# SANTA CLARA COUNTY PLANNING DEVELOPMENT APPLICATION

| PROPERTY OWNER'S NAME | Phone | Email | Prefer correspondence: Email ☒ Mail ☐ |
|---|---|---|---|
| Dorado Leasing LLC c/o JRG Attorneys at Law | (831) 269-7127 | jason@jrgattorneys.com | |
| Mailing Address | City | Zip | |
| 318 Cayuga St. | Salinas,CA | 93908 | |
| APPLICANT OR APPELLANT NAME | Phone | Email | Prefer correspondence: Email ☒ Mail ☐ |
| Dorado Leasing (Appellant) | same as above | same as above | |
| Mailing Address | City | Zip | |
| same as above | same as above | same as above | |

ADDRESS OF SUBJECT PROPERTY: 1020 Hollister Road. Gilroy, CA  APN: 841-36-012

EXISTING USE OF PROPERTY: Agricultural - Farmland  ACCESS RESTRICTIONS (gate, dog, etc.): Gate

The ACKNOWLEDGEMENTS AND AGREEMENTS FORM on the reverse side of this application must be completed and signed by the property owner(s).

## FOR DEPARTMENT USE ONLY

FILE NUMBER: –

PROJECT DESCRIPTION:

| APPLICATION TYPES | FEE(S) | COMMENTS / SUBMITTAL MATERIALS |
|---|---|---|
| Architecture and Site Approval / ASX | | |
| Building Site Approval / BA (Urban / Rural) | | |
| Certificate of Compliance | | |
| Design Review / DRX | | |
| CEQA (EA / Cat Ex / Prior CEQA / EIR) | | |
| Compatible Use Determination (WA / OSE) | | |
| Geologic Report / Letter | | |
| Grading Approval / Abatement | | |
| Lot Line Adjustment / Lot Merger | | |
| Pre-Screening | | |
| Special Permit | | |
| Subdivision | | |
| Use Permit | | |
| Variance | | |
| Other | | |
| TOTAL FEES | | |

**Application fees are not refundable.**

Submittal reviewed and received by:

Date:

Coordinates: X Y

Zoning:

General Plan:

Parcel Size:

USA / SOI

WA / OSE / HCP

Early Outreach: L1 / L2

Previous Files:

# ACKNOWLEDGEMENTS AND AGREEMENTS

**FILE NUMBER:**_____________ – ______________________________

## I. INDEMNITY

**Applies to all Planning applications.**

As it relates to the above referenced application, pursuant to County of Santa Clara Ordinance Code Section A33-6, except where otherwise expressly prohibited by state or federal law, I hereby agree to defend, indemnify and hold harmless the County and its officers, agents, employees, boards and commissions from any claim, action or proceeding brought by any person or entity other than the applicant ("third party") against the County or its officers, agents, employees, boards and commissions that arises from or is in any way related to the approval of this application, including but not limited to claims, actions or proceedings to attack, set aside, void or annul the approval. If a third-party claim, action or proceeding is filed, the County will promptly notify the applicant of the claim, action or proceeding and will cooperate fully in the defense. Notwithstanding the above, the County has the right to participate in the defense of any claim, action or proceeding provided the County bears its own costs and attorney fees directly associated with such participation and defend the action in good faith. The applicant will not be required to pay or perform any settlement unless the applicant agrees to the settlement.

## II. FEES

**Applies to hourly billable application types. Refer to Department of Planning and Development fee schedule.**

a. I/We the Owner(s) of the subject property, understand that my/our application requires payment of a minimum non-refundable fee, plus additional funds when staff hours devoted to the application exhaust the initial payment. Staff hours are billed at the hourly rate in effect at the time the staff hours are accrued.

b. Typical tasks charged to an application include, but are not limited to, the following: intake and distribution of application, staff review of plans and other relevant materials; correspondence; discussions/ meetings with owner, applicant and/or other interested parties; visits to the project site by authorized agency staff; file maintenance; environmental assessment; staff report preparation; agenda and meeting preparation; meeting attendance; presentations to boards, commissions, and community groups; contract administration.

c. The minimum nonrefundable fees for development applications are based on staff billing rates and staff hours needed to process a typical application. Staff hours may exceed a base application fee (requiring additional billing) due to project complexity and public interest on a project. This could include the need to review technical reports, conduct several meetings with the owner / applicant, and respond to public inquiries.

d. Invoiced fees are due within 30 days of the date on the billing letter. **Fees not paid within 30 days are considered late and are subject to collection at the expense of the Owner.** While such fees are outstanding, the Planning Office reserves the right to cease all work on a project until said fees are paid in full.

e. Any fees not paid within 45 days of invoicing shall be subject to interest charged at a rate equal to that earned by the County Treasury investment pool for that period.

f. The owner and applicant are encouraged to periodically check on the status of their projects and fees. Questions regarding the status of hours charged to an application may be addressed to the planner assigned to the project.

g. For more information on Planning Office application fees and how they are calculated, visit the County Planning Office web site at https://plandev.sccgov.org/home.

## III. NOTICE OF LEVINE ACT AND COUNTY OF SANTA CLARA LOBBYIST ORDINANCE

**Levine Act Disclosure Requirements for Parties to a Proceeding**

California Government Code section 84308 ("Levine Act") requires a party to a proceeding involving a license, permit, or other entitlement for use to disclose any contribution of more than $250 that the party (or their agent) has made to an elected or appointed official within the prior 12 months. The Levine Act also prohibits, during the proceeding and for 12 months following a final decision, a party (or their agent) from making a contribution of more than $250 to any elected or appointed official who may participate in the proceeding.

For applications processed by the Department of Planning and Development, the Levine Act Form must be completed by the party (or the party's agent) to a license, permit, or other entitlement for use at the time the party files an application for a license, permit, or other entitlement for use with the Department of Planning and Development. The requirement to submit the Levine Act Form applies where a party (or that party's agent) has contributed more than $250 to a member of the Board of Supervisors or member of the Planning Commission if they may participate in the proceeding.

The party (or their agent) must submit a supplemental form if they make any new reportable contributions while the license, permit, or other entitlement for use is being processed and considered. The party (or their agent) must also use the Levine Act Form if they need to correct any previously submitted form. The completed form submitted to the County of Santa Clara is a public record.

**To complete and submit the Levine Act Form, please visit: https://boardclerk.sccgov.org/mandated-filings/levine-act-disclosure**

**County of Santa Clara Lobbying Ordinance**

County of Santa Clara Ordinance Code sections A3-61 to A3-69 requires lobbyists, including land use lobbyists, to register with the Clerk of the Board and report their lobbying activities on a quarterly basis to the County of Santa Clara ("County"). In addition, a land use lobbyist is required to update their lobbyist reports between 7 and 21 days prior to any meeting or public hearing regarding a major land use approval they have attempted to influence.

A land use lobbyist is any person who, during any consecutive 12-month period, does either of the following: (1) makes payments or incurs expenditures in the aggregate amount of $5,000 or more attempting to influence a major land use approval; or (2) spends an aggregate amount of 10 or more hours of compensated time attempting to influence a major land use approval, including time spent by officers, employees, agents, and members. A major land use approval is any legislative or administrative action by the County on an application relating to: (1) construction, demolition, alteration, development, or use of property in the unincorporated county that, if approved, would affect, in the aggregate, more than 25,000 gross square feet of existing, approved, or proposed buildings or structures; (2) the surface mining operation or reclamation of mined lands involving the disturbance or reclamation of more than 25,000 gross square feet of land; or, (3) any subdivision containing five or more parcels or condominiums.

The applicant or appellant for any major land use approval must certify, on a form provided by the Clerk of the Board and filed with the Clerk of the Board, that it has complied with the land use lobbyist disclosure requirements prior to each meeting or public hearing at which an action relating to the major land use approval, or any component thereof, will be on the agenda. The application for any major land use approval will be suspended at any time the applicant does not comply with the requirements of the registration and disclosure requirements. During the suspension period, the Department of Planning and Development will cease all work on the application.

**For additional information on registration and quarterly disclosure requirements for lobbyists, please visit: https://boardclerk.sccgov.org/mandated-filings/lobbyist-filings.**

## IV. APPLICATION AUTHORIZATION AND AGREEMENT TO PAY

I (We), the Owner(s) of the subject property, hereby authorize(s) the filing of this application and on-site visit by authorized staff. In addition I (We) acknowledge and understand the information above related to fees and agree to pay all application fees. I (We) certify and accept the terms and conditions as described above.

**OWNER'S NAME(S)** (Please Print)

Dorado Leasing LLC (Bruce Taylor, Managing Member)

**OWNER'S SIGNATURE(S)** Bruce Taylor

**DATE** 7/12/2024

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July 12, 2024

Boad of Supervisors
County of Santa Clara
70 West Hedding Street
San Jose, CA 95110

**Re: Appeal of PLN17-6498 – Use Permit, Architectural and Site Approval, and Grading Approval to Upgrade the Z-Best Facility, SR 25, Gilroy**

Dear President Ellenberg and Members of the Board of Supervisors:

We are writing on behalf of Dorado Leasing ("Dorado"), who owns the 570-acre farm that is immediately south of the Z-Best facility. Attached is a map that depicts the boundary of the farm, its proximity right next to the Z-Best facility, and a red line that demarcates the current 1200-foot buffer area where no food crops can be cultivated as a result of the current composting operation (See **Exhibit A**). Currently, ninety (90) acres of the farm are unusable due to food safety buffer requirements from the existing composting facility based on the current volumes of materials being processed and type of enclosed bagged composting system.

Pursuant to Chapter 5.30 of the Santa Clara County Code, Dorado hereby appeals the Planning Commission's decision on June 27, 2024, to certify the Final EIR and approve a Use Permit, Architectural and Site Approval and Grading Approval for the Z-Best Facility at SR 25 the unincorporated portion of Gilroy.

Dorado appeals the Planning Commission's on the grounds that the Final EIR that the Planning Commission certified is legally inadequate and fails to comply with the California Environmental Quality Act and its findings for approval are not supported by substantial evidence. Because critical analysis of key environmental impacts on agricultural resources have been omitted, and all feasible mitigation measures to reduce these impacts have not been incorporated into the project, the Planning Commission could not make an informed decision on the significant environmental impacts of the proposed expansion of the composting operation. Dorado has demonstrated in its written comments on the original 2021 Draft EIR, dated March 1, 2021 (**Exhibit B**), the Recirculated Draft EIR, dated June 20, 2023 (**Exhibit C**), and in its letter to the Planning Commission, dated June 26, 2024 (**Exhibit D**) that substantially increasing the volume of Municipal Solid Waste that will be now be composted in new unenclosed bunkers creates a significant risk to the viability of adjacent prime farmland and the food crops that are cultivated on this land. In addition to Dorado's comments, Dorado's consultant, Dr. Trevor Suslow, has provided some additional technical comments and analysis relating to potentially significant impacts of the proposed Z-Best operation on adjacent farmland and concerns relating to the lack of analysis of key issues. (See **Exhibit E**) As his abbreviated bio included in his analysis indicates, Dr. Suslow is an internationally renowned food safety expert with extensive experience analyzing the risks relating to the transmission of pathogens on food crops.

Due to the risks presented by Z-Best's expanded composting operation, which is explained in these prior letters, and its potential to remove even more prime farmland from future food crop production, Dorado requested previously and now requests that this Board grant the appeal and deny the permit until a legally adequate EIR is prepared. If the Board intends to deny the appeal and approve this permit, the Board must at a minimum require as conditions of approval or mitigation that additional measures set forth below to reduce the project's potentially significant agricultural resources impact.

A. **The Final EIR is Legally Inadequate and Fails to Comply with CEQA.**

**1. The Final EIR's Response to Comments are Inadequate**

Notwithstanding CEQA's requirement to prepare written responses to all written comments raising significant environmental issues, the County responded only to Dorado's RDEIR comment letter. The County has taken the position that the County was not legally obligated to respond to Dorado's DEIR Comment Letter. However, Dorado's RDEIR Comment Letter made clear that the recirculated Draft EIR suffered the same deficiencies as the original Draft EIR and specifically incorporated by reference the comments in that letter and requested a response to those comments. The CEQA Guidelines specifically allow CEQA documents to incorporate other documents by reference and states "where all or part of another document is incorporated by reference, the incorporated language shall be considered to be set forth in full as part of the text of the CEQA document." (14 Cal. Code Regs. Section 15150(a)). If an agency can incorporate by reference other documents in CEQA, surely a commenter on a Draft EIR could do the same. The County's failure to respond to Dorado's DEIR Comment Letter violates CEQA. Prior to certification of the Final EIR, the Final EIR must be supplemented to respond to all of Dorado's comments.

**2. The Final EIR's Analysis of the Project's Potentially Significant Impact on Agricultural Resources is Legally Inadequate.**

a. **The Final EIR Does Not Adequately Address Birds And Other Vectors And Their Potential To Contaminant Adjacent Row Crops.**

Collectively, Dorado's comment letters requested that the DEIR and RDEIR analyze certain specified agricultural and air quality impacts and implement mitigation measures to address the project's potentially significant impact on surrounding prime agricultural land. However, not all potential environmental impacts have been analyzed and addressed. Dorado continues to have concerns about converting the existing enclosed aerated bag process to an exposed aerated static pile system and nearly doubling the amount of material that is currently being composted daily and increasing that amount to 3,500 tons per day for up to 20 days per year. In addition to significantly increasing the volume of material being processed at the facility, the new composting system replaces the **enclosed** aerated bag process with open air bunker style composting process. This new composting process will expose raw Municipal Solid Waste (MSW) that carries pathogens that could become airborne to the elements when the material is transported to the bunkers and when it is initially dumped in the bunkers until the bio-layer cover is applied. Composting material will also be exposed and not covered with any layers during the entirety of the secondary composting process. Accordingly, and as Dorado repeatedly pointed out in its comment letters, this composting material, particularly at the initial primary composting stage, carries pathogens. This exposed raw material will also attract more birds, which can consume the material and then defecate on the surrounding farmland or simply carry this composting material over to the adjacent row crop fields, which will make it impossible to farm row crops due to stringent food safety protocols.

The other concerning project feature is detention basin #1 that is right on the edge of Dorado's farm. According to the staff report, "stormwater that moves through MSW results in leachate, a contaminant with high biological oxygen demand, low pH, and nutrients including nitrogen, phosphorous, and salts." Like the open-air bunkers used during the composting process, this detention pond has no cover and will be exposed to the elements with the potential for birds, rodents or other vectors to wade in the contaminated leachate and then land on or move through the surrounding food crops and contaminating crops pre-harvest.

In addition to Dorado's observation of significant bird activity at the Z-Best facility, Cal-Recycle made the same observations in recent 2024 inspection reports. In all the reports (See **Exhibit F**), the inspector noted bird activity and instructed Z-Best "to ensure that measures are employed to control vectors." During one notable inspection in February 2024, the inspector observed approximately 100 black birds in the processing building. This significant bird activity is occurring at the composting facility based on the current volumes of composting materials being processed at Z-Best. Now the volume of raw material being processed at the property will nearly double and will now occur entirely in unenclosed bunkers with exposed materials regularly being moved throughout the site. Nonetheless, the Final EIR makes no effort to undertake any meaningful study or analysis of the bird or rodent vector issue. Because of this lack of analysis, the Final EIR does not recommend any mitigation that would require Z-Best to employ measures to control the bird vector and prevent birds from transporting raw materials to the adjacent agricultural or row crop areas.

Rather than addressing the bird vector and transmission issue head on and undertaking any meaningful analysis of this potential impact, the Final EIR simply dismisses Dorado's concerns. The Final EIR states that "the commenter does not provide any evidence to suggest that an increase in birds at the facility would result in significant environmental impacts that would require mitigation via the suggested bird deterrent measures." (See Final EIR, p. 35) However, Dorado did provide such evidence in the form of photographs of current bird activity at Dorado's facility and bird droppings on Dorado's farmland. See **Exhibit C** to the DEIR Comment Letter. The significant environmental impact is the potential loss of more prime and productive agricultural land that has already been decimated and converted throughout the County due to urban development. As we have previously explained, the increase in bird activity will lead to an increase in bird activity on adjacent farmland. This increase in activity will inevitably lead to more active prime farmland being taken out of production based on the strict food safety protocols.

Despite Dorado alerting the County to the EIR's ongoing oversight this potentially significant environmental impact and suggesting reasonable mitigation measure in the form of a bird control plan, the Final EIR simply states that "if the Project were to result in neighboring landowners deciding that the growth of crops for human consumption were unviable beyond the areas that are already fallowed…, this would not preclude those properties from being used for other agricultural purposes consistent with the agricultural zoning of the land, such as grazing or non-edible crops." (See Final EIR, p. 35) This response to Dorado's violates CEQA's mandate that the County impose all feasible mitigation measures on the project to minimize or reduce a project's significant environmental impacts. CEQA does not require an existing adjacent owner being impacted by the project to modify their practices to avoid an impact.

**b. The Final EIR's Analysis of Bioaerosol Emission and Their Risk to Adjacent Row Crops is Inadequate.**

As Dr. Suslow has documented in his analysis (**Exhibit E**), the Final EIR focuses primarily on the risk of inhaled bioaersols as opposed to Dorado's concern, which relates to airborne transport and deposit of bioaerosols on food crops. Dr. Suslow opines that despite some of the measures that Z-Best is implementing to reduce the threat of airborne pathogens during the primary composting phase to the adjacent agricultural land, bioaerosol generation is acknowledged to occur at multiple stages of facility handling, from incoming materials, during sorting, turning, and during transport to and from primary composting bunkers. The Final EIR does not analyze or attempt to minimize the threat of bioaersols during these other stages of the composting operation.

**3. The Final EIR Fails to Adequately Analyze a Reasonable Range of Alternatives, Including a Fully Enclosed Composting Operation**.

Due to this project's potential for dangerous pathogens to become airborne and contaminate surrounding agricultural land, Dorado requested that the DEIR undertake a detailed analysis of a fully enclosed composting facility to address this potential impact. In response to Dorado's comments, the RDEIR analyzed the potential impact of an increase in bioaerosol impacts on adjacent agricultural land and concluded that the impact would be less than significant. (See RDEIR, Section 6.4.3) However, the RDEIR concludes that the impact of bioaerosols would be a "significant and unavoidable" air quality impact. (See RDEIR, Section 7.4.7) Both sections of the RDEIR discuss the potential for bioaerosol emissions to affect nearby food crops; however, the RDEIR inexplicably arrives at conflicting conclusions. The RDEIR also states "…since regulatory exposure limits have not been established, and due to the uncertainties explained above [in Section 7.4.7] and detailed in Appendix B-6, potential health and environmental impacts due to bioaerosol emissions cannot be ruled out" (RDEIR, p. 146). Even with implementation of the dust monitoring protocol in MM-AIR-7a and equipment maintenance and biofilter replacement in MMM-AIR-7b, the impact remains significant and unavoidable.

The Final EIR and Z-Best dismiss the need to undertake a more detailed review and analysis of this alternative because they say it would be more expensive. However, just because a project may be more expensive to construct does not mean the project is economically infeasible. There must also be evidence that the additional cost or lost profitability are sufficiently severe to render it impracticable to proceed. No such evidence is provided. The only other statement regarding the infeasibility of an enclosed facility is a statement by Greenwaste that their current revenue stream from contracted cities would not cover the increased cost, but Greenwaste provided no data or analysis to support that conclusion.

Based on the significant and unavoidable bioaerosol impacts and the other potential impacts on adjacent agricultural land, the County should more seriously consider a fully enclosed composting design to protect the public health and safety and surrounding agricultural land. Dorado requests that the Board continue any decision and recommend that the County independently investigate the feasibility of such an alternative, or at a minimum, direct staff to analyze this alternative with the same level of vigor and detail as the EIR's analysis of the other alternatives that are described in the RDEIR. Currently, the RDEIR analyzes only two project alternatives, and both were conceived to address significant traffic impacts. Such a limited analysis of alternative fails to comply with CEQA's requirement to study a reasonable range of project alternatives for the reasons set forth in the Dorado's RDEIR Comment Letter.

**4. The Board Can Not Make the Required Findings to Approve the Use Permit Based on the Impact of the Proposed Z-Best Expansion on Adjacent Farmland**

Aside from whether the Board can certify a legally adequate Final EIR, in order to approve the Use Permit, the County Zoning Ordinance requires the Board to find, among other findings, that:

1. The site is adequate for the proposed use, including but not limited to being of adequate size and shape to accommodate all facilities and development features to integrate the use into the surrounding area and to provide any necessary or appropriate buffers between the use and the surrounding area; and,

2. The proposed use, by its nature, scale, intensity or design, will not impair the integrity and character of the zoning district or neighborhood, and will not be significantly detrimental to any important and distinctive features of the site's natural setting.

In this case and for all the reasons noted above regarding the risk of this open composting operation to the surrounding agricultural land, the Board cannot make these legally required findings.

**5. Dorado Requests that the Board Require Dorado to Implement Reasonable and Feasible Conditions and Mitigation Measures to Address the Aforementioned Project Impacts.**

To mitigate and minimize the potential for more critically important farmland to be removed from row crop production, Dorado requests that the Board incorporate certain requirements into the project. Even assuming Z-Best disagrees with Dorado's assessment of potential impacts of their project on the Dorado's property and other surrounding farmland, we assume Z-Best wants to be a good neighbor and should be willing to accept requirements that would further reduce or minimize the impacts of their facility on their neighbors. Dr. Suslow, in his attached comments on the project, states the following:

> I also recommend that Z-Best incorporate certain mitigation measures to further reduce the potential risk of this facility to adjacent food crops. Measures such as increased, elevated, and routinely inspected dust abatement screens, a minimal 2 year robust pathogen prevalence testing program for pre-composting organic inputs, stage-1 cross-sectional pathogen testing of in-process compost at the open bunkers (before applying a 6-inch finished compost layer and at the "feet" of the pile adjacent to bunker walls (especially during periods of pooled water from any source), a 2-year dust monitoring program, and a comprehensive risk mitigation

performance verification program to assess operational adherence to expected outcomes of the proposed EIR measures for expansion.

We recommend that County staff work with the EIR technical consulting team to discuss a mitigation program or condition of approval that is consistent with the parameters that Dr. Suslow recommends.

In addition, Z-Best is already installing a 35-foot-tall windscreen to separate the primary and secondary composting areas. The same 35-foot-tall windscreen should also be installed on the common property line between the Z-Best property and Dorado's property. While the prevailing winds might blow in specific direction, winds can occasionally blow in different directions including toward Dorado's property. A windscreen at the common property line would minimize the potential for debris, including potentially raw MSW materials, from blowing onto the Dorado's farmland and active crop production.

Finally, as we previously requested and the Planning Commission did not require, we request that the Board require, as a condition of approval or mitigation, that Z-Best prepare and implement a comprehensive vector control program that addresses birds and other rodents.

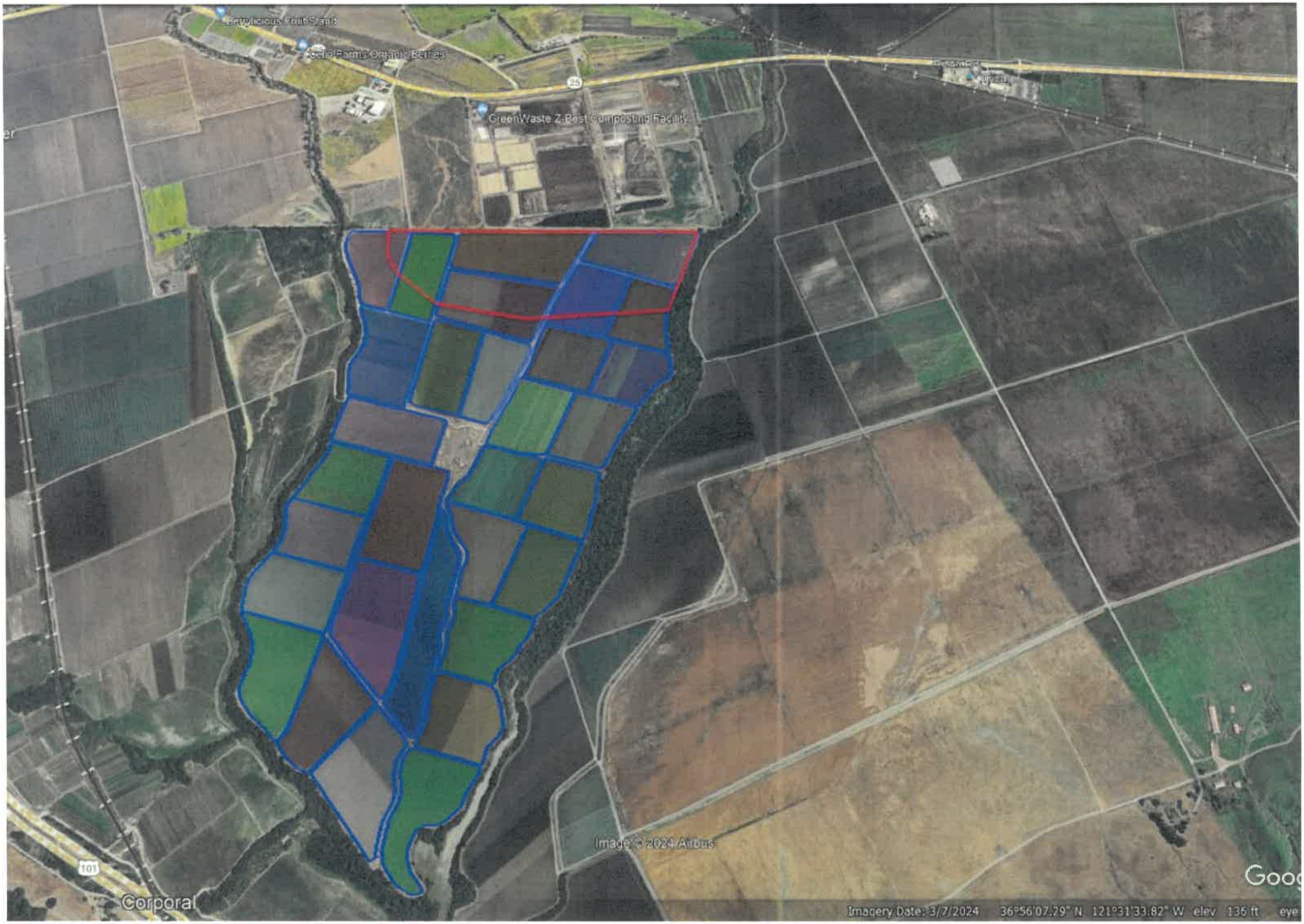
Because Dorado's concerns have not been fully analyzed, addressed and mitigated, we respectfully request that the Board grant Dorado's appeal and deny the entitlements or continue the matter until the above issues are adequately addressed in accordance with CEQA. If the Board intends to conditionally approve the entitlements, Dorado requests that the Board do what the Planning Commission failed to do, which is to incorporate Dorado's requested conditions of approval into the project. We appreciate the Board's consideration of Dorado's appeal and hope you will balance the need to divert waste for existing landfills with the need to preserve critically important farmland for food crop production.

Respectfully Submitted,

Jason Retterer

cc: Valerie Negrete

# EXHIBIT A


Berrylicious Fruit Stand
Serra Farms Organic Berries
25
GreenWaste Z-Best Composting Facility
Image © 2024 Airbus
101
Corporal
Imagery Date: 3/7/2024 36°56'07.79" N 121°31'33.82" W elev 136 ft

# EXHIBIT B

JRG
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March 1, 2021

**Via E-Mail**
County of Santa Clara
Department of Planning and Development
County Government Center, East Wing, 7th Floor
c/o Adam Petersen (apetersen@m-group.us)
70 West Hedding Street
San Jose, CA 95110

**Re: Dorado Leasing Comments on Z-Best facility Draft EIR.**

Dear Mr. Petersen:

On behalf of Dorado Leasing ("Dorado"), who owns the 570-acre Sargent Ranch, which is contiguous to the southern boundary of the Z-Best facility, we submit the following comments on the Draft EIR ("DEIR").

**A. The Important Purpose of CEQA and an EIR**

CEQA is a comprehensive scheme designed to provide long-term protection to the environment. In enacting CEQA, the Legislature declared its intention that all public agencies responsible for regulating activities affecting the environment give prime consideration to preventing environmental damage when carrying out their duties. CEQA is to be interpreted "to afford the fullest possible protection to

> the environment within the reasonable scope of the statutory language."[1] Both the mandate and the procedure of CEQA are carefully crafted and well ingrained into the law of this state.[2]

The process compelled by CEQA "is a meticulous process designed to ensure that the environment is protected . . . ."[3] In fact, "[t]he integrity of the [CEQA] process is dependent on the adequacy of the EIR."[4] Thus, the EIR, with all its specificity and complexity, is the mechanism prescribed by CEQA to force informed decision making and to expose the decision making process to public scrutiny.[5] As the Supreme Court has established, the EIR is "the heart of CEQA."[6]

> An EIR is an "environmental 'alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return." The EIR is also intended "to demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action." Because the EIR must be certified or rejected by public officials, it is a document of accountability. If CEQA is scrupulously followed, the public will know the basis on which its responsible officials either approve or reject environmentally significant action, and the public, being duly informed , can respond accordingly to action with which it disagrees. The EIR process protects not only the environment but also informed self government.[7]

As such , the purpose of any EIR is to provide public agencies and the public with "detailed information about the effect which a project is likely to have on the environment to list ways in which the significant effects of such project might be minimized; and to indicate alternatives to such a project."

As discussed in more detail below, the present EIR, the DEIR is legally inadequate and must be significantly revised and recirculated for further public review and comments.

**B. The DEIR is Legally Inadequate**

An agency abuses its discretion by failing to proceed in the manner required by law if its action or decision does not substantially comply with the requirements of CEQA.[8]Under this test, omission of information that CEQA mandates be included in an environmental analysis constitutes a failure to proceed in the manner required by law.[9]

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[1] Mountain Lion Foundation v. Fish and Game Com. (1997) 16 Cal.4th 105, 112.

[2] County of Amador v. El Dorado County Water Agency (1999) 76 Cal.App.4th 931, 943

[3] Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892

[4] Save Our Peninsula Committee v. Monterey County Board of Supervisors (2001) 87 Cal.App.4th 99, 118-119

[5] No Oil, Inc. v. City of Los Angeles (1974) 13 Cal.3d 68, 86.

[6] Laurel Heights Improvement Ass'n v. Regents of the University of California ( Laurel Heights I ) (1988) 47 Cal.3d 376, 392.

