Appendix C

Odor Study for Pet Food Manufacturing Facility

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Diamond Pet Foods, Inc.

942 South Stockton Avenue Ripon, CA 95366

May 2019

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List of Acronyms and Abbreviations

CEQA	California Environmental Quality Act
CO_2	Carbon Dioxide
EIR	Environmental Impact Report
°F	Degrees Fahrenheit
FIDO	Frequency, Intensity, Duration, and Offensiveness
HAP	Hazardous Air Pollutant
MDAQMD	Mojave Desert Air Quality Management District
RTO	Regenerative Thermal Oxidizers
SJVAPCD	San Joaquin Valley Air Pollution Control District
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Odor Study

1.0 INTRODUCTION

Diamond Pet Foods, Inc. (Diamond) operates a pet food production facility at 942 South Stockton Avenue, in Ripon, CA. The Diamond facility was designed for and has space allocated for a maximum of four pet food production lines, although only three lines were initially permitted by the San Joaquin Valley Air Pollution Control District (SJVAPCD) and installed in 2012. Diamond is currently permitting the construction and operation of the fourth pet food production line (Project). This odor study has been prepared by Yorke Engineering, LLC (Yorke) to be used in support of the Draft Environmental Impact Report (EIR) currently being prepared by Ascent Environmental for the City of Ripon (the Lead Agency) for this Project.

Shortly after the Ripon facility commenced operation on May 14, 2012, the SJVAPCD began receiving odor complaints from citizens in the Ripon community who believed that the odors originated from the Diamond facility. This study examines the history of the odor issues at the Ripon facility and the odor technologies implemented to address the issues, including the recently installed equipment that began operating in December 2018 to mitigate odors. Although the installation of a fourth line will increase total facility production, the new regenerative thermal oxidizers (RTOs), installed in the fall of 2018, were designed to mitigate emissions from four production lines and are sized to allow for the maximum level of odor abatement. As a result, no additional odor mitigation will be necessary for the Project.

1.1 Background

Diamond produces pet food by measuring and loading the meat, grain, water, and other ingredients into steam conditioner units (one per line), where mixing and pasteurization occurs, followed by forming (extruding) the pet food into kibbles, which are then conveyed from the steam conditioners to the dryers and other systems for further processing. At each stage of the production line, the kibble is collected and transported through vacuum tubes to the next part of the process using a blower/cyclone system. Each production line requires four blowers (and four exhaust stacks) to provide the vacuum to move the kibble through the plant.

Beginning in July 2012, shortly after Diamond commenced pet food production, the SJVAPCD started receiving odor complaints from nearby citizens in the Ripon community, which have been described as the same odor that is noted upon opening a bag of dry dog food. The odors were investigated and found to originate from the production exhaust (blower) stacks, which then became the subject of the subsequent odor mitigation efforts. It should be noted that due to the fact that the pet food recipes are constantly changing on the various production lines, Diamond and Yorke have been unable to identify any specific pet food recipes that are more or less odorous than the other. All pet food recipes produce odors and all need to be mitigated.

After an investigation of available odor control systems and upon consultation with the SJVAPCD and odor engineers, Diamond installed a cold plasma system on all 12 of the exhaust stacks in the summer of 2014 to mitigate the odors. Cold plasma operates by injecting a highly reactive plasma into the blower exhaust, creating a reaction which neutralizes the odor prior to discharge from the blower exhaust stack. The cold plasma is created in the plasma reaction chamber, where oxygen and water vapor present in the incoming air drawn into the chamber is dissociated by means of

high-voltage electricity, producing a non-thermal plasma which, when injected into the odorous exhaust, initiates the oxidation and/or reduction of the odorous compounds in the gas stream.

The cold plasma system started operation in July 2014. Although odor complaints decreased, the system was unable to completely resolve the issue. To supplement the odor abatement from the cold plasma system, an odorant injection system was also installed on the most-odorous rooftop stacks in March of 2017.

After a significant period of operation, with both the cold plasma injection and the odorant injection, and upon consultation with the SJVAPCD and odor engineers, Diamond determined that the current odor abatement system was inadequate for the task and a much more aggressive odor mitigation approach was needed.

As a result, and upon a careful review of the odor abatement systems in use at some of the most persistently odorous sources, Diamond decided to permit and install an RTO system, appropriately sized for a wide range of exhaust flows and operating temperatures, and designed with capacity to mitigate odors from all four production lines. This system was installed in the fall of 2018, began operation in December of 2018, tested in January of 2019, and continues to operate reliably and appears to be highly effectively in reducing odors.

2.0 ODOR CONTROL TECHNOLOGIES

2.1 Cold Plasma

Cold plasma operates by producing a highly reactive plasma stream that is injected into the exhaust upstream of the respective blower to react either via oxidation or reduction on the odorous species. During the generation of the plasma, oxygen and water vapor in the intake air are dissociated by means of high-voltage electricity to generate a non-thermal (cold) plasma field, which initiates the oxidation and/or reduction of the odorous compounds in the gas stream.

