety Data Sheet
STP	Sewage treatment plant

Hazard Rating

Health : 0 Minimal Hazard - No significant risk to health

Flammability : 0 Minimal Hazard - Materials that will not burn

Physical : 0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.

Personal protection : B

B - Safety glasses, Gloves

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product

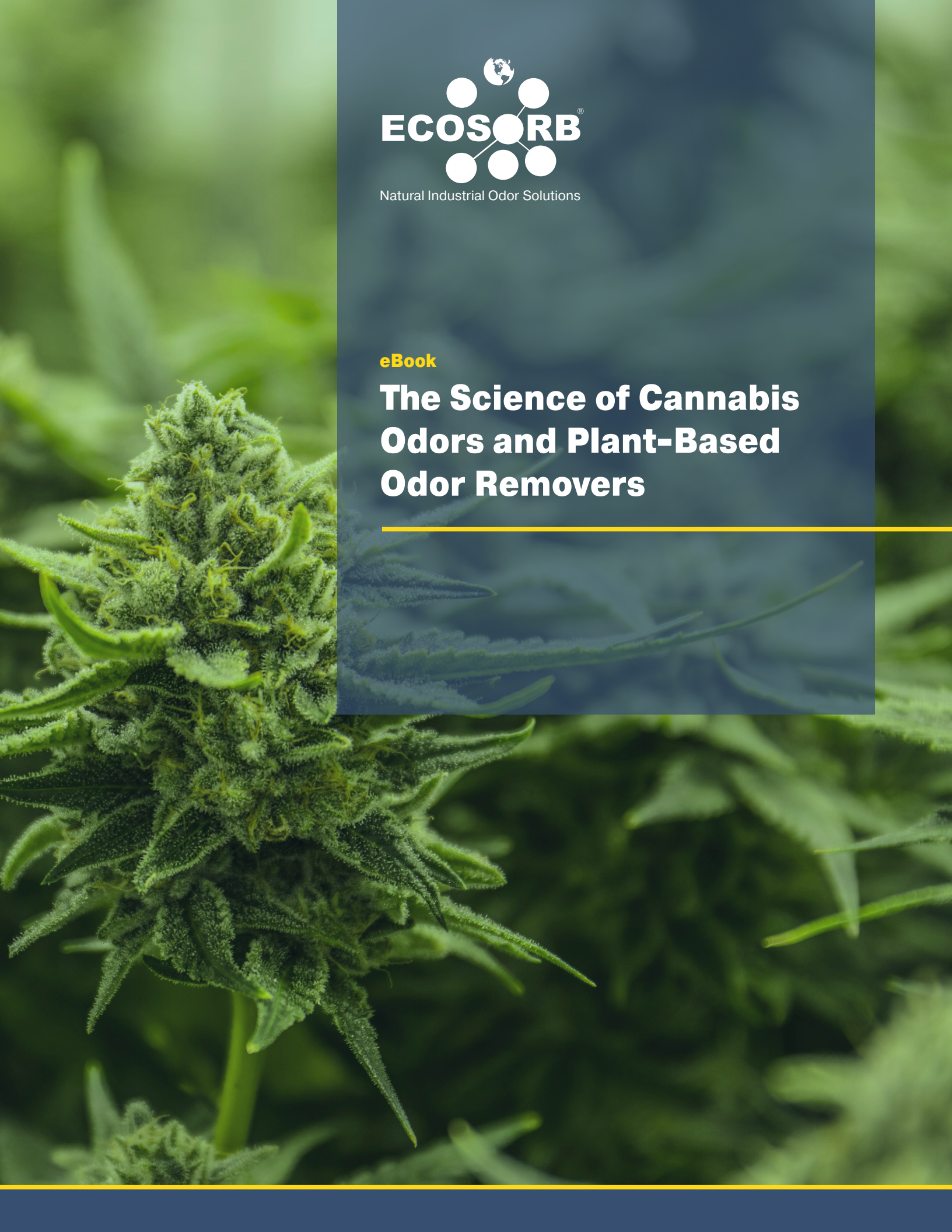
Byers Scientific & Manufacturing
Industrial Odor Management

2332 W. Industrial Park Drive
Bloomington, IN 47404
Ph: (812) 269-6218

WATERLESS VAPOR-PHASE SYSTEM FOR ODOR CONTROL

KEY FEATURES:

- Patent-pending Uniform Vapor-Distribution Technology ensures that a consistent and controllable level of product is dispersed via the perimeter piping
- Remote monitoring 24/7 by Byers Scientific staff on status of all machine operating parameters
- Rugged weather resistant enclosure capable of withstanding prolonged exposure to wind, rain and other elements
- UL Listed control panel is designed for site specific electrical requirements (e.g. 480 VAC, 3 Phase)
- Air filter replacement can be done safely from outside, no need to open/unlock door
- Product reservoir tank provides up to three weeks of uninterrupted operation before needing refill
- Key personnel receive email/SMS text notifications alerting of machine needs such as low tank level or air filter replacement
- Operational data are logged to provide evidence of compliance to local/state/federal agencies
- Optional weather station fully integrated with SCADA system available
- Utilizes Ecosorb® 607, a proprietary blend from OMI Industries that is specifically formulated for use in BS&M equipment
- Each system is custom designed and engineered for a client's site-specific characteristics
- Interior access via lockable 120-degree angle, gas assisted door for general machine maintenance such as product tank filling



ECOSORB®

Natural Industrial Odor Solutions

eBook

The Science of Cannabis Odors and Plant-Based Odor Removers

eBook

The Science of Cannabis Odors and Plant-Based Odor Removers

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INTRODUCTION

As legal marijuana sales continues to explode (it's estimated to quadruple in the U.S. between 2016 and 2021), **growers face mounting challenges** along with enticing profits. Odor complaints from cannabis have jumped in some areas by as much as 87% since growing became legal. In Denver alone, *30% of all municipal odor complaints are now cannabis-related.*

Local governments and clean air agencies are starting to enact laws and issue fines — in the tens of thousands of dollars — to limit odors. Many odor control solutions require complex engineering, expensive permitting, or costly equipment. One option that is gaining interest is plant-based odor removers, a **cost-effective and more earth-friendly way** to get rid of cannabis smells.

It is imperative for cannabis growers to understand the odors produced during cultivation and safely control them to maintain the quality of life for their neighbors and themselves.

DR. LAURA HAUPERT
Director of Research and Development at OMI Industries,
the leader in plant-based odor removing products.

SCIENCE OF CANNABIS ODOR SOURCES

The strong odors produced by growing cannabis are often described as *pungent, skunky, floral, fruity,* or even *"sewer-like."* Created by the plant's essential oils (terpenes), odors are strongest when the flower is budding. Some odors from cannabis farms have been detected more than a mile from their source.

Cannabis odor is a complex mixture of chemicals. The "scent" usually comes from the **terpenoids** and **terpenes** that it contains. Terpenoids can be further classified into monterpenoids, sesquiterpenoids, diterpenoids, and triterpenoids. They can be acyclic, monocyclic, or polycyclic hydrocarbons that may have substitutions on them including alcohols, aldehydes, ethers, ketones, and esters. A mixture of general hydrocarbons also play a role in the odor.

The concentration and combination of odorous chemicals **vary from greenhouse to greenhouse**. Hundreds of different strains of cannabis can be grown, each with a *unique scent profile.* Over 200 individual compounds have been identified as terpenoids, making the chemical makeup of odors complex.

Because smells and their chemistry can vary, it can be difficult to find an odor solution that works for every grower and every facility.

Common Cannabis Terpenes

Terpene	Limonene	Pinene	Myrcene	Linalool	Caryophyllene	Terpinolene	Camphene
Aroma	Citrus, Lemon	Pine, Fir	Musky, Earthy, Cloves	Floral, Lavender	Spices, Black Pepper, Wood	Pine, Herbs	Damp Woods

Terpene	Terpineol	Phellandrene	Carene	Humulene	Pulegone	Sabinene	Geraniol
Aroma	Lilac, Flower Blossoms	Peppermint, Citrus	Sweet, Pungent (Fir)	Hops, Beer	Peppermint	Pine, Orange, Spices	Rose

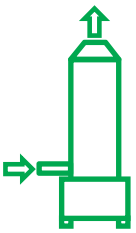
Source 1, Source 2

COMMON CANNABIS CULTIVATION ODOR CONTROL TECHNIQUES

There are several commonly used techniques currently in place to remove odors in cannabis growing facilities. While there are viable options, each come with a variety of limitations and their own shortcomings.

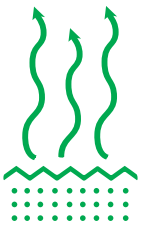
Most cannabis greenhouses use **carbon filters** to remove odors permeating from the facility. Activated carbon works by the contaminated air stream passing through the activated carbon. Carbon is porous, has a large surface area, which allows the carbon to absorb the odorous chemicals in the air stream.

CONS
Activated **carbon filters** work well on sulfur-containing compounds, but it is not as effective at treating nitrogen-based compounds. They also must be replaced about every year, which can be costly and time consuming in larger facilities. Also, carbon filters reduce airflow through greenhouse fans. Since airflow is so important to growing, additional fans are sometimes needed.



Wet scrubbers treat contaminated air by pumping it into an aqueous solution before it escapes outside. The odorous compounds go into the liquid and chemically react with the solution, removing odors. If mercaptans or ammonia is present in the air, a multi-stage scrubber is sometimes used.

CONS
Scrubbers can be expensive to build and must be operated by trained personnel and serviced in protective gear. The complex setups are designed for a specific application and have to include careful considerations for dangerous exhaust gas. Also, the chemicals used are considered reactive, hazardous, and must be neutralized before disposal.



In **Biofiltration**, contaminated air passes through soil, compost, wood chips, or other organic material. As the odorous air flows through the material, pollutants (including odor molecules) transfer into a thin biofilm on its surface. Microorganisms are immobilized in the biofilm and eliminate odors.

CONS
Biofiltration works on odors that are both biodegradable and water-soluble, including hydrogen sulfide and other sulfur-containing compounds. They do not work effectively on chemicals containing nitrogen. In order for the microbes to interact with the odorous compounds, they must be present in them for long periods. To scrub large amounts of odorous air, a sizable amount of material and a massive -footprint are often needed.

Masking agents are chemicals sprayed into the air to cover up produced odors. Masking agents use fragrances to “hide” odors and are used outside greenhouse facilities so they do not impact the taste or smell of actual cannabis plants. They often work by adhering to the outside of odor molecules.

CONS
While **masking agents** give an immediate cover to odors, they will eventually return. After a short period, the fragrance and odor molecules separate, leaving the odor behind.

Other odor control challenges include:

- Most municipalities now restrict how commercial cannabis grow operations handle odors.
- Large-scale ventilation systems that pump untreated air outdoors can be prohibited in some urban areas.
- Industrial filtration systems can be costly to install, operate and maintain.
- Some odor solutions require the use of water to distribute, adding additional costs and equipment (especially in areas of water conservation).
- Multiple partners are often needed for equipment, materials, setup, and maintenance.

USING PLANT POWER TO FIGHT PLANT ODOR

Plant-based odor removers use natural plant oils to destroy cannabis smells. The blend of plant oils attract odor molecules, and use adsorption and absorption reactions to neutralize their offensive scents. These liquid products are distributed by systems placed where exhaust exits a growing facility, eliminating odors before they become a nuisance to neighbors.

There's a saying in chemistry that "like dissolves like." A more common version of this saying is "**fighting fire with fire."** Natural odor removers use plant oils to neutralize plant odors.

As an example, alpha-pinene is a volatile organic compound (VOC) that is a terpene — an odor-causing compound in cannabis. Alpha-pinene is in other plants, including Pine, Rosemary, Frankincense, Cypress, Juniper Berry, and Orange. Some of these oils are effective at attracting and neutralizing odor molecules from cannabis, because of their similar chemical makeup.

Using this knowledge, natural odor removers can be specifically designed to eliminate the odorous chemical compounds in cannabis — including cannabinoids, terpenes, and sesquiterpenes. Since a blend can be engineered for broad-spectrum odor control (it can remove a larger range of odorous compounds), it works better and more universally than other methods.

Plant-based odor removers **do not contain harsh chemicals or synthetic fragrances**. Because they are non-toxic, non-hazardous, biodegradable, non-flammable, and contain no harmful VOCs, they are safe to use around people and require no permits to use. Delivery often needs no added water, thanks to advanced Vapor Phase technology, making it cost effective and more eco-friendly. And they are used outside greenhouses so they do not come into contact or alter the plant itself.

Science of Plant-Based Odor Removers

1

Contact
Ecosorb is delivered into an area affected by odors and attracts to odor molecules.

2

Adsorption
Ecosorb attaches to odor molecules.

3

Absorption
Ecosorb surrounds odor molecules, neutralizing their smell.

COMPARISON OF COMMON ODOR CONTROL TECHNIQUES

Odor Solution Method Comparisons

	Plant-Based Odor Removers	Masking Agents	Adsorption (Carbon Filters)	Ozone	Bio-Filtration
Uses Natural Ingredients	X		X		X
Non-Hazardous	X		X		X
Safe for the Environment	X	?*	X		X
Simple Setup and Use	X	X			
Removes Odors Completely	X			X	
Effective on Organic Odors	X		X	X	X
Effective on Inorganic Odors	X		X		X
Cost-Effective (Implementation)	X	X			
Cost-Effective (Maintenance)	X	X			

*Masking agents that use fragrances have been proven to include harmful ingredients. In University of Washington research of common air fresheners, they found on average 17 chemicals in each product — nearly a quarter which would be classified as toxic or harmful. Source

*Masking agents that use synthetic fragrances have been know to use harmful ingredients

HOW TO USE PLANT-BASED ODOR REMOVERS

Most products come in concentrated liquid. They can be delivered through misting systems at exhaust vents, vapor ducting at the top, or other areas of a greenhouse. Another advantage of natural odor removers is their flexibility. Complete solutions can be customized to every facility to combat any odor issue.

Other options include:

- Distribution equipment placed indoors or outside (weatherproofed for any climate)
- Modular systems for individual greenhouses
- Master, centralized systems for multiple growing areas
- Automated controls that regulate dispersion
- Integrated controls with existing systems

ECOSORB CNB 100: FORMULATED FOR CANNABIODOR CONTROL

Ecosorb® CNB 100 by OMI Industries is a natural odor remover designed for the control of cannabis plant odors. Our blend of purified water, surfactant, and natural plant oils eliminates odor-causing chemical compounds in cannabis — including cannabinoids, terpenes and sesquiterpenes.

Ecosorb products do not contain harsh chemicals or synthetic fragrances. They do not mask odors and are safe for use around people and animals. The distribution of Ecosorb requires no added water, thanks to advanced Vapor Phase technology.

For over 25+ years, Ecosorb has been the trusted solution for organic and inorganic odor removal in many industries. Companies in asphalt production, wastewater treatment, composting and food processing have trusted our products and proven them effective.

Effective
Verifiably, scientifically proven to work.

Natural
Ecosorb uses the natural power of plant oils to remove odors, meaning no permits required.

Safe
Non-toxic, non-hazardous, biodegradable, non-flammable, and no harmful VOCs.

CASE STUDY: ECOSORB CNB100 IN ACTION TO FIGHT PLANT ODOR

Challenge
A marijuana growing operation in the Midwest saw high odor emission from their facility. Neighbors in the surrounding area began to take issue with the odor — a challenge the facility needed to solve quickly.

In the spirit of being a good neighbor, the cannabis operation tested dozens of products to cut down the distinct, potent smell. After six months of trial-and-error, the operation turned to OMI Industries.

Solution
To solve their odor issues, OMI immediately recommended their Ecosorb CNB100 product. CNB100 was designed specifically for the cannabis growing industry and related odors, making it a perfect solution for the operation.

“CNB100 was designed specifically for cannabis production,” said Steve Lattis, Operations Director, OMI Industries. “Each growing operation in this industry is unique, so we created a broad-spectrum odor remover to fit the needs of each grower and facility.”

Ecosorb CNB100 can be used as constituted or diluted with water, based on delivery method. At this cannabis facility, the product is being diluted 300:1 and then atomized through a high-pressure atomization system — eliminating odor before it becomes a nuisance to neighbors.

Result
After trying many products, the cannabis facility finally got the proper odor control they needed with CNB100. With the odor no longer a nuisance to their neighbors, they can now focus on production, like any growing operation should.

“Whatever industry we operate in, our goal is to eliminate issues with production and reduce its effect in the area,” said Lattis. “When cannabis growers have the ability to reduce the effect of their operation, they eliminate preventable issues with their production.”

ABOUT OMI INDUSTRIES

Ecosorb® by OMI Industries is the leader for **natural, safe, effective, and complete** plant-based odor solutions for any industry — including cannabis growing. They don't mask smells, they get rid of them for good by breaking down and neutralizing odor molecules. Each product includes plant-based ingredients that are safe for the public — neighbors, employees, communities — animals, and the planet.

For almost 30 years, Ecosorb has used simple science to harness the power of plants as natural odor removers. Our proprietary blend of plant oils tackle the toughest smells **without dangerous side effects**. Ecosorb® is strong enough to battle the worst odors — from landfills to refineries to wastewater treatment facilities — yet **safe for people and the environment.**

Our Process
Implementing an Ecosorb solution is **less complicated than other common odor control methods**. Our experienced team partners with each customer to create a complete control plan based on specific odor issues.