[7] Ibid

[8] Pub Res C §§21168, 21168.5; Communities for a Better Env't v. South Coast Air Quality Mgmt. Dist. (2010) 48 C4th 310

[9] Banning Ranch Conservancy v. City of Newport Beach (2017) 2 C5th 918, 935

The Court of Appeal in *Galante Vineyards v. Monterey Peninsula Water Mgmt. Dist.* (1997) 60 CA4th 1109, 1117 held:

> "[T]he ultimate decision of whether to approve a project, be that decision right or wrong, is a nullity if based upon an EIR that does not provide the decision-makers, and the public, with the information about the project that is required by CEQA. The error is prejudicial if the failure to include relevant information precludes informed decision-making and informed public participation, thereby thwarting the statutory goals of the EIR process.

With these general legal principles in mind, Dorado submits the following specific comments on the DEIR.

**1. The DEIR's Discussion of the Environmental Setting is Legally Inadequate**

An EIR must include a description of the existing environment in the vicinity of the project from both a local and a regional perspective.[10] The EIR must discuss the project's regional setting and must emphasize discussion of any affected environmental resources that are rare or unique to the region.[11]

A description of important environmental resources that will be adversely affected by the project is critical to a legally adequate discussion of the environmental setting. For example, in *San Joaquin Raptor/Wildlife Rescue Ctr. v. County of Stanislaus* (1994) 27 CA 4th 713, the court found an EIR's description of the environmental setting deficient because it did not disclose the specific location and extent of riparian habitat adjacent to the property, inadequately investigated the possibility of wetlands on the site, understated the significance of the project's location adjacent to a river, and failed to discuss a nearby wildlife preserve. Similarly, the local Sixth District Court of Appeal in *Galante Vineyards, supra,* 60 Cal.App.4th 1109, 1122, in a factually analogous situation, found that a generalized reference to adjacent vineyards that could be affected by a nearby dam and reservoir project that was proposed for construction in Monterey County was an inadequate description of the environmental setting.

This DEIR suffers from the same fatal defects as the EIR in *Galante Vineyards*. The EIR in *Galante* only generally acknowledged the presence of vineyards in the area, but downplayed and failed to mention the important of viticulture in the area of Monterey County that was affected by the proposed dam and reservoir project in that case. There was evidence in the record that the project area included numerous thriving vineyards and small world class, highly regarded wineries that achieved recognition world-wide for its quality wines. Nonetheless, the DEIR was silent regarding the number and specific location of these vineyards as well as other specific details.

As the Court explained in *Galante*:

[10] 14 Cal Code Regs §15125(a).
[11] 14 Cal Code Regs §15125(c).

"Due to the inadequate description of the environmental setting for the project, a proper analysis of project impacts was impossible. CEQA requires that an EIR "identify and focus on the significant environmental effects of the proposed project. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in . . . the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, scenic quality, and public services...."

Similarly, in this case, the DEIR's failure to acknowledge and discuss the significance presence agricultural resources in and around the Z-Best facility has made it impossible to undertake a proper analysis of the impacts of the Z-Best expansion. The DEIR fails to provide key characteristics of the Sargent Ranch (hereinafter "the Ranch") or any other surrounding agricultural resources to ensure a proper and robust impacts analysis, including the types of food crops that are planted and harvested at the Ranch, the number of annual harvests, or the quality of soil and farmland.

**2. The DEIR fails to Adequately Analyze and Disclose Potentially Significant Environmental Impacts of the Z-Best Expansion.**

**a. The DEIR's Analysis of Agricultural Impacts is Legally Deficient.**

To ensure that the DEIR adequately analyzes the potential impact of the Z-Best expansion on adjacent agricultural resources and human health, Dorado engaged Dr. Trevor Suslow. Dr. Suslow is an Extension Research Specialist at the University of California, Davis, who maintains statewide responsibilities in quality and safety of perishable horticultural commodities. Dr. Suslow reviewed the DEIR's analysis of potential agricultural impacts and noted several deficiencies, which are briefly summarized below. Attached as **Exhibit A** is Dr. Suslow's critique of the DEIR's analysis.

In general, the DEIR's analysis of potential impacts on agricultural resources is inadequate and fails to analyze well documented impacts from composting operations that can serious consequences on human health and safety and food crops. The proposed project will double the amount of Municipal Solid Waste ("MSW") being hauled to and processed at the facility and therefore increases the risk that the facility poses to the food crops on the adjacent farmland. Due to the health and safety risk to food crops associated with Z-Best's current level of operations and as documented in a separately submitted letter to the County, the current farmer of the Ranch, Willoughby Farms, Inc., is unable to farm nearly 24% of the 570-acre Ranch due to stringent industry food safety protocols. In other words, the Z-Best facility has caused approximately 135 acres of the Ranch to be unfarmable.

i. **The DEIR fails to analyze the potential for bioaerosols from the composting process to contaminant the adjacent farm fields and food crops.**

As noted in Dr. Suslow's analysis, the Z-Best expansion has "the potential to increase physical, chemical, and microbial contamination of edible horticultural commodities in proximal production zones." Dr. Suslow's conclusion is based on numerous studies and technical reports that are referenced in Dr. Suslow's analysis that found that composting facilities generate airborne microorganisms that could impact surrounding areas, including in this case, the Ranch and neighboring farm fields. The DEIR must carefully consider, analyze, and mitigate, if necessary, the impact of bioaeresols on the Ranch and the surrounding farm fields.

ii. **The DEIR fails to analyze the potential impact of increased vectors such as insects, birds and mammals on the Ranch and other surrounding farm fields.**

The proposed Z-Best expansion includes project components that will increase the number of insects, birds, and mammals that could contaminate food crops and a pose a human health and safety risk. Specifically, the Z-Best expansion will replace the currently fully enclosed bagged composting system used during the primary composting stage when MSW is at its rawest form with open air composting bunkers. Moreover, it is unclear from the DEIR how installation of concreate bunkers for the secondary composting activity would be a significant improvement over the currently exposed windrows. The secondary compost piles will continue to be exposed to the elements because the bunkers have no rooves and one side of the bunkers will remain open. Logic dictates that the secondary compost area will continue to attract insects and birds akin to the current operation.

The problem with having exposed food waste in uncovered bunkers is the potential for birds to transport this food waste and the pathogens that are found in food waste off-site to areas that are being actively farmed. In a 2015 study that examined the feasibility of composting campus dining food waste at California Polytechnic State University – San Luis Obispo's compost facility ("2015 Cal Poly Study"), the Study noted the presence of pathogens in composting activity. (see **Exhibit B**). As noted in the 2015 Cal-Poly Study, "there are several organisms of concern that are generally associated with pathogens in food: such as Salmonella, Listeria and E.coli" and "these food borne illnesses make up more than 90% of all illness caused by food (citation omitted)." (p. 6). The 2015 Cal-Poly Study further explained that "Introducing Campus Dining food waste will increase the risk of pathogens, which also increase the risk of contacting these diseases. Campus dining food waste consists of all kinds of meats and vegetables all of which have the risk of containing many pathogens."

On February 21, 2021, representatives from Dorado undertook a site visit to the Ranch between 11 am and 1 pm to observe the Z-Best operations and the southern boundary of the property. During this two-hour site visit, massive swarms of birds were observed during the entire visit hovering above the compost piles at the Z-Best facility. These birds were not just observed within the confines of the Z-Best property but were regularly flying over, landing and roosting in the farm fields. As documented in the biological reconnaissance surveys that are summarized in the DEIR's analysis of Biological Resource, bird species observed at the site include the American crow and seagulls. In addition, attached as **Exhibit C** is a photo of the Z-Best operation that depicts numerous birds hoovering over and landing on the compost pile and a photo of bird feces on a soil row on the adjacent portion of the Ranch that was taken during a site visit on February 22, 2021.

One staff publication of the USDA National Wildlife Research specifically examined the problem of food scrap compositing and vector control (see **Exhibit D**). Due to the potential wildlife related impacts relating to the location and operation of food waste management facilities, the article concludes that "Responsible development of the industry must include management of facilities to minimize waster material serving as attractants to vectors such as birds and mammals that pose hazards to human health and safety" (p. 35). The article notes that bird use of waste management facilities can pose a number of problems to areas surrounding these facilities. The article specifically calls out gulls, which are also present at the Z-Best facility, as problematic species that are known carriers of bacteria such as E.coli, Salmonella, and Listeria, which cause enteric disease in humans. Gulls are known to nest and defecate areas proximate to waste management facilities. Feathers, nest material, and food remains from gulls also litter the surrounding areas, which poses an additional risk to food crops.

In addition, and as discussed on page 5-14 of the DEIR in context of the project's aesthetic impacts, the Z-Best expansion proposes to remove a row of mature 40-foot-tall trees, which are the only trees that provide roosting opportunities for the swarms of birds hovering over the facility. Even with this row of trees, the birds regularly fly over to Ranch and roost in the field. By removing these trees, the proposed project will exacerbate the existing problem of gulls, crows and other birds roosting on the farm fields.

The DEIR must analyze the impact of increased bird activities due to the doubling of MSW that will be processed at the facility.

**b. The DEIR's Analysis of Air Quality Impacts is Legally Deficient.**

**i. The DEIR fails to analyze the potential impacts from bioaersol transmission on Z-Best workers and off-site farmworkers.**

Bioaerosols generated by compositing facilities have been well documented, yet the DEIR completely overlooks the impacts of bioaersols on human health and safety. As one April 2014 study entitled *Bioaerosols from composting facilities – a review*, (attached as **Exhibit E**) ("2014 Study") explains:

> "The term "bioaerosol" encompasses all particles having a biological source that are in suspension in the air and includes microorganisms (bacteria, fungi, virus, protozoa, algae, pollen.) as well as biomolecules (toxins, debris from membranes.) (Sykes et al., 2011). Current knowledge on microbial diversity in aerosol from composting facilities is largely focused on bacteria and molds. For more than a decade, actinomycetes, Aspergillus fumigatus, and Penicillium sp. have been recognized as the dominant culturable micro-organisms in composting bioaerosols."

The 2014 Study provides a detailed analysis of the impact on health of the exposure to aerosols emitted from compost. Specifically, the study explains that the "main identified risks of infection from composting bioaerosols are represented by opportunistic microorganisms, especially molds which can take advantage of deterioration in the immune system. (p. 4) The 2014 Study further notes that the "main effects of exposure to composting aerosols are on respiratory health; these include organic dust toxic syndrome, extrinsic allergic alveolitis (EAA), allergic rhinitis, asthma, upper airway irritation and mucus membrane irritation." (id.) Finally, the 2014 Study references a number of other studies that showed a link between composting aerosols and adverse health effects on compost workers.

In addition, according to a November 2008 study entitled Assessment of airborne microorganism contamination in an industrial are characterized by an open composting facility and wastewater treatment plan, (attached as **Exhibit F**):

> "...waste handling processes, such as composting and wastewater treatment may be considered potential sources of airborne pathogenic and non-pathogenic microorganisms. (Citations omitted) During the composting process, organic dust is stirred up and growth of various mesophilic and/or themophilic species commonly occurs. As a consequence, processing can cause microorganisms and dust to become aerosolized and inhaled. Therefore, composting plants and wastewater treatment facilities may represent an exposure hazard to workers and people living in the immediate surrounding."

Other studies and reports have been prepared that document and analyze the potential impacts of bioserosols from composting operations. Attached, as **Exhibit G**, is a recent, 2019 Study entitled "Bioaerosols and Health: Current Knowledge and Gaps in the Field of Waste Management." The purpose of the study was to assess the knowledge and gaps regarding the health risks associated with biosersols.

Based on these studies and well documented risk related to bioaersol exposure from composting facilities, CEQA demands that the DEIR analyze, and if necessary, mitigate these impacts. Otherwise, the County's Planning Commission and members of the public do not have sufficient information to make a meaningful decision about the potentially significant environmental effects of this project.

**ii. The DEIR fails to correlate the project's adverse air quality impacts to resultant adverse health effects.**

Failing to correlate the Project's adverse air quality impacts to increased incidents of health ailments constitutes a prejudicial abuse of discretion. As the Court of Appeal in *Bakersfield Citizens for Local Control v. City of Bakersfield* ("Bakersfield") (2004) 124 Cal.App.4th 1184, 1220 explained: health problems caused by a project must be addressed in an environmental impact report, including incidents health effects caused by increases in air pollution. Specifically, CEQA requires an environmental impact report to discuss "health and safety problems caused by the physical changes" by the proposal. §15126.2(a). In order to meet

CEQA's disclosure requirement, an environmental impact report must "correlate the identified adverse air quality impacts to resultant adverse health effects." *Bakersfield* at 1219 (italics added). "Correlate" is defined as: "to bring (a thing) into mutual relation (with another thing); **calculate** or show the reciprocal relation between; specif., to bring (one or two related or interdependent **quantities**, sets of statistics, etc.) into contrast (with the other)." Webster's New World Dictionary 319 (2d College ed. 1985) (italics in original; bold added).

Thus, the court in Bakersfield used "correlate" to mean an environmental impact report must disclose the proportional relationship between increased tonnages in air pollution and increased incidents of health ailments by calculating and quantifying the relationship. The DEIR fails to comply with this necessary informational disclosure requirement. Indeed, Bakersfield teaches us a truncated analysis involving a bare statement that increased air pollution tonnages means more people get ill fails to satisfy CEQA's information disclosure requirement.

In *Bakersfield*, the two EIRs at issue calculated the approximate increased tonnage of air pollution and then baldly concluded that more air pollution means more health and respiratory ailments.' *Id.* at 1220. According to *Bakersfield*, this embryonic level of detail is insufficient and resulted in the Appellate Court rejecting the air quality analyses for failing to quantify or correlate the relationship between increased health ailments and increased air pollution. *Id.* at 1220-1221. Accordingly, it is not enough for an environmental impact report to simplistically conclude air pollution will increase and then supply a laundry list of pollutants and related health effects. Rather, CEQA is satisfied only when an EIR discloses and quantities anticipated increases of health ailment events resulting from a project's increases in air pollution tonnages.

The DEIR essentially suffers the same affliction as the Bakersfield EIRs and likewise fails to satisfy CEQA. The DEIR notes in Table 6 that certain pollutants can contribute to certain health ailments but never correlate the actual increases of air pollutants to the number and type of air pollution related conditions and diseases. For example, the DEIR states that the project would generate 123.19 per day of NOx emissions due the additional truck trips, which exceeds the applicable significance threshold of 54 pounds per day. However, the DEIR fails to correlate this increase in NOx emissions to any potential increased health risk to workers at the Z-Best facility, farmworkers in the adjacent farm fields, or residents in the surrounding area. This error is compounded by the DEIR's failure to adequately address the impact of bioaersols on human health and safety, which can cause the same types of health effects as NOx.

The DEIR's air quality analysis ignores glaring omissions and falls short of fulfilling the statutory disclosure requirement. This truncated analysis violates CEQA by omitting a correlation between adverse air quality impacts and resultant adverse health effects and does not disclose the severity of the Project's environmental impacts. *Bakersfield* holds, brief references to, or the listing of, potential respiratory illnesses do not satisfy CEQA. It is only when correct and feasible scientific analysis is conducted and the EIR calculates the significance of the impact in terms of increased events of disease and suffering, are the public and decision makers notified of a project's true impacts. This correlated information is scientifically possible and legally required, and the omission amounts to a prejudicial failure to proceed in the manner required by law.

**3. The DEIR Fails to Discuss Feasible Mitigation to Reduce Potentially Significant Environmental Impacts on Agricultural Resources.**

A fundamental purpose of an EIR is to identify ways in which a proposed project's significant environmental impacts can be mitigated or avoided. Pub Res C §§21002.1(a), 21061. To implement this goal, an EIR must describe feasible mitigation measures that can minimize the project's significant environmental effects. 14 Cal Code Regs §§15121(a), 15126.4(a). As one court observed, "A gloomy forecast of environmental degradation is of little or no value without pragmatic, concrete means to minimize the impacts and restore ecological equilibrium."[12]

Due to the DEIR's omission of any meaningful analysis of the project's potentially significant impact on contiguous agricultural resources, the DEIR fails to analyze or discuss any potentially feasible mitigation measures to avoid or substantially lessen the project's impacts on such resources. For example, the DEIR should consider requiring the project to implement a bird control program that could include, for example, the use of falconry, bird flares, whistles, remote controlled airplanes that resemble predatory birds, and other noisemakers, to discourage birds. The DEIR should further consider requiring the project to plant additional trees around the property to allow for more roosting opportunities for birds. Currently, the only row that provide on-site roosting opportunities for birds are the row of trees near the detention pond that are proposed for removal. If the project intends to remove these trees, other mature trees should be planted around the property to compensate for the loss of these trees and to provide additional roosting opportunities.

The DEIR should also consider requiring preventative measures to reduce bioaersol emissions, such as, for example, dust control measures that include moisture control of the feedstock and composting, screening operation in a separate area from composting operations, sealing of the turning machinery with rubber mats, dust capture systems, and regular cleaning and wetting of driveways. In addition, building berms and planting trees at appropriate locations on the site have been recommended as measures that can alter wind dispersion patterns and offsite transport of bioaerosols (Millner et al., 1994). The benefit of forest barriers on particulate dispersion has been demonstrated experimentally (Raynor et al., 1974) and highlighted regarding composting (Millner et al., 1994). Forest barrier both dilutes the particulate concentration in the plume and induces impaction and deposition of particles.

**4. The DEIR's fails to Analyze a Reasonable Range of Project Alternatives**

The DEIR currently analyzes three project alternatives. However, one of the alternatives is the No Project alternative, which, while required by CEQA, clearly does not meet any of the key project objectives of the project and is not a true project alternative. The other two alternatives studied include a "Reduced Project Scale" alternative, which is based on a reduction in the number of truck trips to avoid significant air quality impacts and a "No Driveway Relocation" alternative. CEQA demands more than analyzing just two alternatives, particularly for a large-scale composting operation that will result in significant and unavoidable air quality impacts and the

[12] Environmental Council of Sacramento v City of Sacramento (2006) 142 CA4th 1018, 1039

types of potentially significant impacts on agricultural resources and human health and safety discussed above.

There is at least one additional potentially feasible project alternative that should be explored and analyzed that could potentially avoid or substantially reduce potential impacts of the expanded composting facility, including odor and other air quality impacts and vector susceptibility. This alternative should explore an entirely enclosed or indoor composting facility. An example of an indoor compositing facility is one that is described and discussed in the 2015 Cal Poly Study. The 2015 Cal Poly Study discussed the possibility of undertaking composting in a fully enclosed Stationary In-vessel System (p. 14). According to the study:

> The stationary vessel (SV) composter is an advanced control system that optimizes compost stabilization and pathogen reduction rates using its unique aeration design (ECS, 2015). It is a stationary system made with site built insulated concrete vessels; these vessels have stainless steel doors and interiors, with aluminum exterior covers. The SV composter is predominately suited for medium to large scale composting, located in odor sensitive sites such as Cal Poly's compost facility.

This type of system provides the best pathogen, odor, and vector control, and has the smallest footprint compared to other composting technologies (ECS, 2015). The unique aeration design helps capture and dramatically decrease greenhouse gas and odor emissions. The special aeration system provides a controlled airflow in order to maintain uniform biomass temperatures. The aeration system shown in the figure below is designed to conserve energy with adaptive control strategies.

In *Center for Biological Diversity v. County of San Bernardino* (2010) 185 CalApp.4th 866, the Court of Appeal found that an EIR for an outdoor composting facility was legally inadequate because it did not consider an enclosed facility that would significantly reduce air quality impacts. Similar to the Z-Best Draft EIR, the EIR in the *Center for Biological Resources* case only studied three (3) alternatives, the statutorily mandated no-project alternative, a reduced capacity alternative, and an off-site alternative. The Court determined that this range of studied alternatives was inadequate where there was evidence in the record that demonstrated that an enclosed alternative would significantly reduce air quality impacts and was potentially economically feasible.

We appreciate the opportunity to comment on the DEIR for the Z-Best facility expansion and look forward to reviewing the County's responses to the DEIR that address these comments, concerns, and revisions.

Sincerely,

Jason S. Retterer
cc: Bharat Singh, Principle Planner

# EXHIBIT A

Suslow 26 February 2021

**Considerations for Physical, Chemical, and Microbial Food Safety and Buyer Acceptance Impacts Associated with Proximity to Expanded Operations Receiving Green Waste, Commercial Food Waste, and Post-consumer Food Waste**

There are diverse conditions and potentially interrelated factors associated with siting or significant expansion of a waste handling site, which includes wastewater treatment facilities, landfill, composting operations, and hauler-spreader holding and transfer yards. These adjacent land features are known to have the potential to increase physical, chemical, and microbial contamination of edible horticultural commodities in proximal production zones. These sites, depending on variable features and distances, may directly or indirectly result in negative impacts to surrounding agricultural production areas and should be carefully evaluated. The absence of realization of an anticipated impact is wholly dependent upon the quality of the facility and engineering design as well as operational controls of the site as a baseline. To prevent an identified expansion project from realization of a foreseeable agricultural nuisance, the design and effectiveness of innovated proactive measures to prevent, minimize, and contain the potential off-site movement or aerosolized dispersal of hazards and sources of microbial contamination associated with these operations, especially large mixed and variable waste handling facilities, are needed. Planning for the reduction/minimization of the windborne dispersal and deposition of physical and hazardous chemical or pathogen containing aggregates or particulate fines are critical for a comprehensive EIR for these projects. Equally, reduction or mitigation of enhanced attractant factors to vermin and vectors under the most challenging conditions associated with food waste and other post-consumer waste streams must be anticipated. This precautionary impact assessment is well supported and reasonably extrapolated from an abundance of available science-based authoritative and peer-reviewed published knowledge and practice.

The intent of this brief document, at this time, is not to provide a comprehensive literature review, but to support and encourage immediate efforts to develop an objective overview of potential food safety impacts associated with proximity to waste handling sites, with specific focus on large composting operations. The potential for demonstrable risk of contamination of edible horticultural crops as well as the issues of perceived hazard and negative economic affects or competitive market disadvantage are briefly addressed. The current situation in the production and marketing of fresh consumed, raw, or value-added agricultural products, especially leafy greens and herbaceous culinary herbs, necessitates that any broad analysis of the potential for local and adjacent land-use features to influence the real or perceived physical, chemical, and microbial hazards be carefully considered. Domestic and international wholesale, retail, foodservice, and mass merchant buyers, as well as public health regulators, are demanding increasingly complex and comprehensive documented food safety programs. To assess the potential impact of a composting operation expansion on local agricultural and ag-enterprise operations, it is important to evaluate the potential for unintended harm beyond the loss of farmlands, unique farmland, or forested and timberland resources.

Previous related experience by T. Suslow, Ph.D. involved the assessment of potentially contributing factors to a regional *E. coli* O157:H7 outbreak associated with Romaine lettuce produced adjacent to a compost facility which began accepting increased green waste and institutional and urban food scraps and food waste (Cheung, 2015). The implicated compost operation was well managed and had been in operation for many years as an immediate neighboring land use feature to mixed cool season vegetables. Though categorical proof was not obtained, the changed feedstock components to greater volumes of food waste which were associated with increased vector attractant potential, primarily birds, was a notable factor.

**Assessment of the Risk Associated with Composting Sites**

A preliminary digital literature search of scientific journals and related publications and a similar broad search of Internet-accessible public documents revealed extensive information on the risk potential of various hazards, including microbial contamination transfer, from compost operations to off-site lands, communities, and crop production. The uniform conclusion contained within multiple studies, issue briefs, and policy reviews, across global locations, are consistent in supporting the need for applying science-based containment measures, including dust abatement windbreaks, within effective operational design and governance. It is recognized that long established standards, regulated permit requirements, and precautionary measures are needed to protect both operators, the local environment, and agricultural enterprises.

A leading source of presumptive risk of transferable contamination from composting facilities, especially those receiving commercial food waste and post-consumer food waste is the direct and indirect vectoring of microbial pathogens by rodents, insects, and birds, particularly crows, pigeons, and gulls.

In summary, all studies and reports related to or scientifically addressing downstream public health concerns about infectious agents transmitted from waste handling siting decisions and facilities are consistent in defining a presumption of risk in the absence of a properly designed and operated containments and vector control programs.

**Negative Economic Impacts**

Scientific literature and science-based risk assessments cannot be adequately employed to dismiss legitimate concerns for potential economic impact to agricultural enterprises within proximity to a perceptual source of food safety hazards. It is not the purpose of this document to argue either side of this sensitive issue. However, it seems prudent that any compost facility expansion EIR identify and address the current realities of fresh produce processing and marketing, especially with regards to particulate deposition residues and microbial food safety issues. The needs inherent in retaining and improving consumer confidence in the safety of fresh produce, consumed without a terminal kill step, to mitigate the potential for contamination by fecal indicators, which are part of many buyer acceptance requirements, and pathogens mandates that adjacent land use risk factors be seriously and thoroughly evaluated. Once site-specific potential risks have been identified, risk assessment may be engaged as a productive action to determine the science-basis for the level of anticipated risk exposure. As the scientific basis for risk assessment is not yet available for every situation, risk perception tends to be sufficient cause for certain buyer-imposed food safety metrics, which has resulted in the loss of prime agricultural land for high value food crop production. Against this backdrop and the unknown potential for competitors to, unfairly, use proximity to expanded waste handling activities as a negative marketing influence on buyers, it is prudent and responsible to commission a more inclusive review to address concerns for significant negative impacts of site expansion and inadequacies of current prevention and containment measures on immediately surrounding agricultural viability.

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# EXHIBIT B

# FEASIBILITY AND COST ANALYIS OF COMPOSTING CAMPUS DINING FOOD WASTE

# IN CAL POLY'S COMPOST FACILITY

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**2015**

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## ABSTRACT

Composting helps our environment and promotes healthy soil, which decreases the need for fertilizer, pesticides, and supplemental water. Reducing the amount of food waste in landfills has significant environmental, economic, and social benefits. The main goal of this project and a sustainable campus involves increasing awareness of environmentally sustainable developments such as Cal Poly's compost facility. This senior project discusses the feasibility, cost analysis, and evaluation of Campus Dining's food waste in Cal Poly's compost facility. If Cal Poly were to incorporate Campus Dining food waste into their compost facility, Cal Poly would be saving $16,185 a year on tipping fees alone. In addition, the composted food waste could generate a revenue of $2,250 per year for a total offset of $18,435 per year. Cal Poly would not start making a profit until the 9th year, and without consideration of non-market costs and benefits, it is not possible to recommend implementing food waste in Cal Poly's compost facility. If in the future, mandates change for Cal Poly, composting of food waste could be examined.

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# INTRODUCTION

## Background

Cal Poly defines sustainability as "The concept of meeting the needs of the present without compromising the ability of future generations to meet their needs." (Elliot, 2014). The goal of a sustainable campus involves balancing, the needs of the community, and the needs for environmental protection. Cal Poly has strived to become a more sustainable community with solid waste recycling. Reducing the amount of food waste thrown into landfills has significant environmental, economic, and social benefits.

One major factor that affects the environment is the methane that food waste produces when disposed of in a landfill; methane is a potent greenhouse gas with 21 times the global warming potential of carbon dioxide (EPA, 2014). Due to this very harmful gas, today, most everyone is conscious about keeping the environment clean and green. One step to achieve this goal is to reuse food waste rather than discarding it into landfills. Not only does composting food waste help our environment but it also promotes healthy soil, which decreases the need for fertilizer, pesticides, and supplemental water (EPA, 2014). Composting returns nutrients to the eco-system and replenishes Earths soil ultimately leading to a more sustainable campus.

The main markets of finished composted material are the agriculture, and landscape industries. With agriculture being very prominent at Cal Poly, it is clear that composting can have a big impact on this community. Some immediate economic benefits include lower disposal costs and labor costs. It would be more sustainable to Cal Poly if Campus Dining food waste were sent for composting to Cal Poly's facility rather than to the local landfill or to Santa Maria's compost facility.

## Objectives

The first phase of this senior project will consist of researching composting and the benefits of it. The second phase of this senior project will be to contact personnel to quantify costs, and amount of waste sent off campus for disposal of food waste. The third phase of this project will be to conduct an evaluation of sending campus dining food waste to Cal Poly's composting facility. The fourth phase will involve a feasibility study. The operation must in turn be profitable and the costs of running the operation must not exceed current cost. The main objective of this project will be to promote a more sustainable future.

# LITERATURE REVIEW

## Composting

The first step to integrating campus dining food waste into Cal Poly's composting facility is to understand how composting works. "Composting is a process used to convert organic waste materials, both vegetable and animal, to rich, humus-like soil amendment used in agriculture" (Bradley, 1990). Compost is organic material that can be used as an amendment in soil or as a medium to improve the development of plants. It is the end product of decayed organic matter that is used to fertilize soil. The specific type of composting process considered for this project will be aerated windrow composting.

Aerated windrow composting is the aerobic decomposition of organic matter. In aerobic decomposition, microorganisms that use oxygen, feed on organic matter. The microorganisms use the nutrients present such as phosphorous, nitrogen, and carbon. During composting energy is gained from the oxidation of organic matter and is released in the form of heat (Earth-Kind, 2009). In this process oxygen is consumed and carbon dioxide is released. One of the most important aspects of decomposition of organic matter in composting piles is the microbial activity. If microbial growth is slowed down or halted, the composting process is directly affected as well. In aerated windrow composting, mixed organic waste is placed into rows of long piles usually between 5-8 feet tall with a base between 10-20 feet, and placed 14-16 feet apart called a windrow, "The turned windrow approach calls for stacking the material to be composted into a pile that has the shape of a windrow with a more-or-less triangular cross-section" (Bradley, 1990). As seen in Figures 1 and 2.

Figure 1. Compost Facility on Cal Poly Campus, CA (Google Maps. 2015)

Figure 2: Engel and Gray compost factory

The windrows are turned periodically in order to aerate and generate sufficient heat to maintain an internal temperature of about 140 degrees Fahrenheit. This maintained temperature ensures that the microbial activity is not slowed down or halted. Typically windrow composting accommodates large volumes of diverse wastes including, animal wastes, yard trimmings, bulking agents, and food waste. The standards for composting processes are shown in the table below (Richard, 1992).

Table 1: Composting process standards, (Richard, 1992).

| **Condition** | **Reasonable Range** | **Preferred Range** |
|---|---|---|
| Carbon-to-nitrogen ratio (C:N) | 20:1 - 40:1 | 25:1 - 30:1 |
| Moisture content (%) | 45-65 | 50-60 |
| Oxygen concentrations (%) | > 5 | >5 |
| Particle size (diameter - centimeters) | 0.5 - 5.0 | 0.5 - 2.5 |
| pH | 5.5 - 8.0 | 5.5 - 8.0 |
| Temperature (º C) | 43 - 66 | 54 - 60 |

When composting, it is essential to keep the windrows in the conditions stated above. There are four elements necessary for composting: nutrients, oxygen, moisture, and temperature (Earth-Kind, 2009). Efficient decomposition requires aeration, particle size, moisture, and sufficient sources of carbon and nitrogen. All organic matter consists of substantial amounts of carbon combined with a small amount of nitrogen; in order to have a good end product, the preferred range of carbon to nitrogen ratio should be 25:1. Having a good carbon to nitrogen ratio keeps the compost from having odor problems and produces the most fertile compost, which results in a good end product. Shown below is the formula on how to calculate C: N ratio.

$$C{:}N = \frac{weight\ of\ Carbon\ in\ A + weight\ of\ Carbon\ in\ B + \cdots}{weight\ of\ Nitrogen\ in\ A + weight\ of\ Nitrogen\ in\ B + \cdots}$$

If there is too much carbon present the process will be slowed down and incomplete; if there is not enough carbon, problems may occur such as leachate or ammonia volatilization. Leachate is water that has or will percolate through the soil and leach out the constituents. It is important to prevent leachate because it can lead to contamination of the groundwater, which may present risks to human health.