The cold plasma system started operation at the Ripon facility in July of 2014 and operated until December of 2018, which is when the system was replaced by the RTO System. Although the cold plasma reduced odors, the system was not as effective as originally hoped and was therefore replaced by the RTO.

2.2 Odorant Injection

Beginning in March 2017, an odorant was injected into the exhaust streams of the wet cyclone, dryer, and dryer-cooler stacks.

Odorant injection consists of injecting a chemical that has what is thought to be a more pleasing or neutral odor into the exhaust stacks in an effort to mask or neutralize the odors from the pet food manufacturing process. Although the goal of adding a new (generally pleasant) odor to the existing odor is to reduce disagreeable odors, this operation may have actually created more odor complaints because the addition of the odorant may impact a wider portion of the population or may produce a combination that is deemed more offensive than the original odor. Also, the use of an odorant may have increased the noted occurrences of unusual smells and therefore be less tolerable than the present odor. There is also the issue of individual sensitivity (allergy) to perfumes or odorants.

Based on the experience with odorant injection at Diamond, we can conclude that neither cold plasma injection nor cold plasma combined with odorant injection was sufficient to reduce odors to acceptable levels. For this reason, both odorant injection and cold plasma injection were replaced with the RTOs in December of 2018.

2.3 Regenerative Thermal Oxidization

An RTO system was chosen as the best choice with the highest expected level of odor abatement, partly on the basis of the experience reported by the Mojave Desert Air Quality Management District (MDAQMD) in controlling odors from a pet food manufacturing facility in Victorville, CA. According to discussions between Yorke and the MDAQMD, before installation of the RTO systems, the daily odor complaints in Victorville ranged in number from double to triple digits. After the installation of the RTO system, the complaints have dropped to less than 10 a year, and the MDAQMD has deemed the RTO system highly successful.

RTOs operate by oxidizing the odorous compounds in the gas stream to form carbon dioxide (CO_2) and water vapor by means of high temperature destruction of the odor-causing compounds. Thermal oxidation is the most effective means of destroying volatile organic compounds (VOCs) and odors that are primarily organic. An RTO consists of a combustion chamber with natural gas-fired burners and three or more heat recovery chambers filled with inert ceramic packing media or ceramic saddles to enable efficient use of fuel.

The United States Environmental Protection Agency (U.S. EPA)'s air pollution control technology fact sheet for RTOs corroborates that the VOC destruction efficiency of RTOs is expected to be between 95-99%. RTOs have been used in a variety of industrial applications, including coating operations, metal working, automotive manufacturing, and food manufacturing.

2.3.1 RTO Systems at Pet Food Production Facilities

Durr is one of several companies that has built and installed RTO systems to reduce pet food production odors. Durr RTOs are currently controlling odor at the following pet food or similar production facilities:

- Nutro / Mars (3 units) in Victorville, CA;
- Nestle Purina in Mississauga, Ontario, Canada;
- Hills Pet in Eten Leur, Netherlands;
- Hills Pet in Los Angeles, CA;
- Hills Pet (3) in Emporia, KS;
- Corpesca (fish oil production for pet food) in Iquiqui, Chile; and
- Ocean's Protein (fish oil production for pet food) in Hoquiam, WA.

The Nutro Pet Food Processing facility in Victorville is an example of a facility in California that was struggling with odors impacting the neighboring residents but resolved the problems through the installation of three RTOs. The MDAQMD noted that the odor complaints numbered from 20 to over 100 complaints per day. Citizen complaints included acute symptoms of odor-caused nausea, as witnessed by a visiting MDAQMD inspector.

Nutro installed the units as part of an Odor Abatement Plan (Plan) for the MDAQMD that outlined how the facility would comply with all requirements of a Notice to Comply that had been issued by the MDAQMD. The Plan also presented a preliminary odor abatement schedule for the facility.

After the equipment was installed at Nutro, odor complaints dropped to approximately one per month, whereupon the MDAQMD deemed the system both effective and sufficient for pet food odor control.

2.4 Diamond RTO System

The RTO system was installed at the Diamond facility in the fall of 2018. Installation was completed in November of 2018, and the initial firing of the burners and testing of the systems began on December 1st and 2nd of 2018.

The Durr RTO System for Diamond is designed for efficient odor abatement and fuel use. The system is comprised of 12 separate ceramic heat-exchange beds arranged radially over a proprietary rotating diverter valve. Incoming contaminated air enters the RTO through the bottom of the unit and is drawn upwards through five of the 12 beds, which have been previously preheated. The air is heated as it passes through the preheated bed and further heated to the temperature setpoint in the combustion chamber near the top of the RTO, where additional energy is added by a natural gas-fired burner to complete the oxidation process. Hot clean exhaust is then drawn downwards through five adjacent ceramic beds to transfer the thermal energy to preheat the

media before being exhausted to the atmosphere through a stack. The two "spare" beds serve to prevent cross contamination between the inlet and outlet sections and to ensure the high destruction efficiency of the RTO.