Design
Using our years of expertise in odor control, we match your odor problem to an existing Ecosorb blend. In some cases, a custom formula is needed to battle unique odor combinations, like those found in cannabis grows of different strains. Chemists at OMI Industries can determine the best mix of ingredients for each odor issue.

Build
We manufacture, engineer and customize equipment to deliver Ecosorb, based on each application and its environment — weather, delivery method, output volume, and more.

Outfit
Ecosorb delivery systems fully integrate with your existing equipment and processes. Our engineers work with your team to install and maintain a complete odor solution.

Get Started
To learn more about Ecosorb solutions and equipment, visit EcosorbIndustrial.com or contact us at 800-622-6367.

OMI Industries
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Rising Sun, Indiana 47040
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Executive Summary: Odor Unit Testing – Location in PA

On December 18 -19, 2018, a team of three OMI odor scientists were dispatched to a Cannabis Grow Facility. A medical marijuana grower located in Pennsylvania. Their mission is to be the standard bearer for natural quality, expertly grown, modern medical marijuana. Currently, they have 4 greenhouses in two buildings for growing marijuana. Each greenhouse grows a wide variety of cannabis, which produces a mixture of odorous gases upon maturity. The greenhouses vent to a shared hallway and then to the outside through fans. The grower enlisted OMI Industries to control the odors produced by the cannabis in the greenhouses. OMI Industries sent a team of scientists with the goal to test the odor units (OU) produced by the greenhouses before and after the addition of Ecosorb CNB 100 at the fence line.

The team of scientists used two methods to measure the odor units; the Scentroid SM100i OM 2.1 Odor measurement system and Nasal Ranger. The Scentroid SM100i Field Olfactometer is designed to provide accurate in-field automated odor measurement. The SM100i is an automated olfactometer that uses compressed air to dilute sample air that is then introduced to the scientist. The sample is taken using a vacuum generated by the flow of the compressed air through a venturi pump. The dilution ratio of the clean air to the sample of air is controlled through the SM 100i flow regulator valve. Using a yes/no method, scientists record the presence of odor or lack of odor at different dilution ratios. The SM100i then records the final odor units. The Nasal Ranger is a field olfactometer for measuring and quantifying the odor strength in ambient air. The Nasal Ranger creates a calibrated series of discrete dilutions by mixing odorous ambient air with odor free carbon filtered air. Each dilution level is defined as the dilution-to-threshold ratio. Scientists test with the Nasal Ranger by turning the dilution level dial until an odor is detected. The odor units are then recorded by the scientist.

Testing is conducted by each scientist on thirty-minute cycles. Each scientist wears respirators when not measuring odor units in order to prevent the scientist from becoming desensitized to the odors. The scientist goes to the testing location and records the weather conditions, precipitation, temperature, wind direction, wind speed and humidity. Pictures are taken from each location. Each scientist tests with one of the above methods up to 5 times with the Ecosorb product off and the vents open to the green house. The scientist then takes a thirty-minute break wearing a respirator. Each scientist then tests with one of the above methods up to 5 times with the Ecosorb product on and the vents open to the green house. In addition, at the time of this testing, OMI Industries had one 450 vapor phase systems (VPS) in place. The system is capable of providing 4.5 gallons per day of Ecosorb CNB 100.

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Figure 1: Testing location for Growing facility

For this trip to the location, scientists successfully measured odor units at location A before and after the addition of Ecosorb CNB100, shown in Figure 1. Location A is the fence line for the grow facility and around 50 feet from the closest neighbor. As a note, the neighbors by location A have complained in the past about the odor from the greenhouse. The results for testing done by the scientists are summarized in Table 1. It was determined that at a rate of 2.25 gallons per day of Ecosorb CNB 100, the odors from the greenhouse where under control.

Table 1: Results from odor unit measurement.

Location	Ecosorb Flow Rate (%)	Ecosorb Flow Rate (gal/day)	Untreated Odor Units	Percent Reduction	Treated Odor Units
A	50	2.25	15	96	<1.0

The team of scientist tested odor units at the grow locartion. The testing was conducted with the greenhouses venting to outside with and without Ecosorb CNB 100. A reduction of 96 percent in the overall odor units at fence line was recorded after the addition of Ecosorb CNB 100. The scientists noted during testing that the cannabis odor was no longer detected upon the use of Ecosorb at the fence line. In addition, due to weather conditions many of the test were determined to be inconclusive. OMI Industries recommends using Ecosorb CNB 100 at 2.25 gallons per day.

Don't Be a Nasty Neighbor

Posted By Lori Lovely On August 18, 2016 @ 7:28 am In Landfill Management | No Comments

"Not in my backyard" is a familiar phrase in the solid waste industry. People don't want a landfill in their neighborhood, but it's inevitable that these facilities are going to have some type of neighbors—whether residential, commercial, or industrial—so keeping those neighbors happy by reducing dust, odor, and noise is an important part of doing business.

Letting the Dust Settle
Landfills generate mud and dust, which can be carried offsite, creating issues on roadways. Dust is a huge issue, both with regulations and neighbors, states Jesse Levin, vice president with NCM Odor Control. The most common method of combatting it is to roll out the water truck, although that comes with a price: the cost of fuel and operator, and periodic shortages of water.

To offset those costs, a high-pressure fan system can be used instead. "At the working face, you can use a stand system with water tanks and generators to knock down dust," explains Levin.

The drawback is that the fan system isn't effective everywhere. "The working face has only one area, so it works for that, but hitting access road is key to controlling dust."

Because studies question the effectiveness of water in dust and odor control, biodegradable dust control products can be added with little environmental impact. The benefit, Levin says, is that the dust control usage rate is below the mark when not using the product. That's important because the goal is to minimize applications and, in turn, operating costs. "Some sites use the water truck all day," he observes.

A product that controls dust better than water does will result in fewer applications and savings. "We're the only company that offers an atomized vapor system for odor and dust control that's waterless," he adds.

Rinse, Repeat
The severity of the dust issue depends on geographical location, which affects the evaporation rate and soil composition. For example, red clay breaks up into small particles that are difficult to control, according to Tony Knight of New Waste Concepts Inc. (NWC), which designs, builds, and installs evaporation and misting systems for controlling odors and dust in the solid waste and other industries.

Knight says they're testing products to make the particles heavier. One product, HydraGuard, helps control dust on haul roads, as well as in other areas around the landfill. It can even be used as an additive to the daily cover for additional resistance to extreme weather. The proprietary liquid formulation of polymers is effective for long-term dust control in high-traffic areas because the polymers bond particles of dust into larger particles that are too big to become airborne.

Knight says that "Customers using our products reduce the amount and times of application," thereby reducing wear and tear on the equipment.

Quality access roads to the working face and well-maintained site access roads can help diminish the amount of dust and mud that get spread around. Road sweeping contributes to mud abatement and is particularly effective if the road surface is concrete or tarmac.

To further control mud and dust on haul roads, MobyDick Washing Systems remove solids from tires to minimize "track out." The closed-loop water-recycling wheel-washing system incorporates high-volume flow and low pressure to get solids so wet, they fall off.

“Dust is a huge problem,” insists Robert Lodi, national sales director for the company he says is the market leader in the supply of heavy-duty truck, tire, and wheel-washing equipment.

The amount of dust created varies in relation to the type of items being unloaded and if the truck tires are dry or wet. “By making significant strides in management practices, you can halt the creation of dirt,” he says.

A wheel wash at the exit of a landfill or the entrance to a transfer station can remove 80–90% of dust-creating solids. “The goal is to get the tires on the spray wash rack,” explains Lodi.

An average wash in the drive-through system is 35 seconds. While the systems are customizable, the typical footprint averages 12–13 feet wide for the wash platform, a concrete pad slightly below grade to help manage water. An undercarriage wash and fresh water rinse 12 feet up the side can be added. Lodi says 10% of the facilities require a chassis wash.

Wheel-washes should be situated a reasonable distance from public roads to diminish a “skim” of mud left by trucks exiting the site. The skim may freeze in winter.

Dust control cannons designed for long-term operations in rough working conditions emit fine droplets of water that capture dust in the air and drop it down without creating mud. Energy-efficient, the cannons feature low decibel fans and a dual filter system to combine low water consumption with optimum water droplet size and extended throw distance. They can be mounted on pillars to elevate them at transfer stations.

Conventional Wisdom
Sometimes it’s just as important to be proactive as it is to innovative. Firms like Ecolo, provider of odor control solutions, offers several solutions considered conventional practice in the integration of odor management systems.

These include perimeter vapor or high-pressure misting, portable misting cannons—self-contained with heaters for winter use, topical application of odor-neutralizing solutions on roads and working faces, spot treatment of “smelly loads” as they arrive at the working face, biochemical odor control on the working face or temporary open-cell application with foam tracing and leachate treatment, says Michael Beckley, president.

Ecolo allows site operators to efficiently reduce site-generated odor through misting and fogging or by applying topical treatment in areas such as:

- perimeter,
- door and bay openings,
- tipping floors,
- working face,
- roads and scales,
- leachate, and
- windrows.

Their dust control cannons come in many configurations with varying ranges. A site assessment determines what is most suitable for each application.

Going to the Source
Dust and odor are connected, so what helps control one often helps control the other. The law requires landfills to cover the working face daily; many use dirt to do so, which can contribute to dust. NWC offers a variety of cover materials that contain odor control agents to eliminate landfill odors.

Odors come from previously deposited waste disturbed by digging activities; malodorous wastes, such as industrial or agricultural wastes and sewage sludges; landfill gas; stagnant leachate ponds and evaporative ponds; and leachate treatment systems, particularly aerial spraying.

Methods of minimizing landfill odors include effective compaction; adequate cover; rapid deposition of malodorous wastes, using covered trenches where necessary; landfill gas collection and subsequent combustion; burial of excavated wastes; and prevention of stored leachate becoming anaerobic. “We focus on the surface of the landfill,” explains Knight.

They create a geomembrane that restricts odor-causing gas coming out and moisture going in. The sprayable material is mixed with water. “It’s a good ‘film former,’” he says.

The best preventative, Knight believes, is a gas collection system, but it’s expensive.

Sealed geomembranes are also good—and also expensive, and if the landfill is reused, must be thrown away. "Our solution is less expensive," says Knight. "It does 90% of what a geomembrane does for less cost and only requires maintenance every three to four months."

Bacteria and enzymes use microorganisms attack organics in the landfill, eliminating the cause of odors rather than merely masking them. "A lot of landfills use masking agents," indicates Knight. "It's a waste of money."

Instead, he advises adding oxygen to raise the biological activity. "Leachate from rain must be treated. Nitrogen and phosphorous must be treated—it takes a lot of oxygen to degrade them; you must aerate."

It's also important to minimize moisture. Knight estimates that 20% of all rainfall ends up in the bottom of the landfill. Left untended, it creates odor. "You should restrict the amount of rainwater."

On the other hand, perimeter misting systems are reasonably effective, although chemistry and barometric pressure affect their performance.

Weather the Storm

Weather affects the time of day and length of odor issues. Humidity, as well as wind speed and direction, factor into the odor equation. It's important for landfill management to evaluate data in order to predict the weather. "You have to track weather," insists Knight. "Do you have portable equipment?"

Using science to develop an odor control plan will "take things to a new level," he continues. In order to mitigate odor and dust, you must know where they go. Tools such as three-dimensional (3D), topography, and computational fluid dynamics modeling show the air flow, miles per hour, direction, and density as air moves around buildings.

"There are lawsuits all over the place," observes Levin. "Communities organize for class action suits against landfills. This industry is heading to court. People smell with their eyes; the psychological aspect is huge."

Be prepared, he advises. "You need to have a plan in place." First, determine which are valid odor issues through monitoring.

Conduct health and risk assessments, do tracer studies, gather data to be ready for potential legal questions. "A site can use scientific and legally defensible data in court." Tracer studies identify the sources of odors, which are not always from the landfill.

Whether a landfill is preparing a legal defense or merely trying to be a good neighbor by reducing and containing odors, a consultant like OlfactoExpert Inc. can provide necessary information.

First, an audit is conducted in order to determine the source of odors. "We study them one by one," explains Yann Contratto, owner. "We collect samples from different sources—the surface, the wastewater pond, and the arrival of fresh waste—and analyze them."

Once the odor samples have been analyzed, teams prioritize the sources, analyze the data, and generate level II impact studies, including mapping that makes quantitative and qualitative studies possible.

An odor impact study integrates sources of smells, the topography of plant, wind, climate, and where odor goes, using 3D odor dispersion modeling software. "It demonstrates why one neighbor is more affected than another," says Contratto. "Measuring at the source of emission establishes the impact of all these factors."

He says the study is "very representative of the reality of emission," and that simulation source by source enables them to determine what works best and what costs the least.

The Smell of Success

According to Contratto, 20% of sources are responsible for 80% of odor complaints. "Complaints usually come from new neighbors, and it's usually the same: less in winter, worse in summer, when it's humid and hot." Because wind and climate escalate the problem, it becomes a "major issue" if the location is close to a city or ocean. . . or where cities authorize new development.

"New residential complaints make up about 80% of all complaints." That's because people who work at the landfill become accustomed to the odor. "After five years, you can't detect a lower level of odor," says Contratto.

He lists four dimensions of odor:

1. Concentration per square meter or square foot
2. Intensity on a scale of 0 to 10
3. Quality, or the name of the smell: fresh waste, biogas, pond odor, compost, leaves, and herbs
4. Hedonic tone, or the degree of pleasantness or unpleasantness (This is the only dimension that is subjective.)

Considered a legal expert in olfactometry since 2006, Contratto says odors are often a legal issue more than a technical one. Because odor can affect the value of your house, class action lawsuits arise with frequency. In fact, he says they have multiplied by three each year for the last four years in the US. That's why his services are so valuable.

Measuring odor is a new branch of science. "The level of error was too high until 10 years ago," indicates Contratto, "but tools have changed everything."

These tools record a very precise measurement of odor concentration, similar to decibels in sound measurement. Using specific materials, OlfactoExpert measures the landfill surface, liquids, the flare, and leaks. He even measures the difference of emission with different amounts of cover.

But it has taken time to be accepted. "We have to educate the customers and the courts that the tools are reliable," acknowledges Contratto. "Few are specialized and knowledgeable at that level to give advice. You must know chemistry and math." Although he considers it a niche market, he says business is growing and expanding into other industries, such as agriculture, tires, wastewater, and the kind of plant.

He says that if you follow his recommendations, up to a 40% reduction of emissions is possible. Suggestions can include covering with sand or dirt to reduce the impact on neighbors, adjusting duties during the hours of operation, or making changes to accommodate the prevailing winds.

But, beware, he cautions: "Most managers make the same mistake—they trust product salesmen. Most products are masking agents, not controlling agents." Contratto makes clear: OlfactoExpert hires legal, technical experts who make recommendations on actions, but not specific products.

Fugitives on the Lam

Manufacturers, however, recommend products as well as actions. For example, Byers Scientific & Manufacturing's patent-pending Uniform Vapor-Distribution Technology provides a measurable, controllable, and uniform creation and distribution of odor-eliminating vapor.

"State-of-the-art odor control is misting," says Marc Byers, CFO of Byers Scientific & Manufacturing, "but the challenge with misting systems is that odor is lighter than air; it travels with the wind stream. If you can see mist, it's not traveling with the odor; it's falling to the ground. Mist needs time and space to act with malodor."

Odor is a lightweight vapor that needs to be combatted with vapor, he insists. Misting systems produce big droplets, but mist doesn't travel as well as vapor.

"The atomization can't keep up," explains Byers. "It needs to travel with malodor." Byers Scientific's patent-pending technology delivers a chemical designed to do that.

The proprietary formula, which is similar in weight to the odor, is distributed through 4- to 6-inch piping around the perimeter of a landfill and changes the chemical composition of the molecules to change the nature of odor at a molecular level. Benefits of the system include minimal maintenance needs, no water needed, quiet operation, and lack of clogged nozzles. Since implementation at a landfill in Russberg, VA, that had "big odor issues," Byers says the system reduced the number of odor complaints from 36 to 9.

"Odor is a significant issue," emphasizes Byers. "It's the biggest externality, more than dust. Dust is rare."

Managing and controlling such a big problem requires a two-pronged approach: reduce odors at the source and develop an airborne barrier to capture fugitive malodors. Vapor barriers help contain odors on the landfill's surface, but odor control on the working face of a landfill is a challenge when the equipment is working. "In the future, I think managers will put the nozzle on the compactor to spray while they're working," speculates Byers.

Even if managers treat daily and cover topically, odors can become fugitive, airborne beyond the working space. "It comes in on the trucks," remarks Byers. "Food waste is already odorous before it

gets to the landfill."

Gases such as methane, carbon dioxide, ammonia, sulfides, and various unpleasant odors are released. "Unless you're treating the source, there will be odor," he concludes.

Treat Me Right
It's pointless to treat odor if you're not doing it properly. Benzaco Scientific Inc. designs and manufactures chemical and equipment technology that incorporates essential oils, relying on their naturally occurring compounds to counteract odors.