Maintaining a moisture content of 55-60% is an important factor in keeping a compost pile functioning, and maintaining optimal conditions for microbes. In order to control moisture, bulking agents are needed to process the feedstock in an aerobically and efficiently. Bulking agents provide porosity to the material; some examples include sawdust, and wood chips (Francis, 2014). Moisture content can be tested with a simple squeeze test, by taking a handful of compost and squeezing to see if water is released, or with a simple calculation shown below (Francis, 2014).

$$Moisture\ Content = \frac{Weight\ of\ wet\ sample - Weight\ of\ dry\ sample}{Weight\ of\ dry\ sample} \times 100$$

Oxygen is crucial in the composting process; oxygen feeds the aerobic bacteria and thus speeds up the composting process. In the absence of oxygen the chemistry of the compost changes and results in foul odors. Odor management is the most common problem that facilities deal with when composting. Failure to address the odors may lead to complaints and the closure of a facility. However preventing odors is simple; maintain aerobic conditions by having oxygen concentrations greater than 5% (Francis, 2014). Doing so will prevent the compost from going anaerobic and producing foul odors. When considering composting, particle size matters, smaller particles decompose quicker than larger particles thus speeding the process up. The particle size of compost should be between 0.5"-2.5" centimeters diameter, at this size the compost can decompose correctly and efficiently.

High temperatures are essential in aerobic composting; it is due to these high temperatures between 54-60 degrees Celsius that the destruction of pathogenic organisms and weed seeds occurs. Maintaining this temperature is very important because if the pathogenic organisms are not destroyed it can be very hazardous to humans. There are multiple ways of determining good conditions for composting; there are calculations that can be done and guidelines to follow. However most experienced composters will argue the best way to determine if the end product will be good is by conducting a feel test. If no water is visible and a sheen is clearly visible, the moisture content will be around 55-60% which is the ideal starting point in composting. This process is widely used amongst experienced composters.

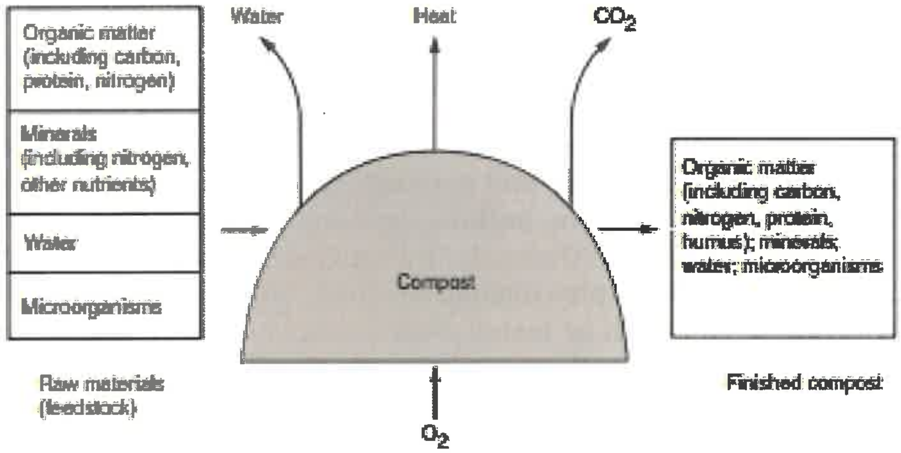


Figure 3: Composting Process (Richard, 1992).

## Food Waste in Composting

Reducing the amount of food waste in landfills has major economic, social, and environmental benefits. Landfills are a major source of human-related methane in the United States, accounting for more than 20 percent of all methane emissions (EPA 2014). With the reduction of food waste in landfills, there will be a significant drop in methane produced from landfills. This reduction of a very potent greenhouse gas can have a huge impact on the environment. Not only will diverting the food waste from landfills benefit the environment but it will also benefit the economy. Diverting food waste to Cal Poly's compost facility will create a valuable soil amendment for local agricultural uses, and will also lower disposal costs. Adding compost to nutrient deprived soil used in agriculture; the farm industry can see immediate benefits in crop yields and quality.

## Pathogen Susceptibility

Following health and safety codes are very important when considering the hazards that are associated with composting. Possible concerns with composting are the potentials for human pathogens and vectors. When dealing with a large-scale compost facility it is crucial that all health and safety codes are followed in order to get rid of pathogens. There are several organisms of concern that are generally associated with pathogens in food: such as Salmonella, Listeria, and E.coli. These food borne illnesses make up more than 90% of all illnesses caused by food (Marler, 2015). Introducing Campus Dining food waste will increase the risk of pathogens, which also increase the risk of contracting these diseases. Campus dining food waste consists of all kinds of meats and vegetables all of which have the risk of containing many pathogens. In order to eliminate pathogens it is crucial to keep the windrows at an internal temperature of at least 140 degrees Fahrenheit for a period of 15 consecutive days (Piper, 2015). It is due to these high temperatures that the destruction of pathogenic organisms occurs. Maintaining this temperature will help ensure that pathogens will be eliminated and help ensure the health and safety of others.

## Vector and Odor Susceptibility

Another health and safety factor that needs to be addressed when composting is the susceptibility to vectors and odors. When composting high volumes of food waste, there can be some concerns such as leachate, odors, and vectors. Leachate is liquid formed by water percolating through the compost pile and extracting dissolved or suspended materials from compost (Bradley, 1990). Odors are the most common problem when considering composting. Due to poor odor control, large-scale facilities have been shut down due to complaints. However odor can be managed with prevention and treatment.

Figure 4: Leachate formed due to large scale composting

Vectors such as insects and rodents can be a problem when including food waste in composting, however, most problems can be minimized if the proper precautions are taken. Practicing good sanitation practices such as keeping grass and weeds mowed, keeping area free of trash and debris, draining any areas of standing water not related to waste handling, and keeping fresh piles covered and active, are all ways to prevent vectors.

## Economic and Environmental Benefits

All around the country landfills are reaching their limit, and composting provides a partial solution to this issue. There are many benefits of composting, not only does composting reduce the amount of waste sent to landfills but it also reduces the emission of greenhouse gases, and promotes higher yields of agricultural crops (EPA, 2011). Composting reduces the need for fertilizer, pesticides, and most importantly water. It is a marketable commodity which can in turn be profitable. When composting in a large-scale facility it is important to remember a significant tipping fee charge can be avoided and profits can even be earned by selling the end product to consumers. Sending Campus Dining food waste to Cal Poly's facility as opposed to other facilities can be a smarter financial decision. If Cal Poly incorporated food waste into their composting facility they would not only save money on tipping fees but also generate more income from the higher yield of their compost facility.

Using composted soil as opposed to chemically enhanced fertilizers can make lasting improvements in the environment for generations to come. Natural composted soil releases nutrients and improves the structure of the soil, which over time will make healthy and strong plants. Most importantly natural composted fertilizers are renewable, biodegradable, environmentally friendly and sustainable.

# PROCEDURES AND METHODS

## Objective

Reducing the amount of food waste in landfills has significant environmental, economic, and social benefits. The scope of this project was to determine if it is feasible to include Campus Dining food waste in Cal Poly's compost facility. Instead of delivering the food waste to landfills and other local composting facilities, a cost analysis was also done to see how much money could be saved if Campus Dining food waste was diverted to Cal Poly's compost facility as opposed to the Engel and Gray compost facility.

## Project Constraints

The total cost of incorporating Campus Dining food waste into Cal Poly's compost facility must not exceed the current costs. It is important that regulations and public needs are met.

## Cost of Operations and Maintenance

The cost for Engel and Gray to pick up the food waste is $65 a ton. Cal Poly is currently diverting 249 tons of waste a year. At a rate of $65 a ton, Cal Poly is spending upwards of $20,000 a year to transport food waste to Engel and Gray. Cost and volume are directly related in this case, if the volume of the food waste were to increase, the cost would increase as well. According to Ellen Curtis, Director Of Marketing and Communications in Cal Poly, in 2010/11 fiscal years alone, 128 tons of food waste was converted to compost, and in 2013/14, that number nearly doubled to 249 tons. Shown in Figure 5 is a graph of how many tons is diverted to Engel and Gray's compost facility monthly in between 2009-2011. It clearly shows that there are Tons of food waste being picked up which results in tipping fee costs.

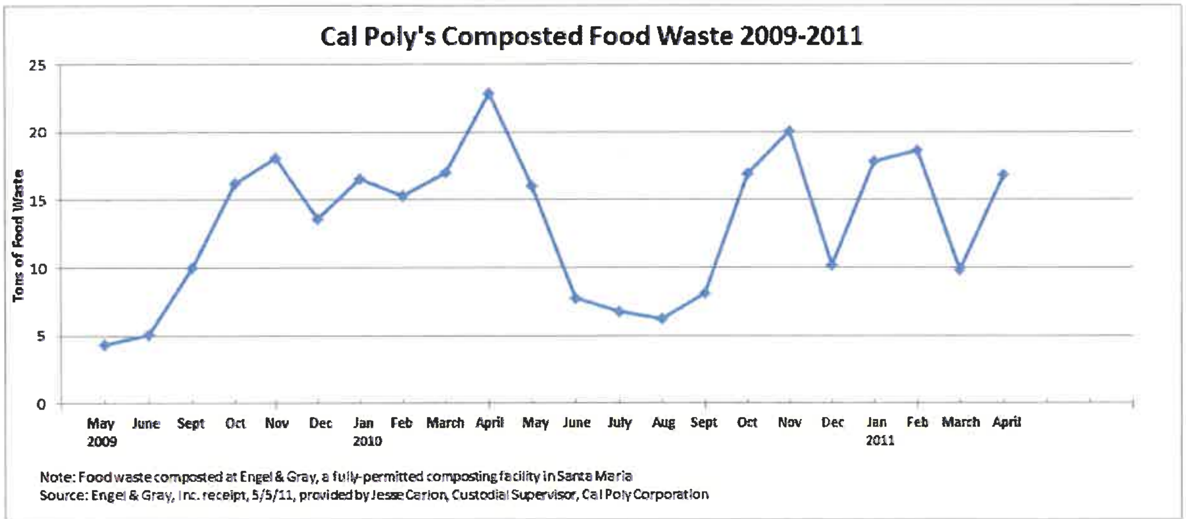


Figure 5: Cal Poly's food waste in tons per month, 2009-2011

Cal Poly is currently spending tens of thousands of dollars diverting food waste to Engel and Gray's compost facility. Cal Poly could not only save money on tipping fees alone, but they can also turn the finished composted product for a profit. Economically, when not considering overhead costs, it makes sense to divert Campus Dining's food waste to Cal Poly's own compost facility.

Table 2: Tipping fee breakdown costs (Curtis, 2015)

| Fiscal Year | Tons of Food diverted | Cost per Ton | Total Cost |
|---|---|---|---|
| 2009/2010 | 140 | $65 | $9,100 |
| 2010/2011 | 128 | $65 | $8,320 |
| 2013/2014 | 249 | $65 | $16,185 |

With Cal Poly holding sustainability as an integral part of its operations, it does not come as a surprise that within a few years, the tons of food diverted from landfills to composting facilities has dramatically increased. Due to the dramatic increase in volume of food waste, tipping fee costs incrementally increase as well.

It should be noted that this is only the cost of the tipping fees and does not take into account for the costs for staffing, specific trash bins, special compostable trash bin liners. Maintenance costs include the cost to hire full time custodians to collect the compost bins and take them out to the Engel and Gray containers, cost for special trash bins, and trash bin liners. Food waste is constantly being collected throughout the day in large venues and once a night from small venues. In terms of hiring more staff to collect the waste, Cal Poly already has 5 full time employees and part of their duty is collecting the compost bins and taking them out to the Engel and Gray container so there is no additional cost (Curtis, 2015).

Table 3: Additional Costs of diverting Food Waste (Curtis, 2015)

| | Cost Per One | Quantity | Annual Cost |
|---|---|---|---|
| Trash Bins | $500 | 96 | $48,000 |
| Trash Bin Liners | $0.13 | 105,120 | $13,665 |

## Current Facility Profit

Cal Poly's compost facility gathers all its materials from Cal Poly's feedstock every Monday and Friday, and places the material into specific piles Tuesday, Wednesday, and Thursday, which makes this facility a full time operation. According to Kevin Piper, head of Agricultural Operations at Cal Poly, the total capacity of the compost facility at any given time is around 7 million lbs. of waste. They are currently only picking up waste from the poultry, and dairy units, leaving out a very nutrient rich feedstock, food waste.

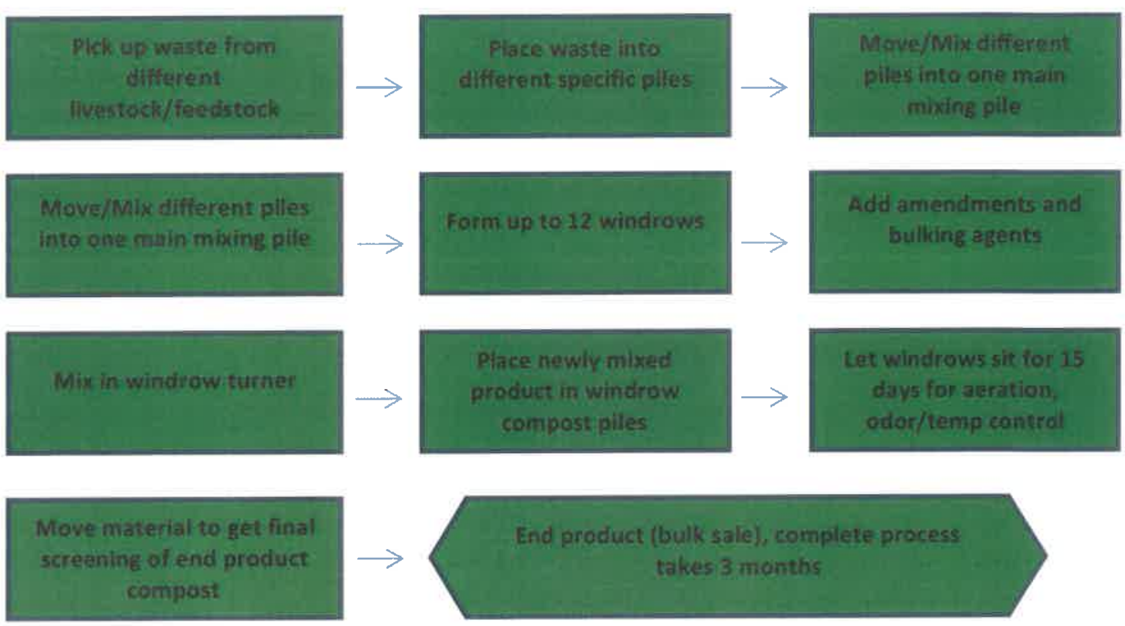

Figure 6: Process flow diagram for Cal Poly's compost facility

Cal Poly's facility currently mixes material into large trapezoidal piles called aerated windrows, in 15-day cycles with 5 minimum turns per cycle, with this method, the windrows can maintain a temperature of 131 degrees which helps with pathogen reduction. Kevin has stated, with transportation needs and the need to turn the windrows 5 times per cycle, the facility needs 1 full time staff and two part time student staff members operating the facility at all times.

The compost facility is currently 38,400 square feet, with the limited size of the facility, they currently lay their windrows in 10 ft. wide piles, 4-5 ft. tall, 160 yards long with 12 rows at a time. Due to the limited space of the facility, if food waste were incorporated to Cal Poly's facility, the net final product per year would increase by 150 tons per year. Cal Poly currently makes a profit of about $31,500 per year; the composting of food waste would add $2,250 per year. The value of the final product on a per ton basis is $30 a ton, while the cost to produce is about $15 a ton.

$$500{,}000\ lbs\ \times 60\%\ reduction = 300{,}000\ Lbs = 150\ tons\ \times \$15/ton = \$2{,}250/yr\ Potential\ profit$$

## Rules and Regulations

All organic material management is regulated with siting, permitting, and management, at state level, except for animal manures and bio solids. Before operating, compost facilities must be approved by the EPA. Examples of permitting process include: detailed facility designs, operating plans, description of incoming materials, and potential environmental releases. Permit requirements vary among states; in California composting operations regulatory requirements are very demanding.

## Site Selection for Composting

When deciding on site selection for composting there are a lot of things to keep in mind. It is crucial to choose a site that is within full compliance with California's Composting Operation and Facility Siting and Design Standards, which states, "Compostable materials handling operations and facilities sited on intermediate cover on a solid waste landfill shall locate operations areas on foundation substrate that is stabilized, either by natural or mechanical compaction, to minimize differential settlement, ponding, soil liquefaction, or failure of pads or structural foundations" (Section 17865. Siting On Landfills). It is also important to select a site in a manner that prevents possible pollution. One of the biggest difficulties when composting is finding a site that is within regulations and does not disturb the public. Commonly compost facilities are best suited for remote areas with a lot of land due to the negative impacts compost facilities have such as vectors, noise, odors, dust, and traffic.

Figure 7: Windrow turner at Cal Poly compost facility

The site should generally be paved with concrete or asphalt in order to avoid groundwater contamination. Cal Poly's compost facility currently sits on 38,400 sq-ft of land. The cost of paving an area that large would be $445,000. Having paved grounds provides a good environment for composting due to the prevention of foreign materials entering windrows.

However the Cal Poly Compost Facility was carefully selected and placed on top of a hill. The grade of Cal Poly's composting site is designed to allow the liquid leachate to flow away from the creek and into a drainage pond, thus concrete would not be needed. This site was very carefully selected as to avoid cross contamination.

When dealing with raw materials such as food waste, it is important to keep in mind the vectors that will inevitably be present. Approximately the same area needed for the composting process should be available for the curing process. With high amounts of food waste added, there will need to be an expansion of Cal Poly's compost facility. Currently Cal Poly has enough space for 12 windrows.

One thing to keep in mind when considering the site of a compost facility is transportation. Transporting waste a long distance is uneconomical; minimizing transportation cost is crucial in economic management. Setting up the composting operation close to the source of the waste is not only economical but also convenient.

## Stationary In-vessel System

The stationary vessel (SV) composter is an advanced control system that optimizes compost stabilization and pathogen reduction rates using its unique aeration design (ECS, 2015). It is a stationary system made with site built insulated concrete vessels; these vessels have stainless steel doors and interiors, with aluminum exterior covers. The SV composter is predominately suited for medium to large scale composting, located in odor sensitive sites such as Cal Poly's compost facility. Shown in the figure below are SV Composters. The stationary vessels can be built up to any size, which is convenient for Cal Poly due to the limited space the compost facility currently has.

Figure 8: SV Composter located in Granby, Canada (ECS, 2015)

This type of system provides the best pathogen, odor, and vector control, and has the smallest footprint compared to other composting technologies (ECS, 2015). The unique aeration design helps capture and dramatically decrease greenhouse gas and odor emissions. The special aeration system provides a controlled airflow in order to maintain uniform biomass temperatures. The aeration system shown in the figure below is designed to conserve energy with adaptive control strategies.

Figure 9: Fan room for SV Composters (ECS, 2015)

ECS claims the operating costs will be low due to low labor requirements, and energy costs. The vessels can be filled with front-end loaders, which is convenient and cost effective. Since the labor requirements do not exceed the current labor requirements, it will not be taken into consideration. This system is best suited for Cal Poly's circumstances; incorporating food waste into this system would negate all the pathogen and vector problems that Cal Poly would face. According to ECS the costs that could accommodate 4,000 tons per year would cost approximately $900,000 including building costs. We estimate that for a 250 ton per year operation the capital cost would be $150,000.

## RESULTS

In order for Campus Dining food waste to be implemented, Cal Poly's Compost facility would need to be redesigned and be pre-approved by the United States Environmental Protection Agency. The cost of building SV Composters would be approximately $150,000. The money that Cal Poly would be saving annually in tipping fees is $16,185 and additional potential profits from sales of $2,250 per year for a total annual revenue of $18,435. At this rate it would take Cal Poly 9 years until they start making a profit. The payback period will be $15,195 at the end of the $9^{th}$ year, and $34,350 at the end of the $10^{th}$ year. Ignoring labor costs and overhead costs, due to them remaining the same.

| Year | Annual Revenue | Cummulative Revenue | Capital Cost Balance |
|---|---|---|---|
| 0 | - | - | $ (150,000) |
| 1 | $ 18,435 | $ 18,435 | $ (131,565) |
| 2 | $ 18,435 | $ 36,870 | $ (113,130) |
| 3 | $ 18,435 | $ 55,305 | $ (94,695) |
| 4 | $ 18,435 | $ 73,740 | $ (76,260) |
| 5 | $ 18,435 | $ 92,175 | $ (57,825) |
| 6 | $ 18,435 | $ 110,610 | $ (39,390) |
| 7 | $ 18,435 | $ 129,045 | $ (20,955) |
| 8 | $ 18,435 | $ 147,480 | $ (2,520) |
| 9 | $ 18,435 | $ 165,915 | $ 15,915 |
| 10 | $ 18,435 | $ 184,350 | $ 34,350 |

Figure 10: Cost Analysis of Implementing Food Waste

Although there is a possibility of making a profit, the time that it will take to start making a profit, and without consideration of non-market costs and benefits, it is not possible to recommend implementing food waste in Cal Poly's compost facility. The SV composters are however very appealing due to the pathogen, vector, and odor problems being virtually nonexistent. Having an SV composter unit would potentially solve all vector, pathogen, and odor problems that are associated with food waste composting. In addition, there would be no further contamination with Cal Poly's current compost facility. Though in the long run it does seem to be feasible to incorporate the food waste into the SV composters, during this time, there is no incentive to do so. Agricultural Operations Director Kevin Piper has expressed that there has been no desire to include Campus dining food waste to the facility due to the changes that have to be done to the facility.

Money is not the only factor that comes into play, time seems to be the biggest dilemma, and seeing as how the compost facility is a small factor in Cal Poly's agricultural operations, there is no incentive to increase the scale of composting. When composting food waste, there are regulations that need to be closely followed due to vectors and diseases. A permit must be acquired before any facility can start incorporating food waste in their compost due to these rules and regulations Cal Poly has not incorporated food waste in their compost facility.

## DISCUSSION

Time is a key component in the possibility of incorporating Campus Dining food waste in Cal Poly's compost facility. The time needed to redesign the facility and obtain the permits required to be able to incorporate food waste in Cal Poly's facility is not available. Cal Poly composting is not the top priority in the universities agricultural operations.

Unless there are government mandates placed, there will be no incentive to increase the facilities operations. However composting food waste is becoming more common due to national and state incentives that are being placed which promote recycling and extend landfill capacities. Something that should be considered is that composting is only one of the numerous things that Cal Poly's Agricultural Operations has to deal with.

When determining whether or not to incorporate Campus Dining food waste in Cal Poly's compost facility, one big factor that should be considered is the vector susceptibility that comes along with composting food waste. Vector control is a big dilemma that compost facilities have to deal with. If food waste is incorporated into Cal Poly's facility, odors, vectors, and leachate are all problems that need to be dealt with. Paving the ground at the current site would help with the leachate problem, however the cost of paving the site is expensive.

There are however many different alternatives to diverting food waste to landfills. Campus dining has also been diverting food scraps from landfills to Engel and Gray's compost facility, which has resulted in a 9% increase in landfill diversion. The university has even gone as far as creating the Cal Poly Compost project, which consists of nine student interns. The student interns have developed informative tours, and implemented new student orientation programs, which have instituted zero waste practices at WOW, SOAR, and Open House. A very simple but effective alternative is conservation. Using fewer resources ultimately reduces waste, which may seem like a minute difference, however if everybody used less resources, the impact would be great. Building more on-campus housing, installing energy-conserving infrastructures, upgrading old facilities with high efficiency water and energy features, and providing more recycling bins all are alternatives that can make our campus more sustainable.

Taking this initiative to promote zero waste practices can have a great positive impact in our environment. Sustainability is crucial because all the choices and actions that are taken today will affect everything in the future. Reducing the bulk of greenhouse gases can have a significant positive impact on the environment. In the end, sustainability is the most important factor.

## RECOMMENDATIONS

Looking for sustainable alternatives can be challenging, but taking an initiative and making the first step could ultimately lead to a more sustainable environment. Sustainability is defined by Cal Poly as the ability of the natural and social systems to survive and thrive together to meet current and future needs. Cal Poly recognizes that practicing sustainability can be challenging with the scope and complexity of the universities culture. Although including Campus Dining food waste in Cal Poly's compost facility does seem feasible, it is not likely that it will be implemented anytime soon. Food waste composting requires a full Compostable Materials Handling Facility Permit, and the time that is needed to renovate the facility in order to obtain the permit would take years. If Cal Poly were to consider the SV composter, they are looking at a turnover rate of 9 years before they make a profit. Although it may seem like a long time, in the long run, it may be a good investment.

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# APPENDIX A

## HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

**ASM Project Requirements**

The ASM project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving. This project addresses these issues as follows.

**Application of Agricultural Technology**. This project involves the application of mechanical systems of composting, power transmission, and fabrication technologies of windrow turners.

**Application of Business and/or Management Skills** The project involves business/management skills in the areas of compost management, cost and productivity analyses of Cal Poly's compost facility, and labor considerations.

**Quantitative, Analytical Problem Solving**. Will include the cost analysis and feasibility study of using campus dining food waste in Cal Poly's composting facility.

**Capstone Project Experience**

The ASM project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses). This project incorporates knowledge/ skills from these key courses.

- BRAE 129 Lab Skills/Safety
- BRAE 133 Engineering Graphics
- BRAE 151 AutoCAD
- BRAE 142 Machinery Management
- BRAE 301 Hydraulic/Mechanical Power Systems
- BRAE 321 Ag Safety
- BRAE 343/344 Mechanical & Fabrication Systems
- BRAE 402 Ag Materials
- BRAE 418/419 Ag Systems Management
- BRAE 348 Energy For a Sustainable Society
- BRAE 448 Bioconversions
- ENGL 148 Technical Writing
- AGB 212 Agriculture Economics

**ASM Approach**

Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. While technical in nature, this approach must also have a clear and present emphasis on planning and management of time, people, and other resources.
This project addresses these issues as follows.

**Systems Approach**. The project involves the integration of multiple functions (mixing, picking up food waste, making sure all standards are met), and the integration of machine/operator/compost husbandry systems to provide an improved profitable waste management solution for Cal Poly.

**Interdisciplinary Features**. The project touches on aspects of mechanical systems, agricultural safety, waste management, and bio resources.

**Specialized Agricultural Knowledge**. The project applies specialized knowledge in the areas of mechanical and fabrication systems, agricultural safety, and bio resource systems.

**Project Parameters and Constraints**
This project addresses a significant number of the categories of constraints listed below.

**Physical**. There must be enough room in Cal Poly's compost facility to accommodate the extra waste. There also must be the right equipment to ensure that health and safety standards are met.

**Economic**. The operation will be able to reduce the size of Cal Poly's traditional waste containers and reduce the frequency of daily pick ups

**Environmental**. The benefit of this project will be to reduce the amount of methane a very potent greenhouse gas; recycling food waste diverts organic materials from landfills thus reducing emissions

**Sustainability**. New turnout must decrease the amount of food waste in landfills and more food waste in Cal Poly's facility allowing for less tipping fee costs

**Manufacturability**. Finished composting product must meet compost quality standards and be readily available for consumers to purchase

**Health and Safety**. Pathogens and vectors must be controlled. Food waste composting must improve safety, health and sanitation.

**Ethical**. Must overcome obstacles such as odors, capacity, and public perception

**Social**. The intent of this project wasn't to create a social impact, but to change Cal Poly's cultural practice. An unintended consequence is that more people will need to be trained to manage the compost facility.

**Political**. Reduced air pollution. Better air quality as well as public perception.

**Aesthetic**. The finished machine was spray painted with high quality automotive paint to provide a professional appearance. A two-tone color scheme was used to provide contrast and high visibility around moving parts.

**Other - Productivity**. The operation must in turn be profitable and the costs of running the operation must not exceed current costs.

# EXHIBIT C


# EXHIBIT D

6-2008

# Foods Scraps Composting and Vector Control

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Thomas W. Seamans
*USDA National Wildlife Research Center, Sandusky OH*

COMMUNICATION AND COLLABORATION

# FOOD SCRAPS COMPOSTING AND VECTOR CONTROL

*In a USDA study, it appeared that immediate bulking and grinding of food waste with shredded wood was a deterrent in attracting birds and mammals.*

*Bradley F. Blackwell and Thomas W. Seamans*

NONTRADITIONAL waste management facilities, particularly new projects to compost food scraps, are becoming more common because of national and state initiatives to promote recycling and extend landfill capacities. In fact, food waste is the third largest component of generated waste by weight, following yard trimmings and corrugated boxes. The U.S. Department of Agriculture (USDA) estimates that each American disposes of 1.3 pounds of food waste daily or nearly 474 pounds annually. While there is a clear need to recycle food waste, the location of waste management facilities and national initiatives on waste management are increasingly controversial, partly because of potential wildlife related impacts. Responsible development of the industry must include management of facilities to minimize waste material serving as attractants to vectors such as birds and mammals that pose hazards to human health and safety.

For example, traditional putrescible waste landfills often attract large numbers of gulls and other bird species that can pose a significant risk to air traffic, if the facility is located near an airport. In response to the concern over bird-aircraft collisions, the Federal Aviation Administration (FAA) issued Order 5200.5A in 1990 to recommend that putrescible waste landfills and other waste management facilities not be located within one mile of runways used by piston powered aircraft or within two miles of runways used by turbine-powered aircraft.

Order 5200.5A also recommends against locating any waste management facility within two to five miles of an airport if the facility "attracts or sustains hazardous bird movements from feeding, water or roosting areas into, or across the runways and/or approach and departure patterns of aircraft." In August 2007, the FAA published Advisory Circular No: 150/5200—33B, *Hazardous wildlife attractants on or near airports*, which includes the recommendations from Order 5200.5A.

In addition to potential bird-aircraft collisions, bird use of waste management facilities can also pose other problems for the surrounding community. Specifically, foraging opportunities at these facilities can enhance survival and productivity of problem bird species that adapt readily to human-based resources. For example, several species of gulls are known to nest on flat roofs in proximity to putrescible waste landfills. Roof-nesting gulls are often considered a nuisance and economic liability because they damage roofs, attack pedestrians and defecate on cars and buildings. Further, feathers, nest material and food remains can plug drains on buildings. Gulls also carry bacteria (e.g., *Eschericia coli, Salmonella, Campylobacter* and *Listeria*) that cause enteric disease in humans.