Each of the three Durr model RL-60 RTOs operate in parallel, with the plant production exhaust entering the units from a common header. Each of the Durr model RL-60 RTOs is a unique single-vessel that is capable of easily destroying more than 95% of VOCs and hazardous air pollutants (HAPs) in industrial process exhaust streams.

The air permit issued to Diamond by the SJVAPCD requires the RTOs to operate at a temperature sufficient to achieve 95% abatement. Based on source testing conducted in January of 2019, Diamond determined that RTO operation at 1500 degrees Fahrenheit (°F) will easily meet the 95% VOC destruction efficiency. However, in order to ensure the highest possible odor abatement, Diamond had the Durr RTOs designed and constructed with an additional 8 feet of vertical combustion chamber volume, thereby providing additional residence time at high temperature for the odorous contaminants to oxidize. In addition to this, Diamond has and continues to operate the units at 1650 °F, which, based on January 2019 source testing, demonstrated VOC abatement of 99.8%.

Figure 2-1 shows the installed and operational RTOs abating the production exhaust from all pet food lines, as viewed on December 14, 2018.

Potential odor-producing compounds from the pet food production are expected to be in the form of VOC emissions. Based on the results of the source testing, the RTOs reduce all VOC emissions from the production lines by 99.8%. This means any odorous compounds associated with the production of the pet food are now reduced by more than 99%.

Figure 2-1: Diamond Pet Foods Fully Operational RTOs – December 2018

Figure 2-2: Diamond Pet Foods Production Pre-RTO Exhaust – December 2012

3.0 ODOR HISTORY

It is important to note that the identification and abatement of odors is somewhat subjective and highly variable depending on numerous factors such as individual odor sensation thresholds, facility exhaust parameters, such as exhaust release height, exhaust velocity, temperature, quantity of odorous compounds, wind speed and direction, atmospheric mixing, and relative humidity.

Individual odor sensation thresholds are highly variable and differ between individuals. What may be a very strong and disagreeable odor to one person may be completely unnoticed by another. Also, odors come and go and are not continuous. It is not unusual that after receiving odor complaints from members of the public, the SJVAPCD inspector is unable to verify either the presence of the odor and/or the source. This difficulty is compounded by the fact that scientific instruments are generally unable to analyze and identify the odorous compounds in a bag sample of air taken from the site of the odor. The human sense of smell is capable of detecting odors in the parts per billion ranges, whereas typical instrumentation lacks this degree of sensitivity.

Pollutant studies sometimes indicate that odors are a combination of a number of different pollutant compounds. Some of the compounds that create odors may also cause individual desensitization over time or may be additive (2 + 3 = 5), synergistic (2 + 3 = 8), or subtractive (2 + 3 = 1), when acting in combination with other pollutants. Some of the compound classes and specific compounds that have been identified as potentially odorous from food preparation (cooking) include aldehydes, amines, esters, volatile fatty acids (carboxylic acids), hexanal, 2-acetyl-1-pyrroline, octanal, heptanal, and 2-nonenal.

Most agencies measure the potential for nuisance odors based on the frequency, intensity, duration, and offensiveness (FIDO) of the odor. Frequency simply refers to how often an odorous emission will be experienced by a population. Intensity refers to the perceived strength of the odor sensation, and generally increases as a function of concentration. Duration is the period of time in which odorants are received by a population and perceived as odors. Offensiveness is the keystone of the four elements of the odor experience and, not coincidentally, the one in which human perception comes to the fore. Offensiveness is “an expression of the degree of unpleasantness of one odor relative to another” (SRF 2004).

Local meteorological conditions influence the frequency and duration of potential odors. The direction of the wind dictates the area where the potential odors may be observed, thus the more frequently the wind blows in a certain direction, the more often that area may experience odors.

Low wind speeds allow lateral dispersion of odors, producing larger impacted areas near the source with a potentially longer duration, although the intensity of the odor will not reach as far downwind. Higher wind speeds tend to coincide with a more turbulent atmosphere, thus potential odors dissipate more quickly.

3.1 Identification of Sources of Odors

In 2013, Yorke conducted several site visits and reviewed the available facility operational and technical data, including source test reports, air permits, compliance history, and weather patterns, and subsequently performed dispersion modeling to estimate the potential odor sources.

The site inspection identified only slight (low intensity) product odors throughout the production areas of the facility, with the exception of the extruder room, where noticeable (high intensity) odors were apparent. These odors were from normal pet food production where the initial

ingredients are mixed and then conditioned (pasteurized) with steam prior to the extrusion of the kibble, although the air that is exhausted from the blowers originates from the intake air handler (filtration) units.