These are not masking agents, which the chemists at Benzaco say only make the problem worse because they can create a more odorous situation. Instead, a limited selection of oils is chosen specifically for their ability to eliminate odors.

One Pennsylvania landfill found out just how unsuccessful masking agents can be. The Pennsylvania Department of Environmental Protection documented over 200 odor complaints from neighbors of the landfill in just one year. The site was required to install an enhanced landfill gas collection system with temporary flares to burn off odorous gas. In addition to the significant expense of this process, they were fined almost $75,000 in civil penalties for past odor violations.

Since then, they have implemented operational solutions, including use of Benzaco Scientific vapor phase odor control measures, which have drastically reduced odor complaints.


[3]

Credit: Moby Dick
A dirty undercarriage


[4]

Credit: Moby Dick
A clean undercarriage

According to Benzaco, "the oils used in odor control display certain chemical properties that allow an oil to have a physical or chemical effect on odorous compounds. These properties are what make the oil effective at eliminating an odor." Their effectiveness depends on how well the oils are chosen and blended to produce the correct chemical or physical reaction on the odorous compounds.

Use of neutralizing chemistry is the preferred method of odor elimination, according to Benzaco, and can be both effective and economical if done correctly with the right application equipment. Their units are designed only for fogging odor control products.

Can You Hear Me Now?
While Byers and others consider noise second in importance to odor, it is always a major concern of landfill neighbors.

Landfills are busy places with multiple pieces of equipment at work— all of which have backup alarms in the 112-decibel range. It's a safety measure; there's a lot of backing up at landfills, drivers frequently get out of the cab, and material is being crushed, Benson Davenport, vice president of regional sales for Autocar, points out. "There's nothing you can do about alarms, especially if you're working above grade," he says.

But, he adds, ear protection is necessary when decibel levels reach 85 for more than eight hours a day. "The only way to lower the alarms is to reduce the total noise," believes Davenport.

That can start with the type of fuel a vehicle runs on. "Diesel versus gas fuel makes a big difference. A spark-ignited engine is quieter, and with every 10-decibel reduction, the range is 10 times quieter."

For example, he says, Cummins' natural gas engines at idle are 10 times quieter than diesel engines—85 decibels, versus 95 decibels.

Because green fuels are better for the environment, there are grants and funding for taking diesels out of commission. "There are several incentives to de-commission diesel engines as a way to encourage the switch," states Davenport.

Nevertheless, most municipal haulers continue to use diesel. "You need a big fleet to justify the cost of natural gas. The capital costs are considerable."

Hindering the move away from diesel trucks are low diesel fuel prices. Davenport believes that's temporary, though. "Surplus production ends this year; oil prices will go up." He urges fleet owners to weigh the fluctuation in diesel prices against the 10- to 12-year investment of a truck.

CNG provides another advantage because there's no regen. A regen increases sound 5–10 times because it requires increased RPM to create: more noise, more fuel. "That goes away with CNG," says Davenport.

Among engines that need to perform a regeneration, he says Autocar does fewer regens, due to their unique onboard diagnostics that monitor the level of soot in the system and alert the operator when regen is needed. The advanced notice allows the operator to choose where and when to do, enabling them to leave the landfill and thus, reduce noise levels at the site.

CNG trucks also get a weight advantage of 2,000 pounds—an exemption on federal roads that allows for the trucks to be heavier than the posted weight limit due to the CNG technology, which is somewhat offset by the added weight of the CNG tanks. Davenport thinks it still leaves room for some extra payload.

Better payload translates to fewer trips to the landfill, and if a truck isn't at the landfill, it isn't contributing to the noise there. Autocar trucks carry about 2,000 more pounds of payload than their competitors, Davenport points out, allowing them to pick up 44 more houses on average. "That's 15% fewer trips if you carry 2,000 more pounds in a 20-yard truck," he says.

Once the trucks go to the landfill, there are some noises that simply cannot be gotten rid of, like those backup alarms. But a better turning radius can help a driver avoid backing.

"Autocar has the best turning radius and visibility in the industry," states Davenport, acknowledging that it may apply more on the route than at the landfill, but still may contribute to lessening noise.

The air brake release is another unavoidable noise, along with the general sounds of traffic, gas flares, and bird scarers. High-quality road surfacing and speed limits can reduce noise. Limiting hours of operation reduces complaints. Sound reduction equipment fitted to power tools and machines muffles noise and acoustic screens can deflect the sound of generators and pumps.

Natural noise control can be implemented by landfills and their neighbors. Trees filter noise, providing natural sound reduction.

"It's like putting up a wall," indicates Davenport. To be mandated, decibels must be over a certain level for a period of time, but adjacent landowners could plant trees to mitigate noise pollution.

Berms and other types of vegetative screens help confine noise within the landfill if properly situated on the site to blend in with the topography and surrounding landscape. They also serve as a visual barrier.

Incorporating see-no-evil, hear-no-evil, smell-no-evil measures to appease neighbors can save landfills money and trouble in the long run.

If You Knew, You'd Floc Your Wheel Wash, Too

Neptune Automated Wash Solutions, understands the importance of clean water. As part of an automated wheel wash system, the wash water is automatically recovered into a tank, cleaned, and recycled. Neptune Systems use Floc, a granular flocculent, that coagulates the solids so they rapidly fall out of suspension and into the bottom of the tank. Once the solids reach the bottom on the tank, a double scraper conveyor belt scrapes the solids out of the tank, dewatering them in the process so that the water remains optically clear.

One of the biggest hurdles to overcome during the decision making process is convincing a client the importance of a scraper conveyor. As Jeff Dworek, Director of Operations at Metro Waste Authority in Des Moines, IA, explains, "When we installed our wheel wash, we decided we could handle the solids ourselves and elected not to include the scraper conveyer system. We felt with the large wheel loaders

and heavy equipment operators onsite removing mud from a drive in concrete basin would be a simple task; however, we underestimated the amount of solids that we were removing from the trucks leaving our site.

“We had Neptune come back and add a 10,000-gallon scraper conveyer tank before our 40,000-gallon concrete tank. They also added their dry floc system; it was the difference in night and day as far as maintenance goes. The dirty water now flows into the scraper tank where it mixes with the floc, the heavy solids fall to the bottom and are removed to a sludge pit by the automated scraper system, allowing much cleaner water to weir over into the concrete tank where we get final settling.”

Odor complaints at Rustburg, VA’s Livestock Road Regional Landfill were growing in numbers sufficient to raise notice at the state legislature level. In early 2016, Region 2000 Services Authority, the landfill’s managing entity, began conducting pilot programs with atomized misting systems using a variety of different masking agents to arrest fugitive airborne odors.

Failing to achieve satisfactory results, the authority contracted with Byers Scientific & Manufacturing to introduce its odor mitigation system that relies on a dry vapor formulation to contact and deodorize offending malodors. The system converts a Byers’ proprietary liquid chemical formulation into a dry vapor that is subsequently inserted into the local airstream though a network of pipes. The vapor then travels at roughly the same speed and direction as the malodors greatly increasing the probability of physical contact and odor destruction.

Byers Scientific & Manufacturing customized a solution particular to the landfill’s unique features, bringing the system online in March 2016. “As a landfill operator, we track and record complaints rigorously,” says Clarke Gibson, P.E., the Region 2000 solid waste manager. “Upon installation of the system, odor complaints have subsided and have remained that way to the present.”

MSW

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Odorous Assault

Posted By Carol Brzozowski On December 15, 2016 @ 2:56 pm In Landfill Management | No Comments

While perhaps the increased emphasis on separate collections of organic wastes such as food scraps and other green waste has contributed to more odors, the development of neighborhoods closer to what was once a remote MSW operation is the overriding factor, say industry observers. Marc L. Byers, owner of Byers Scientific & Manufacturing, notes that odor is an ongoing challenge for landfills and compost operations, but not because of biological changes.

"Odors are still derived from all of the typical wastestreams," he points out. The prevailing issue, he adds, is progress: "As communities expand further out from previous areas, they eventually start to butt up against landfills."

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On a website for Sunshine Canyon Landfill Local Enforcement Agency (SCL LEA), in California, maintained by Eugene Tseng—an environmental engineer, attorney specializing in environmental sustainability infrastructure planning and environmental law, and teacher at UCLA—a September 2015 report outlines odors' myriad sources. Odors are not now just "fresh"—that is, odor from trash being dumped and spread on the working face during operating hours, but more significantly are emanating their own distinctive smell during non-operating hours from landfill gas (LFG) through the existing daily cover and intermediate cover, according to the report.

It goes on to say that, despite the application of compacted daily soil cover for many years, odors continue to be a problem and are coming from a variety of sources, mandating a more comprehensive approach.

Odors may be sourced from waste vehicles: from the incoming trash, from litter or liquids that may fall from the vehicles, while vehicles wait in queue to dump, and during the unloading process at the tipping face area. Odors also may be sourced from the fresh trash on the working face before it is covered, trash carried into neighborhood by winds, carried by LFG, which passes through the fresh trash that has been disposed or placed upon the working face during operational hours, the LFG through the daily cover, and the odor that passes during closed hours through fresh trash that has been disposed upon the working face and daily cover.

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Additionally, odors may be carried into the neighborhood via the water spray used to mitigate odors as odorous compounds attach to heavier droplets of water, from older decomposing trash not captured by the LFG collection system, or result from operational activities associated with landfill repair and maintenance such as LFG collection well installation, trenching, well repair, equipment breakdowns, and shutdowns.

Other odors occasionally present that may contribute to complaints from the community include leachate collection and treatment systems, portable toilets, naturally occurring sources associated with an adjacent oil field and from decomposition of plants that are part of the natural habitat areas or from plants that have not taken root on the intermediate (and other) cover areas, or from community sources such as manure from horse properties and curbside trash collection.

The agency recommends the most significant mitigation arises from an approach combining practical preventative programs, facility design features, operational practices, maintenance protocols, and odor alleviation programs providing for optimal operating conditions at the working face and of the LFG collection system.

In his presentation on an integrated strategy for effective odor control at WasteCon 2016, Ray Kapahi, odor control specialist at NCM Odor and Dust Control, pointed out how odors can be categorized by

character—"rotten egg," pungent, sweet—strength (parts per million), and duration.

Odors are classified as fugitive or point source, with most landfill odors classified as fugitive. They are transient or steady state.

The fugitive nature of odors makes them difficult to intercept and treat, notes Kapahi. Odors dilute in response to local winds and vary with atmospheric conditions, such as wind speed and stability. Dilution involves large air volumes, he adds.

Odorous sulfur-containing compounds such as dimethyl sulfide have a very low threshold of odor perception, notes Kapahi. For example: hydrogen sulfide (0.0047 ppm), ethyl mercaptan (0.00019 ppm), and dimethyl sulfide (0.1 to 0.01 ppm).

Visualizing movement of fugitive dust can help people understand movement of odors, which have a plume movement entailing height and distance, says Kapahi. "The fact that odor complaints persist in spite of our best efforts indicates the difficulty in controlling odors," he says, adding the use of appropriate technology, products, and monitoring can minimize but not completely eliminate odors.

For landfills handling MSW, odors can change "dramatically in intensity and character within minutes," notes Kapahi. He points out that landfill operators have no control on waste variables such as age, origin, and local temperatures. Additionally, one odor can overpower another depending on the specific situation.

Environmental and geographic conditions can magnify odor problems, Kapahi points out, adding environmental effects include weather and temperature inversions that lead to odor buildup.

Location also affects odor movement, says Kapahi. "Odors from landfills located in hilly terrain pose a unique challenge to operators due to changing wind conditions, both spatially and temporarily," he says. "Under these conditions, the odor mitigation system needs to be responsive to changing conditions."

Michael Lannan, president of Tech Environmental, notes a general trend regarding landfill odors "is that the expectations from neighbors are that thou shall not be a nuisance are based on not being a nuisance and they're not necessarily numerical definitions."

An example of areas that do have numerical definitions would be a dilution to thresholds, such as how much air does it take to dilute an odorous segment of air to become non-odorous, he says. "That's an indication of the strength of an odor," adds Lannan. "Areas that have those types of regulations tend to establish an understanding of what would and would not be a nuisance."

Tech Environmental trains regulators and MSW operations' owners and operators in understanding what is an odor and what could potentially be a nuisance. In the initial training stage, regulators tend to hold the opinion that if they can smell something, it must be a nuisance, says Lannan. Eventually, those going through training understand odor is everywhere every day, but when it changes behavior, that's when it starts to become a nuisance, he adds.

"If facilities have an expectation of a nuisance threshold, that is very advantageous," says Lannan.

Laura Haupert, director of research and development for OMI Industries, points out that compared to other industrial applications such as wastewater treatment and asphalt production, landfills face more challenges in fighting odors. "Landfills often encompass many acres and are constantly changing, with new areas being continually filled in with waste," she says. "As they also become higher in elevation over time, keeping foul odors from being carried off by often-erratic wind patterns becomes all the more difficult."

While landfill odor problems typically remain consistent, certain times of the year such as hot summer months can intensify the foul smells as food items rapidly deteriorate, attracting the bacteria that causes foul odor, says Haupert.

In rainy periods, extra moisture can lead to the trash decomposing much faster. Wind can carry the foul odors into neighboring residential and commercial areas, she adds.

Whether one odor can start to overpower another is not so much an issue as the mixture of multiple odor sources, says Haupert.

"The number one influence to odor issues at any solid waste facility is most definitely the proximity of their neighbors," she adds. "Also having impact are moisture, humidity, agitation, and temperature, which makes the summer months obviously more difficult. Receiving different types of solid waste such as food-related garbage can make odor management a challenge for any landfill. If neighboring houses

are at a lower altitude than the landfill—in a valley-like environment—the foul odors can travel down and essentially get stuck in these areas."

Other factors such as distance driven to the landfills and the financial obligations in collections contribute to odor challenges, says Todd Dunderdale, vice president of marketing for Komptech Americas. "There are tipping fees and tipping fees drive recycling," he says. "There's also the issue of landfill space. If you have a landfill that is 100 years and you are concerned about diversion and your landfill tipping rate is $25 a ton, it doesn't leave much more to recycling."

Komptech Americas' equipment is used for everything from shredding for volume reduction at landfills to windrow turning for compost, as well as reclaiming various wastestreams. The company bases its approach on European waste practices and the issues that have occurred overseas. "They've run out of landfill space and have had a lot of incentive to recycle because of legislation requiring them to do that," says Dunderdale. "The tipping fees are astronomical. You put that all together and you've got a lot of diversion. We've got to find a way to keep everything we can out of the few landfills we have left.

"We have a very large population density with a very small landfill space," he adds. "If you look on the East Coast, there are very few landfills and they're shipping their waste to Ohio. All of the waste is going to be transported by rail to the center of the country."

Permitting for a landfill is difficult as is expanding an existing one and no one wants one by their neighborhood, Dunderdale points out. "Odor shouldn't be a problem if it's being treated right and the landfill is located where there aren't many people," he adds. "The reason it continues to be an issue is that people have moved away from cities to places where they are close to the landfill. At some point, they can't transfer the trash further and there's not economics in doing it that way. Eventually, all of the landfills are going to have to start pre-treating their waste."

Lannan says changing wastestream is affecting odors, especially in the Northeast. Pulling organic material out of the waste stream has a positive effect on landfill odor generation, he says, adding that the odor does transfer into wherever the organics is being processed.

In situations where waste is moving further away from its generation point to the disposal location, "that added time takes away from the time when you apply the fresh material before it has a significant amount of cover on top of it," points out Lannan.

The number one solution to dealing with odors is having a standard odor control plan, notes J. T. Bielan III, director of sales and marketing for Rusmar. "The most successful landfills are the ones that are proactive about their odor control policy," he says.

Rusmar offers technologies that include alternative daily cover systems of cover material, application equipment, storage, and dilution equipment designed to meet the performance criteria of Subtitle D.

The cover material, RusFoam ADC, is designed as a non-hardening protein-based foam that can be adjusted to last from overnight to over a weekend by changing dilution ratio and depth of coverage.

The application unit, PFU2500, is a self- propelled, single operator, Caterpillar-based system designed to cover a 28,000-square-foot working face with a single fill in 40 minutes. The BSD7000 storage and dilution system is designed for bulk deliveries of RusFoam ADC and connects to PFU2500 with a single hose.

The BSD7000 automatically dilutes the RusFoam ADC concentrate, pumps the desired volume of diluted material to the PFU2500, which uses compressed air to generate 50,000 gallons of foam per fill.

Rusmar also offers various-sized trailer-mounted foam generation units to meet the smaller landfill needs. They are fitted with hose reels or turrets for ease of application. Supplemental solutions include perimeter odor control methods such as RusScent Odor Neutralizing Granules that can be applied with the company's nozzle spray or mist stick systems.

Kapahi contends that most facilities are not using the most up-to-date odor mitigation systems available today. According to Kapahi, three elements of an odor control strategy include identifying their source, monitoring them at the facility and treating them near the source, such as a landfill's working face, fugitive LFG, and compost windrows.

An operation should continually monitor odors and wind, says Kapahi. In monitoring odors, an H2S analyzer such as Arizona Instrument's portable Jerome 631 Gold Film Hydrogen Sulfide Analyzer is designed to display low level concentrations within seconds. It offers an analysis range of 0.003 to 50 ppm for odor and corrosion control, safety, and leak detection. Locked in survey mode, the instrument

can display concentrations every three seconds. It comes with an internal rechargeable battery pack or alternating current (AC) power.