In addition, there is evidence that the water quality of reservoirs can be degraded by large numbers of roosting gulls that are benefiting from both roof-top nesting areas and waste facilities. Other nuisance birds often associated with landfills (rock pigeons [*Columba livia*], European starlings [*Sturnus vulgaris*] and house sparrows [*Passer domesticus*]) are reported to carry more than 60 diseases transmissible to humans and domestic animals.

Finally, there is the factor of attraction of rodents at waste management facilities. Small mammals are prey to many bird species, particularly raptors, which can be a threat to air traffic because of their large size and soaring behavior. Also, the presence of commensal rodents such as Norway rats (*Rattus norvegicus*) and house mice (*Mus musculus*) is an issue because of the possibility of transmitting disease to humans (e.g., hantavirus pulmonary syndrome, the bacterial diseases, leptospirosis and plague), causing structural damage to buildings, and strong public aversion to these species.

## COMMUNICATION AND COLLABORATION

A key component in developing food waste composting operations in a manner that is environmentally safe is communication and collaboration with local, state and federal agencies responsible for human health and safety, and management of wildlife. As little data exist on bird and rodent use of the various types of nontraditional waste management facilities, particularly those processing food waste, a


Figure 1

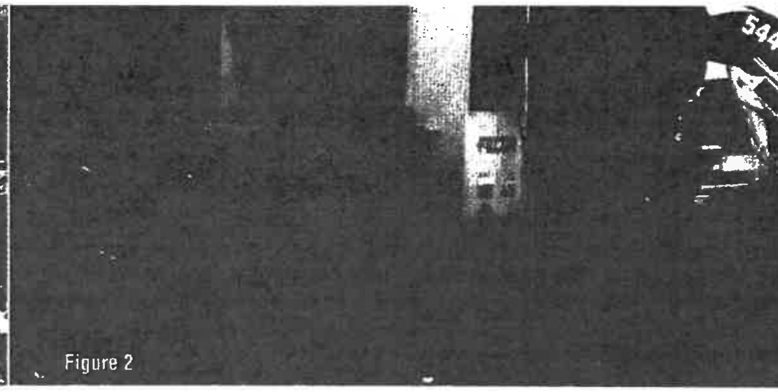
Figure 2

collaborative approach to assess wildlife hazards provides information critical not only to the business and management agencies, but also to the surrounding community. In some cases, funding agencies involved in the development of this industry will request that businesses work with consultants on wildlife issues.

For example, Barnes Nursery, Inc. in Huron, Ohio, received a grant in 2007 from the Ohio Department of Natural Resources and logistic support from the Ohio Environmental Protection Agency (EPA) and the U.S. EPA to pursue new methodologies in food waste composting and energy recovery. These agencies encouraged the owners to document potential wildlife hazards at this initial phase in the development of their food waste composting business. In April 2007, Barnes initiated a cooperative service agreement with the USDA Animal and Plant Health Inspection Service (APHIS), Wildlife Services, National Wildlife Research Center's Ohio Field Station to design and conduct a wildlife hazard assessment.

Barnes Nursery initiated a cooperative service agreement to design and conduct a wildlife hazard assessment of its food waste composting project.

**FACILITY BACKGROUND**

The Barnes composting facility opened in May 1991 on a 25-acre property less than one mile south of Lake Erie and two miles west of Huron, in Erie County. The facility is in a rural area surrounded by farmland, a tree nursery, a four-lane highway and a general aviation airport within one mile. Although yard waste (i.e., grass, leaves and woody debris) is the primary type of material received at the site, Barnes also accepts soils, manure, sludges, woodchips and, recently, food waste.

For the purposes of this article, food waste is defined as including, but not restricted to, fruit and vegetable trimmings, outdated bakery goods and dough, dairy products, seafood (including shells), plate scraps (including meat) and leftover prepared foods, coffee grounds and filters, tea bags, floral waste, egg shells, slurry from pulpers, beverages and liquids such as vinegar. In addition, food waste might contain soiled napkins, tissues, compostable bags, plates, cups and packaging. At the Barnes facility, the food feedstock area and the other waste areas (hereafter, yard waste) are contiguous, but proportionate areas are not constant because of intake of material, processing and storage changes.

From June through October 2007, the Barnes facility received a monthly average of 821 tons of yard trimmings and 50 tons of food waste. Food waste was tipped and placed next to a shredded woodpile (Figure 1). Upon delivery, the food waste was immediately bulked with shredded wood, a process intended to control odors and the emission of free water from the waste. The mixture was then ground in a Fecon 250 Wood Hog Shredder (Figure 2), and distributed in windrows (15 feet wide by 8 feet high by 150 feet long) in an area between other yard trimmings collection points (Figure 3). The windrowed material (Figure 4) remains in thermophilic decomposition (105°F to 155°F) until packaging material is broken down and the mixture is stable (i.e., heating due to the decomposition processes ceases). Each windrow was turned on a 7- to 10-day interval (via KW Straddle Type Windrow Turner) to add porosity to the material, thereby maintaining maximum oxygen levels for aerobic decomposition and moisture levels at approximately 50 percent by weight. When the mixture was stable, it was screened to remove noncompostables, cured and tested relative to the U.S. Composting Council Seal of Testing Assurance Program standards.

**THE WILDLIFE HAZARD ASSESSMENT**

The USDA objective was to quantify relative use of food and yard waste operation areas at the Barnes facility by bird and mammal species from June through October 2007. Biologists used snap traps for small mammals, placed systematically during two consecutive trapping nights per month, and conducted point counts twice weekly of birds using the facility. Notably, the biologists captured no small mammals in the food waste area, nor observed mammals using the material. Further, only 17 individuals, representing 5 small mammal species, were captured in the yard trimmings area (predominantly deer mice or white footed mice; *Peromyscus* sp.). In addition, there was no indication, based on observations of predators, tracks, carcasses of prey items and absence of predator fecal material, that population levels of small mammals using the facility were sufficient to attract larger mammalian carnivores (e.g., coyotes, *Canis latrans*) or raptors.

In contrast, the biologists observed 27 bird species on or aerial foraging over the

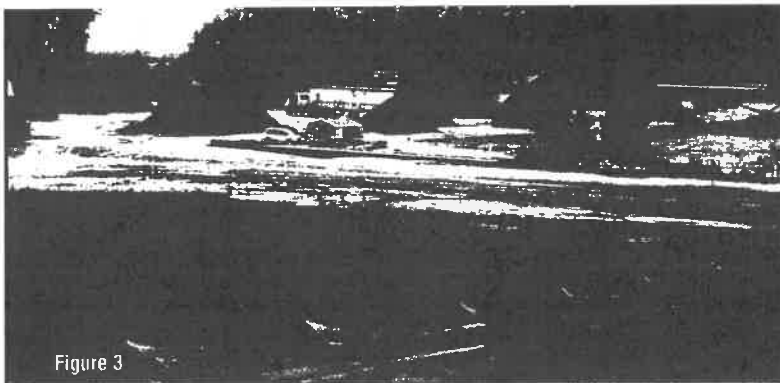
Figure 3

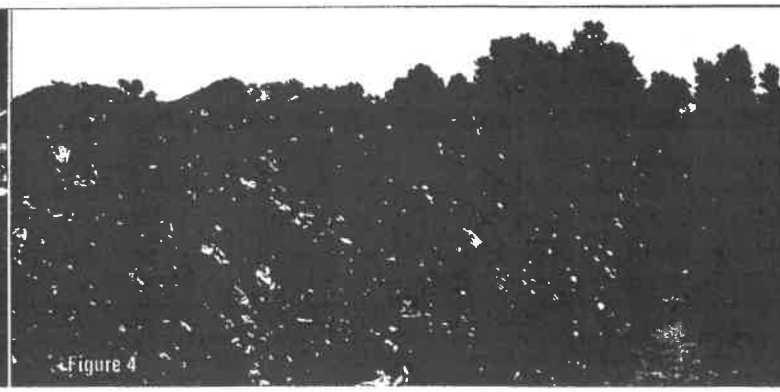
Figure 4

yard waste area, predominated by mourning doves (*Zenaida macroura*), killdeer (*Charadrius vociferous*) and bank swallows (*Riparia riparia*). However, only 6 of the 27 bird species, primarily mourning doves and killdeer, were observed landing on, foraging on, or aerial foraging over the food waste. Notably, bank swallows nested in the face of a large soil pile on the facility and were frequently observed over the site through the second week of July. Barnes Nursery, Inc. personnel were aware of the nesting cavities and, in deference to the Migratory Bird Treaty Act, did not disturb the soil pile. Also, gulls, European starlings and turkey vultures (*Cathartes aura*) were rarely observed, and observations of species foraging on the yard waste materials were uncommon. Large flocks of gulls, mixed flocks of blackbirds and European starlings (during late summer and fall) and flocks of Canada geese (*Branta canadensis*) were observed flying over the facility on routes from Lake Erie to nearby agricultural fields and back. These flock movements were, however, unrelated to the yard or food waste at the Barnes facility.

Ultimately, weekly counts of individual birds across all species yielded only 9 to 13 birds/acre of the facility. Biologically, there was no differential use of food waste and yard waste areas by birds, and captures of small mammals using the yard waste were few.

Though specific data on relative availability of food resources between food and yard waste areas were not collected, nor were data on odor emissions, the inference from the USDA study is that the immediate bulking of food waste with shredded wood upon delivery, and subsequent grinding of the mixture, was effective in reducing the attractiveness of the material to birds and mammals. Further, indices of bird and mammal use of the processed food waste windrowed on site indicated that the material did not serve as a significant attractant to wildlife. However, the USDA assessment was based solely on the tonnage of waste delivered and processing methods used during the 21 weeks of observation. Subsequently, the biologists encouraged Barnes Nursery, Inc. to consider additional site assessment by USDA/APHIS Wildlife Services personnel as operational capacity changes and new processing protocols are developed.

**SUMMARY**

The communication by Barnes Nursery, Inc. with local, state and federal officials about potential wildlife hazards posed by the development of their food waste composting business created an atmosphere of collaboration. We suggest a similar approach for others considering food waste composting operations. However, for those operations proposed within FAA siting criteria for certificated airports under Part 139 of the Code of Federal Regulations, or other airports receiving FAA funding, a Wildlife Hazard Assessment might be deemed mandatory. As noted earlier, good communication with the public and government agencies charged with the safety of the public will benefit your business. ■

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Indices of bird and mammal use of the processed food waste windrowed showed the material did not serve as a significant attractant to wildlife.

# EXHIBIT E

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# Bioaerosols from composting facilities—a review

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Bioaerosols generated at composting plants are released during processes that involve the vigorous movement of material such as shredding, compost pile turning, or compost screening. Such bioaerosols are a cause of concern because of their potential impact on both occupational health and the public living in close proximity to such facilities. The biological hazards potentially associated with bioaerosol emissions from composting activities include fungi, bacteria, endotoxin, and 1-3 β-glucans. There is a major lack of knowledge concerning the dispersal of airborne microorganisms emitted by composting plants as well as the potential exposure of nearby residents. This is due in part to the difficulty of tracing specifically these microorganisms in air. In recent years, molecular tools have been used to develop new tracers which should help in risk assessments. This review summarizes current knowledge of microbial diversity in composting aerosols and of the associated risks to health. It also considers methodologies introduced recently to enhance understanding of bioaerosol dispersal, including new molecular indicators and modeling.

**Keywords: compost, bioaerosol, microbial diversity, impact on health, dispersal, molecular tools**

## INTRODUCTION

Composting is a method of waste management based on the biological degradation and stabilization of organic matter under aerobic conditions. It results in a sanitized and stabilized product rich in humic substances that can be used as fertilizer (Sykes et al., 2007). Large-scale composting has become a commonly used method worldwide for diverting agricultural waste, sewage sludge and other organic waste from landfills and incinerators. The degradation of organic matter is carried out by a complex and highly dynamic microflora containing Gram-positive and Gram-negative bacteria and fungi (Ishii et al., 2000; Ryckeboer et al., 2003; Hansgate et al., 2005). During the composting process, along with the microbial degradation of organic matter, the physico-chemical conditions pH, temperature and moisture content evolve and changes in microbial diversity are important. The intense microbial activity associated with degradation of easyly-degradable compounds leads to a rise in temperature at the beginning of the process. The fermentation phase is characterized by the degradation of organic matter by thermophilic species. It is followed by a maturing phase with degradation of cellulolytic and ligno-cellulosic compounds and humification reactions. The dynamics of microbial diversity during composting has been recently revealed by high-throughput sequencing (De Gannes et al., 2013).

Normal operations taking place at composting plants can be the source of nuisance or pollution involving odors, noise, dust, leachate, and bioaerosols (Sanchez-Monedero et al., 2005). The emission of bioaerosols during operational activities increases the concentration of microorganisms in the air by several orders of magnitude (Persoons et al., 2010; ADEME, 2012). The implications of the release of bioaerosols is especially significant for composting plants operating in the open because their bioaerosols are released directly into the surrounding environment without any pretreatment using biofilters or bioscrubbers. This paper focuses on data collected from large-scale composting operations with open-air windrow systems, which today remains the predominant composting technology. It gathers together recent findings on bioaerosols emitted from composting facilities in terms of microbial diversity, sanitary impact and dispersal beyond the site.

## MICROBIAL DIVERSITY

The term "bioaerosol" encompasses all particles having a biological source that are in suspension in the air and includes microorganisms (bacteria, fungi, virus, protozoa, algae, pollen...) as well as biomolecules (toxins, debris from membranes...) (Sykes et al., 2011). Current knowledge on microbial diversity in aerosol from composting facilities is largely focused on bacteria and molds. For more than a decade, actinomycetes, *Aspergillus fumigatus*, and *Penicillium* sp. have been recognized as the dominant culturable micro-organisms in composting bioaerosols (Millner et al., 1980; Fischer et al., 1999; Hryhorczuk et al., 2001; Kampfer et al., 2002; Ryckeboer et al., 2003). However, cultivation-based techniques systematically underestimate the diversity of bioaerosols. Albrecht et al. (2007) showed that only 1.5–15.3% of airborne bacterial cells of a composting facility enumerated by direct counting formed countable colonies after incubation on TSA-agar. Recent culture-independent studies using sequencing of 16S rRNA and 18S rRNA gave some new data on the microbial diversity in composting aerosols. **Tables 1, 2** present, respectively, the bacterial and fungal species that have been identified in composting bioaerosols using both culture-dependent and culture-independent approaches.

In two studies on aerosols collected during the turning of composting piles in the thermophilic phase (Le Goff et al., 2010)

**Table 1 | Dominant bacteria identified in aerosols from composting facilities using culture-dependent and culture independent techniques from Reinthaler et al. (1997), Le Goff et al. (2010), Bru-Adan et al. (2009), ADEME (2012), Pankhurst et al. (2012), and Betelli et al. (2013).**

| Phyla | Genus | Species | Technique* |
|---|---|---|---|
| **FIRMICUTES** | | | |
| | *Bacillus* | sp. | Cult., Seq. |
| | | *B. subtilis, B. smithii, B. coagulans* | Seq. |
| | *Ureibacillus* | sp. | Seq. |
| | | *U. koreensis* | Seq. |
| | *Geobacillus* | sp. | Seq. |
| | | *G. thermodenitrificans, G. caldoxylosilyticus* | Seq. |
| | *Thermoactinomyces* | sp. | Seq. |
| | | *T. intermedius, T. sacchari* | Seq. |
| | | *T. thalpophilus* | Cult., Seq. |
| | | *T. vulgaris* | Cult., qPCR |
| | *Planifilum* | sp. | Seq. |
| | | *P. yunnanesis* | Seq. |
| | *Clostridium* | *C. peptidovorans* | Seq. |
| | *Symbiobacterium* | *S. thermophilum* | Seq. |
| | *Ammoniphilus* | sp. | Seq. |
| | *Streptococcus* | *S. sanguinis* | Seq. |
| | *Staphylococcus* | sp. | Cult. |
| | | *S. epidermidis* | Cult. |
| **ACTINOBACTERIA** | | | |
| | *Saccharopolyspora* | *S. rectivirgula (syn: Faenia rectivirgula, Micropolyspora faeni)* | Cult., Seq. |
| | | *S. hirsuta* | |
| | *Saccharomonospora* | sp. | Cult., Seq. |
| | | *S. glauca, S. caesia* | Seq. |
| | | *S. viridis* | Cult., Seq. |
| | *Thermomonospora* | sp. | Cult., Seq. |
| | | *T. mesouviformis, T. chromogena* | Seq. |
| | *Thermobifida* | *T. fusca* | Seq. |
| | *Streptomyces* | sp. | Cult., Seq. |
| | | *S. thermoviolaceus, S. cellulosae, S. thermoatroviridis* | Seq. |
| | *Corynebacterium* | sp. | Seq. |
| | | *C. variabile, C. efficiens, C. glutamicum* | Seq. |
| | *Nocardiopsis* | *N. composta* | Seq. |
| | *Thermocrispum* | *T. agreste, T. municipale* | Seq. |
| | *Actinomadura* | *A. hallensis* | Seq. |
| | *Rhodococcus* | sp. | Seq. |
| | *Rothia* | sp. | Seq. |
| | *Arthrobacter* | sp. | Seq. |
| | *Microbacterium* | sp. | Seq. |
| | *Kutzneria* | sp. | Seq. |
| **ALPHAPROTEOBACTERIA** | | | |
| | *Sphingomonas* | sp. | Seq. |
| | | *S. suberifaciens* | Seq. |
| | *Brevundimonas* | *B. nasdae* | Seq. |
| | *Mesorhizobium* | sp. | Seq. |
| | *Devosia* | sp. | Seq. |
| **GAMMAPROTEOBACTERIA** | | | |
| | *Pseudomonas* | sp. | Cult., Seq. |
| | | *P. aeruginosa, P. fluorescens, P. oryzihabitans* | Cult. |
| | *Acinetobacter* | sp. | Seq. |
| | | *A. calcoaceticus, A. lwoffii* | Seq. |
| | *Enhydrobacter* | *E. aerosaccus* | Seq. |
| | *Moraxella* | *M. osloensis* | Seq. |
| | *Enterobacter* | *E. cloacae* | Cult. |
| | *Pantoea* | *P. agglomerans* | Cult. |
| | *Klebsiella* | *K. oxytoca* | Cult. |
| | *Proteus* | *P. mirabilis* | Cult. |
| | *Xanthomonas* | *X. maltophila* | Cult. |
| | *Serratia* | *S. rubidea, S. marcescens* | Cult. |
| **BETAPROTEOBACTERIA** | | | |
| | *Delftia* | *D. acidovorans* | Seq. |
| | *Alcaligenes* | *A. faecalis* | Cult. |
| **BACTEROIDETES** | | | |
| | *Flavobacteriaceae* | sp. | Seq. |
| | *Taxeobacter* | sp. | Seq. |

**Cult., culture; Seq., 16S rRNA sequencing; for rRNA sequencing data, the genus and species names are given for percentage of similarity above 95 and 97%, respectively. Only phylotypes with abundancy above 1% of the total number of sequences are presented.*

and during the screening of matured compost (Bru-Adan et al., 2009), *Fimicutes* and *Actinobacteria* were the two dominant bacterial phyla. From sequencing data present in public databases, it appears that *Firmicutes*, *Proteobacteria*, and *Bacteroidetes* are more dominant in compost than are *Actinobacteria*. In particular, the percentage of *Bacteroidetes* is much higher in compost than in composting bioaerosols. The selection of sporulating species during aerosolization may explain the dominance of *Firmicutes* and *Actinobacteria*. *Actinobacteria*, *Thermoactinomyces* sp. and *Bacillus* sp., in fact produce resistant spores that spread widely. Nielsen et al. (1997) analyzed the concentration of microorganisms in bioaerosols related to the concentration in bulk samples of compost from household waste. They found that actinomycetes or their spores were particularly prone to becoming airborne (Nielsen et al., 1995). Using PLFA (PhosphoLipid Fatty Acid analysis), PCR-DGGE (Denaturing Gradient Gel Electrophoresis) and pyrosequencing, Pankhurst et al. (2012) have shown the influence that green-waste composting has on the on-site and downwind airborne microbial communities. They

**Table 2 | Dominant fungi identified in aerosols from composting facilities using culture-dependent and culture independent techniques from Le Goff et al. (2010), Bru-Adan et al. (2009), and ADEME (2012).**

| Phylum or subphylum | Genus | Species | Technique* |
|---|---|---|---|
| **ASCOMYCOTA** | | | |
| | *Aspergillus* | sp. | Cult., Seq. |
| | | *A. fumigatus* | Cult., Seq |
| | | *A. versicolor* | Cult., Seq. |
| | | *A. candidus* | Cult. |
| | | *A. nidulans* | Cult. |
| | | *A. niger* | Cult. |
| | | *A. flavus* | Cult. |
| | | *A.eburneo-cremeus* | Cult. |
| | *Penicillium* | sp. | Cult., Seq. |
| | *Eurotium* | sp. | Cult. |
| | *Thermomyces* | *T. lanuginosus* | Seq. |
| | *Clathrospora* | *C. diplospora* | Seq. |
| | *Illosporium* | *I. carneum* | Seq. |
| | *Microascus* | *M. cirrosus* | Seq. |
| | *Neurospora* | sp. | Seq. |
| | *Paraphaeosphaeria* | *P. nolinae* | Seq. |
| | *Pithia* | sp. | Seq. |
| | *Cladosporium* | sp. | Cult., Seq. |
| | *Marcelleina* | sp. | Seq. |
| | *Talaromyces* | *T. byssochlamydoides* | Seq. |
| | *Madurella* | *M. mycetomatis* | Seq. |
| | *Chalara* | *hyalina* | Seq. |
| | *Geotrichum* | *G. candidum* | Seq. |
| | *Pichia* | *P. guilliermondii* | Seq. |
| | *Phoma* | sp. | Seq. |
| | | *P. herbarum* | Seq. |
| | *Ascolobus sp.* | sp. | Seq. |
| | *Anguillospora sp.* | *A. rubsecens* | Seq. |
| | *Trichoderma* | sp. | Cult. |
| | *Emericella* | sp. | Cult. |
| | *Tritirachium* | sp. | Cult. |
| | *Alternaria* | sp. | Cult. |
| | *Verticillium* | sp. | Cult. |
| | *Didymella* | sp. | Cult. |
| | *Candida* | sp. | Cult. |
| **BASIDIOMYCOTA** | | | |
| | *Dichostereum* | sp. | Cult., Seq. |
| | *Coprinus* | *C. comatus* | Cult., Seq. |
| | *Athelia* | *A. bombacina* | Cult., Seq. |
| | *Ustilago* | *U. hordei* | Seq. |
| | *Clitocybe* | *C. candicans* | Seq. |
| | *Filobasidium* | *F. globisporum* | Seq. |
| | *Sistotrema* | *S. sernanderi* | Seq. |
| | *Vuilleminia* | *V. comedens* | Seq. |
| | *Exidiopsis* | sp. | Seq. |
| | *Acanthophysium* | *A. cerussatum* | Seq. |
| | *Boletellus* | *B. projectellus* | Seq. |
| | *Exidiopsis* | sp. | Seq. |
| | *Peniophora* | *P. nuda* | Seq. |
| | *Itersonilia* | *I. perplexans* | Seq. |
| | *Filobasidium* | sp. | Seq. |
| | *Perenniporia* | *P. subacida* | Seq. |
| | *Botryobasidium* | *B. subcoronatum* | Seq. |
| | *Dioszegia* | *D. aurantiaca* | Seq. |
| | *Coleosporium* | *C. asterum* | Seq. |
| | *Rhodotorula* | *R. minuta* | Seq. |
| | *Classicula* | *C. fluitans* | Seq. |
| | *Sporobolomyces* | sp. | Seq. |
| | *Rhodotorella* | sp. | Cult. |
| **MUCOROMYCOTINA** | | | |
| | *Mucor* | *M. plumbeus* | Cult., Seq. |
| | *Absidia* | *A. corymbifera* | Cult., Seq. |
| | *Pilobolus* | *P. phaerosporus* | Seq. |
| | *Rhizopus* | sp. | Cult. |
| | *Circinella* | *C. umbellata* | Seq. |
| **ENTOMOPHTHOROMYCOTINA** | | | |
| | *Furia* | *F. ithacensis* | Seq. |
| **ZYGOMYCETES** | | | |
| | *Conidiobolus* | *C. thromboides* | Seq. |
| | *Pandora* | *P. neoaphidis* | Seq. |
| | *Rhizomucor* | *R. miehei* | Seq. |

*(Continued)*

**Cult., culture; Seq., 18S rRNA sequencing; for rRNA sequencing data, only phylotypes with abundancy above 1% of the total number of sequences are presented.*

found that in some cases, gamma-*Proteobacteria* (*Pseudomonas*, *Acinetobacter*) can also dominate bioaerosols emitted by composting platforms. At the genus level, these studies confirmed the high representativity in bioaerosols of the following species which were already known as major components of compost microflora (Song et al., 2001; Steger et al., 2007): *Aspergillus*, *Penicillium*, *Bacillus*, *Thermoactinomyces*, *Thermobifida*, *Saccharomonospora*, and *Saccharopolyspora*. The studies provided interesting new data concerning the importance of the fungus *Thermomyces lanuginosus* and of the bacteria *Geobacillus* and *Planifilum* in composting bioaerosols. They also showed that thermophilic species were strongly represented, even in mature compost (34% of the total number of bacterial sequences in the study by Bru-Adan et al., 2009).

Concerning fungi, the samples collected during the thermophilic phase by Le Goff et al. (2010) were dominated by Ascomycota (*Thermomyces lanuginosus*, *Aspergillus*, *Penicillium*...) whereas the air sample collected during the screening of more matured compost mainly contained representatives of the *Basidiomycetes* group (59% of the sequences), although sequences closely related to *Aspergillus* were also recovered (9% of the sequences). The potential changes in the microbial diversity of composting bioaerosols during the process still remain to be better characterized. Further studies are also needed to explain the differences recorded between diversity in compost and diversity in the associated aerosols (enrichment in sporulating species). Finally, despite their potential impact on health, data on the presence and dispersal of virus or eucaryotes (amoeba, algae...) in composting aerosols are scarce. Conza et al. (2013) have recently demonstrated the presence of amoebae in composting aerosols. In molecular inventories based on 18S rRNA sequencing, sequences from algae and protozoa were obtained (Bru-Adan et al., 2009; Le Goff et al., 2010).

## IMPACT ON HEALTH OF THE EXPOSURE TO AEROSOLS EMITTED FROM COMPOST

Some pathogenic organisms (bacteria, viruses, and parasites) are present in raw materials and composts, notably pathogens of enteric origin in sludge from municipal sewage plants or animal waste, but such pathogens are rapidly inactivated by heat during the composting process. The main identified risks of infection from composting bioaerosols are represented by opportunistic micro-organisms, especially molds which can take advantage of deterioration in the immune system. Prolonged exposure to *Aspergillus fumigatus*, an opportunistic fungal pathogen, may cause invasive aspergillosis in immuno-compromised individuals. (Shen et al., 2004; Taha et al., 2006). Rare cases of invasive aspergillosis have been described among people exposed to dusts originating in decomposing vegetable matter (ADEME, 2012). However, data in the literature does not indicate an excess of severe infectious illness among compost workers. The main effects of exposure to composting aerosols are on respiratory health; these include organic dust toxic syndrome, extrinsic allergic alveolitis (EAA), allergic rhinitis, asthma, upper airway irritation and mucous membrane irritation (Swan et al., 2003; Sykes et al., 2007). *A. fumigatus* and thermophilic actinomycetes (*Thermoactinomyces vulgaris, Saccharopolyspora rectivirgula*) are implicated in hypersensitivity-induced pneumonitis and other allergic reactions such as alveolitis or bronchial asthma (Lacey and Crook, 1988; Dutkiewicz et al., 1994; Poulsen et al., 1995; Kampfer et al., 2002; Albrecht et al., 2008). In addition to these micro-organisms, certain biological agents can also affect human health: endotoxins, components of the cell wall of Gram-negative bacteria, peptidoglycans in the wall of Gram-positive bacteria, the β(1-3)-D-glucans in the cell wall of molds and the mycotoxins (Sykes et al., 2011). The main pathway leading to exposure is by inhalation of particles which reach the respiratory system. Particle deposition in lungs is closely related to their size. Many of the bioaerosol particles emitted by compost are very fine and can reach down the pulmonary alveoli (Chiang et al., 2003; Byeon et al., 2008). The size of spores of molds colonizing compost (*Aspergillus, Penicillium*) is below 3 μm (Madelin and Johnson, 1992) and the one of thermophilic actinomycetes is around 1 μm (Reponen et al., 1998).

Over the last 5 years, more knowledge has been acquired on the relevance of *Saccharopolyspora rectivirgula* and of *Legionella* species in aerosols from composting. *Saccharopolyspora rectivirgula* is often found in environments of agricultural production where the classic form of EAA ("farmer's lung disease") is common. Schäfer et al. (2013) showed that high concentrations of airborne *S. rectivirgula* were to be found in composting plants at levels similar to those found in agricultural production. Using quantitative real-time polymerase chain reaction (PCR), they detected *S. rectivirgula* in 85% of the 124 aerosols sampled at 31 different composting plants. Estimated concentrations ranged between $1.2 \times 10^2$ and $1.5 \times 10^7$ cell counts/$m^3$. Compost is also one of the recognized reservoirs of *Legionella*. One recent study has reported the presence of *L. pneumophila* and *L. bozemanii* and of free-living amoebae in compost and shown that the bioaerosols developed from 3 of the 4 composting facilities analyzed contain *L. pneumophila* (Conza et al., 2013). However, a survey of the seroprevalence of anti- *Legionella pneumophila* antibodies among workers composting sludge did not show a significant rise when compared to the non-exposed group (Clark et al., 1984).

The association between exposure to composting bioaerosol and adverse health effects has been demonstrated for compost workers (Herr et al., 2003; Bünger et al., 2007). According to Schlosser et al. (2009), the mean personal exposure levels to dust, bacteria, molds and endotoxins are fully consistent with the occurrence of inflammatory and allergic respiratory outcomes among workers. Certain studies have reported high levels of immunoglobulins in the blood of workers which suggests a high level of exposure leading to stimulation of the immune system (Clark et al., 1984; Beffa et al., 1998; Bünger et al., 2000, 2007). In a cross-sectional study, Van Kampen et al. (2012) investigated work-related symptoms and diseases of 190 currently-exposed compost workers, 59 former compost workers and 38 unexposed control subjects. Compared to controls, compost workers suffered more often from cough and irritation of the eyes in terms of mucosal membrane irritation. Former compost workers reported similar work-related complaints but these symptoms improved when exposure to bioaerosols ceased. In contrast, cough and dyspnea persisted, indicating a chronic process. There was no higher frequency of mold sensitization in the group of compost workers compared to controls, which, according to the authors, may be an indication of a healthy worker survivor effect.