At that time, each production line included four blowers and four exhaust points, with exhaust from the wet cyclone, drier, drier-cooler, and vertical cooler blower exhausts, equaling a total of 12 exhaust points for the facility. The initial analysis concluded that the wet cyclone blower exhaust stacks and dryer blower exhaust stacks had the greatest contribution to the odors being experienced in the community. The drier-cooler and vertical cooler blower exhausts generated less odor contribution because these streams are drier and have a lower VOC loading.

As noted previously, Diamond and Yorke have been unable to determine if any particular pet food recipes produce more odors than any other recipe.

3.2 Complaint History

Shortly after the facility began operation, odor complaints were filed with the SJVAPCD. The first complaint occurred in July 2012. Since that time, complaints have been found to be highly seasonal, typically occurring during autumn and winter months, although complaints have been filed in every month. Also, the majority of the complaints occur during morning and evening hours, although complaints at other hours of the day have occurred as well.

Since Diamond began operation in 2012, there have been a total of 539 complaints, with approximately 20% of the complaints confirmed by SJVAPCD staff upon investigation. A short duration odor may be difficult for an inspector to confirm, as it may have dissipated prior to the inspector's arrival.

Figures 3-1 and 3-2 present maps showing the relative number of complaints per location since the installation/operation of the respective cold plasma and RTO systems. Therefore, the size of the area of the circles is a proportional representation of the number of complaints that have been logged in that general location. Data are not presented for the time prior to the cold plasma installation, as the complaint locations were not accurately recorded, although the same locations appeared to be similarly affected.

Based on complaint records from the SJVAPCD, the majority of the odor complaints are from the neighborhood northeast of the facility and secondarily northwest of the facility in the downtown Ripon area. Occasionally, odor complaints have been logged at locations as far south as Salida (Figure 3-1).

Since the installation of the RTOs, the majority of the odor complaints occur in the same areas; the neighborhood northeast of the facility and the areas near downtown (Figure 3-2). Three complaints were filed from a location approximately 2.5 miles north of the facility and as will be discussed later, it is questionable whether these can be attributed to the Diamond facility.