Current odor technologies can be divided into three main categories, says Kapahi:

- Topical sprays: This type of system is a spray-bar type application allowing sites to directly apply odor control neutralizing agents to the odorous source. This is used for treatment of sludge odors, working face odors, or aids in treating odors when landfills are conducting odor-causing events.
- Portable odor control systems: There are multiple types of portable odor control systems that disperse neutralizing agents, from waterless vapor units, to misting systems. Landfills use these to treat areas that don't have readily available power and water. These units are also beneficial for landfills to aid in spot treatments or small areas that have breakouts.
- Perimeter systems: These are used to treat potential fugitive odors by positioning the odor control system in a location that is going to allow the neutralizer to mix with the odors. The release of odor neutralizer in a liquid or gaseous form into the air can be achieved by using a water-based atomizing system or a waterless vapor system.

Both odors and wind should be monitored onsite, says Kapahi, adding that such monitoring should encompass frequent onsite and offsite staff patrols. Control odors at or near the source, he says, adding the greater the distance between odor controls and the source, the lower the effectiveness.

Landfill and compost operators should consider a two-tier odor control system that includes source- and perimeter-based approaches. The delivery system of odor neutralizers is as important as the neutralizer, he says, adding that an odor control system must be dynamic and respond to changing levels of odor emission.

The best way to counter landfill odor problems is to seek out solutions that are both effective and safe for employers and the community, Haupert points out. "There are solutions that use natural ingredients to eliminate industrial smells without the need for harsh chemicals or masking fragrances," she says. "These solutions can be dispersed through oscillating fan systems, vaporization, atomization nozzles, and even sprayed on waste being transferred by trucks."

OMI offers Ecosorb technology, a blend of plant extracts, food grade surfactant, and water designed to eliminate organic and inorganic odors on a molecular level without the use of harsh or hazardous chemicals, emission control systems, or masking fragrances.

In transfer stations, Ecosorb often is dispersed through vapor systems that can be ducted to exhaust fans, doorway perimeters, and any other areas where odors might escape. Landfill operations use Ecosorb through the use of perimeter vapor systems and oscillating fan systems for direct application to the workface.

Ecosorb Spray Gel solution is used to cap odors from escaping into the atmosphere and can be dispersed onto trucks hauling solid waste or sludge and around landfills to effectively and safely neutralize malodors, says Haupert.

Tech Environmental helps its clients work on air quality, odor, noise, and dust issues affecting landfills, neighbors of landfills, and regulators. The company focuses on nuisance potential relative to odor, examining such factors as the existence of a regulation that specifies odor numerically and if not, what would be an appropriate regulation. "We help people understand that, help with some control technologies if necessary and help them get permitted," says Lannan. "In many landfill cases, the key is to establish an odor prevention and response program defining the odor baseline. As the landfill changes, the operators and management can monitor that."

Monitoring the amount of odor considered acceptable onsite that doesn't result in offsite nuisances enables landfill operators to modify those onsite odors before a change occurs in offsite odors, he adds.

Tech Environmental does not promote one odor technology over others on the market. In most cases, the best approach is a mix of odor control technologies, says Lannan, adding from a source point of view, landfills are area sources, whereas composting can be area, point or volume sources, depending on the technologies used, of which one may be more beneficial than the other.

The primary issue for all landfills is managing expectations, says Lannan. "Very often, landfill operators feel they are managing expectations relative to their job descriptions and tasks and they very well might be doing that, but it's getting everybody understanding what the expectations are, and managing them together."

Byers Scientific and Manufacturing first conducts an odor assessment to establish an immediate understanding of whether the odor is working face or LFG. "If you're not using an odor panel and just being binary, it's either this odor or that odor," says Byers. "It's the first step in an assessment—is it landfill gas, or is it garbage odor? Those two are distinctive. If it's garbage—which is working face odor—it all smells the same from one landfill to the next."

However, everyone's sensitivity is somewhat different, Byers points out, adding what really affects odor more than the waste stream is landfill practices. "Even the best-run outfits with gas wells can still have landfill gas that percolates up through the ground that they're just not able to pinpoint and that can get into the airstream," says Byers.

If a determination is made that there is a fair amount of fugitive malodor, Byers Scientific & Manufacturing's waterless vapor phase technology is installed. "We put a perimeter around the landfill inasmuch as we can," says Byers. "It doesn't mean 360 degrees. It's really more putting a virtual wall of deodorizer in its vapor state downwind of the emissions source and upwind from an affected community."

The waterless vapor system can go 500 feet or 4,000 feet continuous, says Byers. The equipment takes a third-party liquid formulation, transfers it to its vapor state and delivers it through a piping system, creating what Byers calls a "virtual curtain."

The malodors being addressed is why the company focuses on vapor technology, says Byers. "It's never pure H2S [hydrogen sulfide]—it's H2S with something attached to it," says Byers. "You can't see those odors because they're a gas. If you can't see them, that means they're traveling in the wind stream. The best way to combat them is to increase the probability of contact of the deodorizer molecule with the odorous molecule as opposed to a misting system."

Byers contends that with misting systems, "the fact that you can see it right there is a bit of a weakness, because clearly, those droplets are heavier than air, and while they're going to carry in the air for a short time, they're going to fall eventually.

"Anything they don't come into contact with, such as fugitive malodor compounds, are free to travel the air stream and ultimately make their way to a neighborhood. Better to put a vapor up in the same airstream so they travel together further."

Deodorization is predicated on physical contact, notes Byers. "The deodorizer has to come into physical contact with the malodor and a number of different chemical reactions such as absorption or displacement can take place," he says. "In its gaseous state, the only thing that's going to keep up with it effectively is another gas. That's why we deploy vapor systems."

In applications where the goal is for the deodorizer to fall out quickly, the company will employ a fan system using atomization. "That's what we call closed quarters fighting—the working face as an example," says Byers. "In that case, we want products that are heavy, getting right out over the top of the working face and falling down onto it. That way, we're increasing the probability of contact. We apply that same methodology—whether it's vapor or misting—to material transfer stations where we do a virtual vapor curtain around the doors."

Byers points out that while communities surrounding landfills may be put off by the odors, another concern is whether the "cure" is worse.

Byers Scientific & Manufacturing has undergone and passed the highest level of EPA guideline testing for toxicity in addition to engaging in third-party research showing the product significantly exceeds acceptable standards, Byers says.

Timothy K. Nytra, principal with Civil & Environmental Consultants, points out when it comes to landfill odors, "an ounce of prevention is worth a pound of cure. The proper management of these items minimizes offsite odors through the design and installation of active LFG systems, final cover caps and a well-maintained working face."

It is much easier to prevent offsite odors from becoming a problem rather than correct the problem after it's become an issue, Nytra points out. "Most of the offsite landfill odor issues that become a public nuisance are the result of an ineffective LFG system that needs to be improved and or expanded," he says. "The elimination of offsite LFG odor is not readily resolvable with a quick fix."

The solution is accomplished at a considerable financial cost to the landfill and may take weeks to resolve, much to the anger and resentment of the affected residents complaining of odor, and the governing regulatory agencies receiving public complaints on a daily basis, he adds.

As odors are a function of the waste that was and is being disposed of at the landfill, they change and evolve during the landfill's life, says Nytra. "For example, if the landfill begins to accept sewage sludge from a municipal wastewater treatment plant for the first time and does not take the proper precautions to quickly bury the sludge or mix it with other waste types when it arrives, then it is possible for the smell of sludge to migrate offsite," he points out.

Persistent offsite odors are not standard operating procedure for a landfill, Nytra contends. "Properly operated landfills do not generate persistent offsite odors," he adds. "That's not to infer that an occasional odor won't be detected. Landfills are complicated and there are many variables—including weather—that impact offsite odor."

If the landfill doesn't properly maintain its active LFG system, construct final cover shortly after waste reaches permitted grade or manage the working face on a daily basis by covering the waste at the end of the day, then it is possible that odor could migrate offsite and become an intense nuisance issue, says Nytra.

Some wastestreams are "much more fragrant than others" and as such, their smells could dominate all the other wastestreams.

Nytra points out that of all of the technologies available to combat shifting or changing odors, they all have varying degrees of effectiveness. "It is best to use a neutralizer and not a masking agent," he says. "Dispensing a cherry- or lemon-scented fragrance into the air of the surrounding neighborhoods will generate as many complaints as the landfill odor itself. Each landfill is unique given its location, prominent wind direction and the type and amount of waste received. Odor products that have some degree of success at one landfill may not work at another."

Incoming wastestreams are a "huge" factor that landfill operators must understand and be ready to handle, says Nytra.

Compost has its own unique odor generation. Dunderdale notes that the decomposition of organics results in greater odors.

"It's like putting green waste in a trash bag and tying the top of it," he points out. "It creates ammonia gas and when you open it up again, it reeks." A primary preventative approach is diversion through a dedicated green waste program and proper composting that addresses the underlying odor problems caused by anaerobic conditions.

Odor is one of the more difficult facets to manage on a compost site, "and is one of the issues that can cause a facility to be fined or shut down, so it's critical to them," notes Nathan O'Connor, marketing and product manager for compost products for Reotemp Instruments.

Reotemp Instruments offers an oxy temp probe which samples oxygen and temperature. The probe is inserted into a compost pile; the sample drawn is analyzed for the percentage of oxygen that is present. "It allows them to know if their pile has gone anaerobic or has a very low level of oxygen, which can be very relevant to odors," he explains. "If the oxygen levels go to the point where it's gone anaerobic, odor issues can be a lot more prevalent."

SCARAB International offers a variety of windrow composters from 8 feet wide 4 feet tall, to 27 feet wide 11 feet tall. The machines are self-propelled, straddle-type turners that will turn 6- through 27-foot windrows. They are belt- or hydraulic-driven machines with a track design and independent suspension, designed to allow the machine to "float" across many varieties of terrain. Drive systems options include front-drive tires with castors in the back or transverse configuration, four-wheel drive, rubber tires, and full track 14 to 30 inches wide. Drums are available in six sizes with eight flail designs and various configurations. SCARAB constructs the machines to facility specifications and accounts for the type of material that is going to be turned, notes Richard Miller, sales manager for SCARAB.

The rule of thumb for using the machines is that no matter the composition of the material, the windrow should be turned two to three times a week for six to eight weeks at 60% humidity, Miller says. "By doing so, you're helping nature along its pathway to decompose and to create compost. We also recommend using a thermometer to measure the heat of the mixture. We always recommend that somewhere around 137 degrees Fahrenheit you can start, and that starts to erode and starts eating up all of the bad bugs in there. At 165 degrees, you're reaching greenhouse quality compost, which means it's killed all of the weeds, spores, and the bad bugs, no matter what you are turning."

In some composting operations, temperatures reach 137°F in two days, says Miller. "The more you turn it instead of letting it sit there, you put more air with it and it cuts the odor down. If you let it sit there, it's going to start losing its aeration, which goes into making an odor. It's going to trap the gasses.

When you aerate it, you're letting those gasses go. It mixes with the air, but with that process, you're reducing the odor."

He says the method is "simple, basic composting," which company founder Marvin Urbanczyk has taught at United States Composting Council conferences.

"Some companies might use bugs to enhance it," adds Miller. "That might speed the process up by two weeks, but if you can compost it naturally, that's the way to go."

Humidity is an influencing factor in the process. "The natural climate humidity will always affect whether the air is heavier or lighter. Arid climates are going to have to inject water into the piles to get it to compost. Dry matter can't really decompose. It has to have some type of moisture in there to act as the generator of the composting," says Miller.

A Florida operation produces compost in 20 days because the product is turned quite a bit in the high humidity climate, notes Miller. "They're under roof and they turn their raw sludge with yard waste. Anywhere you go, once you have that smell, you know what they're turning. You'll recognize the odor. The way they turn it as quickly as they turn it, their odor is very minimal."

Another operation in an arid area around Fresno, CA, has to inject water into the compost piles, Miller adds.

The occurrences of odor issues have become more numerous as municipalities fail to integrate odor and annoyances when they plan new buildings and infrastructure close to composting plants or landfills, says Yann Contratto, president and senior odor expert for OflactoExpert. "Most managers of a compost plant or landfill will tell you 20 years ago, they had no issue. This wasn't because people weren't less attentive to the odor, dust, or to the noise. The sites were implemented far enough away from cities to avoid any of these annoyances. Due to cities wanting to have more tax revenue, they've established more neighborhoods closer to these plants."

Another impact: the waste material. Case in point: Toronto. "In a few months, the city successfully moved ahead for the sorting of the organics to compost instead of going to landfill and the campaign had been very efficient—in fact, too efficient," he says. "Very quickly, the compost facilities in Toronto closed because they were completely full and then they were obliged to start to send the materials far away."

Toronto now picks up organics and takes them to an organics processing facility, one of which is the Disco Organic Processing Facility. An anaerobic digestion process is used to break down the organics, producing a digestate sent to contractors to be converted into compost for use in parks and gardens.

Odor was a byproduct of the quick success of the organics collection program, Contratto says. "We not only had traces of fish, chicken, vegetables, and fruits—we also had a lot of diapers. We had a lot of very odorous material inside these sortings and it was an absolute nightmare to treat everywhere."

He recommends consulting with the US Composting Council for information regarding what can and can't be composted, and to convey that information to the general population. "A compost manager would have tremendous difficulties to do that job appropriately because there would be too many odors and the compost would have decreased quality to it. When the information is not properly given to the population, it can very quickly become a huge odor issue."

The type of feedstock and the technologies utilized at a compost operation also can impact dust and odor emissions, he says.

An initial odor may be "acceptable," but after waiting three or four weeks before turning the material in the windrow, "the odor emission explodes during the operation, which can take three to four," says Contratto. "[The odor] can move very far into the population," he says, adding that the weather conditions also will play a factor and given the changing intensity of odors in reaction to temperatures, it's critical for a compost operator to be cognizant of the threshold.

Geographical placement also is a consideration, says Contratto. A compost operation in Maine may not have the same humidity concerns as one in California, he points out.

Topography is another issue. "There are a lot of land features that can change odor emissions," he says. "The best way to deal with that is through regulation of what can and cannot be emitted."

His company conducts odor impact studies. "If each state establishes a few odor impact studies on a compost facility, that can help them to regulate what can be acceptable and what cannot be acceptable in terms of compost features," says Contratto.

OlfactoExpert helps compost facilities and landfills by conducting olfactory audits and diagnoses, measuring emissions, and providing support. The company uses emetrics, a tool that draws together the operations of independent or assisted odor measurements, integrated sampling tools, outcome mapping, and real-time, reverse modelling calculations.

Rotochopper offers a line of grinders and shredders to process wood waste, food waste and other green waste inputs used to make compost, notes Nick Korn, West Coast regional sales manager for Rotochopper.

Wood waste can be ground up and added to other components that create a biofilter to help control odor, he adds. The machinery also serves to properly size waste so when it is put into windrows or aerated piles to compost it, it composts efficiently and in such a way that odor is minimized.

Some end users of Rotochopper technology are located close to residential areas "and are trying to prove urban composting can effectively be done even in a sensitive environment," he says, adding that the issue of controlling odors will take on increasing importance.

Odors evolve and change as the "tremendous growth and interest in food recycling" moves forward, notes Korn. "California, for example, has an upcoming mandate to move from 50% landfill diversion, up to 75%. One of the next key arenas to help accomplish that goal is food waste. Odor control is difficult for a lot of different materials—food waste in particular. Being able to process the food waste properly through our Rotochopper grinders, having the right mixture of food waste which is nitrogen dense and having the right ratios of the food waste with the carbon base and with the wood material is crucial."

Korn points out that some regions have flow control laws restricting the outbound movement of waste. "On the West Coast, it's that classic challenge of the majority of waste gets generated in the densely populated urban areas, and it costs money to move waste out of that area, so the goal is to show how it can be done most efficiently—how it can be recycled, turned into soil and mulched, or produce other products right in the local area. It doesn't make sense to incur a tremendous amount of transport costs when the compost and mulch that could be produced could be used by folks in the same area."

The Brown Bear Corporation's potassium permanganate product is used in situations where a sludge product from a wastewater plant is taken to a landfill and blended with green waste material to mitigate the odor that results from the initial mix into the composting processes as hydrogen sulfide and ammonia is given off. The company has a spray system for its composting equipment that applies soluble potassium permanganate to help knock down the odor, "which is really the bad odor you get a lot of complaints on," notes Stan Brown, owner of Brown Bear.

A 2–5% solution is used depending on the strength of the odor. "It doesn't mask it—it oxidizes it," says Brown. MSW

ECOSORB CNB 100

Safety Data Sheet
according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations
Date of issue: 12/04/2017 Version: 1.0

SECTION 1: Identification

1.1. Identification

Product form : Mixture

Product name : ECOSORB CNB 100

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Odor Neutralizer

Recommended use : Odor Neutralizer

Restrictions on use : None known

1.3. Details of the supplier of the safety data sheet

Manufacturer
OMI Industries
1300 Barbour Way
Rising Sun, IN 47040 - U.S.A
T 1-847-304-9111

1.4. Emergency telephone number

Emergency number : 1-800-662-6367, Monday - Friday 8 am to 5 pm CST

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Not classified

2.2. Label elements

2.3. Other hazards

Other hazards not contributing to the classification : None under normal conditions. Keep out of reach of children.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substances

3.2. Mixtures

This mixture does not contain any substances to be mentioned according to the criteria of section 3.2 of HazCom 2012

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Call a poison center/doctor/physician if you feel unwell.