Sykes et al. (2011) recommended that consideration be given to robust approaches to ensure dust suppression at source and that employees' exposures to organic dust are reduced as far as possible when waste is being agitated. Shredder and siever adjustments, sampling at the core of windrows in the turning phase, cleaning and maintenance of aeration/composting containers were found as producing the highest bioaerosols ambient concentrations by Persoons et al. (2010). Engineered measured such as water sprays, negative aeration systems or biofilters did not prevent on-site bioaerosol emissions. Composting in enclosed units prevent bioaerosol dispersal in the environment but is likely to increase occupational exposures.

Concerning nearby residents of composting plants, some epidemiological studies have found no relationship between respiratory symptoms and place of residence (Cobb et al., 1995), nor with the concentration of *Aspergillus fumigatus* (Browne et al., 2001). Others, in contrast, have shown that residents living within 150–200 m of a composting plant were affected, suffering from irritative respiratory complaints similar to mucous membrane irritation and from excessive tiredness (Herr et al., 2003).

## DISPERSAL OF COMPOSTING AEROSOLS IN THE SURROUNDINGS

The risk assessments undertaken to date have relied on air dispersion studies to estimate downwind concentrations of bioaerosols and to permit comparisons with data measured upwind or at background locations (Taha et al., 2006). Bioaerosol concentrations decrease rapidly with distance from their source and it becomes difficult to verify that measurements at a distance are related to a specific activity rather than to other non-compost sources (Taha et al., 2005).

The airborne microorganisms usually monitored in composting aerosols are cultivable bacteria and fungi (mesophilic and/or thermophilic) (Heida et al., 1995; Van Tongeren et al., 1997), Gram-negative bacteria or more definite microbial taxons such as *Aspergillus fumigatus* and actinomycetes (Millner et al., 1980; Gumonski et al., 1992; Darragh et al., 1997; Fischer et al., 1999; Hryhorczuk et al., 2001; Kampfer et al., 2002; Sanchez-Monedero and Stentiford, 2003; Sanchez-Monedero et al., 2005; Taha et al., 2006; Albrecht et al., 2007; Fischer et al., 2008; Schlosser et al., 2009; Pankhurst et al., 2011).

Thermophilic actinomycetes such as *Thermoactinomyces* and *Saccharomonospora* and thermotolerant microfungi have been put forward as potential indicators because they are rare in natural environments due to their thermotolerant or obligatory thermophilic characteristics. Their concentrations in air samples in the surroundings of composting plants are indeed higher than in background samples (Kampfer et al., 2002; Neef et al., 2003; Swan et al., 2003; Albrecht et al., 2008; Fischer et al., 2008). *Aspergillus fumigatus* is common in the environment but its concentration increases when there are sources of self-heating materials. For some authors, therefore, dominance of *Aspergillus fumigatus* in the downwind vicinity of a composting plant is an indication of the release of emissions from the plant (Recer et al., 2001; Taha et al., 2006; Albrecht et al., 2008; Pankhurst et al., 2011). The United Kingdom Composting Association has proposed a procedure for monitoring bioaerosols, based on the monitoring of two airborne groups, *Aspergillus fumigatus* and total mesophilic bacteria, at different upwind and downwind locations at a composting plant (Environment Agency, 2010).

Most studies on composting bioaerosols have been carried out using culture. However, the culturability of bacteria occurring in bioaerosols is low (Albrecht et al., 2007). Furthermore, culture techniques may underestimate the exposure to some composting bioaerosols; this is especially true for biological agents other than viable cells: endotoxins, mycotoxines, β (1-3)-D-glucans. In contrast to culture techniques, qPCR targeting DNA will not underestimate bioaerosol concentration. It is sensitive and robust, and is used widely for monitoring microoganisms in other environments (soil, water) (Peccia and Hernandez, 2006). Recently, thermophilic species from compost have been quantified by qPCR in order to monitor composting aerosols. Le Goff et al. (2010, 2011, 2012) used data obtained from molecular inventories to identify new indicators affiliated to *Saccharopolyspora rectivirgula*, to the *Thermoactinomycetaceae* and to the fungus *Thermomyces lanuginosus*. Schäfer et al. (2011, 2013) used qPCR to monitor *S. rectivirgula* in composting aerosols. Betelli et al. (2013) developed a system for monitoring *Thermoactinomyces vulgaris* as a basis for a standardized method for quantifying worker exposure to bioaerosols at composting facilities. To evaluate the exposure and the dispersal of composting bioaerosols, it is necessary to know their background concentrations in air from unaffected areas. Most studies have used concentrations measured upwind of the composting site with respect to the dominant wind. **Table 3** gathers the microbial groups used in monitoring of bioaerosols emitted by composting facilities and their background concentrations.

An efficient indicator for tracing bioaerosols from composting should have the following characteristics: (i) be readily transposed into an aerosol in high concentrations during the stages of composting that produce bioaerosols; (ii) be specifically associated with the "compost" environment such that it is scarce in the air in environments not associated with composting activities. However, microorganisms such as *A. fumigatus*, *Thermoactinomyces* or *Saccharopolyspora* are not specific to a compost origin (Song et al., 2001; Pankhurst et al., 2011). Indeed, they play an important role in other habitats where decomposition of organic matter takes place at high temperatures and under aerobic conditions (e.g., improperly stored hay, cereal grains, manure, straw, etc.). It is therefore important to analyze other potential source of emissions (agricultural activities) when collecting air samples for dispersal studies.

In the literature, very disparate results can be found concerning the distance at which composting bioaerosols remain detectable. Some authors did not expect finding elevated loads beyond a distance of 150 m from the facilities during normal operation (Reinthaler et al., 1997; Swan et al., 2003). In other studies, however, microbial concentrations fell to the background level only at distances further then 500 m (Hryhorczuk et al., 2001; Recer et al., 2001; Fischer et al., 2008). Le Goff et al. (2012) compiled data obtained from 12 different sampling campaigns carried out at 11 composting plants at distances from 30 to 500 m, with samples collected during a turning activity. For all campaigns, an impact was measureable up to distances of 100 m. Further away, the impact was not systematically observed as it depended on meteorological conditions (wind speed) and on levels of bioaerosol emissions. Beyond 200 m, the signal was largely dispersed, falling to the background level.

The UK Environmental Agency considers that concentrations can return to those of the background noise as near as 250 m from the source emission (Environment Agency, 2001, 2010). However, some studies show the presence of bioaerosols at much greater distances (Recer et al., 2001; Kampfer et al., 2002; Fischer et al., 2008). Fischer et al. (2008) observed that, in normal wind conditions and as a function of the site investigated, the concentrations of thermophilic actinomycetes and of thermotolerant fungi at a distance of 600–1400 m from the site were 1–2 orders of size greater than the background noise. Recer et al. (2001) analyzed the aerosol bio-concentration upstream and downstream of a composting site, with sampling done roughly once a week over a year. The authors concluded that the emissions could increase the level of exposure to bioaerosols up to at least 500 m from the site.

**Table 3 | Microbial groups used to monitor bioaerosols from composting facilities from O'Gorman and Fuller (2008), Schlosser et al. (2009), Persoons et al. (2010), Pankhurst et al. (2011), ADEME (2012), Le Goff et al. (2012), Schäfer et al. (2013), and Betelli et al. (2013).**

| Microbial group | Technique | Background levels[a] | Concentrations in aerosols from composting facilities[b] |
|---|---|---|---|
| | | UFC, gene copies, or cells/m[c] | UFC, gene copies, or cells/m$^3$ |
| Mesophilic bacteria | Culture | $1.6 \pm 1.2 \times 10^3$ $n = 13$ | $10^2$–$10^8$ |
| Total bacteria | Epifluorescence microscopy (DAPI) | $2.5 \pm 6.9 \times 10^6$ $n = 16$ | $10^5$–$6.5 \times 10^9$ |
| Viable bacteria | Solid-phase cytometry | $2.3 \pm 1.9 \times 10^3$ $n = 16$ | $9 \times 10^4$–$2 \times 10^8$ |
| Gram-negative bacteria | Culture | | $10$ –$8 \times 10^5$ |
| Thermophilic bacteria | Culture | $10 - 1.6 \times 10^3$ | $3 \times 10^1 - 10^9$ |
| Thermophilic actinomycetes | Culture | | $10^2 - 4 \times 10^7$ |
| Molds | Culture | $1.1 \pm 0.8 \times 10^3$ $n = 13$ | $10^1 - 10^7$ |
| *Aspergillus* spp. | | | $9 \times 10^2 - 7 \times 10^4$ |
| *Aspergillus fumigatus* | Culture | <80 | $<10^2 - 4 \times 10^7$ |
| *Saccharopolyspora rectivirgula* | qPCR | | $10^2 - 1.5 \times 10^7$ |
| *Saccharopolyspora rectivirgula* and *rel.*[c] | qPCR | $1.9 \pm 2.3 \times 10^3$ $n = 16$ | $5 \times 10^3 - 4 \times 10^7$ |
| NC38, phylotype affiliated to the *Thermoactinomycetaceae* | qPCR | $0.9 \pm 1.4 \times 10^3$ $n = 16$ | $2 \times 10^3 - 2 \times 10^6$ |
| EQ05, phylotype affiliated to *Thermomyces* | qPCR | $0.7 \pm 1.9 \times 10^5$ $n = 16$ | $10^4 - 5 \times 10^8$ |
| *Thermoactinomyces vulgaris* | qPCR | | $3 \times 10^2 - 3 \times 10^6$ |

[a] *concentration in air collected in unaffected areas (samples collected upwind or in natural environments).*

[b] *concentration in air from composting sites during activities causing bioaerosol emissions; concentrations are expressed as Unit Forming Colonies/m$^3$ for culture, as gene copies/m$^3$ for qPCR, and as cells/m$^3$ for epifluorescence microscopy and cytometry.*

[c] *The qPCR system targets partial 16S rDNA sequences from Saccharopolyspora rectivirgula and from phylotypes dominating 16S rDNA molecular inventories in aerosol emitted on composting facilities, and having a close phylogenetic positioning to S. rectivirgula.*

Lastly, according to Pankhurst et al. (2011), the reversion to levels measured upstream will not take place at the same distance for each of the different components of the bioaerosol. Actinomycetes and Gram-negative bacteria did not return to upwind levels until 300–400 m downwind, although other bioaerosols (*A. fumigatus*, endotoxins) reduced to concentrations statistically similar to upwind within 250 m from site.

The concentration and composition of bioaerosols at a given point in the environment close to a composting site will depend on many factors. These include (Recer et al., 2001; Jones and Harrison, 2004; Pankhurst et al., 2011): (i) the size and topography of the composting site, (ii) the composting activities in progress and the technology used (which can modify the level of emissions), (iii) the physical/chemical characteristics (humidity, granulometry) of the microflora in the handled compost and (iv) the meteorological conditions (wind speed, temperature, hygrometry, hours of sunshine...). The meteorological conditions are effectively the determining factor for the fate of the particulate material in the atmosphere and, also, for the survival of microbes. Most of the microorganisms caught up in aerosols (with the exception of those having a protective form such as spores) would be rapidly inactivated in air because of the process of desiccation, warm temperatures or UV radiations (Mohr, 1997). It should be noted that the effect of each of these factors remains poorly characterized.

Pankhurst et al. (2012) showed how specific site parameters such as compost process activity and meteorological conditions affect bioaerosol communities, although more data are required to qualify and quantify the causes for these variations. Overall, our understanding as to how the microflora changes in aerosols according to the composting process is limited.

## USING MODELING TO ASSESS EMISSION FLUX AND DISPERSAL

Models have been used to predict downwind concentrations based on at- or near-source measurements (Swan et al., 2003). Most authors have assumed that bioaerosol spores are sufficiently small to model bioaerosols as a gas and to permit the use of Gaussian dispersion models such as the Pasquill model, the US EPA SCREEN3 and ADMS (Atmospheric Dispersion Modeling System) (Drew et al., 2006). The literature on modeling the dispersal of bioaerosols emitted by composting facilities is not abundant. This is partly due to the fact that a facility's source term is difficult to calculate. Activities will produce episodic or periodic releases of aerosols due to factors such as operational cycles, fluctuations in the daytime temperature that alter the characteritics of the emissions, or fluctuations in atmospheric pressure that dictate the initial release of pollutants. Furthermore, given the range of activities (shredding, screening, turning, moving the windrows...) there are often a number of sources which make up a "source term" (Taha et al., 2006). Taha et al. (2006, 2007) used source depletion curves drawn up for *A. fumigatus* and actinomycetes during composting activities (turning, shredding, screening) to estimate emission rates and then evaluated the distance at which concentrations fell to background levels using SCREEN 3. They showed that bioaerosol concentrations are likely to decrease to within acceptable levels before the UK Environment Agency 250 m risk assessment threshold. Some rare studies have combined bioaerosol dispersion modeling results with models calculating human exposure (Dowd et al., 2000; Chalvatzaki et al., 2012). Chalvatzaki et al. (2012) analyzed the effect of dust emissions from open storage piles at a municipal solid waste composting site and concluded that the exposure to $PM_{10}$ for an adult who is not working at the composting site was 20–74% lower compared to that of a worker at the composting site.

## PROSPECTS FOR THE FUTURE

The impact of composting facilities on air quality in downwind environments remains difficult to assess. In particular, the distance at which the bioaerosol concentration reverts to the level of the background noise is still under debate. The different results in the literature are due notably to the variable nature of emissions as well as to the influence of diverse factors on aerosol dispersal. Modeling studies can help to better assess bioaerosol dispersal and facilitate conclusions concerning risk assessment. Molecular techniques provide access to non-culturable microorganisms and are widely used to monitor microorganisms in water or soil. Integrating data obtained using molecular techniques into modeling should enhance understanding of dispersal of bioaerosols. Today, several microbial indicators with good specificity to compost origin are available which can be monitored by qPCR. Combining molecular tools and modeling constitutes one important future line of investigation.

When modeling dispersion, particle size and agglomeration play an important role in the aerodynamics of bioaerosols. Furthermore, these factors determine the penetration into the human respiratory system. Additional field studies are required to examine particle size distribution in bioaerosols emitted by composting facilities along with the possible tendency of bioaerosols to form aggregates.

Furthermore, the study carried out by Pankhurst et al. (2011) showed differences in the dispersion of *A. fumigatus*, the actinomycetes and Gram-negative bacteria. This can be explained by the fact that the ecology of the micro-organisms, their physiology and their mechanisms of dissemination (sporulating and non-sporulating microorganisms) all influence the formation of aerosols and their dispersion in the atmosphere. Thus, it is important to gather more data on the emission rates and the dispersal of the indicators used to trace the aerosols emitted by composting facilities, and, also, to compare them to the other microbial components of the aerosols.

The changes in the microbial make-up of the aerosols emitted at the different stages of the composting process must be better characterized, in light of the microbial diversity of the source, i.e., the compost. This would help us to understand the mechanisms of selection during aerosol emission, insofar as some microorganisms are more prone to being aerosolized. Diversity studies could also help in identifying the microbial agents responsible for effects on health.

More research is needed on analyzing the emission and dispersal of bioaerosols emitted by composting facilities in order to better implement regulations by determining acceptable levels of bioaerosols and defining buffer zones between compost sites and nearby residential areas. Regulations should evolve together with monitoring techniques and take into account recent advances in molecular tools.

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# EXHIBIT F

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# Assessment of airborne microorganism contamination in an industrial area characterized by an open composting facility and a wastewater treatment plant ☆

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ABSTRACT

In order to assess the potential exposure hazard to workers and people living in the immediate surroundings of an area characterized by an open composting facility and a wastewater treatment plant, a quantitative and a qualitative analysis of airborne microorganisms were carried out. Air sampling was performed once a week for four consecutive weeks in summer and winter. Six sites were selected as air sampling sites: one was upwind at approximately 40 m from the facilities; the other five were downwind at increasing distances from the facilities, with the furthest at 100 m away. Monitoring permitted us to verify the influence that the composting activities and wastewater treatment had on the bacterial and fungal contamination of the air. The results obtained have been expressed by means of contamination indexes that have already been used in previous works: a major microbiological contamination near the plants was evidenced. Near the facilities, mesophilic bacteria, psychrophilic bacteria and microfungi showed the highest median concentrations, respectively, of 307.5, 327.5 and 257.5 CFU/m$^3$. Moreover, the season generally influenced the concentration of the bacteria as well as of the fungi; higher in summer than in winter. The contamination index global index of microbial contamination (GIMC/m$^3$) showed mean values of 4058.9 in summer and 439.7 in winter and the contamination index—amplification index (AI) showed values of 4.5 and 1.1 in the same seasons, respectively. Controlling the seasonal effect, mesophilic bacteria, *Pseudomonas* spp. and Enterobacteriaceae showed a significant decline in concentration with respect to upwind air samples and with increasing distance. Both GIMC and AI showed a significant decline with respect to upwind air samples by increasing the distance from facilities after adjusting for the seasonal effect. In conclusion, even if these plants do not represent a potential risk for nearby populations, they may pose a potential health risk for workers.



## 1. Introduction

A number of industrial processes determine both the formation and the diffusion of bioaerosols including viruses, bacteria, fungi and their respective products (i.e. bacterial and fungal spores, airborne endotoxins, components of dead microorganisms such as bacterial peptidoglycans and cell wall glucans of moulds) (Brandl et al., 2005). In particular, waste handling processes, such as composting and wastewater treatment, may be considered as potential sources of airborne pathogenic and non-pathogenic microorganisms (Orsini et al., 2002; Fracchia et al., 2006). During the composting process, organic dust is stirred up and a growth of various mesophilic and/or thermophilic species commonly occurs. As a consequence, processing can cause microorganisms and dust to become aerosolized and inhaled. Therefore, composting plants and wastewater treatment facilities may represent an exposure hazard to workers and people living in their immediate surroundings (Johnson et al., 1980; Sawyer et al., 1993).

A number of studies have already indicated the important role of bacterial and fungal airborne microorganisms as potential opportunistic human pathogens. For instance, continued exposure to large concentrations may lead to a sensitization and to the

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development of occupational diseases, such as allergic alveolitis, asthma and organic dust toxic syndrome in workers (Lacey, 1991; Lacey and Dutkiewicz, 1994; Eduard, 1997). In addition, airborne fungi are often reported to be important causes of respiratory complaints in atopic individuals (Howard, 1984). Apart from the pathogenicity of some species of microorganisms, potential impacts of bioaerosols on health should also be discussed from both the allergological and toxicological points of view. A great risk may be connected to the presence of microbial allergens and endotoxins, of which a lipopolysaccharide produced by Gram-negative bacteria is considered as the most important hazard. Endotoxins could be the cause of airway and intestinal inflammation and work-related symptoms (i.e. diarrhoea, fatigue and nose irritation) in sewer workers. A causal relationship between exposure to non-infectious airborne biohazards (i.e. endotoxins, $(1\rightarrow3)$-$\beta$-D glucans, allergens of bacteria and fungi) and the occurrence of gastrointestinal symptoms, fever, respiratory symptoms, skin disorders, eye irritation, headache, fatigue and nausea in the workers of sewage treatment plants has also been considered by many authors (Bünger et al., 2000; Dowes et al., 2003; Ivens et al., 1999). A significant relationship between exposure to rod-shaped bacteria and the occurrence of fatigue and headache in sewage treatment workers has already been demonstrated (Prazmo et al., 2003). Finally, even if numerous toxic properties (i.e. nephro- and hepathotoxic, tremorgenic and carcinogenic effects) have been described in connection with food borne intoxications, mycotoxins can also be present in both living and dead airborne fungal spores or propagules. However, it has been assessed that bioaerosol concentrations decline with the distance from plants due to atmospheric dispersion and dilution. Both mathematical and computational models can be used to estimate this dispersion and to examine the effects that different atmospheric stability classes have on the reduction of bioaerosol concentrations (Hryhorczuk et al., 2001).

The aim of the present investigation was to evaluate exposure to airborne microorganism contamination in an area characterized by an open composting facility and a wastewater treatment plant in summer and in winter by qualitative and quantitative biomonitoring. The authors propose to evaluate the microorganism contamination levels by means of already tested microbial contamination indexes (Dacarro et al., 2000, 2003, 2005).

## 2. Materials and methods

### 2.1. Description of sampling site

An open composting facility flanked by a civil wastewater treatment plant located in a rural area of Northern Italy were investigated as a possible source of airborne microorganisms. The composting facility monitored receives and treats a quantity of waste equal to 28,000 tons/year of which 11,000 are vegetable, 12,000 are domestic humid waste and 5000 are agro-alimentary and treated urban muds. It is characterized by two areas. The first one is a completely closed fermentation area covering a surface of 6000 $m^2$. It consists of a forced air extraction plant in which the fermentation process lasts 30 days and the complete turning of the bio-mass takes place on the 12th day. Then fermented material is transferred to a second flanked area of maturation, occupying a surface of 3000 $m^2$, covered by a canopy, without aeration, in which the aging process lasts 60 days and a complete turning of the bio-mass takes place every 15 days. The final product is sifted; the fine portion is used as compost in agriculture while plant debris are reprocessed.

The wastewater treatment plant receives the sewer discharge from various communities with around 70,000 inhabitants. The total daily average is about 15,000 $m^3$/day. The treatment phases foresee a beginning collection in a container for equalization and pre-aeration, followed by a series of physical treatments consisting in a screening process (to eliminate suspended material), and a process of primary sedimentation (sedimentation of sand and other materials). The liquid waste, now partially treated, arrives at the oxidation tanks and finally to the mud-sedimentation tanks.

This biological treatment process takes place along two parallel lines of equal capacity. The air inlet in the process of oxidation occurs through turbines. The wastewater treatment follows the traditional pattern of activated sludge wastewater treatment systems.

### 2.2. Sampling strategy

Air sampling was performed once a week for four consecutive weeks in summer (21 June–22 September 2006) and winter (21 December 2006–22 March 2007). Six sites located in the uncultivated soil of a rural area were selected as air sampling sites; one of which was upwind at approximately 40 m from the facilities and five were downwind at successively farther distances from the facilities up to 100 m away. Microbiological investigations were carried out during ordinary workdays by means of settling plates and an active sampler. The samples were simultaneously collected in flanking sites. Throughout the period studied, data regarding temperature and relative humidity (RH) were collected by means of the multi-parameter monitoring system called Babuc A (LSI-LASTEM Italy). Babuc is a portable instrument for fast measurements with data logging. The wind direction and speed were determined by means of an anemometer DNA 021 (LSI-LASTEM Italy).

#### 2.2.1. Settling method

Using the gravity settling culture method, the Petri plates were exposed in duplicate at soil level for 10 min (for fungi, mesophilic and psychrophilic bacteria) and for 30 min (for *Pseudomonas* spp., *Clostridium* spp. and Enterobacteriaceae). Bacteria and fungi were sedimented on Tryptone Soya Agar (TSA, Oxoid, Basingstoke, United Kingdom) for mesophilic and psychrophilic bacteria, Cetrimide Agar (Oxoid, Basingstoke, United Kingdom) for *Pseudomonas* spp., MacConkey Agar (Oxoid, Basingstoke, United Kingdom) for Enterobacteriaceae, SPS Agar (Oxoid, Basingstoke, United Kingdom) for *Clostridium* spp. and Potato Dextrose Agar (PDA, Oxoid, Basingstoke, United Kingdom) for fungi. The identification of *Pseudomonas* spp., Enterobacteriaceae and *Clostridium* spp. was presumptive, using the referred media. Settling TSA plates were incubated for 2 days at 37 °C for the detection of mesophilic bacteria and 6 days at 20 °C for psychrophilic bacteria (Dacarro et al., 2003, 2005). Similarly, for the detection of mesophilic bacteria, SPS Agar plates were incubated for 2 days at 37 °C and both MacConkey Agar and Cetrimide Agar plates for 1 day at 37 °C. Bacterial counts were expressed as colony forming units (CFU) per Petri plate area (64 $cm^2$). For the investigation of fungi, settling plates were incubated at 25 °C in a natural day/night period and examined for another 2 weeks. Counts of fungal colonies were expressed as colony forming units per Petri plate area (154 $cm^2$) and pure cultures were made from all the morphologically different colonies. Fungal isolates were transferred to culture media suitable for classification. Identification was based on morphological and physiological characteristics following the standardized procedures for the various genera of fungi (Rapper and Fennel, 1965; Ellis, 1971, 1976; Domsch et al., 1980; Pitt, 1980; Nelson et al., 1983; De Hoog and Guarro, 1995). Qualitative data regarding airborne fungi were collected by identification of all the fungal colonies grown on both the settling Petri plates (reported as "settling").

#### 2.2.2. Active method

Quantitative data were also collected in duplicate using an orthogonal impact Microflow Active Sampler (AQUARIA s.r.l., Lacchiarella, Italy) for active Petri plates (reported as "active"), at a flow rate of 1.5 l./s, held 1.5 m above soil level by a tripod. Air sampling volumes were carried out for 2.13 min (corresponding to 200 l of air) for psychrophilic, mesophilic bacteria and fungi and for 4.27 min (corresponding to 400 l of air) for Enterobacteriaceae, *Pseudomonas* spp. and *Clostridium* spp. Media and incubation temperatures were the same used for settled plate methods. Total fungal concentration was determined on Sabouraud Dextrose Agar (SAB, Oxoid, Basingstoke, United Kingdom) and on Dichloran-Glycerol Agar (DG18, Oxoid, Basingstoke, United Kingdom), for a more selective detection of xerophilic fungal genera. Bacterial and fungal counts were expressed as CFU per cubic metre of air sampled (CFU/$m^3$).

When the count was reported as zero, it meant that the microorganism concentration was below the limit of detection of the methods.

### 2.3. Microbial contamination indexes

Contamination levels of microorganisms were analysed using three different microbial contamination indexes: the global index of microbial contamination (GIMC/$m^3$ for active plates, GIMC/64 $cm^2$ for settling plates), representing the sum of the values of mesophilic, psychrophilic bacteria and fungi; the index of mesophilic bacterial contamination (IMC), expressed by calculating the ratio between mesophilic and psychrophilic bacterial counts (CFU/$m^3$ for active plates and CFU/64 $cm^2$ for settling plates) in the same sampling point; the amplification index (AI), determined by calculating the ratio, respectively, between GIMC/$m^3$ for active plates and GIMC/64 $cm^2$ for settling plates measured downwind and those measured upwind (Dacarro et al., 2000, 2003, 2005).

### 2.4. Statistical analysis

The microbial contamination was described both by the distance from the flanked plants and by the season and separately for the techniques of sample collection (settling or active plates). To improve consistency of analysis, air sampling sites were grouped in two categories, ⩽40 m; 60–100 m, plus the upwind control site. To evaluate the changes in microbial contamination levels in relation to distance, a non-parametric test for trend was applied. Unpaired $t$ test to evaluate seasonal variation was used: Satterthwaite's degrees of freedom correction was applied if the homogeneity of variance was lacking. A multivariate analysis of variance was carried out on (log-transformed) microbial contaminations and indexes to test the difference in relation to distance and taking into account the effect of season. A one-side $p$-value of less than 0.05 was considered significant in the test for trend; otherwise a two-tailed $p$-value below 0.05 was considered to be statistically significant. The analyses were conducted using STATA 8.

## 3. Results

### 3.1. The level of microbial contamination by distance

Contamination levels in relation to distance from the investigated facilities and separately by sampling methods are summarized in Table 1. For both sampling methods, with the increase in distance from the facilities, a decreasing trend in the concentrations of almost all the microbial types generally appeared. Mesophilic bacteria showed the maximum median level in the downwind site nearest to the plants (⩽40 m). The same results were found for psychrophilic bacteria, *Pseudomonas* spp. and Enterobacteriaceae, independent of the sampling method used. Nevertheless, the fall in microbial contamination was seldom significant. The mesophilic decreasing trend was significant for the active plates ($p = 0.04$) and borderline for settling ones ($p = 0.05$). A relevant decline was also detected for *Pseudomonas* spp. active plates ($p = 0.03$) and Enterobacteriaceae settling plates ($p = 0.05$).

On the contrary to the bacteria, microfungi showed a median concentration in the downwind site ⩽40 m near the facilities which was lower than at upwind control for active sampler (275.5 vs. 340 CFU/m$^3$).

Finally, low levels of *Pseudomonas* and Enterobacteriaceae were evidenced and no relevant contamination due to *Clostridium* spp. was detected (Table 1). The contamination indexes (GIMC, IMC and AI) generally showed a marked decreasing trend from the composting site and wastewater treatment plant, but never statistically relevant.

### 3.2. The effect of season on microbial contamination

The collected meteorological data evidenced: temperatures ranged from 24 to 29 °C and RH from 72% to 85% during the summer monitoring period; temperatures ranged from 6 to 16 °C and RH from 44% to 59% during the winter sampling period.