Figure 3-1: Ripon Odor Complaints with Cold Plasma Abatement

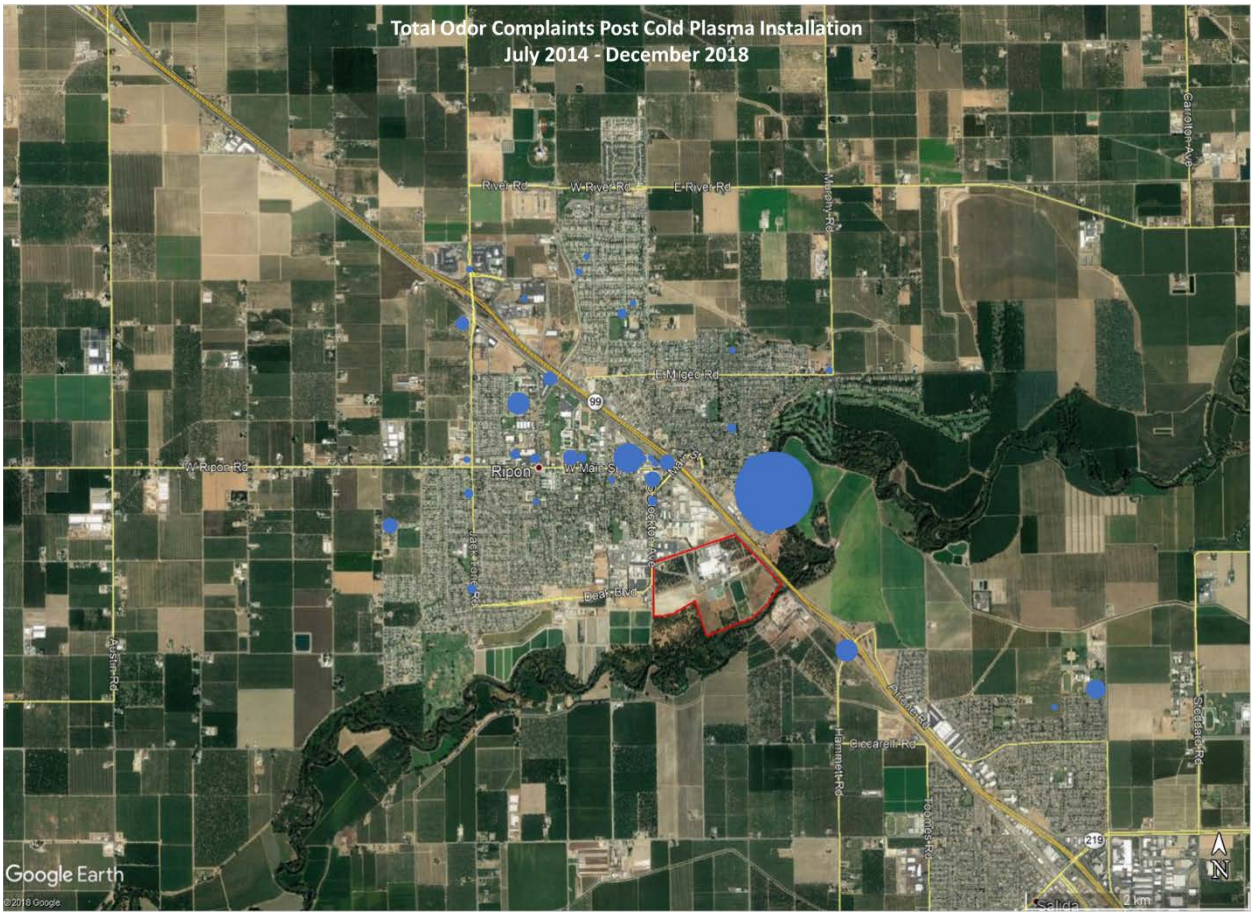


Figure 3-2: Ripon Odor Complaints with RTO Abatement

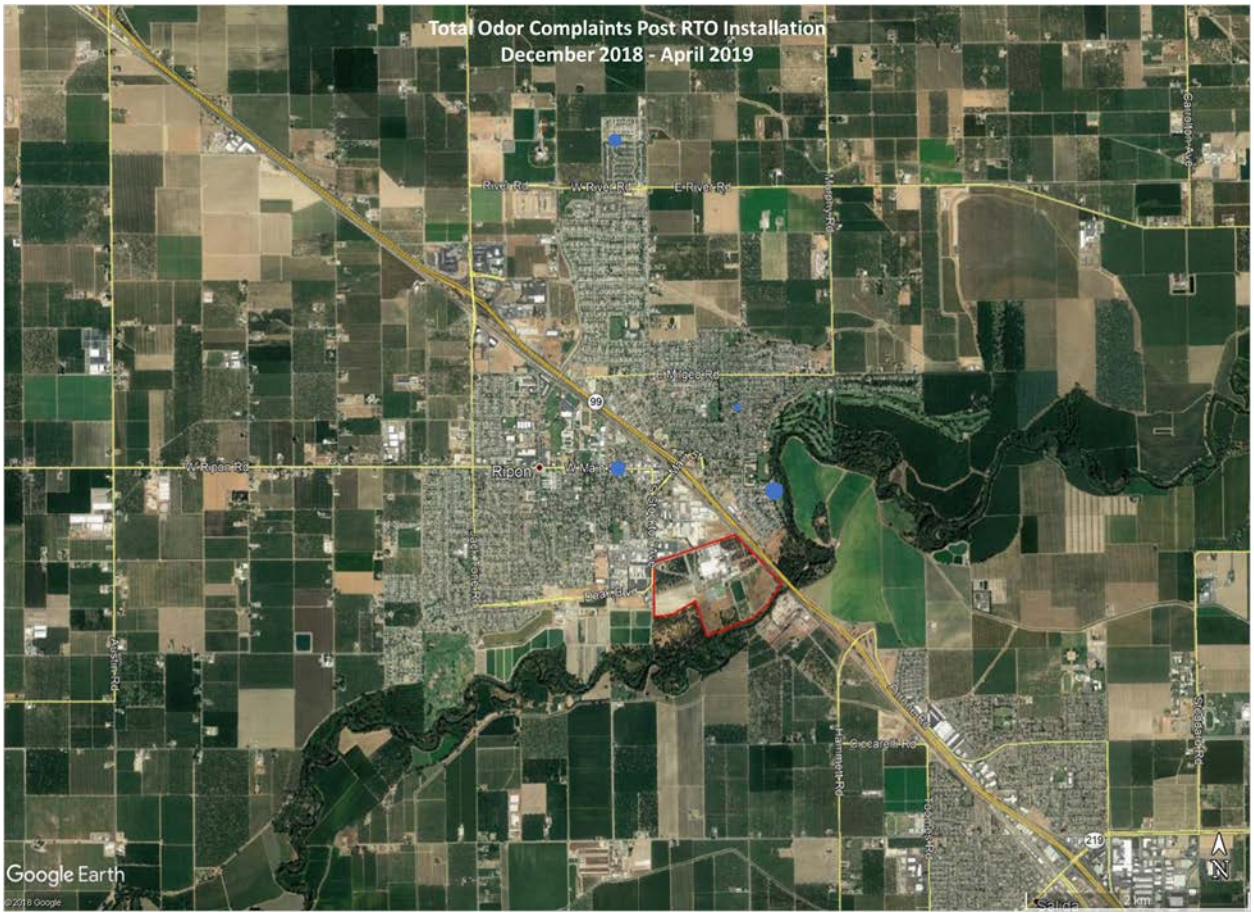


Figure 3-3 presents a chart of all complaints received by month and year. Figure 3-3 also shows the seasonal character of the complaints, as well as the history of the cold plasma and RTO odor abatement system. This shows graphically how the odor complaints change from season to season and from year to year, as well as the relative effectiveness of the various odor abatement systems.