First-aid measures after inhalation : Move to fresh air if necessary.

First-aid measures after skin contact : Wash skin with plenty of water.

First-aid measures after eye contact : Rinse eyes with water as a precaution.

First-aid measures after ingestion : Call a poison center/doctor/physician if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects : None under normal use.

Symptoms/effects after inhalation : No effects known.

Symptoms/effects after skin contact : No effects known.

Symptoms/effects after eye contact : No effects known.

Symptoms/effects after ingestion : No effects known.

Symptoms/effects upon intravenous administration : No other effects known.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Dry powder. Foam. Carbon dioxide.

Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : Not flammable.

Reactivity : The product is non-reactive under normal conditions of use, storage and transport.

5.3. Advice for firefighters

Firefighting instructions : Cool tanks/drums with water spray/remove them into safety.

Protection during firefighting : Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Stop leak if safe to do so.

6.1.1. For non-emergency personnel

Protective equipment : Gloves and safety glasses recommended.

Emergency procedures : Ventilate spillage area.

6.1.2. For emergency responders

Protective equipment : Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment. Prevent liquid from entering sewers, watercourses, underground or low areas.

6.3. Methods and material for containment and cleaning up

For containment : Collect spillage.

Methods for cleaning up : Take up liquid spill into absorbent material.

Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13. For further information refer to section 8: "Exposure controls/personal protection".

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Ensure good ventilation of the work station. Wear personal protective equipment.

Hygiene measures : Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures : Does not require any specific or particular technical measures.

Storage conditions : Store in a well-ventilated place. Keep cool.

Incompatible products : Oxidizing agent. Strong acids.

Incompatible materials : Keep away from strong acids and strong oxidizers.

Storage temperature : 4 - 29 °C 40°F and 85°F Allowing product to freeze may cause layering.

Heat-ignition : KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.

Information on mixed storage : KEEP SUBSTANCE AWAY FROM: (strong) acids. oxidizing agents.

Storage area : Keep container in a well-ventilated place. Store in a cool area. Keep out of direct sunlight. Store in a well-ventilated place.

Special rules on packaging : Keep only in original container.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

8.2. Exposure controls

Appropriate engineering controls : Ensure good ventilation of the work station.

8.3. Individual protection measures/Personal protective equipment

Personal protective equipment : Gloves and safety glasses recommended.

Hand protection : Protective gloves. Recommended.

Eye protection : Safety glasses. Recommended.

Skin and body protection : None under normal use.

Respiratory protection : Respiratory protection not required in normal conditions.

Thermal hazard protection : Not applicable.

Environmental exposure controls : Avoid release to the environment.

Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance	: White liquid.
Color	: White
Odor	: Characteristic odour
Odor threshold	: No data available
pH	: 6 - 8.5
Melting point	: Not applicable
Freezing point	: No data available
Boiling point	: ≈ 99 °C
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Not applicable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: ≈ 0.99
Solubility	: Soluble in water.
Partition coefficient n-octanol/water	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: ≈ 1 cSt
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No dangerous reactions known under normal conditions of use.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Oxidizing agent. Strong acids.

10.6. Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure : Inhalation; Dermal

Acute toxicity : Not classified

Skin corrosion/irritation : Not classified
pH: 6 - 8.5

Serious eye damage/irritation : Not classified
pH: 6 - 8.5

Respiratory or skin sensitization : Not classified.

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity – single exposure : Not classified

Specific target organ toxicity – repeated exposure : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : No other effects known.

Symptoms/effects after inhalation : No effects known.

Symptoms/effects after skin contact : No effects known.

Symptoms/effects after eye contact : No effects known.

Symptoms/effects after ingestion : No effects known.

Symptoms/effects upon intravenous administration : No other effects known.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment.

12.2. Persistence and degradability

ECOSORB CNB 100	
Persistence and degradability	Biodegradability in water: no data available.

12.3. Bioaccumulative potential

ECOSORB CNB 100	
Bioaccumulative potential	Not established.

12.4. Mobility in soil

ECOSORB CNB 100	
Ecology - soil	The product is predicted to have high mobility in soil. Soluble in water.

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste)	: Disposal must be done according to official regulations.
Waste treatment methods	: Dispose of contents/container in accordance with licensed collector's sorting instructions.
Sewage disposal recommendations	: Disposal must be done according to official regulations.
Product/Packaging disposal recommendations	: Avoid release to the environment.
Ecology - waste materials	: Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Not regulated

Transportation of Dangerous Goods

Not regulated

Transport by sea

Not regulated

Air transport

Not regulated

SECTION 15: Regulatory information

15.1. US Federal regulations

ALL COMPONENTS OF THIS PRODUCT ARE LISTED, OR EXCLUDED FROM LISTING, ON THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY TOXIC SUBSTANCES CONTROL ACT (TSCA) INVENTORY

15.2. International regulations

CANADA

ECOSORB CNB 100
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

ECOSORB CNB 100
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

National regulations

ECOSORB CNB 100
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Korean ECL (Existing Chemicals List) Listed on INSQ (Mexican National Inventory of Chemical Substances)

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

SECTION 16: Other information

Training advice : Normal use of this product shall imply use in accordance with the instructions on the packaging.

Other information : None.

ABBREVIATIONS AND ACRONYMS:	
ATE	Acute Toxicity Estimate
BCF	Bioconcentration factor
IATA	International Air Transport Association
IMDG	International Maritime Dangerous Goods
LC50	Median lethal concentration
IARC	International Agency for Research on Cancer
OECD	Organisation for Economic Co-operation and Development
LD50	Median lethal dose
SDS	Safety Data Sheet
STP	Sewage treatment plant

Hazard Rating

Health : 0 Minimal Hazard - No significant risk to health

Flammability : 0 Minimal Hazard - Materials that will not burn

Physical : 0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.

Personal protection : B

B - Safety glasses, Gloves

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product

LANDFILL > NUISANCES

Employing New Weapons to Fight Landfill Odors

Even the best methods can't stop all the odors that arise from decaying garbage.

Arlene Karidis | Mar 03, 2017

Landfill owners spend millions to control or prevent noxious odors, one of their greatest struggles. In less common, worst-case scenarios, they invest millions more dealing with lawsuits .

Some of best defenses against the uphill battle are complex gas collection systems, practices to minimize storm water infiltration and diligent monitoring. But even the best methods can't stop all the odors that arise from decaying garbage, refuse trucks themselves and elements like shifting elevations, winds and fluctuating

temperatures. All of those factors make it difficult to determine where odors are or how to control them, explains Laura Haupert, director of research and development at Long Grove, Ill.-based OMI. The company offers odor control systems within the solid waste management and other industrial niches.

OMI's misting technology, which includes multiple application types for landfills, is among the stench-fighting tools on the market. The company is partnering

with Bloomington, Ind.-based Byers Scientific and Manufacturing , incorporating that company's technology to improve delivery of OMI's products. San Diego's Miramar landfill may soon be among the first to employ the product on a commercial scale.

OMI's brand, Ecosorb, is a blend of plant oils and water, sprayed in the air. It forms droplets that attract and absorb airborne odor molecules.

There are several ways to spray it, including through large overhead devices that trucks drive underneath that emit fine mists.

Another system, which can be applied around entire landfills, leverages a technology to vaporize OMI's liquid product. It's pumped through nozzles and blown into collapsible tubing.

Landfill gas odors are especially problematic in mornings and evenings when cool temperatures can elicit reactions, explains Marc Byers, president of Byers Scientific and Manufacturing in Bloomington, Ind.

"The colder air holds the warmer air closer to the ground with gases that aren't making their way into the atmosphere," Byers says. "And that's when most verifiable odor complaints happen, from early evening until around 7 in the morning," he says.

Misting deodorizing systems like OMI's help. But they have limitations.

Within mists, deodorizing particles are heavier than air and often fall to the ground before they come in contact with odors. The longer the particles travel together the higher the likelihood they will come in contact and that a reaction will occur.

“That’s the idea in practice, but execution still needs to be addressed,” Byers says. “And this requires equipment that can transition the deodorizer from liquid to gas, in a uniform, controllable manner. We’ve done that and have a patent pending on it.”

Byers was focusing on deodorizing agents with a proven reaction with a broad spectrum of malodors in the solid waste industry.

“Instead of trying to fight many malodor particles with one deodorizer particle, we use a formulation with several odor-fighting particles,” he says.

The manufacturing company took different dilutions of OMI’s Ecosorb product, and worked with these dilutions “until we came out with a probability of product effectiveness that we were comfortable works with our equipment,” Byers says. “And that’s what OMI blends for us. We needed to match the formula with our equipment’s delivery system.”

Alternative misting products face issues such as clogged nozzels. In cold enough weather, the mists can also freeze. Byers says his company’s system can run at colder temperatures when landfill odors tend to be worse.

San Diego launched a pilot at the Miramar landfill employing a mobile vapor unit using the firm’s technology and is proposing adding a fixed, 3,500-ft. system for its composting facility. The goal of the larger setup would be to address variable wind conditions without having to move the system around to ensure optimum coverage.

The pilot is still in progress, but early results demonstrate that the system is able to neutralize the odors under potential odor-conducive atmospheric conditions.

“Both our regulators and participating community members are reporting fewer odors in the impacted communities,” says Mark zu Hone, program manager of landfill operations at Miramar.

The operation has only used the technology since Jan. 13, and has yet to go through seasonal fluctuations to help validate overall effectiveness.

“There is a long way to go to see how it works throughout an operational year,” zu Hone says. “However, early results are very favorable, and the product and technology appear to be meeting our needs during what is traditionally the most difficult time of year for potential odor impacts.”

ATTACHMENT 2
Meteorological Data

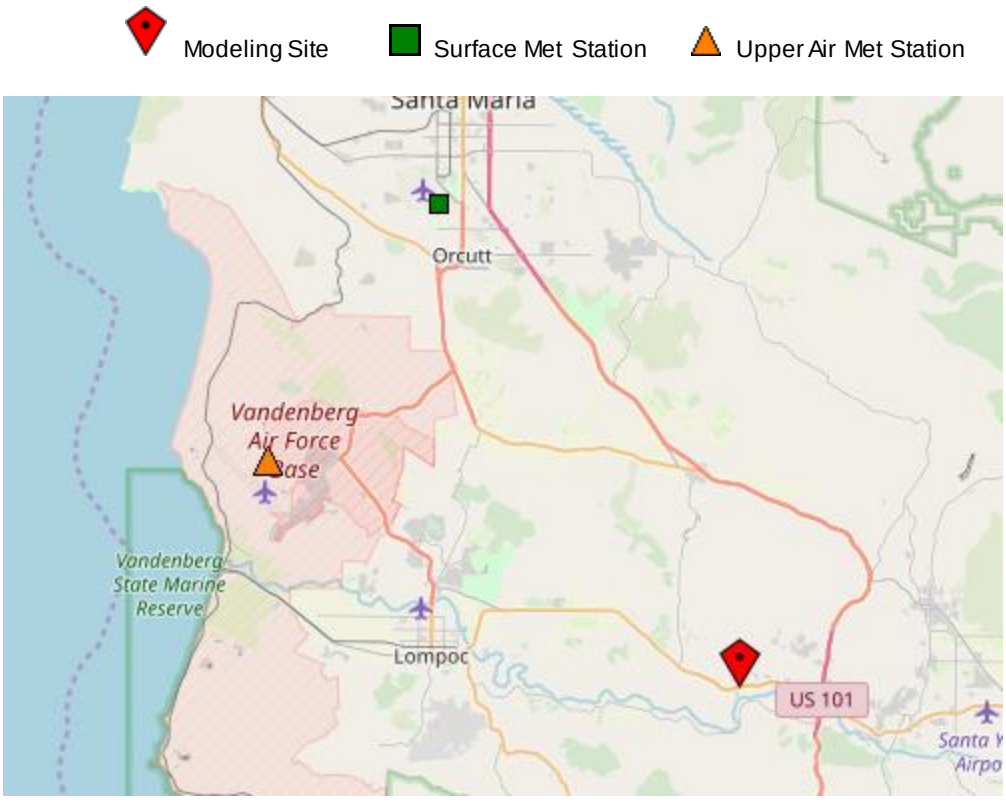
AERMOD-Ready Station Met Data

SFC and PFL Met Data Files

August 1, 2019

Met Data Order Information

Order #	MET1914753
Ordered by	Andre Almeida
Company	Sespe Consulting
Met Data Type	AERMOD-Ready Station Met Data (Surface & Profile Met Data Files)
Start-End Date	Jan 1, 2014 to Dec 31, 2018
Modeling Site Latitude	34.62083 N
Modeling Site Longitude	120.24722 W
Datum	WGS 84
Site Time Zone	UTC/GMT UTC-0800 hour(s)
Closest City & State	Buellton, California - USA



Location of Modeling Site, Surface Station, and Upper Air Station

Lakes Environmental Software
E-mail: sales@webLakes.com
Web: www.webLakes.com

Model Versions Used for Met Data Preprocessing

Parameter	Value
AERMET	Version 18081
AERMINUTE	Version 15272
AERSURFACE	Version 13016

Hourly Surface Station Met Data Information

Parameter	Value
Surface Station Name	SANTA MARIA PUBLIC, CA
Latitude, Longitude	34.89406 N, 120.45216 W
Station ID (WBAN)	23273
ASOS Station?	Yes
File Format	NCDC TD-3505 (ISHD)
Base Elevation	72.5 m
Adjustment to Local Time	8 hours
Anemometer Height	10 m

1-Minute & 5-Minute ASOS Wind Data Information

Parameter	Value
AERMINUTE Data Used?	Yes
Station Name	SANTA MARIA PUBLIC, CA
Latitude, Longitude	34.89406 N, 120.45216 W
Station Code	SMX
Station ID (WBAN)	23273
File Format	NCDC TD-6405
IFW Installation Date	June 6, 2007

Upper Air Station Met Data Information

Parameter	Value
Upper Air Station Name	VANDENBERG, CA
Latitude, Longitude	34.75 N, 120.57 W
Station ID (WBAN)	93214
File Format	FSL
Adjustment to Local Time	8 hours

Lakes Environmental Software
E-mail: sales@webLakes.com
Web: www.webLakes.com

AERSURFACE Parameters

Parameter	Value
Land Use Data File	USGS NLCD92 – Binary Format
Center Lat/Long	34.89406 N, 120.45216 W
Datum	NAD83
Radius for Surface Roughness	1km
Number of Sectors	12 sectors of 30° (starting at 0°)
Period	Monthly
Surface Moisture	Year 2014: Average Year 2015: Dry Year 2016: Average Year 2017: Average Year 2018: Average
Other Settings	Continuous Snow: No Airport Site: Yes Arid Region: No

Lakes Environmental Software
E-mail: sales@webLakes.com
Web: www.webLakes.com

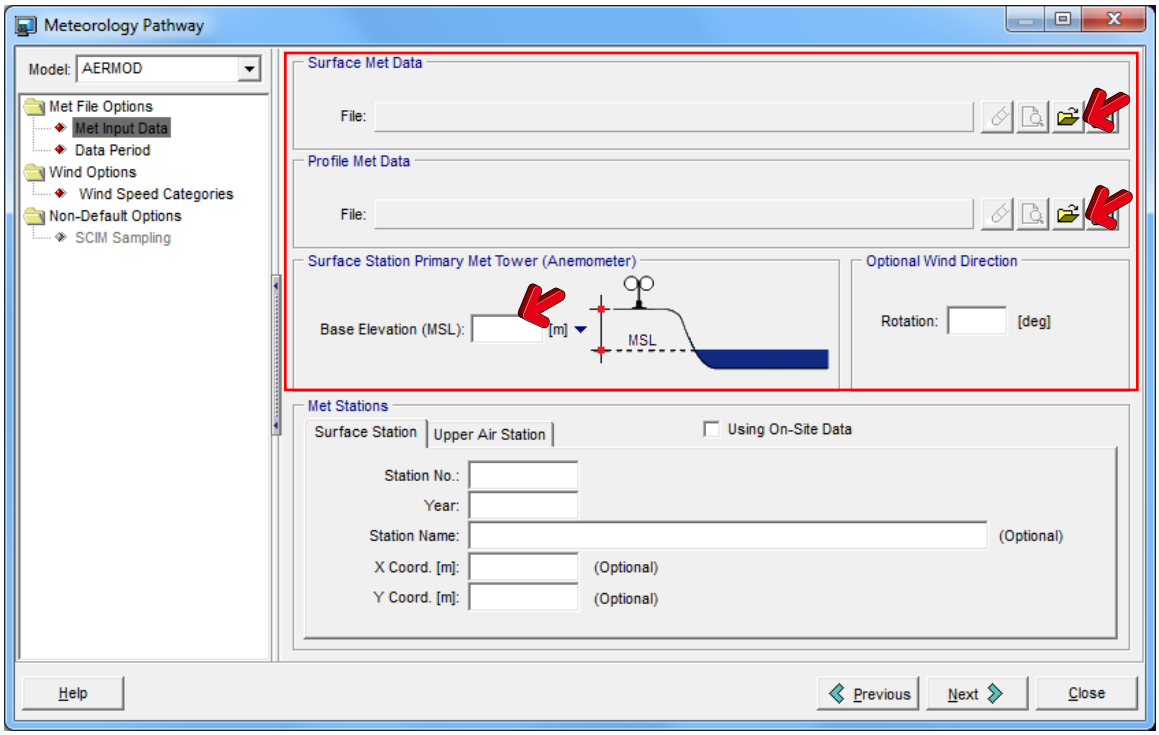
AERMOD View Instructions

Start your **AERMOD View** project and go to the **Meteorology Pathway – Met Input Data** window.