**Table 1**
Mean levels ± standard deviation (SD) of microbial contamination by distance from the facilities (both settling and active plates); the statistical test for trend and $p$-value was also reported.

| Type of microbial contamination | Distance from facilities | | | | | | | | | Test for trend and $p$-value |
|---|---|---|---|---|---|---|---|---|---|---|
| | ⩽40 m ($n$[a] = 16) | | | 60–100 m ($n$ = 24) | | | Upwind control ($n$ = 8) | | | |
| | Median | Mean | SD | Median | Mean | SD | Median | Mean | SD | |
| Mesophilic bacteria | | | | | | | | | | |
| Settling[b] | 166 | 187.8 | 163.3 | 69 | 125.0 | 118.4 | 26.5 | 63.0 | 77.0 | $z = -1.92$; $p = 0.05$ |
| Active[c] | 307.5 | 625.9 | 963.7 | 70 | 231.3 | 298.8 | 90 | 97.5 | 56.7 | $z = -2.09$; $p = 0.04$ |
| Psychrophilic bacteria | | | | | | | | | | |
| Settling[b] | 218 | 244.7 | 211.1 | 123.5 | 190.2 | 195.4 | 90 | 110.8 | 96.4 | $z = -1.55$; $p = 0.12$ |
| Active[c] | 327.5 | 1374.3 | 3258.5 | 172.5 | 421.8 | 834.9 | 210 | 268.1 | 186.1 | $z = -1.10$; $p = 0.27$ |
| Microfungi | | | | | | | | | | |
| Settling[d] | 18.5 | 35.7 | 41.1 | 11 | 20.4 | 24.1 | 10 | 14.75 | 13.9 | $z = -1.51$; $p = 0.13$ |
| Active[c] | 257.5 | 2160.1 | 4313 | 162.5 | 695.0 | 959 | 340 | 770 | 1068.1 | $z = -0.97$; $p = 0.33$ |
| *Clostridium* spp. | | | | | | | | | | |
| Settling[b] | 0 | 0.7 | 1.5 | 0 | 0.2 | 0.4 | 0 | 0.4 | 0.7 | $z = -0.53$; $p = 0.60$ |
| Active[c] | 0 | 0.6 | 1.2 | 0 | 0.1 | 0.4 | 0 | 0.5 | 0.9 | $z = -0.38$; $p = 0.70$ |
| *Pseudomonas* spp. | | | | | | | | | | |
| Settling[b] | 2 | 8.4 | 12.1 | 2 | 6.3 | 13.7 | 0 | 1.9 | 2.6 | $z = -1.66$; $p = 0.10$ |
| Active[c] | 3 | 54.1 | 150.8 | 0 | 1.0 | 2.1 | 0 | 0.5 | 0.8 | $z = -2.12$; $p = 0.03$ |
| Enterobacteriaceae | | | | | | | | | | |
| Settling[b] | 6.5 | 32.4 | 80.4 | 5 | 9.0 | 10.6 | 1.5 | 2.9 | 3.9 | $z = -1.99$; $p = 0.05$ |
| Active[c] | 9 | 16.9 | 28.1 | 3.5 | 6.3 | 9.2 | 4 | 4.4 | 3.8 | $z = -1.80$; $p = 0.07$ |
| GIMC[e] | | | | | | | | | | |
| Settling[b] | 415.5 | 468.1 | 389.6 | 195 | 335.5 | 305.1 | 140.5 | 188.5 | 179.2 | $z = -1.67$; $p = 0.10$ |
| Active[c] | 1376 | 4158.3 | 7679.1 | 445 | 1347.8 | 1636.5 | 607.5 | 1135.6 | 1087.6 | $z = -1.46$; $p = 0.15$ |
| IMC[f] | | | | | | | | | | |
| Settling[b] | 0.75 | 0.74 | 0.21 | 0.67 | 0.72 | 0.29 | 0.54 | 0.55 | 0.28 | $z = -0.99$; $p = 0.32$ |
| Active[c] | 0.64 | 1.57 | 2.59 | 0.74 | 1.69 | 3.62 | 0.39 | 0.44 | 0.26 | $z = -1.33$; $p = 0.19$ |
| AI[g] | | | | | | | | | | |
| Settling[b] | 1.45 | 4.9 | 6.8 | 0.83 | 3.3 | 4.6 | 1 | 1 | | $z = -1.68$; $p = 0.09$ |
| Active[c] | 1.70 | 5.0 | 10.5 | 0.86 | 1.3 | 1.1 | 1 | 1 | | $z = -1.74$; $p = 0.08$ |

A zero count means a microorganism concentration below the limit of detection of the methods.

[a] $n$ = number of samples for each sampling point.

[b] CFU/64 cm$^2$.

[c] CFU/m$^3$.

[d] CFU/154 cm$^2$.

[e] GIMC = global index of microbiological contamination.

[f] IMC = index of mesophilic bacterial contamination.

[g] AI = amplification index.

**Table 2**
Mean levels (±standard deviation or SD) of microbial contamination by season and by sampling methods (settling and active plates).

| Season | n[a] | Type of microbial contamination | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mesophilic bacteria | | Psychrophilic bacteria | | Microfungi | |
| | | Settling (Mean±SD) | Active (Mean±SD) | Settling (Mean±SD) | Active (Mean±SD) | Settling (Mean±SD) | Active (Mean±SD) |
| Winter | 24 | 52.5±100.7 | 102.1±100.4 | 78.1±123.8 | 189.6±151.1 | 11.0±10.5 | 148.0±156.6 |
| Summer | 24 | 218.6±111.9 | 579.0±810.5 | 312.1±174.3 | 1236.2±2738.2 | 38.2±41.6 | 2243.8±3471.9 |
| | | $t = -5.40$ | $t = -2.86$ | $t = -5.36$ | $t = -1.87$ | $t = -3.11$ | $t = -2.95$ |
| | | $p<0.0001$ | $p<0.009$ | $p<0.0001$ | $p = 0.07$ | $p = 0.005$ | $p = 0.007$ |
| | | *Pseudomonas* spp. | | Enterobacteriaceae | | *Clostridium* spp. | |
| Winter | 24 | 5.8±12.6 | 1.2±2.4 | 3.2±8.3 | 3.3±4.5 | 0.1±0.3 | 0.2±0.6 |
| Summer | 24 | 6.8±11.7 | 36.0±124.5 | 28.3±65.1 | 15.8±23.7 | 0.7±1.3 | 0.5±1.0 |
| | | $t = -0.30$ | $t = -1.36$ | $t = -1.87$ | $t = -2.52$ | $t = -1.96$ | $t = -1.04$ |
| | | $p = 0.77$ | $p = 0.18$ | $p = 0.07$ | $p = 0.02$ | $p = 0.06$ | $p = 0.31$ |
| | | GIMC | | IMC | | AI | |
| Winter | 24 | 141.6±221.7 | 439.7±324.9 | 0.6±0.3 | 1.4±3.5 | 0.9± 1.1 | 1.1±1.1 |
| Summer | 24 | 568.9±276.4 | 4058.9±6194.4 | 0.8±0.3 | 1.5±2.3 | 7.0±6.5 | 4.5±9.4 |
| | | $t = -5.91$ | $t = -2.89$ | $t = -1.43$ | $t = -0.13$ | $t = -4.17$ | $t = -1.61$ |
| | | $p<0.0001$ | $p = 0.009$ | $p = 0.16$ | $p = 0.90$ | $p = 0.0005$ | $p = 0.12$ |

[a] $n$ = number of samples for season.

The values reported in Table 2 show the influence of season on airborne microorganism levels. The microbial contamination was, on average, higher in summer than in winter, but the difference was statistically significant only for mesophilic bacteria (settling plates $p<0.0001$; active plates $p<0.009$), psycrophilic bacteria (settling plates $p<0.0001$) and microfungi (settling plates $p = 0.005$; active plates $p = 0.007$). The GIMC showed a relevant seasonal difference for both sampling methods (settling plates $p<0.0001$; active plates $p = 0.009$), while the AI was significantly higher during summer than during winter only for the gravity settling method ($p = 0.0005$).

### 3.3. The effect of distance adjusted for season

Tables 3 and 4 show the multi-variate analysis of variance separately for the two sampling methods used. Mesophilic bacteria were significantly more concentrated in the downwind site nearer to the facilities (⩽40 m) than at the upwind control site, independently from the season. No relevant difference with respect to the upwind control site was found at medium (60–100 m) downwind distances from the plants. The concentration of psychrophilic bacteria and microfungi did not show any relevant difference with respect to the upwind control site both at ⩽40 and 60–100 downwind metres: only the season was important ($p<0.001$) (Table 3). The same pattern observed for mesophilic bacteria was evidenced for *Pseudomonas* spp. (active plates) and for both the settling plates (distance: ⩽40 downwind metres vs. upwind control site, $p = 0.005$; season: summer vs. winter, $p = <0.001$) and the active plates (season: summer vs. winter, $p = <0.001$) of Enterobacteriaceae. The same trend also resulted for the GIMC and the AI indexes (Table 4). For all bacteria, the GIMC and the AI indexes showed higher concentrations during summer than during winter, independently from the distance from the compost facility and the wastewater treatment plant.

### 3.4. Airborne fungi: qualitative data

All the fungal taxa isolated by means of the gravity settled method are listed in Tables 5 and 6. A total of 1143 colonies, representing 16 genera and 35 species, were isolated during the summer monitoring period; results showed the presence of six fungal taxa in the air of the upwind site and 37, 31, 30, 27, 26 fungal taxa in the air of downwind sites (respectively, 20, 40, 60, 80 and 100 m of distance from the plants). *Alternaria alternata*, *Aspergillus niger*, *Cladosporium cladosporioides*, *Epicoccum nigrum* and *Phoma* sp. were constantly sampled. Only the species *E. nigrum* showed a higher value at 100 m than at 40 m and *Phoma* sp. was higher upwind during summer. In the downwind sampling sites, *Aspergillus*, *Fusarium* and *Penicillium* showed the highest biodiversity, being isolated with 12, six and five species, respectively.

During the winter monitoring period, a total of 208 colonies, classified in 19 genera and 26 species, were obtained from settled plates. Results show the presence of four fungal taxa in the air of the upwind control site and of 27, 21, 21, 21, 19 fungal taxa in the air of downwind sites. *A. alternata*, *Aspergillus fumigatus*, *A. niger*, *Aureobasidium pullulans*, *Beauveria bassiana*, *C. cladosporioides*, *E. nigrum*, *Fusarium sambucinum*, *Phoma* sp. and *Rhizopus stolonifer* were constantly sampled. Even if lower than in summer, the highest abundance of species was still detected for *Aspergillus* and *Penicillium* (respectively, eight and five different species) in the air of downwind sampling sites. On the contrary, in the winter sampling period, the genus *Fusarium* resulted present with only the species *F. sambucinum*.

## 4. Discussion

The biological risks produced by composting procedures can come from potentially pathogenic microorganisms present in the raw material as well as from microbial forms that can develop during the composting process (Strauch, 1987). In fact, if the initial danger tends to diminish during the composting procedure, it is still possible for the material to be contaminated during the successive phases of processing with great biological risks due to the inhalation of dusts produced, above all, during the periods of mechanical mixing. In the same way, though depending on the waste treatment technology employed, aerosol formation capable of transporting breathable particles contaminated by microorganisms

**Table 3**
The effect of distance on contamination levels of microorganisms adjusted for season. The estimated coefficients ($\beta$) with standard error (SE[$\beta$]) and the $p$-values were reported for the models with a goodness-of-fit lower than 0.05.

| | Mesophilic bacteria | | | | Psychrophilic bacteria | | | | Microfungi | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Settling | | Active | | Settling | | Active | | Settling | | Active | |
| | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value |
| *Distance* | | | | | | | | | | | | |
| ≤40 m vs. upwind control | 1.02 [0.47] | 0.036 | 1.26 [0.45] | 0.007 | 0.62 [0.46] | 0.184 | 0.60 [0.50] | 0.239 | 0.65 [0.39] | 0.101 | 0.40 [0.45] | 0.374 |
| 60–100 m vs. upwind control | 0.51 [0.44] | 0.253 | 0.32 [0.42] | 0.448 | 0.17 [0.43] | 0.694 | −0.26 [0.47] | 0.584 | 0.17 [0.37] | 0.647 | −0.33 [0.42] | 0.440 |
| *Season* | | | | | | | | | | | | |
| summer vs. winter | 2.10 [0.32] | <0.001 | 1.52 [0.30] | <0.001 | 1.92 [0.31] | <0.001 | 1.21 [0.33] | 0.001 | 1.00 [0.26] | <0.001 | 2.23 [0.30] | <0.001 |
| *Constant* | *4.57 [0.41]* | | *5.09 [0.40]* | | *5.23 [0.40]* | | *5.98 [0.44]* | | *2.83 [0.34]* | | *6.96 [0.40]* | |

| | *Pseudomonas* spp. | | | | Enterobacteriaceae | | | | *Clostridium* spp. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Settling | | Active | | Settling | | Active | | Settling | | Active | |
| | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value | $\beta$ [SE($\beta$)] | $p$-Value |
| *Distance* | | | | | | | | | | | | |
| ≤40 m vs. upwind control | – | – | 1.38 [0.53] | 0.013 | 1.21[0.41] | 0.005 | 0.74 [0.42] | 0.088 | – | – | – | – |
| 60–100 m vs. upwind control | – | – | 0.05 [0.50] | 0.918 | 0.61 [0.39] | 0.120 | −0.12 [0.40] | 0.768 | – | – | – | – |
| *Season* | | | | | | | | | | | | |
| summer vs. winter | – | – | 0.75 [0.35] | 0.038 | 1.84 [0.27] | <0.001 | 0.26 [0.28] | <0.001 | – | – | – | – |
| *Constant* | – | – | *0.69 [0.7]* | | *1.92 [0.36]* | | *2.06 [0.37]* | | – | – | – | – |

**Table 4**
The effect of distance on contamination indexes adjusted for season. The estimated coefficients ($\beta$) with standard error (SE[$\beta$]) and the *p*-values were reported for the models with a goodness-of-fit lower than 0.05.

| | GIMC | | | | IMC | | | | AI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Settling | | Active | | Settling | | Active | | Settling | | Active | |
| | $\beta$ [SE($\beta$)] | *p* | $\beta$ [SE($\beta$)] | *p* | $\beta$ [SE($\beta$)] | *p* | $\beta$ [SE($\beta$)] | *p* | $\beta$ [SE($\beta$)] | *p* | $\beta$ [SE($\beta$)] | *p* |
| Distance | | | | | | | | | | | | |
| ⩽40 m vs. upwind control | 0.76 [0.40] | 0.064 | 0.68 [0.34] | 0.048 | – | – | – | – | 0.76 [0.40] | 0.060 | 0.68 [0.40] | 0.094 |
| 60–100 m vs. upwind control | 0.35 [0.38] | 0.359 | −0.15 [0.32] | 0.637 | – | – | – | – | 0.35 [0.37] | 0.352 | −0.15 [0.38] | 0.690 |
| Season | | | | | | | | | | | | |
| Summer vs. winter | 1.80 [0.27] | <0.001 | 1.89 [0.22] | <0.001 | – | – | – | – | 1.58 [0.26] | <0.001 | 0.96 [0.27] | <0.001 |
| *Constant* | *5.71[0.35]* | | *7.60 [0.30]* | | – | – | – | – | *0.79 [0.35]* | | *0.48 [0.35]* | |

**Table 5**
Fungal *taxa* isolated during summer samplings by the settled plate method.

| Fungal *taxa* (CFU/154 cm$^2$) | Upwind control | 20 m | 40 m | 60 m | 80 m | 100 m |
|---|---|---|---|---|---|---|
| *Alternaria alternata* Keissl. | 28 | 40 | 45 | 23 | 24 | 14 |
| *Arthrinium phaeospermum* (Corda) Ellis | | 1 | 1 | 1 | 4 | 1 |
| *Aspergillus chevalieri* Mangin | | 2 | 3 | 1 | | 2 |
| *A. clavato-nanica* Batista, Maia & Alecrim | | 3 | | | | |
| *A. flavus* Link | | 8 | 9 | 3 | 9 | 5 |
| *A. fumigatus* Fres. | | | 6 | 1 | | 5 |
| *A. glaucus* group | | 2 | 1 | 1 | 1 | 1 |
| *A. nidulans* (Eidam) Winter | | 100 | 17 | 3 | 2 | 2 |
| *A. niger* Van Tieghem | 6 | 2 | 48 | 17 | 6 | 6 |
| *A. ochraeus* Wilhelm | | 1 | | 1 | | 1 |
| *A. rescrictus* Smith | | 1 | 2 | | 1 | |
| *A. ruber* Thom & Church | | 3 | 5 | 1 | 4 | 1 |
| *A. sydowii* (Bain & Sart.) Tom & Church | | 2 | 1 | 1 | 2 | 1 |
| *A. terreus* Thom | | 6 | 7 | | 2 | 2 |
| *A. thomii* Smith | | 3 | 2 | 2 | 6 | |
| *Aspergillus* sp. | 3 | 3 | 1 | 1 | 2 | |
| *Aureobasidium pullulans* (de Bary) Arnaud | | | 17 | | | |
| *Cladosporium cladosporioides* (Fres.) De Vries | 40 | 49 | 99 | 19 | 43 | 56 |
| *C. macrocarpum* Preuss | | 2 | | | | |
| *C. oxysporum* Berk & Curtis | | 5 | 1 | 1 | 6 | 3 |
| *Doratomyces* sp. | | 1 | | | | |
| *Epicoccum nigrum* Link | 11 | 1 | 18 | 8 | 9 | 24 |
| *Fusarium avenaceum* Sacc. | | | 1 | | | 1 |
| *F. lateritium* Nees | | 4 | 1 | 1 | 1 | 1 |
| *F. poae* (Peck) Wollenweb. | | 1 | | | | |
| *F. sambucinum* Fuckel | | | 7 | 2 | 8 | |
| *F. solani* (Mart.) Appel & Wollenw. | | | | 4 | | |
| *F. subglutinans* Nelson, Toussoun & Marasas | | 1 | | 1 | 1 | 1 |
| *Fusarium* sp. | | 1 | 2 | 2 | 3 | 1 |
| *Mucor* sp. | | 1 | | | | |
| *Penicillium brevicompactum* Dierckx | | 2 | 4 | 3 | 6 | 2 |
| *P. duclauxii* Delacr. | | 1 | | | | |
| *P. minioluteum* Dierckx | | 1 | | 1 | | |
| *P. olsonii* Bainier & Sartory | | 2 | 5 | 3 | 1 | |
| *P. purpurogenum* Stoll | | 1 | 5 | 1 | 4 | 1 |
| *Penicillium* sp. | | 3 | 6 | 1 | 1 | 1 |
| *Phoma* sp. | 13 | 6 | 10 | 7 | 5 | 4 |
| *Pseudorobillarda phragmitis* Morelet | | 1 | 6 | | | |
| *Rhizopus stolonifer* (Ehrenb.) Vuill. | | 4 | 4 | 2 | 4 | 1 |
| *Scopulariopsis brevicaulis* Bainier | | 1 | | | | |
| *Trichoderma viride* Pers. | | 1 | 1 | 1 | 1 | 4 |
| *Trichothecium roseum* Link | | 13 | 11 | 2 | 2 | 3 |
| Total count | 101 | 279 | 346 | 115 | 158 | 144 |

has been documented in the treatment plants. In particular, several investigations on wastewater treatment workers have shown that certain work-related symptoms are more frequent among employees of sewage treatment plants than among control groups (Nethercott and Holness, 1988; Rylander, 1999). For these reasons, in order to protect both the plant workers and local residents, it is necessary to evaluate the presence and concentration of airborne microorganisms in the proximity of the plants (Brandi et al., 2000).

Our results show that for human health, a potentially dangerous microbial contamination is present only close to the composting facility and wastewater treatment plant. In fact, the application of the microbiological indexes that we proposed shows a kinetic environmental contamination with the critical point of microorganism diffusion in proximity of the plants and up to a maximum distance of 40 m, the point at which we found the highest microbe contamination values. The findings evidenced

**Table 6**
Fungal *taxa* isolated during winter samplings by the settled plate method.

| Fungal *taxa* (CFU/154 $cm^2$) | Upwind control | 20 m | 40 m | 60 m | 80 m | 100 m |
|---|---|---|---|---|---|---|
| *Alternaria alternata* Keissl. | 13 | 23 | 20 | 20 | 8 | 5 |
| *Arthrinium phaeospermum* (Corda) Ellis | | 2 | | | | |
| *Aspergillus amstelodami* Thom & Church | | | 1 | 1 | 1 | 1 |
| *A. candidus* Link | | 3 | 3 | | 1 | 1 |
| *A. chevalieri* Mangi | | 1 | 1 | 1 | 1 | |
| *A. cristatus* Raper & Fennel | | | 1 | | | |
| *A. flavus* Link | | 3 | | 3 | 1 | |
| *A. fumigatus* Fres. | | 8 | 5 | 1 | 1 | 1 |
| *A. glaucus* group | | | | | 1 | |
| *A. niger* Van Tieghem | 4 | 3 | 5 | 6 | 1 | 1 |
| *A. repens* de Bary | | 1 | | | | |
| *Aureobasidium pullulans* (de Bary) Arnaud | | 7 | 7 | 5 | 5 | 2 |
| *Beauveria bassiana* (Bals.) Vuill. | | 3 | 1 | 1 | 1 | 1 |
| *Botryotrichum piluliferum* Sacc. & March. | | 1 | | | | |
| *Botrytis cinerea* Pers. | | 3 | 3 | 1 | 1 | 1 |
| *Circinella muscae* (Sorokin) Berl. & De Toni | | 2 | | | | |
| *Cladosporium cladosporioides* (Fres.) De Vries | 28 | 41 | 32 | 30 | 28 | 26 |
| *Epicoccum nigrum* Link | 5 | 11 | 5 | 3 | 3 | 3 |
| *Fusarium sambucinum* Fuckel | | 13 | 11 | 10 | 1 | 1 |
| *Mucor* sp. | | 1 | | | 1 | 1 |
| *Nigrospora oryzae* (Berk & Broome) Petch | | 2 | 2 | 1 | 1 | 1 |
| *Penicillium brevicompactum* Dierckx | | 3 | | 1 | | |
| *P. camemberti* Sopp | | 5 | 1 | | | |
| *P. chrysogenum* Thom | | 3 | 1 | 1 | 1 | |
| *P. expansum* Link | | 13 | 10 | 2 | | |
| *P. italicum* Wehmer | | 20 | 11 | 4 | 1 | 1 |
| *P. olsonii* Bainier & Sartory | | 1 | 1 | | | |
| *P. verrucosum* Dieckx | | | | | 1 | |
| *Phoma* sp. | | 10 | 5 | 1 | 1 | 1 |
| *Rhizopus stolonifer* (Ehrenb.) Vuill. | | 1 | 1 | 1 | 1 | 1 |
| *Rhodotorula rubra* (Schimon) Harrison | | 3 | | | | |
| *Trichoderma viride* Pers. | | 1 | | 1 | 1 | 1 |
| *Trichothecium roseum* Link | | | | | | 1 |
| Total count | 50 | 188 | 127 | 94 | 62 | 50 |

that the microbial contamination declined by increasing the distance from facilities, but the trend is significant only in some cases: mesophilic bacteria, *Pseudomonas* spp. and Enterobacteriaceae.

High counts of microorganisms, including the potentially pathogenic ones, are generally to be expected in a waste handling process area. However, extensive study is needed. Even if efforts have been made to determine the "safety" of various air samples and some health risks associated with bioaerosols have been identified, no occupational exposure limits exist for airborne microorganisms. For instance, for work sites in composting facilities and sewage treatment plants, exposure–response relationships have been described only for a few agents such as endotoxins and allergens (Dowes et al., 2003). Limit values up to $10^4$ CFU/$m^3$ for culturable bacteria, $10^3$ CFU/$m^3$ for Gram-negative bacteria and $10^3$ CFU/$m^3$ for fungi have only been suggested (Malmros, 1990; Oppliger et al., 2005). On the contrary, exposure frequency and concentrations of moulds are highly dependent on individual susceptibility and it is difficult to suggest exposure limits for fungal spores in relation to occupational allergic asthma (Poulsen et al., 1995).

In our study, a comparison between the seasons indicated a higher contamination level in summer. Samples collected during the winter working period were substantially lower and the contamination indexes GIMC and AI showed a significant decline by increasing the distance from the facilities and adjusting for seasonal effects. For a long time (Gregory, 1961), it has been known that the seasons affect the air-spores profoundly: the dominant airborne species show pronounced seasonal periodicity, as do the pollens and the spores of mosses and pathogenic plant fungi. Moreover, concentrations are significantly increased by increases in temperature, dew or relative humidity.

As the composting process is based, to a vast extent, on fungal activity, a high amount of airborne fungal spores can be emitted from the monitored plants. As a consequence, in the vacuum plates, moulds usually grow together, making their count difficult, and their characterization inaccurate and incomplete. For this reason, we focused our study on making a detailed characterization of airborne fungal spores detected in the area by means of settling plates, a method which is very useful in determining the fungal species involved, although it underestimates smaller particles.

The high fungal biodiversity found in the air is, for the most part, retraceable to the nature of certain composting materials, such as the percentage of humid solid urban waste, wood-cellulose waste, and agro-alimentary muds. The air-spores of the saprotrophic fungi and parasites originate from this vegetation (Kendrick, 1992). Probably for this reason, the species *E. nigrum*, a phylloplane invader which normally grows extensively when environmental conditions are particularly favourable, showed a high detection at 100 m from the plants during summer; its presence probably related to the rural landscape of the immediate surroundings. Moreover, during the composting process, the bacterial populations that were at first present, were gradually substituted by fungal populations whose spores were liberated into the environment, enriching the aerial mycological load of the air. It is important to give warning of a possible risk for workers: there is an inadequate understanding of both the biomedical and the mycological issues, but there is adequate evidence that inhalation of fungi results in immunological deregulation, with potential neurological effects (Flanningan and Miller, 1994). Moreover, knowledge regarding the presence of mycotoxins in bioaerosols from composting facilities is still widely uncertain and the spectrum of airborne toxins and metabolites needs to be further investigated (Fischer et al., 1999).

To protect the plant workers, it is necessary, in particular, to focus attention on the fungi that are called the "opportunistic moulds", represented by *Aspergillus* spp., *Fusarium* spp., *Penicillium* spp. and by dematiaceous microfungi, able to cause allergic reactions in healthy subjects and infections in immune-compromised people (Friedman et al., 1991; Washburn, 1996). To this aim, we underline the isolation of 13 species of *Aspergillus*, a genera responsible for various clinical syndromes known as "Aspergillosis" and the constant presence of *A. alternata* and *Cladosporium* spp., dematiaceous fungi responsible for complex allergic manifestations (Caretta, 1992; Ivens et al., 1997).

In light of the problems discussed, it is evident that an increase in the quality of breathing air, and a reduction of the levels of exposure to microorganisms must be closely considered both by employers and plant workers. For these reasons, the data obtained in this study can be useful when planning new plants and informing workers on the possible risks related to this working environment.

In conclusion, the contamination indexes suggest that these plants do not represent a potential risk for nearby populations. The major levels of microbial contamination detected downwind near the facilities decrease with distance and do not exceed the limit values suggested by Malmros, 1990 and Oppliger et al. However, they might represent a potential health hazard for workers. In spite of the uncertainty of the effects, in particular that of fungal spores on the respiratory systems, important measures, such as respiratory protection or adequate allergological examination prior to and during employment, should be taken.

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# EXHIBIT G

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# BIOAEROSOLS AND HEALTH: CURRENT KNOWLEDGE AND GAPS IN THE FIELD OF WASTE MANAGEMENT

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Organic waste

ABSTRACT

The development of biodegradable waste recycling leads to increased amounts of decaying organic materials handled, and encourages the conditions in which workers, households and neighbouring communities are potentially exposed to bioaerosols. The objective of this study was to assess the knowledge and gaps regarding the health risks associated to bioaerosols in the field of municipal solid waste (MSW) and commercial and industrial waste (C&IW) management. Additional objective was to identify priority issues for research in order to improve knowledge and prevention. Overall, 368 studies have been selected. Strong qualitative evidence links occupational exposure to bioaerosols in the waste industry to adverse effects on health including long-term respiratory disease, notably in the fields of composting, mechanical biological treatment (MBT) and materials recovery facilities (MRF). The literature review highlighted numerous gaps in knowledge about exposure and health effects of bioaerosols that need to be addressed to assess the risk. Most importantly, valid and standardized methods for quantitative exposure assessment are needed. Identification of environmental indicators, estimate of factors influencing the level of bioaerosol exposure at the workplace, well-designed epidemiological studies and validation of dispersion models are other priority issues.

## 1. INTRODUCTION

As an alternative to landfill disposal, processes are being developed that ensure recycling and energy recovery of biodegradable fractions of waste. In the European Union, the bio-fraction of municipal solid waste (MSW) and commercial and industrial waste (C&IW) has been estimated at 189 and 133 wet million tons, respectively, in 2014 (Arup URS Consortium, 2014).

Biodegradable fractions of waste include: (1) biowaste segregated by households and commercial and industrial activities and (2) the organic matter/waste fraction that remains in dry recovered waste and in residual waste when dry solid waste is segregated by households for separate collection. (Park et al., 2011a ; Schlosser et al., 2015 ; Tolvanen et al., 2001, 2004). Further processes aim at separating the organic wet fraction from the dry solid recovery waste, and to treat it mainly by composting, anaerobic digestion, or stabilisation. Consequently, the biodegradable fraction of waste is present in all MSW and C&IW management sectors.

The development of biodegradable waste recycling leads to increased amounts of decaying organic materials handled. The age of the waste, environmental conditions such as humidity and temperature, and some processes, such as composting, encourage the growth of micro-organisms in the biodegradable waste fraction and associated products. These factors encourage the conditions in which workers, households and neighbouring communities are potentially exposed to airborne biological agents, i.e., bioaerosols (Pankhurst et al., 2011a; Pearson et al., 2015; Schlosser et al., 2015; Wouters et al., 2000).

Bioaerosols consist of live and dead micro-organisms either as individual micro-organisms or as aggregates, fragments and micro-organisms products, such as bacterial endotoxins, β (1-3)-D glucans and mycotoxins. All these biological agents can also be carried by other particles (ACGIH, 1999). The interest of scientists and health authorities in bioaerosols has increased over the past two decades due to the wide range of adverse health outcomes associated with exposure in occupational and residential environments. These include infections, immuno-allergic, non-allergic inflammatory and toxic effects (ACGIH, 1999; ADEME, 2012; Douwes et al., 2003; Dutkiewicz, 1997; Swan et al., 2003).

The main objective of this study was to assess the knowledge and gaps relative to bioaerosol-related health issues in the field of MSW and C&IW management activities, and to have an insight into the weight of evidence from the literature and SUEZ experience. Additional objective

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was to identify priority issues for research in order to improve knowledge and prevention. As a preamble, is briefly given background information on bioaerosols and related health issues.

## 2. MATERIALS AND METHODS

A scoping review of the literature covering the topic of bioaerosols in the waste management field between 1990 and 2018 was carried out. The literature search for peer-reviewed scientific publications has been conducted on Medline, accessed via PubMed. In addition, technical and grey literature publications were searched using internet-wide search engines (Google, Google Scholar).

Studies were included in this review if they reported data in the MSW/C&IW management field on at least one of the following topics: biohazard identification, bioaerosol measurement, exposure assessment, health outcome in exposed people (case reports, epidemiological studies), quantitative microbial risk assessment, experimentation in humans, measures of prevention, regulation. Studies on bioaerosols from wastewater treatment plants and health-care waste management activities were not included in the review. In addition to studies specific to the MSW and C&IW management field, articles about the measurement methods and the health effects of bioaerosols were included in the scoping review.

Overall, 368 studies were selected. Of these, 165 were related to bioaerosol monitoring in the field of MSW and C&IW, and 48 to epidemiology. Overall, 77% of the articles were related to the field of occupational exposure. For each of the waste management sectors, the identified studies were critically assessed in order to estimate whether or not hazard identification, exposure assessment and health effect (epidemiological studies, case reports) aspects were "sufficiently", "insufficiently" or "not" documented. An aspect was qualified as "sufficiently documented" if there were numerous studies that present similar conclusions, "insufficiently documented" if major gaps in knowledge still persisted regarding one or more issues, "not documented" if no documentation reporting the data mentioned above was found. It is noteworthy that industrial composting was by far the most investigated sector, accounting for 53% of the studies included. Inversely, in regards to food waste depackaging technology, as far as it could be established, only internal data was available.