Figure 3-3: Monthly Odor Complaints Since 2012

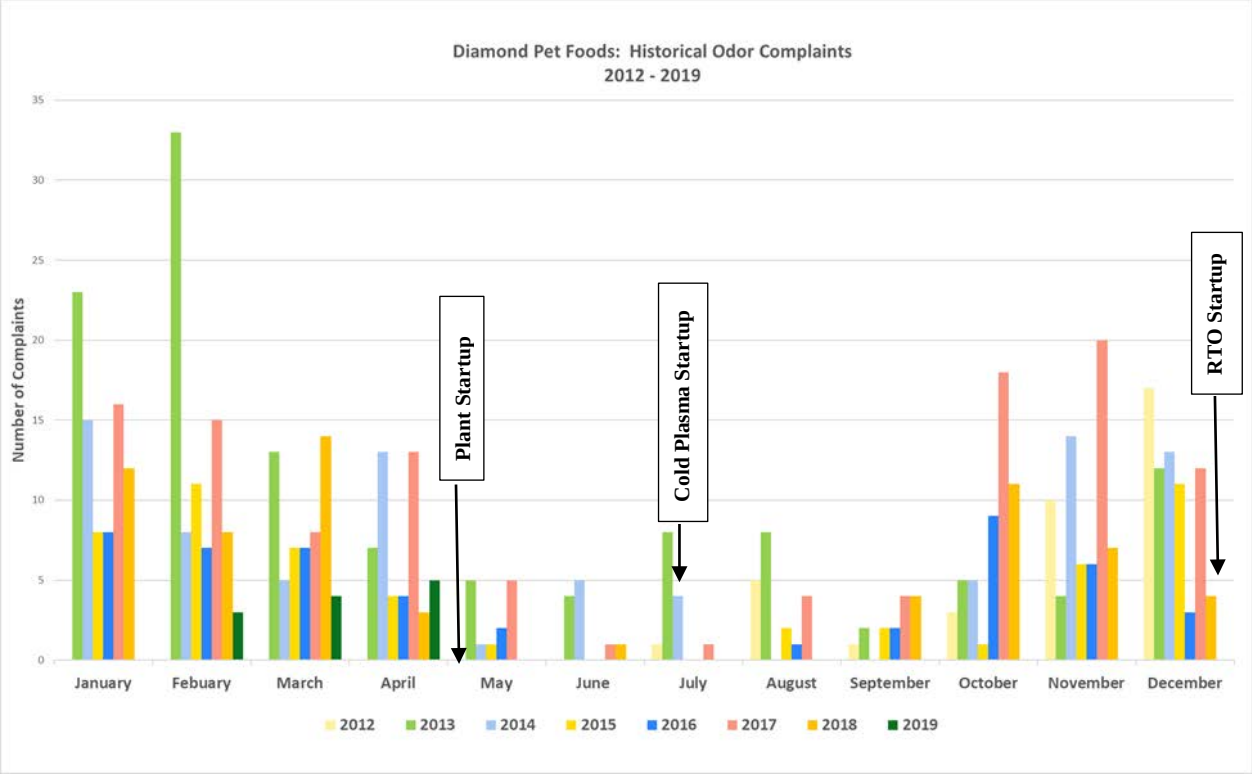


Figure 3-4 presents the average monthly complaints received on the basis of each control technology. After the installation of the cold plasma system, there was a reduction in the average monthly odor complaints, as shown by Figures 3-3 and 3-4. However, over time, this reduction appeared to be insufficient to solve the odor problem, in part due to the adverse weather conditions in the colder months and possibly as people grew tired of the odor. Additionally, as residents were reminded to file their odor complaints with the SJVAPCD, more complaints were logged with the SJVAPCD, potentially skewing the odor counts upward.