Under the **Meteorology Pathway – Met Input Data** window, specify the Surface Met Data file (*.SFC) and the Profile Met Data file (*.PFL) you received from Lakes Environmental according to table below:

AERMOD Parameters

Parameter	Value
Surface Met Data File	MET1914753_2014_2018.SFC
Profile Met Data File	MET1914753_2014_2018.PFL
Station Base Elevation (MSL)	72.5 m
Surface Station No.	23273
Surface Station Name	SANTA MARIA PUBLIC, CA
Start Year	2014
Upper Air Station No.	93214
Upper Air Station Name	VANDENBERG, CA
Start Year	2014



Lakes Environmental Software
E-mail: sales@webLakes.com
Web: www.webLakes.com

Having Problems?

If you have any problems with the met data you received from us or need additional information on the above steps, please do not hesitate to contact us by sending an email to:

sales@webLakes.com

When contacting us, please provide:

- Met data Order # MET1914753
- Detailed description of the problem

Lakes Environmental Software
E-mail: sales@webLakes.com
Web: www.webLakes.com

Station ID: 23273
Year: 2014
Time Range: 00:00 - 23:00

Run ID: Flowering Months

Date Range Report

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan																															
Feb																															
Mar																															
Apr																															
May																															
Jun																															
Jul																															
Aug	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sep	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Oct																															
Nov																															
Dec																															

Station ID: 23273
Start Date: 8/1/2014 - 00:00
End Date: 9/30/2018 - 23:59

Run ID: Flowering Months

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (Knots)

	0.97 - 4.08	4.08 - 7.00	7.00 - 11.08	11.08 - 17.11	17.11 - 21.58	>= 21.58	Total
355-5	44	14	0	0	0	0	**58**
5-15	33	6	0	1	0	0	**40**
15-25	22	1	0	0	0	0	**23**
25-35	23	4	1	0	0	0	**28**
35-45	26	4	0	0	0	0	**30**
45-55	23	3	0	0	0	0	**26**
55-65	36	4	2	0	0	0	**42**
65-75	23	6	1	0	0	0	**30**
75-85	28	2	0	0	0	0	**30**
85-95	29	2	0	0	0	0	**31**
95-105	44	7	1	0	0	0	**52**
105-115	58	5	0	0	0	0	**63**
115-125	84	3	0	0	0	0	**87**
125-135	83	8	1	0	0	0	**92**
135-145	94	12	0	0	0	0	**106**
145-155	132	22	1	0	0	0	**155**
155-165	108	26	0	0	0	0	**134**
165-175	112	33	1	0	0	0	**146**
175-185	110	34	3	4	0	0	**151**
185-195	81	15	2	1	0	0	**99**
195-205	87	11	1	0	0	0	**99**
205-215	60	5	0	0	0	0	**65**
215-225	59	6	3	0	0	0	**68**
225-235	63	9	1	1	0	0	**74**
235-245	84	13	7	3	0	0	**107**
245-255	75	14	10	2	0	0	**101**
255-265	105	16	8	2	0	0	**131**
265-275	116	40	11	1	0	0	**168**
275-285	225	89	15	0	0	0	**329**
285-295	234	194	65	32	16	2	**543**
295-305	278	336	386	224	79	19	**1322**
305-315	213	354	691	394	29	1	**1682**
315-325	160	189	235	142	0	0	**726**
325-335	99	92	42	12	0	0	**245**
335-345	78	35	5	2	0	0	**120**
345-355	54	17	2	0	0	0	**73**
Total	3183	1631	1495	821	124	22	7320

Frequency of Calm Winds: 37
Average Wind Speed: 6.14 Knots

Station ID: 23273
Start Date: 8/1/2014 - 00:00
End Date: 9/30/2018 - 23:59

Run ID: Flowering Months

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (Knots)

	0.97 - 4.08	4.08 - 7.00	7.00 - 11.08	11.08 - 17.11	17.11 - 21.58	>= 21.58	Total
355-5	0.006011	0.001913	0.000000	0.000000	0.000000	0.000000	**0.007923**
5-15	0.004508	0.000820	0.000000	0.000137	0.000000	0.000000	**0.005464**
15-25	0.003005	0.000137	0.000000	0.000000	0.000000	0.000000	**0.003142**
25-35	0.003142	0.000546	0.000137	0.000000	0.000000	0.000000	**0.003825**
35-45	0.003552	0.000546	0.000000	0.000000	0.000000	0.000000	**0.004098**
45-55	0.003142	0.000410	0.000000	0.000000	0.000000	0.000000	**0.003552**
55-65	0.004918	0.000546	0.000273	0.000000	0.000000	0.000000	**0.005738**
65-75	0.003142	0.000820	0.000137	0.000000	0.000000	0.000000	**0.004098**
75-85	0.003825	0.000273	0.000000	0.000000	0.000000	0.000000	**0.004098**
85-95	0.003962	0.000273	0.000000	0.000000	0.000000	0.000000	**0.004235**
95-105	0.006011	0.000956	0.000137	0.000000	0.000000	0.000000	**0.007104**
105-115	0.007923	0.000683	0.000000	0.000000	0.000000	0.000000	**0.008607**
115-125	0.011475	0.000410	0.000000	0.000000	0.000000	0.000000	**0.011885**
125-135	0.011339	0.001093	0.000137	0.000000	0.000000	0.000000	**0.012568**
135-145	0.012842	0.001639	0.000000	0.000000	0.000000	0.000000	**0.014481**
145-155	0.018033	0.003005	0.000137	0.000000	0.000000	0.000000	**0.021175**
155-165	0.014754	0.003552	0.000000	0.000000	0.000000	0.000000	**0.018306**
165-175	0.015301	0.004508	0.000137	0.000000	0.000000	0.000000	**0.019945**
175-185	0.015027	0.004645	0.000410	0.000546	0.000000	0.000000	**0.020628**
185-195	0.011066	0.002049	0.000273	0.000137	0.000000	0.000000	**0.013525**
195-205	0.011885	0.001503	0.000137	0.000000	0.000000	0.000000	**0.013525**
205-215	0.008197	0.000683	0.000000	0.000000	0.000000	0.000000	**0.008880**
215-225	0.008060	0.000820	0.000410	0.000000	0.000000	0.000000	**0.009290**
225-235	0.008607	0.001230	0.000137	0.000137	0.000000	0.000000	**0.010109**
235-245	0.011475	0.001776	0.000956	0.000410	0.000000	0.000000	**0.014617**
245-255	0.010246	0.001913	0.001366	0.000273	0.000000	0.000000	**0.013798**
255-265	0.014344	0.002186	0.001093	0.000273	0.000000	0.000000	**0.017896**
265-275	0.015847	0.005464	0.001503	0.000137	0.000000	0.000000	**0.022951**
275-285	0.030738	0.012158	0.002049	0.000000	0.000000	0.000000	**0.044945**
285-295	0.031967	0.026503	0.008880	0.004372	0.002186	0.000273	**0.074180**
295-305	0.037978	0.045902	0.052732	0.030601	0.010792	0.002596	**0.180601**
305-315	0.029098	0.048361	0.094399	0.053825	0.003962	0.000137	**0.229781**
315-325	0.021858	0.025820	0.032104	0.019399	0.000000	0.000000	**0.099180**
325-335	0.013525	0.012568	0.005738	0.001639	0.000000	0.000000	**0.033470**
335-345	0.010656	0.004781	0.000683	0.000273	0.000000	0.000000	**0.016393**
345-355	0.007377	0.002322	0.000273	0.000000	0.000000	0.000000	**0.009973**
Total	0.434836	0.222814	0.204235	0.112158	0.016940	0.003005	0.993989

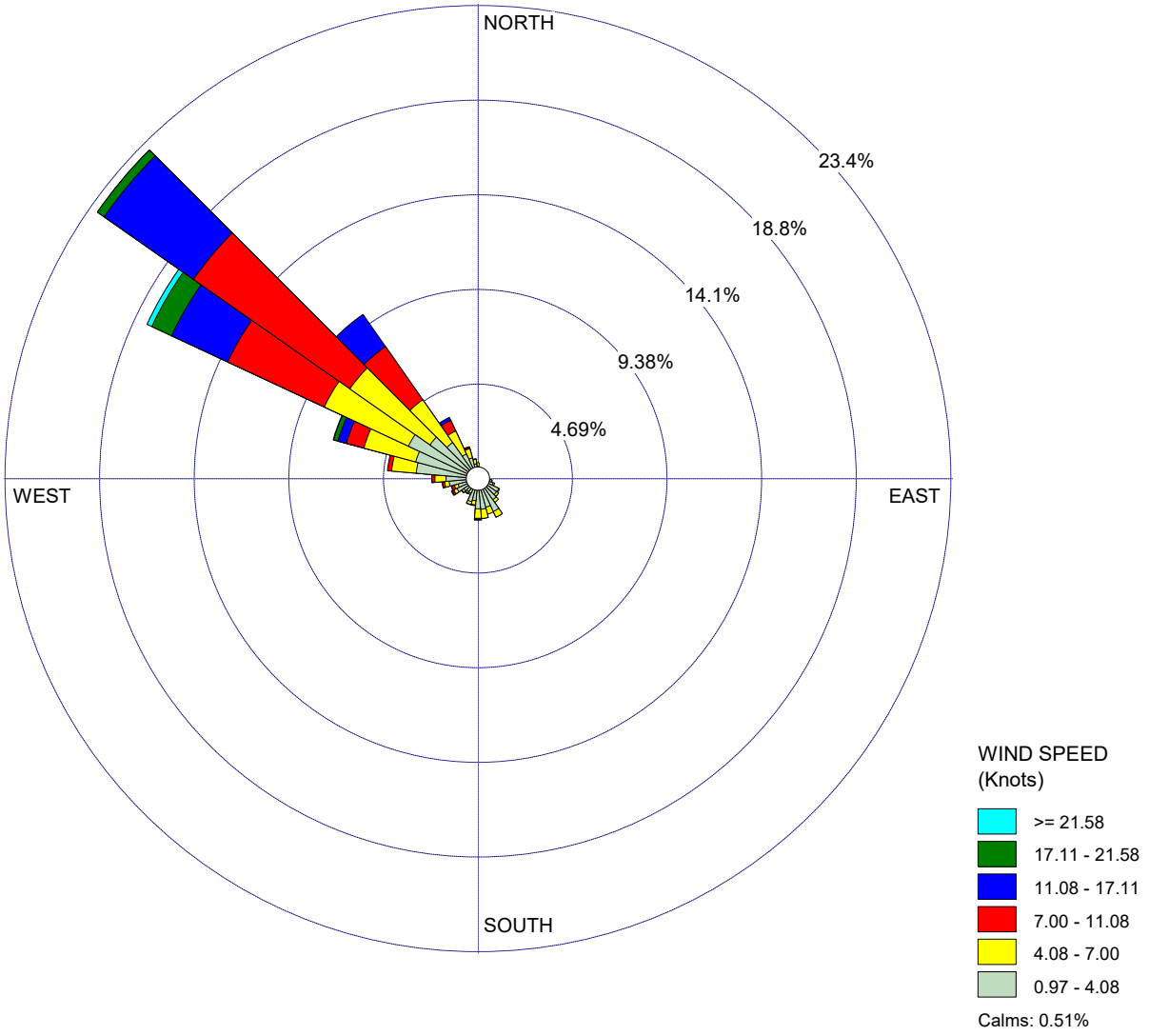
Frequency of Calm Winds: 0.51%
Average Wind Speed: 6.14 Knots

WIND ROSE PLOT:

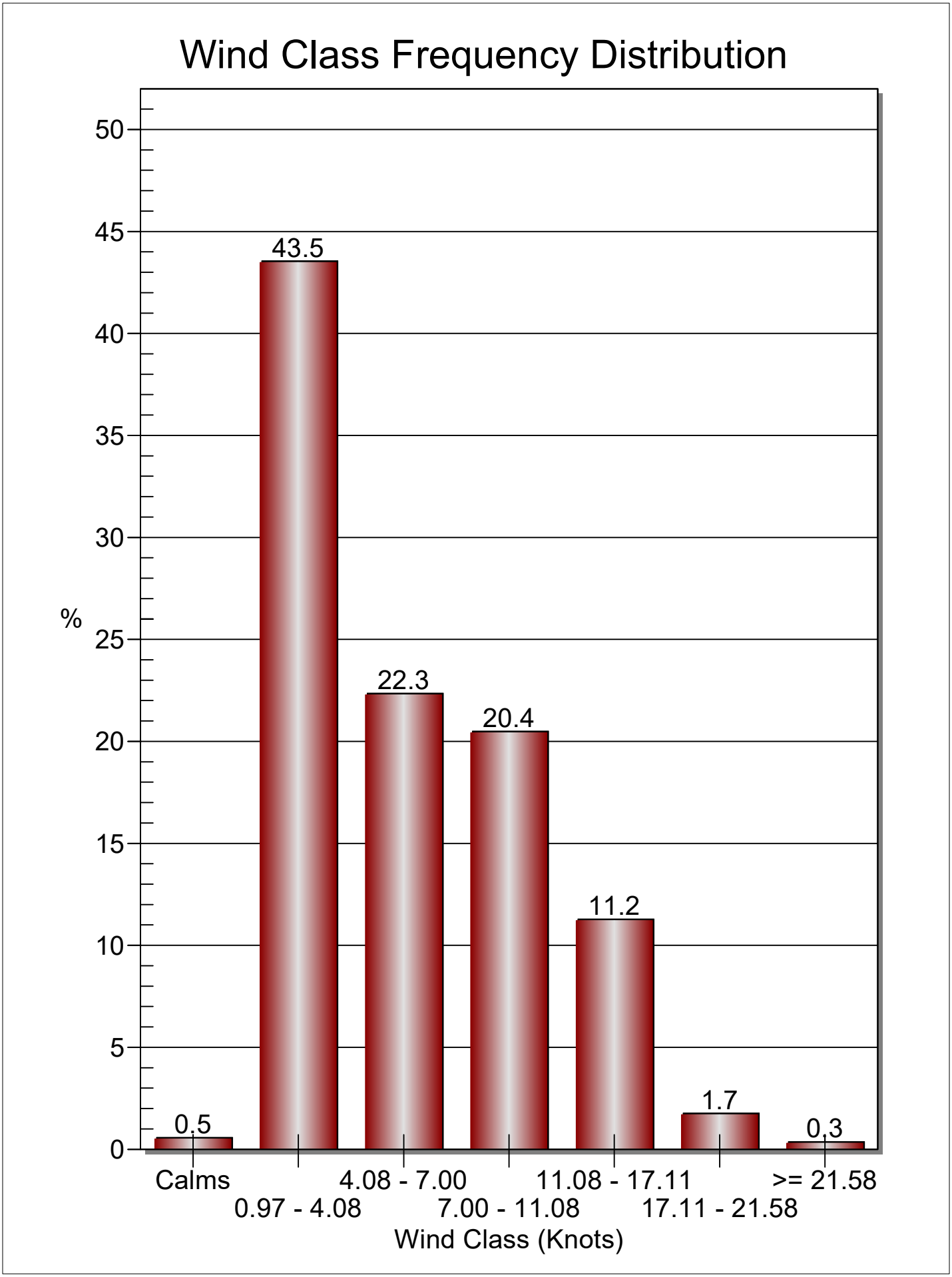
Santa Barbara West Coast Farms - Flowering Months
MM5 Wind Data (WGS 84 : 34.62083 N, 120.24722 W)

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 8/1/2014 - 00:00** **End Date: 9/30/2018 - 23:59**	COMPANY NAME:	
		MODELER:	SESPE CONSULTING, INC.
	CALM WINDS: **0.51%**	TOTAL COUNT: **7313 hrs.**	
	AVG. WIND SPEED: **6.14 Knots**	DATE: **8/4/2019**	PROJECT NO.:


Wind Class Frequency Distribution
%
50
45
40
35
30
25
20
15
10
5
0
43.5
22.3
20.4
11.2
0.5
1.7
0.3
Calms
0.97 - 4.08
4.08 - 7.00
7.00 - 11.08
11.08 - 17.11
17.11 - 21.58
>= 21.58
Wind Class (Knots)

Station ID: 23273
Year: 2014
Time Range: 00:00 - 23:00

Run ID: Full Year

Date Range Report

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Feb	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Mar	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Apr	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
May	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Jun	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Jul	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aug	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sep	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Oct	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nov	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Dec	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Station ID: 23273
Start Date: 1/1/2014 - 00:00
End Date: 12/31/2018 - 23:59