## 3. BACKGROUND INFORMATION ON BIOAEROSOLS AND RELATED HEALTH EFFECTS

Bioaerosols are ubiquitous in nature, however some human activities such as animal farming, gain harvesting and handling, wood processing, the food industry, the textile industry, and waste management may substantially influence them both quantitatively and qualitatively (ACGIH, 1999; Douwes et al., 2003; Eduard et al., 2012; Oppliger and Duquenne, 2015; Rylander and Jacobs, 1994). Bioaerosols are airborne particles, and thus, strictly speaking, gaseous metabolites such as microbial volatile organic compounds (mVOC) are not considered as bioaerosols (ACGIH, 1999; Vilavert et al., 2012). Airborne biological agents can be free in air, such as mould spores, or carried by another particle, of organic or mineral content. Individual bioaerosols range in size from <0.01 µm to 100 µm in diameter (ACGIH, 1999).

Biological agents in aerosol can be transmitted through three routes:

- The inhalation route, which exposes the mucous membrane of the airways and the lungs to the agent impact according to the aerodynamic diameter ($D_{ae}$) of the particulate. The smaller the inhaled particle, the deeper the deposit into the lung. In addition, largest inhaled particles that impacted in upper airways ($D_{ae}$ above 10 µm) can be swallowed in a second phase;
- the ingestion route, mainly by the contact of dirty hands to the mouth or through a direct projection of materials on face, and also from inhaled coarse particles as mentioned above;
- and the skin and eye contact mode.

### 3.1 Health outcomes of bioaerosols

Adverse health effects of inhaled bioaerosol can be divided into infectious diseases and non-infectious effects.

#### *3.1.1 Infectious diseases*

Bioaerosol inhalation is recognised as one of the main transmission routes for infectious diseases (Eames et al., 2009; Moretti et al., 2018; Qian and Zheng, 2018; Valade et al., 2015; Yates et al., 2016). Infection requires that a micro-organism (bacteria, viruses, fungi) be alive, and the severity of the disease depends on the virulence of the strain and individual risk factors, such as immune deficiency. Depending on the micro-organism, the reservoirs are humans, animals and/or the environment. The occurrence of airborne infectious diseases is facilitated by the clustering of people in close environments (e.g., influenza, tuberculosis) and by exposures that are specific to occupations (e.g., Q-fever in farmers, psittacosis in bird breeders) or environments (e.g., legionellosis, non-tuberculous mycobacterial pulmonary disease, histoplasmosis) (Cavalazzi et al., 2018; Clark et al., 2018; Drummond et al., 2019; Herwaldt et al., 2018; Hogerwerf et al., 2017; Maloney et al., 1995; McKinsey et al., 2011). Health care workers, veterinarians, farmers and biomedical workers have been identified as carrying out high risk occupations (Douwes et al., 2003).

Some micro-organisms are opportunistic pathogens; this means that infection occurs when the host defenses are compromised by disease or the treatment of the disease. Immune deficiency is the most common condition associated with opportunistic infection, including malignant disease, organ transplantation and human immunodeficiency virus (HIV) infection (Bunch and Crook, 1998). Opportunistic airborne micro-organisms include fungi (moulds, such as *Aspergillus fumigatus*, *Zygomycetes* species, *Fusarium*, *Coccidiodes immitis*, and yeasts such as *Cryptococcus neoformans* and *Pneumocystis jirovecii*) and bacteria (e.g., *Mycobacterium Avium* Complex, *Pseudomonas aeruginosa*, *Micrococcus*) (Brandt and Warnock, 2007; Clifton and Peckham, 2010; Lande et al., 2018; Lemonovich, 2018; Lin, 2009; Ma et al., 2018).

*3.1.2 Non-infectious effects*

Non-infectious effects of inhaled bioaerosols gather inflammation of airways from non-allergic mechanisms (usually cytokine-mediated effects), immuno-allergic respiratory diseases (asthma, rhinitis, hypersensitivity pneumonitis) that need previous sensitization to the allergenic compound(s) of the micro-organism, and toxic effects on organs (liver, kidney, central neurologic system, immune system, ...) (ACGIH, 1999; Douwes et al., 2003; Rylander and Jacobs, 1994). Main non-infectious effects due to inhaled bioaerosols are summarized in Table 1. Non-infectious effects do not need the micro-organism to be alive; dead micro-organisms and fragments do keep pro-inflammatory and allergenic properties. Some mycotoxins (Aflatoxin B1) are classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer (IARC, 2012). The critical route of exposure to mycotoxins is usually ingestion, however, there is growing evidence that lung can also be a target for aflatoxin B1 carcinogenicity (Donnelly et al., 1996; Jakšić et al., 2012; Marchese et al;, 2018; Massey et al., 2000).

Occurrence of immuno-allergic outcomes is influenced by both features of exposure to micro-organisms (the level and duration of exposure, occurrence of peaks of exposure), and the presence of individual risk factors, such as atopy for asthma, or asthma and cystic fibrosis for allergic bronchopulmonary aspergillosis (ABPA), which is the principal clinical disorder due to *Aspergillus* hypersensitivity (Denning et al., 2013; Knutsen and Slavin, 2011). In addition, sensitisation to *A. fumigatus* has also been associated with reduced lung function in severe asthma and chronic obstructive pulmonary disease patients (Denning et al., 2014; Fairs et al., 2010). The burden of allergic fungal airway disease is important. In a scoping review, Denning et al. (2013) estimated that the prevalence of ABPA in adults with asthma was 2.5%, whilst modelling suggests an ABPA global burden of 4.8 million adult patients. As regards severe asthma with fungal sensitisation, the global burden has been estimated at about 6.5 million patients (Denning et al., 2014). Furthermore, thermophilic actinomycetes and fungi are well-known causal agents of occupational hypersensitivity pneumonitis (ACGIH, 1999; Eduard, 2009; Quirce et al., 2016).

At the workplace, exposure to endotoxins has been associated with both acute and chronic respiratory outcomes, due to their pro-inflammatory properties (Rylander, 2006). Short-term respiratory and systemic outcomes can lead to sick leaves, and repeated exposure to high levels of endotoxins have been associated with chronic bronchopulmonary disorders and reduction in lung function (Searl et al., 2008). Endotoxin exposure substantially aggravates airways inflammation in patients with allergic rhinitis and atopic asthma (Michel et al., 1989; Rylander, 2006). Moreover, it has been shown that genetic variations in proteins that mediate endotoxin recognition impact the airways and immune response to endotoxin exposure (Holla et al., 2002). These data emphasize that the response to endotoxin exposure is not similar between individuals.

The results of workplace studies suggest that the development of respiratory symptoms as a result of exposure to bioaerosols is likely to lead to chronic respiratory illness following prolonged exposure (Rylander, 2006) and this negative effect is biologically plausible due to chronic inflammatory reaction of the respiratory tract (Bolund et al., 2017; Liebers et al., 2008). A recent meta-analysis of the association between organic dust (i.e., bioaerosol) exposure and decline in lung function, the first of its kind, showed a small significant excess loss in forced expiratory volume in the first second (FEV1) (on average 4.92 mL/year) among exposed compared with controls (Bolund et al., 2017). However, the authors highlight that this small excess decline could lead to possible important health issues after many years of exposure. Furthermore, the healthy worker selection bias (i.e., the potential bias caused by the phenomenon that more susceptible individuals may be excluded from employment or, once employed, may leave the job they do not tolerate) could be an evident problem in all the studies included in this review and may suggest that the associations found were underestimated (Bolund et al., 2017). Other symptoms associated with bioaerosol exposure are nausea, diarrhoea, headache and fatigue (Douwes et al., 2001; Gladding and Cloggins, 1997; Hambach et al., 2012; Ivens et al., 1999; Krajewski et al., 2004).

On the other hand, it is worth noting that microbial exposure, and particularly exposure to endotoxins may have a protective effect against atopy and asthma, as suggested by epidemiological studies in farmers (Eduard et al., 2004; Riedler et al, 2001) and recent experimental works (Schuijs et al., 2015). Several epidemiological studies also support hypothesis that endotoxin exposure may protect against lung cancer, as a result of stimulation of cytokin release, and notably Tumor Necrosis Factor α (TNFα) (Ben

TABLE 1: Non-infectious effects from exposure to airborne micro-organisms.

| Microorganisms | Constituents/Metabolites | Allergy | Non-allergic inflammation | Others [b] |
|---|---|---|---|---|
| Gram negative bacteria | Endotoxin | | + | |
| Non-sporulated Gram positive bacteria | Peptidoglycans | | + | |
| Fungi | Allergens<br>β (1-3)-D-glucans<br>Mycotoxins | +<br>a<br> | <br>+<br>+ | <br><br>c |
| Thermophilic actinomycetes | Allergens<br>Peptidoglycans | +<br> | <br>+ | |

*a: Enhancement of the allergic response to inhaled allergens; b: Others: cytotoxic and carcinogenic effects; c: Limited evidence of systemic and carcinogenic effects of inhaled mycotoxins, in contrast with ingested mycotoxins.*

Khedher et al, 2017; Lenters et al., 2010). However, optimal dose of exposure to endotoxin, if any, is unknown, as on the other hand long-term exposure to endotoxin is associated with chronic bronchopulmonary disorders as mentioned above.

### 3.2 Main gaps in knowledge on bioaerosol health effects

Several gaps remain in our knowledge of the potential health impact of exposure to bioaerosols generally, and notably from MSW and C&IW regardless of the specificity of the activity or process. These gaps concern each of the four steps of health risk assessment process (USEPA, 2018): hazard identification, exposure assessment, exposure-response relationship and health risk assessment.

#### *3.2.1 Hazard identification*

Exposure to bioaerosols is often estimated by analysis of microbial sum parameters in air samples using culture-based methods, and less frequently by microscope examination (ACGIH, 1999; Cartwright et al., 2009; Douwes et al., 2003; Eduard, 2009; Eduard et al., 2012). As highlighted above, bioaerosol in the organic waste management field is a complex mixture of microorganisms, constituents and metabolites. Moreover, bioaerosol exposure is associated with a large variety of symptoms and diseases. In fact, it is often not clear which agents are primarily involved in health outcomes that have been described by exposed groups. Many biological agents that may cause health effects are currently not identified. Even if a few studies carried out a large identification approach for microorganisms with molecular biology (quantitative PCR) (Le Goff et al., 2010; Pankhurst L.J. et al., 2012) or mass spectrometry (MALDI-TOF) (Madsen et al., 2016; Nasir et al., 2018a), or investigated specific antigens with enzyme immunoassays (van Kampen et al. 2014), data in most studies do not reflect the variety of different species. New biomolecular technologies such as next-generation DNA sequencing can help in informing on the microbial diversity and the relative abundance of airborne microorganisms and in identifying indicators for monitoring bioaerosols emission (Duquenne et al., 2018). Such indicators may help to distinguish the contribution of a specific source, such as a non-hazardous waste landfill, versus other sources (such as intensive poultry farming). They have been applied to the waste management field for a very few years (Degois et al., 2017; Dubuis et al., 2017; Mbareche et al., 2017, 2018; Wéry et al., 2018). In fact, there is a need for identification of indicator parameter(s) for exposure assessment and health risk assessment in the specific field of interest, depending on the goal of the study (Douwes et al., 2003). There is a need for clear demonstration of the relevance of the selected indicator parameter, according to the question to be answered. For example, to answer the question of assessing bioaerosol dispersion in the surroundings of composting facilities, a combination of three microbial indicators using culture-independent techniques (viable bacteria using solid-phase cytometry, and two bacterial phylotypes, affiliated to *Saccharopolyspora* sp and the *Thermoactinomycetaceae*, respectively, using qPCR) has been proposed as a relevant marker for monitoring composting aerosol (Le Goff et al., 2012). However, this combination would be would be of little interest for assessing the health effects of exposure of neighbouring residents to composting bioaerosols. To answer part of that question, the focus will rather be on micro-organisms such as *Aspergillus fumigatus*, which is a real concern for the health of susceptible individuals (Deacon et al., 2009a; Epstein, 1994; Kramer et al., 1989; Schlosser et al., 2016).

#### *3.2.2 Exposure assessment*

Exposure assessment is closely linked to the sampling strategy, which includes the selection of the collection and analysis methods and the sampling plan (stationary and personal sampling, sampling locations, sampling duration and sample size) (ACGIH, 1999; ADEME, 2012; Douwes et al., 2003; Eduard and Heederik, 1998). Measurement of bioaerosols should be performed according to a protocol representative of the exposure pattern and duration at the workplace or in the surrounding environment. Different factors may influence the pattern of exposure to bioaerosol components and the variability in exposure levels. The study design and the sampling strategy should take these factors into consideration. Furthermore, the particle size dispersion should be taken into account, for both health risk assessment process and bioaerosol dispersion modelling (Byeon et al., 2008; Galès et al., 2015; Rolph and Gladding, 2017).

As a major key point, there is a lack of valid methods to assess exposure, and of protocols that should include internationally accepted guidelines on sampling, transport and storage, and analytical procedures (Duquenne et al., 2013; Searl et al., 2008; Walser et al., 2015). This lack makes it difficult to compare the results of the different exposure studies, and of epidemiological findings. Several documents have been published by standardisation organisations or occupational health and safety institutes that describe protocols of bioaerosol measurement at the workplace. However, these protocols are not internationally recognised, and some of these documents should be reviewed to incorporate newly available knowledge (Duquenne et al., 2013). In Europe, the European Committee for Standardization (Comité Européen de Normalisation, CEN) published three standards in the early 2000s, EN 13098 (CEN, 2000), EN 14031 (CEN, 2003) and EN 14583 (CEN, 2004). EN 13098 and EN 14031 are currently being revised by the CEN technical committee 137.

Alongside the identification of appropriate indicator parameters, there is a need for developing standardized measurement methods and for harmonized approach to sampling strategy. There is also a clear need for developing continuous monitoring methods which provide real-time information (Nasir et al., 2018b; O'Connor et al., 2015; Robinson et al., 2013).

#### *3.2.3 Exposure-response relationship*

Regarding bioaerosols, exposure-response relationship is lacking for most agents (ACGIH, 1999, Eduard, 2009, Searl et al., 2008; Walser et al., 2015). Indeed, establishing exposure-response relationships for bioaerosols is difficult due to: (1) the definition of exposure (e.g., what indicator parameter? what exposure time scale? what exposure unit?), (2) the definition of the response (what critical effect as the relevant endpoint? threshold versus non-threshold response?), and (3) the complexity of the mixture of micro-organisms and components in bioaerosols. Moreover, the combined effects of biological agents (such as endotoxin and specific allergens) should not be ruled out. Neither should interactive effects between bioaerosols and chemical hazards such as ammonia and volatile organic compounds (Viegas et al., 2017). These points highlight potential differences in response to an environmental indicator depending on the occupational sector (e.g., differences in response to endotoxin exposure in pig farming versus paper and cardboard recycling depending on other associated air pollutants).

Establishing exposure-response relationships also faces difficulty associated with variation between individuals and within individual (i.e., over-time) in the response to a particular inhaled biological agent. There is a need for investigating the issue of individual susceptibility to allergens, endotoxin and other bioaerosol components, and the potential influence on the shape of the exposure-response relationships.

There is a need for further research on exposure–response relationships for most bioaerosol components.

*3.2.4 Health risk assessment*

According to the above sub-sections, it is obvious that health risk characterization regarding bioaerosols, and in the waste industry particularly, is seriously hampered by several major gaps in each of the constitutive steps of the process. That means we cannot precisely predict the risk of a particular health outcome associated with a specific job, nor can we for general community. Owing to the lack of established exposure-response relationship for inhaled biological agents, quantitative microbial risk assessment (QMRA) cannot be performed.

As an alternative to a predictive approach with risk characterization, epidemiological studies provide observational results and risk measurement estimate. However, regarding bioaerosols, available epidemiological studies do not provide strong evidence that would allow establishment of exposure-response relationships and subsequent exposure limits (Walser et al., 2015). There is a need for further epidemiological studies, particularly prospective cohort studies, which allow consideration of both exposure level and individual risk factors as covariates. If ethically feasible, experimental studies involving human subjects may also help to establish health-based guidelines for airborne biological agents, such as endotoxin (Health Council of the Netherlands, 2010).

Whatever the risk assessment approach, large uncertainties in exposure assessment (mainly due to the lack of reliable and standardized quantitative exposure assessment methods) greatly hamper the development of legal health-based exposure limits for most bioaerosols (Douwes et al., 2003). A few specific components are exceptions, such as subtilisin, which is an enzyme produced by Bacillus subtilis and used in detergents, and endotoxin, as mentioned above (Douwes et al., 2003; Eduard et al., 2012). In the Netherlands, 90 EU $m^{-3}$ has been proposed as a health-based recommended limit (8-hr time-weighted average) for endotoxins at the workplace, which affords adequate protection against the effects of both acute and chronic exposure (Health Council of the Netherlands, 2010). Otherwise, regulatory occupational exposure limits have been set for cotton, grain, wood, and flour dust, however these limits do not consider specific components present in the dust (Eduard et al., 2012).

## 4. BIOAEROSOLS FROM MSW AND C&IW MANAGEMENT AND HEALTH: WHAT WE KNOW AND WHAT WE DO NOT KNOW

This section synthetizes knowledge and gaps related to bioaerosols in the MSW and C&IW management field. Some data are specific to this sector, other ones are more generic as they apply to other occupational and environmental fields.

### 4.1 What are the target groups regarding exposure to bioaerosols from MSW and C&IW management activities?

Main target groups are workers, households and nearby residents of waste management facilities. Additional target groups are represented by occasional visitors of the facility (school pupils, municipal representatives, ...) and since recently by pupils and teachers in schools where an on-site composting program has been implemented (Brown, 2005; Garden Organic, 2018; Green Mountain Farm to School, 2010). There are marked differences in features of target groups and in respective exposure patterns that can influence the response of individuals to bioaerosols. Workers in MSW and C&IW management activities are clearly the target group with highest levels of exposure. Workers are adults, generally healthy (although some of them may present asthma and/or be smokers), and high levels of exposure to bioaerosols from waste are limited to the working time. Households may be exposed to MSW bioaerosols from separate storage of biowaste and home composting. Households' exposure is intermittent, but may occur over the lifetime. Individuals may obviously be ill and present risk factors. Residents living or working nearby open air waste management facilities (composting plants, non-hazardous waste landfill sites) may be exposed to bioaerosol emissions from the facility. Residents' exposure is irregular, depending on the on-site activity, and may potentially occur all over the lifetime. These individuals may also be ill and present risk factors.

As a result, although exposed to highest concentrations of bioaerosols, waste workers should not be considered as a "sentinel group" for surveillance programs on health impact of bioaerosols. In other words, the absence of reported health problems among workers does not mean there is no risk among household members, neighbouring residents and school pupils. Waste workers are not representative of the general population, as they may be markedly different with regard to individual risk factors and exposure patterns.

## 4.2 What do we know about waste workers' exposure to bioaerosols?

MSW and C&IW materials present in the waste management sectors contain micro-organisms from biodegradable fraction of incoming waste, and from the growth of bacteria and fungi favoured by humidity and temperature (Miller and Clesceri, 2002; Pahren, 1987; Palmisano and Barlaz, 1996). Microorganism occurring in bioaerosol from MSW and C&IW are mainly fungi and bacteria, and are divided into four major groups: Gram-negative bacteria, Gram positive bacteria, actinomycetes and fungi (Dutkiewicz, 1997) (Table 2). The composition of bioaerosols depends on the nature of the feedstock and the processed used. For example, in the composting process, mesophilic bacteria and fungi in feedstock are succeeded by thermophilic actinomycetes and fungi species as the temperature rises above 45°C (Millner et al., 1994; Swan et al., 2003). Exposure to viruses in solid waste processing facilities is poorly documented. Human adenovirus and Torque teno virus (which has been proposed as an indicator of viral faecal contamination in the environment) have been detected in the air of waste disposal and recycling plants (Carducci et al., 2013). Most of human adenovirus positive air samples were able to grow in cell culture and were thus considered infective. In another study, human adenovirus genome could not be quantified in any of the air samples from biomethanization facilities (Traversi et al., 2018).

Levels of exposure to bioaerosols in the MSW/C&IW industry are highly variable between sectors and within individual sectors, and between workers and within workers (variation in personal exposure over time) (Spaan et al., 2008; Wouters et al., 2006) (Figure 1). Measurement uncertainty might be factor of variation; however, waste composition, extended residual waste collection cycles, enclosed vs. open air facility, types of process, season, tasks being performed and control measures in place are major potential determinant factors of bioaerosol concentration in the air (Gladding et al., 2003; Gladding and Gwyther, 2017; Persoons et al., 2010, Schlosser et al., 2009, 2015; Sykes et al., 2011; Wouters et al., 2006). Processes that are particularly associated with high levels of exposure to bioaerosols are all sources of mechanical agitation (waste unloading, stored waste handling, shredding, screening, windrow turning, material transfer operations, truck loading) or tasks involving manual agitation of waste (manual sorting of waste, cleaning and maintenance operations, blockage clearing) (Millner et al., 1994; Persoons et al., 2010; Sanchez-Monedero et al., 2005; Schlosser et al., 2009, 2015; Taha et al., 2006). In addition, vehicle traffic on dirty roadways contributes to bioaerosol emission (Epstein et al., 2001; Millner et al., 1994; Reinthaler et al. 2004). All these processes and activities generate dust, which contains biological agents. In a recent multivariable study, the level of inhalable dust has been shown to be the factor that most influenced within-site variability in endotoxin and culturable bacteria concentration in the air in sewage sludge composting facilities (Schlosser et al., 2018). These findings suggest that measurement of dust can efficiently assist decision making for prevention measures against endotoxin and bacteria in sludge composting plants. Further work could help to determine whether inhalable dust may be used as a marker of exposure to endotoxin and other airborne biological agents in other fields of waste management.

The highest levels of exposure to airborne bacteria and

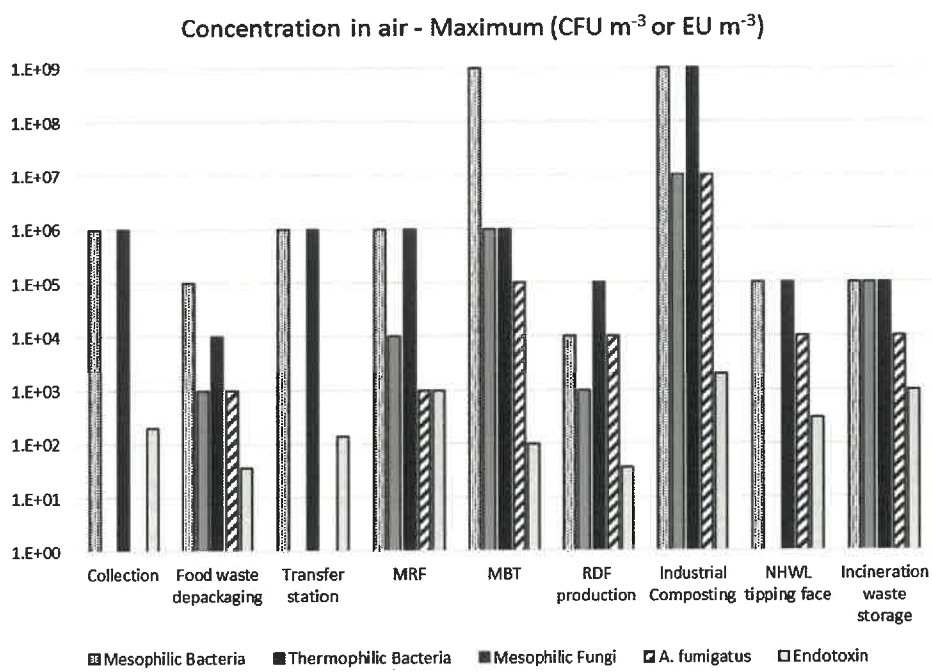


FIGURE 1: Maximum concentrations (orders of magnitude) of bioaerosols in waste management activities reported in the literature and from internal measurements.

fungi have been reported at composting sites and mechanical biological treatment (MBT) facilities (Pearson et al., 2015; Persoons et al., 2010; Schlosser et al., 2009; Searl, 2008; Sykes et al., 2011; Tolvanen and Hänninen, 2005; Wouters et al., 2006) , followed by material recovery facilities (MRFs) and during waste collection operation (Cerna et al., 2017; Gladding and Coggins, 1997; Lavoie et al., 2002; Madsen et al., 2016; Neumann et al., 2002; Nielsen et al., 1995; Schlosser et al., 2015; Würtz and Breum, 1997) (Figure 1). These exposure levels were 100 to 100,000 times higher than highest outdoor background levels. Levels of exposure to endotoxins reached several tenths or hundreds Endotoxin Units $m^{-3}$ in most sectors. These exposure levels were 10 to 1000 times higher than outdoor background levels.

### 4.3 What do we know about bioaerosol-related risk for waste workers' health?

In the MSW and C&IW field, associated microorganisms are mostly not pathogens, i.e. they are not infectious for healthy people. However, a few are real pathogens, such as *Legionella* species (Conza et al., 2013; Currie et al., 2014) or enteric pathogens in pet excrements and disposable diapers (Gerba et al., 1995, 2011). Some airborne microorganisms (mainly fungi, such as *Aspergillus fumigatus* and *Zygomycetes* species) may act as opportunists in fragile people, that are immunocompromised or present lung damages often associated with prescription of steroids (Cornillet et al., 2006; Latgé, 1999; Roden et al., 2005). These individual risk factors are significant determinants of the risk of severe fungal infection. However, it is worth stressing that huge levels of exposure to *A. fumigatus* spores have been associated with severe *Aspergillus* infection in immunocompetent persons (Arendrup et al., 2006; Jung et al., 2014; Russell et al., 2008; Zuk et al., 1989). These atypical cases are rare.

Case reports of respiratory disease in waste workers, with either immune-allergic, non-allergic inflammatory or infectious mechanism, provide evidence in support of an association with bioaerosol exposure in composting plants and in MRFs (reviewed by: ADEME, 2012; Schlosser et al., 2009, 2015; Swan et al., 2003). However, case reporting does not mean a confirmed excess of risk, and epidemiological investigations are necessary to estimate whether the risk is significantly increased in exposed workers and how large this increase may be. In the field of MSW/C&IW management, most epidemiological studies are of cross-sectional design (29 out of the 48 studies identified). Most of these studies agree in indicating an excess of upper airway (nose and throat), eye and respiratory tract irritation symptoms in exposed workers (e.g., Athanasiou et al., 2010; Bünger et al., 2000; Gladding et al., 2003; 2010; Hambach et al., 2012; Heldal and Eduard, 2004; Heldal et al., 2015; Hoffmeyer et al., 2014; Ray et al., 2005; Schantora et al., 2015). These findings support the hypothesis of an inflammatory effect of bioaerosol exposure in waste workers, which is confirmed by the association between inflammatory symptoms of the airway and increases in inflammation cells and markers in nasal lavage or induced sputum samples (Douwes et al., 2000; Heldal et al., 2003; Wouters, 1999). Furthermore, several studies showed a cross-shift decline in respiratory function in waste workers exposed to bioaerosols (Heldal et al., 2003, 2015; Sigsgaard et al., 1994). However, quantitative evidence of an excess risk of chronic respiratory disease following long-term exposure to bioaerosols in the waste industry is limited. In a 5-year follow-up study in composting workers, a slight decline of the Forced Vital Capacity in percent of predicted (FVC%) of the non-smoking compost workers was observed during the observation period compared to control subjects (Bünger et al., 2007). Conversely, in a prospective study over 5 years in garbage collectors in Switzerland, the respiratory function was not altered (Tschopp et al., 2011). The authors emphasize that the lack of effect of bioaerosols in this population probably resulted from low exposure levels due to good working conditions. In a 13-year follow-up study in Germany, van Kampen et al. (2016) demonstrated that working as a compost worker for more than 5 years significantly increased the risk of coughing by an average of 28% and that for cough with phlegm by an average of 32%, suggesting an increased risk of chronic bronchitis. However, compared to controls, no higher inci-

TABLE 2: Micro-organism genera or species most often isolated from bioaerosols in the MSW management field.

| Group of micro-organisms | Origin | Microorganism genera or species |
|---|---|---|
| Gram-negative bacteria | Fresh and stored plant materials | *Pantoea, Pseudomonas, Klebsiella, Aeromonas, Rahnella, Flavobacterium* |
| | Animal products | *Acinetobacter* |
| Gram-positive bacteria | Animal products and stored plant materials | Coryneform bacteria (*Arthrobacter, Corynebacterium, Brevibacterium, Microbacterium*), cocci (*Staphylococcus, Micrococcus, Streptococcus*), spore forming bacilli (*Bacillus*), *Listeria* |
| Actinomycetes | Stored plant materials | Thermophilic species (*Saccharopolyspora rectivirgula, Thermoactinomycetes vulgaris, Saccharomonospora viridis, Thermomonospora spp*) |
| | Soil and vegetable materials | Mesophilic species (*Streptomyces, Rhodococcus, Agromyces*) |
| Fungi | Saprophytic and pathogen plant fungi | *Cladosporium, Alternaria, Fusarium, Davidiella, Didymella, Curvularia, Drechslera* |
| | Decaying organic matter | *Penicillium, Aspergillus, Acremonium, Paecilomyces, Zygomycetes* species (*Rhizopus, Mucor, Absidia*) |
| | Low-moisture food waste | *Wallemia* |

*Sources : ADEME, 2012 ; Cerná et al., 2017; Degois et al. 2017 ; Dutkiewicz, 1997 ; Huang et al., 2002 ; Kalwasinska et al., 2014 ; Krajewski et al., 2002 ; Lis et al., 2004 ; Madsen et al., Mbareche et al., 2018 ; 2016 ; Nielsen et al., 1997 ; Pinto et al., 2015 ; Rahkonen et al., 1990 ; Viegas et al., 2014 ; Wéry, 2014.*

dence of loss of respiratory function during the follow-up was observed in compost workers. A distinct improvement in health protection measures during the 13 years of study (which reduced the level of exposure to bioaerosols) and a potential healthy worker effect are limitations of the study. To date, no other long-term prospective epidemiological studies have been published.

It is important to stress that several factors may suggest that prevalence of respiratory disorders in the waste industry is under-reported. Some of these factors are associated with potential selection bias due to the healthy worker effect, the employment patterns in the waste industry, the low specificity of most symptoms, and the time scale over which chronic respiratory disease usually develops.

Nevertheless, as supported by exposure data in the waste industry and epidemiological findings in other sectors such as agriculture, farming, and textile industry, strong qualitative evidence links occupational exposure to bioaerosols in the waste industry to adverse effects on health including long-term respiratory disease, notably in the fields of composting, MBT and MRF (Pearson et al., 2015; Schlosser et al., 2009, 2015; Searl, 2008). In a richly documented report delivered to DEFRA in UK in 2008, strong warnings were issued about the potential for bioaerosols to cause major respiratory health problems to waste workers in the future (Searl, 2008; Letsrecycle.com news, 2009).