Figure 3-4: Average Monthly Odor Complaints per Abatement Technology

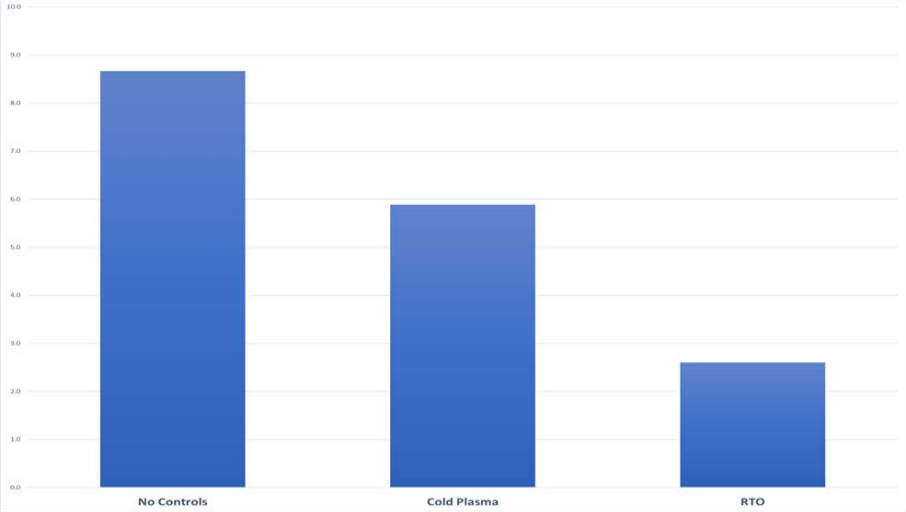


Figure 3-3 shows the seasonality of the odor complaints, which demonstrates the impact of local weather on the odorous emissions from the plant. Approximately 85% of all odor complaints have occurred between October and April, and mostly during stable atmospheric conditions.

During the winter months, the weather is typically colder, wetter, less windy, and the valley is prone to inversions. The combination of a stable atmosphere, low wind speeds, a temperature inversion, and moist air all tend to trap pollutants (including odorous air) in an area, leading to conditions where the odors may linger longer without being dispersed.

Meteorological data from Modesto Airport are representative of the conditions at the project site. The data for years 2013-2017 were obtained from the SJVAPCD (2019). Figures 3-5 and 3-6 show the windroses for the cooler "winter" months (October through April) and warmer "summer" months (May through September), respectively. Each petal of the rose represents the frequency a wind blows from that direction and the relative strength. Figure 3-5 shows that there are lighter winds during the colder, winter months and they tend to blow either up or down valley. During the summer, the faster winds blow very predominantly from the northwest.

Notably, these figures show that winds rarely blow from the southwest sector toward the neighborhood northeast of the facility, therefore the potential frequency for any emissions from the facility to reach that area is less than 5% of all hours. For a puff of air from the facility to reach a location 2.5 miles north of the facility, as was noted in paragraph 6 of §3.2, the wind speed would need to be greater than 15 miles per hour. At this speed, typically the atmosphere is more turbulent, and the puff would disperse significantly before reaching the destination. In addition, the wind

rarely blows from the south (less than 2% of the year), thus it is unlikely that any odors complaints from the location 2.5 miles north of the facility could be attributed to Diamond.

Figure 3-5: Winter Windrose

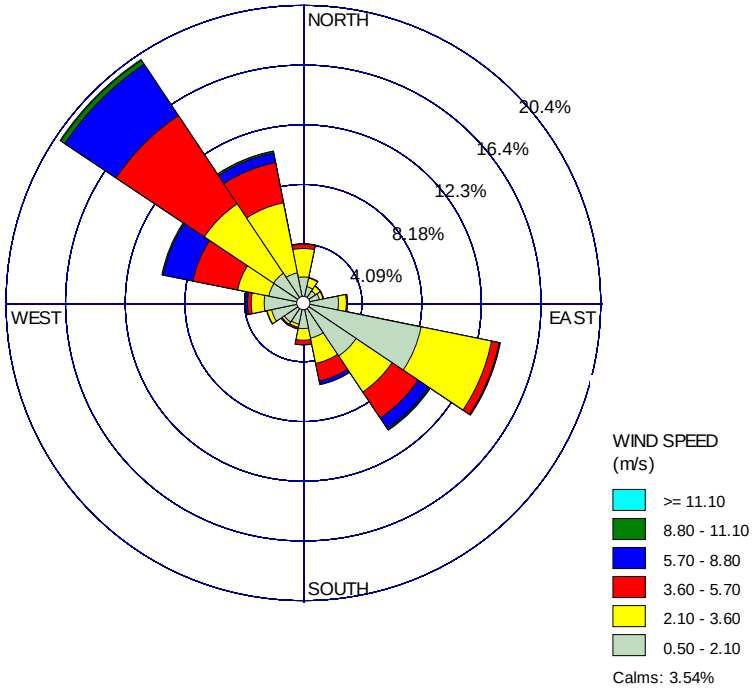
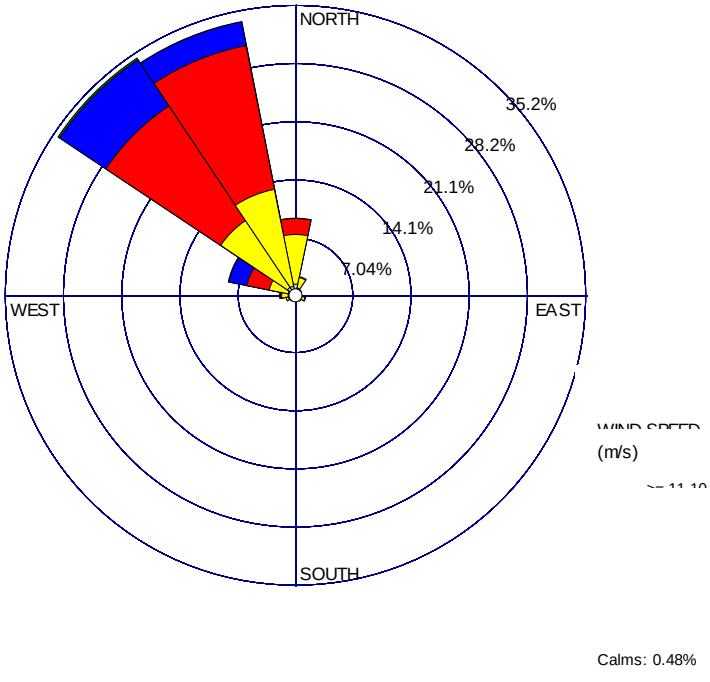