Run ID: Full Year

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (Knots)

	0.97 - 4.08	4.08 - 7.00	7.00 - 11.08	11.08 - 17.11	17.11 - 21.58	>= 21.58	Total
355-5	204	96	93	107	2	0	502
5-15	184	69	99	135	12	0	499
15-25	148	43	69	164	28	0	452
25-35	176	32	61	147	21	0	437
35-45	146	35	42	57	3	0	283
45-55	178	41	19	14	1	0	253
55-65	181	48	10	0	0	0	239
65-75	177	54	11	0	0	0	242
75-85	270	59	6	0	0	0	335
85-95	293	81	2	0	0	0	376
95-105	397	101	12	1	0	0	511
105-115	654	130	12	0	0	0	796
115-125	845	227	18	2	2	0	1094
125-135	1034	243	32	15	1	1	1326
135-145	1064	288	64	43	12	6	1477
145-155	1081	324	96	69	8	1	1579
155-165	977	353	75	91	9	1	1506
165-175	749	274	67	73	12	0	1175
175-185	616	189	70	39	1	0	915
185-195	446	120	53	29	0	0	648
195-205	403	76	30	10	1	0	520
205-215	351	49	21	7	0	0	428
215-225	307	66	33	7	0	0	413
225-235	319	83	52	9	0	0	463
235-245	366	97	87	21	1	0	572
245-255	397	116	132	33	2	0	680
255-265	468	145	107	28	0	0	748
265-275	593	204	102	9	1	0	909
275-285	782	449	138	34	3	0	1406
285-295	901	943	532	386	184	34	2980
295-305	934	1461	1820	1530	661	262	6668
305-315	800	1529	2570	1560	160	40	6659
315-325	613	944	1284	559	11	3	3414
325-335	422	463	382	153	3	0	1423
335-345	320	245	183	76	4	1	829
345-355	254	138	103	83	3	0	581
Total	18050	9815	8487	5491	1146	349	43824

Frequency of Calm Winds: 381
Average Wind Speed: 6.49 Knots

Station ID: 23273
Start Date: 1/1/2014 - 00:00
End Date: 12/31/2018 - 23:59

Run ID: Full Year

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (Knots)

	0.97 - 4.08	4.08 - 7.00	7.00 - 11.08	11.08 - 17.11	17.11 - 21.58	>= 21.58	Total
355-5	0.004655	0.002191	0.002122	0.002442	0.000046	0.000000	0.011455
5-15	0.004199	0.001574	0.002259	0.003081	0.000274	0.000000	0.011386
15-25	0.003377	0.000981	0.001574	0.003742	0.000639	0.000000	0.010314
25-35	0.004016	0.000730	0.001392	0.003354	0.000479	0.000000	0.009972
35-45	0.003332	0.000799	0.000958	0.001301	0.000068	0.000000	0.006458
45-55	0.004062	0.000936	0.000434	0.000319	0.000023	0.000000	0.005773
55-65	0.004130	0.001095	0.000228	0.000000	0.000000	0.000000	0.005454
65-75	0.004039	0.001232	0.000251	0.000000	0.000000	0.000000	0.005522
75-85	0.006161	0.001346	0.000137	0.000000	0.000000	0.000000	0.007644
85-95	0.006686	0.001848	0.000046	0.000000	0.000000	0.000000	0.008580
95-105	0.009059	0.002305	0.000274	0.000023	0.000000	0.000000	0.011660
105-115	0.014923	0.002966	0.000274	0.000000	0.000000	0.000000	0.018164
115-125	0.019282	0.005180	0.000411	0.000046	0.000046	0.000000	0.024963
125-135	0.023594	0.005545	0.000730	0.000342	0.000023	0.000023	0.030257
135-145	0.024279	0.006572	0.001460	0.000981	0.000274	0.000137	0.033703
145-155	0.024667	0.007393	0.002191	0.001574	0.000183	0.000023	0.036030
155-165	0.022294	0.008055	0.001711	0.002076	0.000205	0.000023	0.034365
165-175	0.017091	0.006252	0.001529	0.001666	0.000274	0.000000	0.026812
175-185	0.014056	0.004313	0.001597	0.000890	0.000023	0.000000	0.020879
185-195	0.010177	0.002738	0.001209	0.000662	0.000000	0.000000	0.014786
195-205	0.009196	0.001734	0.000685	0.000228	0.000023	0.000000	0.011866
205-215	0.008009	0.001118	0.000479	0.000160	0.000000	0.000000	0.009766
215-225	0.007005	0.001506	0.000753	0.000160	0.000000	0.000000	0.009424
225-235	0.007279	0.001894	0.001187	0.000205	0.000000	0.000000	0.010565
235-245	0.008352	0.002213	0.001985	0.000479	0.000023	0.000000	0.013052
245-255	0.009059	0.002647	0.003012	0.000753	0.000046	0.000000	0.015517
255-265	0.010679	0.003309	0.002442	0.000639	0.000000	0.000000	0.017068
265-275	0.013531	0.004655	0.002327	0.000205	0.000023	0.000000	0.020742
275-285	0.017844	0.010246	0.003149	0.000776	0.000068	0.000000	0.032083
285-295	0.020560	0.021518	0.012139	0.008808	0.004199	0.000776	0.067999
295-305	0.021313	0.033338	0.041530	0.034912	0.015083	0.005978	0.152154
305-315	0.018255	0.034890	0.058644	0.035597	0.003651	0.000913	0.151949
315-325	0.013988	0.021541	0.029299	0.012756	0.000251	0.000068	0.077903
325-335	0.009629	0.010565	0.008717	0.003491	0.000068	0.000000	0.032471
335-345	0.007302	0.005591	0.004176	0.001734	0.000091	0.000023	0.018917
345-355	0.005796	0.003149	0.002350	0.001894	0.000068	0.000000	0.013258
Total	0.411875	0.223964	0.193661	0.125297	0.026150	0.007964	0.988910

Frequency of Calm Winds: 0.87%
Average Wind Speed: 6.49 Knots

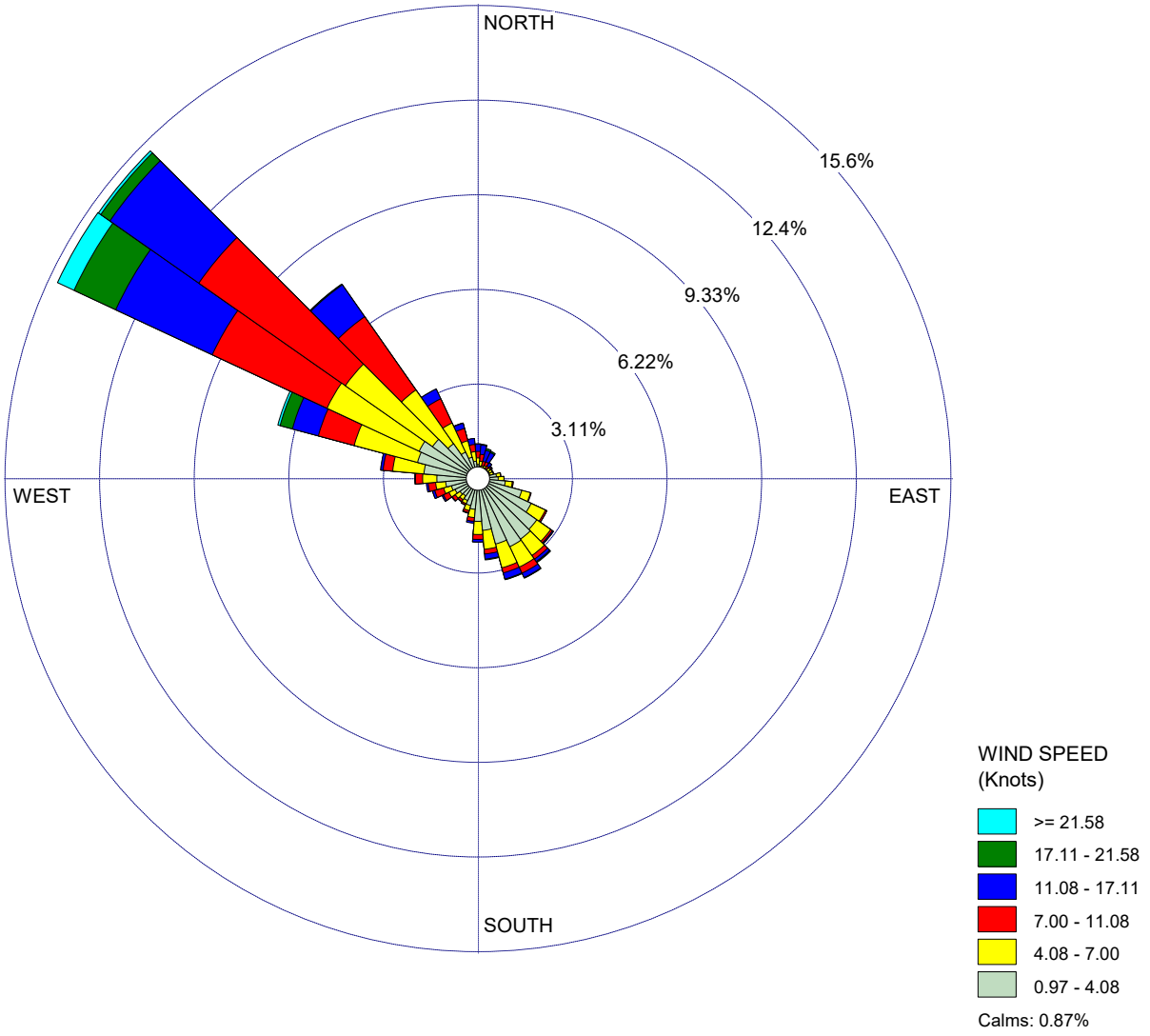
Run ID: Full Year

WIND ROSE PLOT:

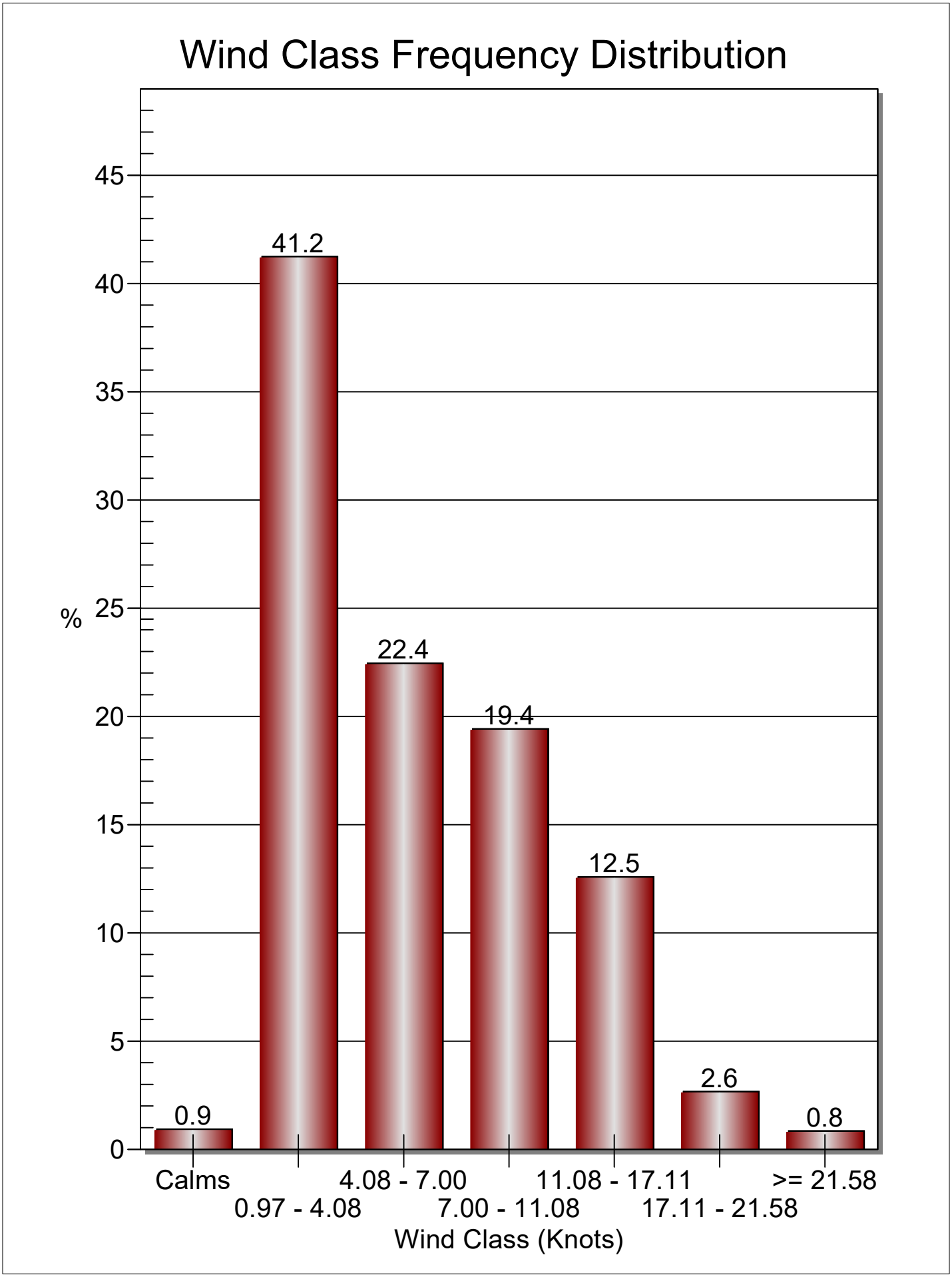
Santa Barbara West Coast Farms
MM5 Wind Data (WGS 84 : 34.62083 N, 120.24722 W)

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 1/1/2014 - 00:00** **End Date: 12/31/2018 - 23:59**	COMPANY NAME:	
		MODELER:	SESPE CONSULTING, INC.
	CALM WINDS: **0.87%**	TOTAL COUNT: **43719 hrs.**	
	AVG. WIND SPEED: **6.49 Knots**	DATE: **8/4/2019**	PROJECT NO.:


Wind Class Frequency Distribution
45
40
35
30
25
20
15
10
5
0
%
41.2
22.4
19.4
12.5
2.6
0.9
0.8
Calms
0.97 - 4.08
4.08 - 7.00
7.00 - 11.08
11.08 - 17.11
17.11 - 21.58
>= 21.58
Wind Class (Knots)

ATTACHMENT 3
Sespe Staff Resumes And Project Briefs

SESPE CONSULTING, INC.

1565 Hotel Circle South, Ste. 370 • San Diego, California 92108
Office: (619) 894-8669 Fax: (805) 667-8104

Andre Almeida, P.E.
Engineer II
aalmeida@sespe.com

EDUCATION

UNIVERSITY OF CALIFORNIA, SAN DIEGO — La Jolla, CA
B.S., Chemical Engineering — 2016

WORK HISTORY

SESPE CONSULTING, INC. — San Diego, CA
Engineer I, Engineer II — September 2016 – Present

UNIVERSITY OF CALIFORNIA, SAN DIEGO, FACILITIES MANAGEMENT — San Diego, CA
Energy Management Systems Engineer — January 2016 – September 2016

ALLIANCE TO SAVE ENERGY — San Diego, CA
Project Manager — February 2013 – December 2015

SCRIPPS INSTITUTION OF OCEANOGRAPHY — San Diego, CA
Thermodynamics Engineering Consultant — April 2013 – January 2014

EXPERIENCE

AIR QUALITY

Experience in modeling air pollutant diffusion from industrial projects and preparation of technical reports. Familiarity with applicable federal, state, and county guidance for air quality modeling, including guidance from 6+ California air districts.

Prepared air dispersion models using AERMOD and assessed health risk using CARB HARP software for many projects and purposes including as part of air permitting and CEQA impact analysis.

Proficiency writing Health Risk Assessments for CEQA Environmental Impact Reports that involve calculations of:

- The pollution output levels of facility devices;
- Resulting ground level concentrations of pollutants at various receptors;
- Health impact to receptors, including;
    - Acute impact,
    - Chronic impact,
    - Long term cancer risk.

Prepared various compliance reporting documents and provided consultation related to compliance issues. Specifically, emissions inventory (GHG, criteria and air toxics) protocols and reporting; violation response and negotiation, and annual compliance certifications/renewals.

COMPUTATIONAL MODELING

Experience modeling natural and industrial systems, including:

- Health risk assessment and criteria pollutant modeling using software including AERMOD, HARP2, and CalEEMod;
- Industrial project toxics, criteria pollutant, and GHG emissions estimating using CalEEMod software;
- Developing and implementing energy use optimization models for high energy use industrial equipment, including HVAC equipment, lab fume hoods, -80°C freezers ; and
- Preparing energy production potential calculations and reports on geological heat flow.

Data Science, Software Development, and Automation

Scripting Experience in the following languages:

Python (specialization in "NumPy" and "PANDAS" Modules)
Visual Basic for Applications (VBA)
Matrix Laboratory (MATLAB)

Successful design, production, and implementation of software for:

- Automated dataset analysis and manipulation;
- health risk assessment modeling; and
- stormwater chemical compliance assessment.