Figure 3-6: Summer Windrose



4.0 CONCLUSIONS

Since the startup of the RTOs in December 2018, the number of odor complaints have decreased dramatically, and Diamond has been informed that there has been a highly positive tone on social media from the residents about the absence of pet food odors.

Based on our experience during the past 7+ years, the following are our general observations:

- Weather: Local weather conditions greatly impact odorous emissions dispersion and odor intensity. During the warmer months when the prevailing winds blow stronger from the northwest, with good mixing, it is common to have multiple months with no complaints logged. Wintertime is the opposite, with lighter and more variable winds, and frequent inversions limiting atmospheric mixing, odors are noted and reported to the SJVAPCD.
- Confirmed vs. unconfirmed odor complaints: The difference between confirmed and unconfirmed odor complaints is also an indicator of the transitory nature of odors. During the colder months, when there are low wind conditions, odors move about and sometimes remain in a single location for a few minutes or possibly up to several hours in duration. Due to the seasonal weather phenomena, whether an odor is confirmed or not, does not call into question the veracity of the complainant.
- Human element: Odors cannot be measured directly by any instrumentation and are identified and characterized by individuals. The human nose is sensitive of detecting odors of certain compounds down to the parts per million or lower concentrations.
- Pre-RTO complaints: During colder months, the average number of monthly complaints from 2012 through 2018 ranged from seven to 14 complaints per month.
- Post-RTO complaints: Since the RTO went into operation, there have been on average 2.6 complaints per month (13 complaints total), and these have all been during cold-weather months (January through April). Of the total number of odor complaints during this period, our analysis indicates that over half of the complaints are in the category of being inscrutable, which are difficult to understand and/or explain.
- Inscrutable Odor Complaints: Some odor complaints cannot be explained or understood. An example would be if an odor complaint was logged by the SJVAPCD from a resident on a day when the entire plant was shut down. Such was the case on Sunday, February 22, 2015, when the entire facility was shut down. During this period, no blowers were operating and no pet food was being produced. Therefore, no odors would be expected, particularly not at a location nearly 1.5 miles from the plant.

  Another example are odor complaints logged with the SJVAPCD after the RTO was installed. The complainant states that the odors are still present with the same intensity, when the RTOs are abating over 99% of the odor-causing compounds. Although odors may still be observed, it is difficult to reconcile the notion that the odor intensity has not changed when the source testing demonstrates otherwise.
- Another questionable situation would be receiving an odor complaint(s) from a location so far distant that the existing weather data and known high abatement efficiency of the RTO system do not support multiple consecutive day complaints from a single distant location. Such is the case for three odor complaints from a single location, approximately 2.5 miles from the facility on 3 consecutive days. In a case such as this, it is more reasonable to

believe the complainant is mistaken about either the nature of the odor, or the source, or both.

The SJVAPCD has developed screening distances for various potential odor sources for the California Environmental Quality Act (CEQA). For sources such as food processing facilities, feed lots, landfills, etc., receptors greater than 1 mile are not expected to experience nuisance odors. The previous two complaints are farther than these distances and thus, it is unlikely that Diamond was the source of the odor.

- Follow-up post RTO startup complaints: Previous to the installation of the RTO system, odor complaints have been verified by numerous inspectors, citizens, plant operators, and various disinterested third parties, and therefore have largely been accepted with an unquestioned level of validity.

  Based on a number of carefully reviewed factors, specific to eight of the 13 odor complaints, it is possible these complaints could be outliers and/or the source is mistaken. In this case, the resulting number of odor complaints potentially attributable to Diamond for the 4½-month period from mid-December through April is approximately 1 per month.

  With the installation of the RTO system, future odor complaints will be subject to review. Based on the recent odor complaints that could reasonably be attributable to Diamond, we conclude that the odors from Diamond have largely been reduced to a level that are equivalent or less-than-normal background odors in the Central Valley, including those from agriculture, other industry, water treatment, power generation, transportation, etc.

Based on the consistent operation of the RTOs at Diamond's Ripon facility, the source test confirmation of the VOC abatement efficiency of greater than 99%, the success at the Nutro Pet Food Processing facility in Victorville, and the dramatic reduction in odor complaints, we are optimistic that the odor issues associated with this facility have been resolved.

5.0 REFERENCES

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