ENERGY AUDITING AND OPTIMIZATION

Experience analyzing office, laboratory, and industrial spaces and providing recommendations for reducing energy use and increasing efficiency, including:

- Behavioral changes;
- Process adjustments;
- Retrofits.

INDUSTRIAL HYGIENE

Experience in worker health and safety including:

- Sampling for Silica and Noise in mining environments;
- Conducting assessments of employee exposure to hazardous materials during industrial operations; and
- Providing safety training to lab occupants working with volatile reagents in a lab setting.

REGISTRATIONS AND CERTIFICATIONS

Registered Chemical Engineer: California CH6933

SESPE CONSULTING, INC.

1565 Hotel Circle South, Ste. 370 • San Diego, California 92108
Office: (619) 894-8670 • Fax: (805) 667-8104

Scott D. Cohen, P.E., C.I.H.
Principal Engineer
scohen@sespe.com

EDUCATION

UNIVERSITY OF CALIFORNIA, SANTA BARBARA — Santa Barbara, CA
B. S. Mechanical Engineering — June 1993

WORK HISTORY

SESPE CONSULTING, INC. — Ventura, CA; San Diego, CA
Principal Engineer — May 2019 – Present
Project Manager III — June 2009 – May 2019

COUNTY OF SAN DIEGO. — San Diego, CA
Air Pollution Control District Hearing Board Member — September 2014 – September 2018

WEST COAST ENVIRONMENTAL AND ENGINEERING — Ventura, CA; San Diego, CA
Managing Engineer — 1996 – May 2009

LOS ALAMOS NATIONAL LABORATORY — Los Alamos, NM
Hazardous Waste Technician IV — 1994 – 1995
Graduate Research Assistant, Hydrology Group — 1993 – 1994

Recent work history includes:

- Provision of EH&S permitting and compliance services for industrial and municipal clientele.
- Management of southern California branch office(s) and staff including acquisition of office space, furniture, equipment, and consumables; installation and maintenance of network infrastructure and information systems; human resource functions such as hiring, firing, and policy enforcement; transitional duties during acquisition of another small consulting company; and interface with property manager(s).
- Management of multiple, simultaneous consulting projects of various sizes, durations, locations, complexities, and subject matter. Tasks include proposal scoping, costing, writing and interviewing; primary contact for client, agency staff and other stakeholders; budget and schedule tracking; invoice preparation and distribution.
- Interpretation and tracking of regulatory, planning and legal developments and documentation to identify potential opportunities and challenges; ensure that work product is prepared using the most current and defensible method available; and illuminate alternative and/or novel approaches that may be implemented.
- Marketing through active participation in various associations and other groups including volunteering to serve as chair, secretary, host, or another role in committees and for meetings; public speaking, booth attendance, and entertainment of clients during conferences; writing articles for trade journals; and donation of professional services as may be needed to track issues, attend meetings, strategize and communicate when an undesirable restriction has been proposed.

- Using and learning to use computers to most efficiently accomplish work at-hand including specialized software (e.g., AERMOD, HARP, EMFAC, CalEEMod, GIS, RTNM, SoundPlan, AggFlow); office productivity software (e.g., Word, Excel, Access, VBA); graphics software (e.g., Photoshop/Illustrator, 2D CAD, etc.); networking software (e.g., LAMP stack).
- Technical support and process development for publishing large environmental documents (EIRs).
- Core skill set includes:
  - Project Management
  - Technical Writing
  - Air Quality and Greenhouse Gases
  - Noise and Vibration
  - CEQA/NEPA
  - Dispersion Modeling and Health Risk Assessment
  - Construction and Mining
  - Industrial Hygiene

EXPERIENCE

Technical Analysis for CEQA/NEPA and Special Studies

- Practiced in the subject areas of air quality, health risk assessment, climate change, noise, vibration, and hazardous materials. Emphasis in assessing fugitive dust and diesel exhaust.
- Applied CEQA requirements in light of existing case law to assess baseline, cumulative effects, and project fair share of mitigation for cumulative effects.
- Developed feasible, enforceable mitigation measure language including some creative solutions.
- Successfully defended work-product through litigation of several project EIRs by supporting efforts of legal counsel in the analysis of opposition arguments and the development counter arguments.
- Experienced a variety of project types including mining, asphalt, ready mix concrete, residential/commercial developments, arterial-freeway interchange improvements, and a university long range development plan.

Industrial Environmental Compliance and Permitting

- Involved in most aspects of environmental compliance for industrial clients including development of management systems and policy.
- Permitted air emissions sources in local and federal (Title V) programs including all aspects of new source review, emissions calculations and modeling, health risk assessment, best available control technology (BACT) cost effectiveness, and portable equipment regulation.
- Permitted industrial process water discharge to land under National Pollutant Discharge Elimination System (NPDES) and to sewer.

- Prepared storm water pollution prevention plans (SWPPP) and related documents including notices of intent, annual reports, and notification to regional water board of illicit discharges.
- Performed services related to characterization and management of hazardous materials and wastes including:
  - Release investigation and sampling.
  - Storage, use and transport as regulated by EPA, OSHA, DOT and the Uniform Fire Code.
  - Risk management plans (RMPs) for facilities with acutely hazardous material.
  - Emergency response plans and spill pollution control and countermeasures (SPCC) plans for facilities with bulk petroleum storage.

Air Quality Expertise

- Prepared air permit applications and negotiated conditions on permits to construct and operate various types of sources and facilities (including those in Title V) in each major California air district, some smaller districts, and several states. Work included each facet of new source review including cost effectiveness and feasibility for BACT, offsets, modeling and coordination of start-up/initial source testing.
- Prepared air dispersion models using AERMOD and assessed health risk using CARB HARP software for many projects and purposes including as part of air permitting and CEQA impact analysis.
- Represented California Mining Association and provided consultation to Arizona Rock Products Association during fugitive dust rulemaking in South Coast AQMD (Rule 1157) and Maricopa County (Rule 316).
- Prepared various compliance reporting documents and provided consultation related to compliance issues. Specifically, emissions inventory (GHG, criteria and air toxics) protocols and reporting; violation response and negotiation, and annual compliance certifications/renewals under Title V.

Worker Safety and Industrial Hygiene

- Provided regulatory analysis and technical support to clients with issues in the areas of indoor air quality (IAQ) and other employee exposure investigations.
- Process hazard analysis, injury and illness prevention (IIPP), safety program management, OSHA violation response, employee training, hazard communication (HAZCOM), personal protective equipment (PPE) selection, confined space, lockout/tagout, health risk assessment, noise, and fall protection.

REGISTRATIONS AND CERTIFICATIONS

Registered Mechanical Engineer: California M30545

Certified Industrial Hygienist: 8162CP

County of San Diego CEQA Air Quality and Noise Consultant Lists

PUBLISHED ARTICLES AND PRESENTATIONS

California Construction and Industrial Mineral Association Education Conference or Meeting
The Air UP There – Positive Health Impacts from Industry's Investments in Diesel Truck Engines (2018).
Distance Matters – Assessing Regional Air and GHG Impacts of Mining Projects Under CEQA (2015).
Industrial Hygiene Statistics and Exposure Assessment (H&S Committee Meeting, 7/2015).
Navigating the Rocky Road to Portable Permitting in California (2013).
Community Noise Impact Assessment Primer (2011).
Portable Plant Air Permitting, What You Need to Know (2009).
Case Study – CEQA Analysis of Air Quality, Greenhouse Gas, and Health Risk Impacts (2008).

Industrial Environmental Association Education Conference or Meeting
Air Permitting 101 & 102 (2015 & 2016).
California Health Risk Assessment Methodology Changes (Air Committee Meeting, 4/2014).

California Asphalt Magazine
Health Risk Assessment – What to Expect and How to Prepare (July 2017).
Portable Equipment Air Permitting and Compliance Status Update (July 2012).
Can California Afford its Climate Change Policies? (July 2011).

California Precast Concrete Association (CPCA) Member Meeting
Current Air Quality Issues Facing Processors of Non-Metallic Minerals (November 2005).

AFFILIATIONS AND MEMBERSHIPS

California Construction and Industrial Materials Association Member and *Associate of the Year in 2015*

California Asphalt Pavement Association Environmental Committee Co-chair (2010 to present)

Industrial Environmental Association Member

Industrial Minerals Association of North America Member

American Industrial Hygiene Association Member

San Diego APCD Air Pollution Permit Streamlining Committee/Compliance Improvement Team (APPS/CIT) Meeting Chair (7/2012 to 7/2017)

SESPE CONSULTING, INC.
374 Poli St., Ste. 200 • Ventura, California 93001
Office: (805) 275-1515 Fax: (805) 667-8104

Rob Dal Farra, P.E.
Vice President
rdalfarra@sespe.com

EDUCATION

UNIVERSITY OF WINDSOR, — Windsor, Ontario, Canada
BASc, Chemical Engineering — 1981

REGISTRATIONS

- Professional Engineer, Chemical Engineering, California (#CH005847)
- South Coast Air Quality Management District Certified Permitting Professional (#B4317)

WORK HISTORY

SESPE CONSULTING, INC. — Ventura, CA
Vice President — Present

- Provide executive management and company quality assurance/quality control.
- Develop work product methodologies, procedures and formats for numerous company services including site assessment, regulatory compliance, hazardous materials, hazardous waste, etc.
- Hiring, training, developing, and managing junior staff.
- Client management.
- Project management including scheduling, coordination, budgeting, and quality control.

EXPERIENCE

35 years of professional experience including 30 years of wide ranging consulting experience covering all aspects of environmental compliance, assessment and management.

INDUSTRY EXPERIENCE

- Provided consulting services to a wide variety of industries, including:
  - Aggregate mining and processing
  - Ready mixed and asphaltic concrete production
  - Crude oil production and processing
  - Refined oil bulk storage, blending and distribution
  - Scrap metal recycling
  - Metal forging and forming
  - Food processing and agricultural
  - Water purveyors
  - Semiconductor manufacturing
  - Real estate development
  - Power generation
  - Glass production

WATER QUALITY

- National Pollutant Discharge Elimination System (NPDES) and Waste Discharge Requirements (WDR) permitting, monitoring, reporting and compliance support including evaluation of technical issues such as ion imbalance toxicity and mixing zones.
- Discharge treatment studies for various manufacturing facilities, in particular ion exchange pilot testing for removal of toxic metals to meet CTR/NPDES permit limits for inland surface waters.
- Industrial sewer discharge support including preparing baseline monitoring reports, obtaining local sewer permits, Notice of Violation (NOV) resolution and treatment system evaluations.
- Preparation of Storm Water Pollution Prevention Plans (SWPPPs) for a variety of industrial and manufacturing facilities.

SITE ASSESSMENT AND ENVIRONMENTAL AUDITS

- Completed environmental compliance audits for numerous manufacturing operations including construction materials, wastepaper recycling, circuit board manufacturing, electronics equipment manufacturing, and bottled water production.
- Conducted pre-acquisition due diligence compliance audits for aggregate mining, ready mixed and asphaltic concrete production facilities.
- Provided project management for more than 1,000 Phase I Site Assessment projects including agricultural parcels, heavy and light manufacturing sites, oil and gas production facilities, and commercial and residential lands.

HAZARDOUS MATERIALS

- Hazard Communication Program development and implementation including conducting hazardous material audits and creating MSDS tracking and reporting systems.
- Hazardous Material Business Plan preparation and Tier II reporting.
- Prepared and/or certified Spill Prevention Control and Countermeasure (SPCC)
- Prepared Facility Response Plans for large oil blending and packaging facilities.
- Prepared Toxic Release Inventory (TRI) reports for a variety of manufacturing facilities and reported emissions using Form R/Form A.
- Risk Management Plan (RMP) preparation for facilities storing anhydrous ammonia and chlorine gas.
- Facility design support for California Fire Code (CFC) and California Building Code (CBC) requirements.

HAZARDOUS WASTE

- Hazardous waste compliance support.
- Waste Minimization (SB14) Plan and Report preparation.
- California Tiered Permitting support including preparation of necessary reporting forms, developing closure cost estimates, and certifying hazardous waste treatment tanks and containment areas.

LAND USE PLANNING AND PERMITTING

- Conditional Use Permitting (CUP) support
- Managing the preparation of technical studies in support of environmental impact reports
- Permitting of new crude oil wells and production facilities

SESPE CONSULTING, INC.

www.SespeConsulting.com

Ventura 805.275.1515
San Diego 619.894.8669

Project: Azusa Rock Quarry Expansion Project EIR

Air Quality and Climate Change Studies and Subsequent Litigation Support

Dates: 2006 to 2011

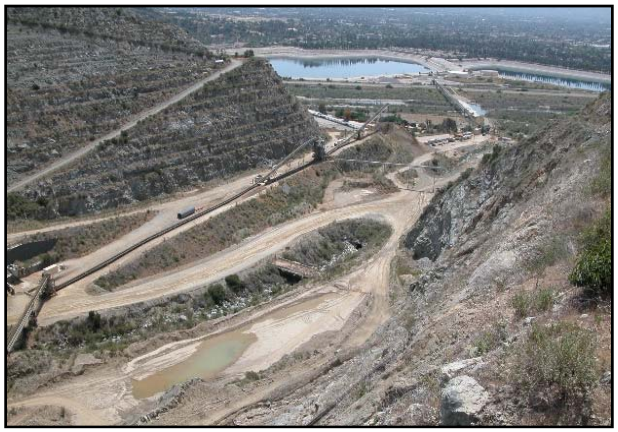
Client: Vulcan Materials Company – Western Division

Location: City of Azusa

Contract Value: $ 150,000

Contact: Jim Gore, Permitting and Government Relations
323.474.3231
gorej@vmcmail.com

Description: Vulcan Materials Company was proposing to increase mining from approximately 1.5 million tons per year (MTPY) to an estimated 10.8 MTPY and increase material processing, which required amending the existing Reclamation Plan and Conditional Use Permit, and preparing an Environmental Impact Report (EIR). SESPE employees, while at another firm, were hired to prepare stand-alone technical reports in support of the EIR. This effort included developing impact reduction strategies and creating Project Design Features that were incorporated into the project to reduce potentially significant impacts to air quality.



The Project sought to process up to 6 MTPY at a rate of 50 percent above the average day on the peak day in a 312-day year (i.e. 28,800 tons per day on the peak day). This peak day amount coincided with the maximum throughput that could be processed by mining equipment and haul trucks that load the processing plant as determined by cycle time analysis for the process. Peak day assumptions are important because they are used to estimate regional air quality impacts in the South Coast Air Quality Management District.

Distinctive Characteristics: Several distinctive characteristics are associated with the Azusa Rock Quarry. Two residential neighborhoods are located within one and one-half miles from the site. The northern quarry boundary is adjacent to the Angeles National Forest. Reclamation included a new process known as “micro benching” that will allow for native vegetation to be planted in benches on the previously mined slopes thereby integrating the facility with the surrounding topography.

Outcome: Project Design Features were successfully developed that were incorporated in the EIR, which eliminated the need to develop mitigation measures.

SESPE CONSULTING, INC.

www.SespeConsulting.com

Ventura 805.275.1515
San Diego 619.894.8669

Project: Lebata Big Rock Creek Project Surface Mine Reclamation Plan and EIR Air Quality and Climate Change Impact Assessments

Dates: 2004-2014

Client: McGee and Associates

Location: Los Angeles County, CA

Contract Value: ≈ $150,000

Contact: Jim McGee, Esq.
McGee and Associates
949.640.0050
jimmcgee@mcgee-law.com

Description: A newly proposed mine, this project involves mining approximately 275 acres of a 310-acre site over a 50-year permit period. Approximately 42.3 million gross tons of sand and gravel would be excavated in two phases at an extraction rate ranging from 0.5 million and 2.5 million tons per year. In addition to aggregate surface mining and processing facilities, the project would include a ready-mixed concrete plant, a Vac-Lite plant (producing lightweight concrete), an asphalt mixing plant, a raw cement and aggregate transfer and distribution facility (via existing rail), and water reclamation and fines recovery facilities. The reclaimed end use for disturbed lands would be open space/groundwater recharge and/or stormwater retention basins. Beginning with a previous employer, SESPE staff members have been working on this project since 2004. Lebata submitted an application to the County for the Surface Mining Permit and Reclamation Plan in 2007. From 2009 to 2014, regulatory issues and project design changes led to numerous revisions to the Reclamation Plan, the environmental impact report (EIR), and supporting technical studies. SESPE was actively involved in addressing those changes, and circulated a Draft EIR for public review in February 2014.

A - Existing conditions

B - View after proposed facility is installed.

Distinctive Characteristics: At the conclusion of a pre-production phase of mining (up to 5 years), the project facilities pad would be about 25 to 35 feet below surrounding natural grade and thus shielded to reduce noise and to minimize visibility of processing facilities and off-site lighting impacts. In addition to minimizing distance setbacks and maintaining aggregate reserve volume, mining and reclamation phasing are timed so at least 71 percent of the site will be available as undisturbed and/or reclaimed habitat areas at any point in time.

Outcome: The County of Los Angeles certified the Final EIR in 2014 and approved the Draft EIR's "environmentally superior" alternative. SESPE finalized the Reclamation Plan consistent with the County approval.