These data emphasize the need for appropriate preventive measures against bioaerosols at the workplace in the MSW and C&IW industry, even if the epidemiological evidence is limited. As highlighted by the literature review, the levels of exposure to dust and bioaerosols vary within individual waste management sector, suggesting that there is potential to reduce exposures through good practice and prevention measures. These measures involve facility and process design, operational activities and, as a last resort, personal protection. The positive effect of vehicle technical factors has been demonstrated in the waste collection field (Breum et al., 1996; Neumann et al., 2002, 2005). At MRFs, several prevention measures have been recommended, such as adopting a site layout that uses separate areas for different processes, adopting a first in-first out order of treatment of the incoming waste, installing appropriate ventilation and dust capture systems in the processing areas, and installing adequate ventilation systems in the sorting rooms (Felten et al., 2001; INRS, 2011; Rapp et al., 2009; Schlosser et al., 2015; Stagg et al., 2013). Furthermore, in order to reduce microbial growth in the incoming waste, households are requested to dispose raw waste and biowaste into the container for separate collection and use containers with a cover in order to protect waste from the rain (INRS, 2011; Schlosser et al., 2015). In composting plants, several preventive measures have been recommended, such as dust control measures that include moisture control of the feedstock and composting, screening operation in a separate area from composting operations, sealing of the turning machinery with rubber mats, dust capture systems, adequate ventilation in buildings, regular cleaning and wetting of driveways, and protection of the vehicle cab with a pressurisation and high efficiency particulate air (HEPA) filtration system (Epstein, 1996, 2001; Millner et al., 1994; Reinthaler et al., 2004, Schlosser et al., 2012; Spencer and Alix, 2006; Sykes et al., 2007). Furthermore, frequent windrow turning has been shown to reduce *A. fumigatus* on the compost surface due to improved thermohygienisation, resulting in a reduction in cumulative health risk despite more frequent turnings (Fischer et al., 1998). In all waste management sectors, the use of respiratory protective equipment (at least a FFP2/N95 filtering half mask) is recommended for tasks during which workers are most exposed, such as cleaning and maintenance. All these recommendations are based on common sense, however, quantitative data on their efficiency is limited (Breum et al., 1996; Epstein et al., 2001; Neumann et al., 2002, 2005; Park et al., 2011a; Rapp et al., 2009; Schlosser et al., 2012, 2015). Moreover, there is no consensus on the advantages (control of dust emission)-disadvantages (e.g., microbial growth due to humidity, dirty equipment) balance of the use of water spray misters in the waste management field and quantitative data is lacking (Epstein et al., 1996, INRS, 2011, Millner et al., 1994; Schlosser et al., 2015; Spencer and Alix, 2006; Stagg et al., 2013). Further research, and notably intervention studies, is needed in order to better assess the efficiency of prevention measures against bioaerosols at the workplace.

### 4.4 What are the main gaps in knowledge about exposure to bioaerosols and related risks for waste workers' health?

As a general rule, most studies investigated microbial sum parameters (e.g., mesophilic fungi), endotoxins, and mainly *A. fumigatus* as a micro-organism species. There is a lack in hazard identification in all sectors, as mentioned above, and exposure to some biological agents such as mycotoxins and *Legionella* is poorly documented. Workers' exposure to bioaerosols is not or insufficiently documented in several fields: this is the case for activities in household waste recycling centres (HWRC), waste transfer stations, MBT facilities, non-hazardous waste landfill sites(NHWL), incineration plants, and for those associated with refuse-derived fuel (RDF) production or food waste depackaging. Importantly, there are major knowledge gaps in all sectors about identification of determinant factors of bioaerosol exposure at the workplace and the size effect of these determinants. Most exposure studies are descriptive works, or only bivariable statistical analysis was performed. Another gap is the limited data on personal sampling, as compared to results of stationary sampling. These personal measurement results are necessary for estimating actual worker's exposure. Moreover, most personal samplings were full-shift and resulted in time-weighted averaged exposure estimates. Information on task-specific exposure is needed in most sectors for appropriate health risk management. Finally, most of epidemiological studies in the waste industry are cross-sectional designed, generally involving small numbers of subjects, and they provide limited information for exposure-response relationship. Prospective cohort studies are lacking, for both short-term health adverse effects and long-term ones (Bünger et al., 2007; Tschopp et al., 2011; van Kampen et al., 2016).

### 4.5 What do we know about households' exposure to bioaerosols and associated health risk, and what are the major gaps?

Limited data suggests that separate storage of biowaste by households could increase exposure to bioaerosols and health effects in susceptible individuals (Herr et al., 2004; Naegele et al., 2016; Wouters et al. 2000). However, data on personal exposure associated with separate storage of biowaste by households is lacking. Potential impact that could be associated with changes in collection regime (switch for fortnightly collection of residual waste, extension of the sorting instruction of plastic packaging) would deserve attention; however, it is extremely poorly documented (Gladding and Gwyther, 2017; Schlosser et al., 2015). In particular, it should be stressed that home composting raises the question of potential health risk for susceptible individuals, mainly because of potential exposure to high concentrations of *A. fumigatus*. This hypothesis is supported by two severe infection case reports (Jung et al., 2014; Russel et al., 2008), and the occurrence of a deadly invasive pulmonary aspergillosis associated with gardening in the UK reported by Russel et al. (2008) has been given a lot of media coverage (National Health Service, 2008). However, households' personal exposure to *A. fumigatus* during compost agitation is not documented. To our knowledge, no epidemiological study is available.

In addition to home composting, urban community composting and composting programs at school are being developed. However, there is very little work on associated health issues (Pankhurst et al., 2011a), and to the best of our knowledge personal exposure is not documented. Strong evidence supports causality between exposure to moulds and the development and exacerbation of asthma in children (ANSES, 2016). Implementing an on-site composting program at school can expose vulnerable children to mould spores when turning and handling compost and further research is needed.

### 4.6 What do we know about nearby residents' exposure to bioaerosols from MSW/C&IW treatment facilities and associated health risk?

Regarding bioaerosols, potential health impact on nearby residents is primarily relevant for open-air composting facilities (Pankhurst et al., 2011b; Taha et al., 2006) and NHWL sites (Reinthaler et al., 1999; Schlosser et al., 2016). This issue can also be addressed for on-site waste handling in the open as it generates bioaerosol emission, and for enclosed composting facilities and MRFs as biofilter exhaust contains bioaerosols (Ibanga et al., 2018; Sanchez-Monedero et al., 2003).

*A. fumigatus* and thermophilic actinomycetes species have been identified as relevant indicators for monitoring of bioaerosols in the surrounding areas of large-scale outdoor composting facilities (Albrecht et al., 2008; Environment Agency, 2018; Le Goff et al., 2012). Data on bioaerosol monitoring in the surrounding environment of open-air composting facilities shows that concentrations generally drop to near-background levels within 300 m, although raised levels of exposure may occasionally arise at distance of up to 500 m from composting facilities (Pankhusrt et al., 2011b; Recer et al., 2001). Data on bioaerosol measurements in the surroundings of NHWL sites is limited. A recent study suggested that mesophilic moulds and *A. fumigatus* may be transported beyond 500 m from the property boundary at concentrations above those found locally upwind of the landfill site (Schlosser et al., 2016). In addition to distance from the facility, other mitigation factors linked to the facility design have been the focus of published studies. These measures contribute to reduce the off-site transport of bioaerosols and include site enclosure, negative pressure of the air above the composting process, installation of biofilters, bioscrubbers equipped with a droplet separator, or equipment with a dielelectric barrier discharge reactor (Ibanga et al., 2018; Millner et al., 1994; Morey et al., 2003; Park et al., 2011b; Sanchez-Monedero et al., 2003; Schlegelmilch et al., 2005). Removal efficiency was different depending on the equipment and the micro-organism, however, it did not reach 2 log removal (i.e., 99% reduction in concentration). Building berms and planting trees at appropriate locations on the site have been recommended as measures that can alter wind dispersion patterns and off-site transport of bioaerosols (Millner et al., 1994). The benefit of forest barriers on particulate dispersion has been demonstrated experimentally (Raynor et al., 1974) and highlighted regarding composting (Millner et al., 1994). Forest barrier both dilutes the particulate concentration in the plume and induces impaction and deposition of particles onto foliage.

Community-based epidemiological data is very limited. In a cross-sectional study in Germany, health questionnaires were collected from residents near a large-scale composting site and from unexposed controls (Herr et al, 2003). Residents exposed to bioaerosol pollution were shown to report irritative respiratory complaints independently of perceived odours. Recently, a national-scale study in England showed that it is unlikely that there is an increased risk of severe respiratory health outcome in healthy nearby residents of large-scale composting facilities (Douglas et al., 2016). However, such a conclusion cannot be drawn for minor respiratory health problems and for vulnerable groups.

### 4.7 What are the main gaps in knowledge about bioaerosol exposure of nearby residents of MSW/C&IW treatment facilities and related health impact?

There is a lack of information on dispersion of biological agents from waste facilities that may be of health concern for nearby residents. This is especially the case for opportunist *Zygomycetes* mould species and pathogenic species of *Legionella* from composting sites. Data on dispersion of endotoxin in the surrounding environment of waste processes is quite limited (Danneberg et al., 1997; Deacon et al., 2009b). Moreover, sampling strategies that have been performed (short sampling time that provides only a snapshot of concentrations at the time of sampling) do not provide information on long-term exposure, which is particularly important for community-based health studies (Pearson et al., 2015). Real-time bioaerosol sensors based on light-induced fluorescence techniques, such as SIBS (spectral intensity bioaerosol sensor), are being developed, however, SIBS equipment is still in its infancy and further research is needed (Nasir et al., 2018b). To the best of our knowledge, there is as yet no large-scale prospective study on adverse health effects on residents of bioaerosols emitted from composting facilities that has been conducted, and no data is available on the potential health impact of bioaerosols on nearby residents of NHWL sites and other plants with waste handling in the open. Importantly, there is no information on the potential impact of bioaerosols (and mainly *A. fumigatus*) from waste management plants on vulnerable groups such as immunocompromised, patients with lung damage and asthmatics.

Attempts have been made to use atmospheric dispersion models for predicting bioaerosol concentration in the surrounding environment of composting facilities. However, despite recent improvement, there is still limited confidence in these predictions due to uncertainties in source term definition and dispersal characteristics (Douglas et al., 2017).

The definition of a "safe" buffer distance from the site has been proposed as one of the responses to manage potential health risks for nearby residents of waste management sites. At that distance, bioaerosol concentrations should be reduced to the background levels. The principle is that if at this distance the outdoor background levels are not exceeded, there is no threat of excess health risk linked to the facility's presence (Schlosser, 2017). However, this statement raises two problems. First, outdoor background levels of bioaerosols need better characterization as they vary both temporally and spatially (Pearson et al., 2015; Schlosser et al., 2017). Secondly, the setting of a hypothetic "safety boundary" around waste management facilities is based on the non-rejection of null hypothesis in difference tests. That is to say, the setting of the safe buffer distance is linked to the power of the statistical test, and notably to the number of measurement results. A study designed with a large sampling plan may lead to conclude that at a given distance, bioaerosol concentrations are still significantly higher than background levels, even if this increase is low and does not suggest an unacceptable risk for health. On the other hand, the absence of a rejection of the null hypothesis could be linked to a lack of the power of the statistical test, especially because the sample size was too low. There is a need to explain what is meant by "bioaerosols concentration should be reduced to background levels" and to stress that the definition of a safety distance is based on a statistical approach (Schlosser et al., 2017).

### 4.8 What do we know about visitors' exposure to bioaerosol and associated risk for health?

To the best of our knowledge, this issue has not been addressed and neither published article nor grey literature is available.

## 5. CONCLUSIONS AND PROSPECTS

The synthesis of data from the literature on the health outcomes of bioaerosol exposure and exposure patterns in the MSW and C&IW industry highlights the following key points:

- Levels of exposure to fungi, bacteria and endotoxins at the workplace can be very high if appropriate prevention measures are not taken. The highest levels of exposure are a real concern for the respiratory health of workers in the long term;
- The literature review does not provide evidence of an excess risk to the health of nearby residents of open-air waste management facilities, such as composting plants or non-hazardous waste landfill sites. However, one of the key aspects when addressing this issue is the potential presence of at-risk individuals among nearby residents, such as patients with immune deficiency or severe lung damage. Fungal opportunistic pathogens, such as *Aspergillus fumigatus* or *Zygomycetes* species, are ubiquitous and not specific to organic waste decomposition and the waste management field. In the absence of exposure-response relationships, the relevant question is whether the level of exposure to airborne biological agents of interest is significantly increased by the presence of the facility, as compared to the outdoor background levels. Facility siting and design, operational changes and dispersion control measures can help to reduce bioaerosol emission and transport off-site;
- Waste handling may be of concern for the health of households if they have individual risk factors for adverse effects related to fungal exposure (e.g., immunodeficiency, asthma, severe lung damage, cystic fibrosis). This question is especially relevant for home composting. Urban community composting and composting at-school raises the same question.

However, this scoping review also highlighted numerous gaps in knowledge.

First, there are general needs for further research on the bioaerosol and health topic, regardless of the waste industry field. There are needs particularly for hazard identification and definition of relevant environmental indicators, for identification of health endpoints as the dependent variable in health studies, for standardized measurement methods, for better characterization of background bioaerosol levels, for investigation of impacts in vulnerable groups, and for more knowledge on interaction of bioaerosols with chemical pollutants and on potential protective effects of bioaerosols on atopic diseases and cancers.

Then, there are specific needs for further research in the field of the MSW/C&IW industry. Several knowledge gaps should be filled as a priority: identification of relevant indicators for exposure and health studies, reliable and detailed assessment of personal exposure, estimate of factors influencing the level of exposure at the workplace, estimate of the benefit of the control measures that have been implemented on sites to reduce exposure to bioaerosols, well-designed epidemiological studies that would especially estimate the health risk over long time scales, validation of dispersion models predicting concentration in the surrounding environment of open-air sites and especially composting plants. Several sectors have been poorly investigated, such as HWRC, food waste depackaging technology, MBT, RDF production, NHWL and incineration.

Most importantly, valid and standardized methods for quantitative exposure assessment are needed to better assess health risk and contribute to establish reliable health-based guidelines for bioaerosols. However, available exposure and health data emphasize the need for appropriate preventive measures against bioaerosols in MSW and C&IW handling and treatment activities, including workers training, medical examination prior to employment and regular surveillance. Furthermore, information should be given to susceptible individuals about potential biohazards associated with home composting and on-site composting at school.

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# EXHIBIT C

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June 20, 2023

**Via E-Mail**
County of Santa Clara Planning
Attention: Valerie Negrete (valerie.negrete@pln.sccgov.org)
70 West Hedding Street
San Jose, CA 95110

**Re: Dorado Leasing Comments on Z-Best Recirculated Draft EIR.**

Dear Ms. Negrete:

On behalf of Dorado Leasing ("Dorado"), the owner of the 570-acre Sargent Ranch, which is contiguous to the southern boundary of the Z-Best facility, we submit the following comments on the Recirculated Draft EIR ("RDEIR"). These comments are in addition to the comments our firm submitted on the original Draft EIR, which remain relevant to the Z-Best project and highlight the potential environmental impacts of the project on adjacent high-quality farmland. Rather than resubmitting our prior March 1, 2021, letter ("March 1 Letter") in its entirety, we incorporate by reference the various points and environmental issues that Dorado raised in this letter, which remain relevant. Accordingly, we request and CEQA demands that the Final EIR include written responses to Dorado's comment letter on the original Draft EIR, dated March 1, 2021, and these additional comments on the RDEIR.

## A. The Important Purpose of CEQA and an EIR

As we explained in our March 1 Letter, CEQA is a comprehensive scheme designed to provide long-term protection to the environment. In enacting CEQA, the Legislature declared its intention that all public agencies responsible for regulating activities affecting the environment give prime consideration to preventing environmental damage when carrying out their duties. CEQA is to be interpreted "to afford the fullest possible protection to the environment within the reasonable scope of the statutory language."[1] Both the mandate and the procedure of CEQA are carefully crafted and well ingrained into the law of this state.[2]

The process compelled by CEQA "is a meticulous process designed to ensure that the environment is protected . . . ."[3] In fact, "[t]he integrity of the [CEQA] process is dependent on the adequacy of the EIR."[4] Thus, the EIR, with all its specificity and complexity, is the mechanism prescribed by CEQA to force informed decision making and to expose the decision making process to public scrutiny.[5] As the Supreme Court has established, the EIR is "the heart of CEQA."[6]

> An EIR is an "environmental 'alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return." The EIR is also intended "to demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action." Because the EIR must be certified or rejected by public officials, it is a document of accountability. If CEQA is scrupulously followed, the public will know the basis on which its responsible officials either approve or reject environmentally significant action, and the public, being duly informed, can respond accordingly to action with which it disagrees. The EIR process protects not only the environment but also informs self-government.[7]

As such, the purpose of any EIR is to provide public agencies and the public with "detailed information about the effect which a project is likely to have on the environment to list ways in which the significant effects of such project might be minimized; and to indicate alternatives to such a project."

## B. The RDEIR Continues to be Legally Inadequate

An agency abuses its discretion by failing to proceed in the manner required by law if its action or decision does not substantially comply with the requirements of CEQA.[8]Under this test, omission of information that CEQA mandates be included in an environmental analysis constitutes a failure to proceed in the manner required by law.[9]

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[1] Mountain Lion Foundation v. Fish and Game Com. (1997) 16 Cal.4th 105, 112.

[2] County of Amador v. El Dorado County Water Agency (1999) 76 Cal.App.4th 931, 943

[3] Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892

[4] Save Our Peninsula Committee v. Monterey County Board of Supervisors (2001) 87 Cal.App.4th 99, 118-119

[5] No Oil, Inc. v. City of Los Angeles (1974) 13 Cal.3d 68, 86.

[6] Laurel Heights Improvement Ass'n v. Regents of the University of California (Laurel Heights I) (1988) 47 Cal.3d 376, 392.

[7] Ibid

[8] Pub Res C §§21168, 21168.5; Communities for a Better Env't v. South Coast Air Quality Mgmt. Dist. (2010) 48 C4th 310

[9] Banning Ranch Conservancy v. City of Newport Beach (2017) 2 C5th 918, 935

The Court of Appeal in *Galante Vineyards v. Monterey Peninsula Water Mgmt. Dist.* (1997) 60 CA4th 1109, 1117 held:

> "[T]he ultimate decision of whether to approve a project, be that decision right or wrong, is a nullity if based upon an EIR that does not provide the decision-makers, and the public, with the information about the project that is required by CEQA. The error is prejudicial if the failure to include relevant information precludes informed decision-making and informed public participation, thereby thwarting the statutory goals of the EIR process.

With these general legal principles in mind, Dorado submits the following specific comments on the RDEIR.

**1. The RDEIR's Analysis of Agricultural Impacts Continues to Be Legally Deficient.**

Dorado re-engaged Dr. Trevor Suslow to review the additional technical information that was added to the RDEIR relating to the project's potential impact on farmland. As you know, Dr. Suslow previously submitted comments on the original Draft EIR, which explained and documented these potential impacts, and those comments are attached as **Exhibit A** and incorporated herein by refence. As noted in Dr. Suslow's original analysis, the Z-Best expansion has "the potential to increase physical, chemical, and microbial contamination of edible horticultural commodities in proximal production zones." Dr. Suslow's conclusion is based on numerous studies and technical reports that are referenced in Dr. Suslow's analysis that found that composting facilities generate airborne microorganisms that could impact surrounding areas, including in this case, the Ranch and neighboring farm fields.

Dr. Suslow reviewed the RDEIR's analysis of the project's potential agricultural impacts and the supporting technical data and analysis to determine whether his prior comments and concerns were adequately addressed. As documented in Dr. Suslow's comments on the RDEIR, which are attached as **Exhibit B** and incorporated by reference, the RDEIR continues to overlook and omit any analysis of certain discrete impacts of the composting operation that could impact adjacent farmland.

Until this additional analysis is undertaken, it is impossible to determine what specific mitigation or minimization measures could be incorporated into the project design or otherwise required to address these impacts. Nonetheless, Dr. Suslow identifies and recommends that the project implement certain mitigation measures to address the potentially significant increase in bird vectors and bioaerosol impacts. Dorado also identified and described several other mitigation measures in its March 2001 letter that have been ignored or rejected.

As we noted in our March 2021 letter, a fundamental purpose of an EIR is to identify ways in which a proposed project's significant environmental impacts can be mitigated or avoided. Pub Res C §§21002.1(a), 21061. To implement this goal, an EIR must describe feasible mitigation measures that can minimize the project's significant environmental effects. 14 Cal Code Regs §§15121(a), 15126.4(a). As one court observed, "A gloomy forecast of environmental degradation is of little or no value without pragmatic, concrete means to minimize the impacts and restore ecological equilibrium."[10] Accordingly, Dorado again requests that the County require Z-Best to implement mitigation measures that would further reduce or minimize the potential impacts of the logical increase in bird vectors and bioaerosol transmission. Even assuming the RDEIR's authors disagree with Dr. Suslow's conclusions, in an abundance of caution, the County should require Z-Best to implement such measures.

**2. The RDEIR continues to fail to correlate the project's adverse air quality impacts to resultant adverse health effects.**

Failing to correlate the Project's adverse air quality impacts to increased incidents of health ailments constitutes a prejudicial abuse of discretion. As the Court of Appeal in *Bakersfield Citizens for Local Control v. City of Bakersfield* ("Bakersfield") (2004) 124 Cal.App.4th 1184, 1220 explained: health problems caused by a project must be addressed in an environmental impact report, including incidents health effects caused by increases in air pollution. Specifically, CEQA requires an environmental impact report to discuss "health and safety problems caused by the physical changes" by the proposal. §15126.2(a). To meet CEQA's disclosure requirement, an environmental impact report must "correlate the identified adverse air quality impacts to resultant adverse health effects." *Bakersfield* at 1219 (italics added). "Correlate" is defined as: "to bring (a thing) into mutual relation (with another thing); **calculate** or show the reciprocal relation between; specif., to bring (one or two related or interdependent **quantities**, sets of statistics, etc.) into contrast (with the other)." Webster's New World Dictionary 319 (2d College ed. 1985) (italics in original; bold added).

Thus, the court in Bakersfield used "correlate" to mean an environmental impact report must disclose the proportional relationship between increased tonnages in air pollution and increased incidents of health ailments by calculating and quantifying the relationship. The DEIR fails to comply with this necessary informational disclosure requirement. Indeed, *Bakersfield* teaches us a truncated analysis involving a bare statement that increased air pollution tonnages means more people get ill fails to satisfy CEQA's information disclosure requirement.

In *Bakersfield*, the two EIRs at issue calculated the approximate increased tonnage of air pollution and then baldly concluded that more air pollution means more health and respiratory ailments.' *Id.* at 1220. According to *Bakersfield*, this embryonic level of detail is insufficient and

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[10] Environmental Council of Sacramento v City of Sacramento (2006) 142 CA4th 1018, 1039

resulted in the Appellate Court rejecting the air quality analyses for failing to quantify or correlate the relationship between increased health ailments and increased air pollution. *Id.* at 1220-1221. Accordingly, it is not enough for an environmental impact report to simplistically conclude air pollution will increase and then supply a laundry list of pollutants and related health effects. Rather, CEQA is satisfied only when an EIR discloses, and quantities anticipated increases of health ailment events resulting from a project's increases in air pollution tonnages.

The RDEIR continues to suffer the same affliction as the DEIR and the *Bakersfield* EIRs and likewise fails to satisfy CEQA. The RDEIR notes in Table 7-1 that certain pollutants can contribute to certain health ailments but never correlate the actual increases of air pollutants to the number and type of air pollution related conditions and diseases. For example, Table 7-7 of the DEIR states that the project would generate 123.19 per day of NOx emissions due to the additional truck trips, which exceeds the applicable significance threshold of 54 pounds per day. However, the DEIR fails to correlate this increase in NOx emissions to any potential increased health risk to workers at the Z-Best facility, farmworkers in the adjacent farm fields, or residents in the surrounding area. The RDEIR appears to blame the existing modeling for its inability to translate project generated pollutant emissions into specific health effects on people. However, it's unclear why the Health Risk Assessment that was prepared for Toxic Air Contaminants could not assess the potential impact of other types of pollutant emissions on people or surrounding and uses. This error is compounded by the RDEIR's ongoing failure to adequately address the impact of bioaerosols on human health and safety as Dr. Suslow explains in **Exhibit B**, which can cause the same types of health effects as NOx.

The RDEIR's air quality analysis continues to ignore glaring omissions and falls short of fulfilling the statutory disclosure requirement. This truncated analysis violates CEQA by omitting a correlation between adverse air quality impacts and resultant adverse health effects and does not disclose the severity of the Project's environmental impacts. *Bakersfield* holds that brief references to, or the listing of, potential respiratory illnesses do not satisfy CEQA. It is only when correct and feasible scientific analysis is conducted and the EIR calculates the significance of the impact in terms of increased events of disease and suffering, are the public and decision makers notified of a project's true impacts. This correlated information is scientifically possible and legally required, and the omission amounts to a prejudicial failure to proceed in the manner required by law.

### 3. The RDEIR Fails to Analyze a Reasonable Range of Project Alternative and Its Rejection of the Fully Enclosed Alternative, Which Would Significantly Minimize or Avoid Agricultural Impacts, Is Not Supported by Substantial Evidence.

CEQA requires that an EIR analyze a "reasonable range" of project alternatives that would minimize or avoid the significant environmental impacts of a project. The California Supreme

Court has described the discussion of mitigation and alternatives as "the core of an EIR."[11] An EIR must also discuss alternatives even if all the project's significant environmental impacts will be avoided or reduced by mitigation measures.[12]

In our March 2021 letter, Dorado criticized the Draft EIR's abbreviated alternatives analysis, which only studied two potential alternatives, a "Reduced Project Scale" alternative and a "No Driveway Relocation" alternative." The other alternative, the No Project Alternative, clearly does not meet any of the key project objectives of the project and is not a true project alternative. We explained that CEQA demands more than analyzing just two alternatives, particularly for a large-scale composting operation that will result in significant and unavoidable air quality impacts and the types of potentially significant impacts on agricultural resources and human health and safety discussed above.

Dorado recommended that the Draft EIR analyze an entirely enclosed or indoor composting facility like the one that was described and discussed in the 2015 Cal Poly Study that was referenced in our letter. This type of system provides the best pathogen, odor, and vector control, and has the smallest footprint compared to other composting technologies (ECS, 2015). The unique aeration design helps capture and dramatically decreases greenhouse gas and odor emissions. The special aeration system provides a controlled airflow to maintain uniform biomass temperatures. The aeration system shown in the figure below is designed to conserve energy with adaptive control strategies.

In *Center for Biological Diversity v. County of San Bernardino* (2010) 185 CalApp.4th 866, the Court of Appeal found that an EIR for an outdoor composting facility was legally inadequate because it did not consider an enclosed facility alternative that would significantly reduce air quality impacts. Like the RDEIR, the EIR in the *Center for Biological Resources* case only studied three (3) alternatives, the statutorily mandated no-project alternative, a reduced capacity alternative, and an off-site alternative. The Court determined that this range of studied alternatives was inadequate where there was evidence in the record that demonstrated that an enclosed alternative would significantly reduce air quality impacts and was potentially economically feasible.

Rather than analyzing a fully enclosed composting facility, the RDEIR (Section 18.3.2) dismisses this alternative for several reasons. First, the RDEIR suggests that the alternative is not economically infeasible because it would substantially increase capital expenditures and increase the overall cost of the project by 2.5 to 3 times. However, the only cited reference for this statement is a 2022 personal communication with someone named O'Neill, who is presumably a representative of the project applicant. There is no written comparative analysis of the cost of the

[11] *Citizens of Goleta Valley v Board of Supervisors* (1990) 52 C3d 553, 564.
[12] *Laurel Heights Improvement Ass'n v Regents of Univ. of Cal.* (1988) 47 C3d 376, 403

open bunker composting versus the enclosed facility option and other context for this conclusion. As the Court of Appeal has explained:

> "The fact that an alternative may be more expensive or less profitable is not sufficient to show that the alternative is financially infeasible. What is required is evidence that the additional costs or lost profitability are sufficiently severe as to render it impractical to proceed with the project." (citation omitted) While an EIR need not analyze "every imaginable alternative or mitigation measure," "it should evince good faith and a reasoned analysis."[13]

Second, the RDEIR dismisses the alternative based on conclusory statements that construction of the enclosed systems would increase construction-related haul trips and air pollutant emissions, aesthetic impacts, energy use, and GHG emissions and would not decrease the project's significant and unavoidable environmental impacts relating to NOx emissions, Clean Air Plan Consistency, or VMT. However, the RDEIR provides no specific information relating to the construction (e.g., number and types of construction equipment) or operational requirements of a fully enclosed project to provide any meaningful comparison with the project to substantiate these statements. Unless such a comparative analysis is provided, neither the County decision-makers, nor the public, have sufficient information to assess the veracity of this conclusion.

We request that the County require more detailed review and analysis of a fully enclosed project alternative, which could demonstrate that indeed such an alternative is economically feasible and that the project would remain profitable even assuming the additional capital expenditures.

We appreciate the opportunity to comment on the DEIR for the Z-Best facility expansion and look forward to reviewing the County's responses to the DEIR that address these comments, concerns, and revisions.

Sincerely.

JRG Attorneys at Law

Jason S. Retterer

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[13] *Uphold Our Heritage v. Town of Woodside* (2007) 147 Cal.App.4th 587, 599.

# EXHIBIT A

Suslow 26 February 2021

**Considerations for Physical, Chemical, and Microbial Food Safety and Buyer Acceptance Impacts Associated with Proximity to Expanded Operations Receiving Green Waste, Commercial Food Waste, and Post-consumer Food Waste**

There are diverse conditions and potentially interrelated factors associated with siting or significant expansion of a waste handling site, which includes wastewater treatment facilities, landfill, composting operations, and hauler-spreader holding and transfer yards. These adjacent land features are known to have the potential to increase physical, chemical, and microbial contamination of edible horticultural commodities in proximal production zones. These sites, depending on variable features and distances, may directly or indirectly result in negative impacts to surrounding agricultural production areas and should be carefully evaluated. The absence of realization of an anticipated impact is wholly dependent upon the quality of the facility and engineering design as well as operational controls of the site as a baseline. To prevent an identified expansion project from realization of a foreseeable agricultural nuisance, the design and effectiveness of innovated proactive measures to prevent, minimize, and contain the potential off-site movement or aerosolized dispersal of hazards and sources of microbial contamination associated with these operations, especially large mixed and variable waste handling facilities, are needed. Planning for the reduction/minimization of the windborne dispersal and deposition of physical and hazardous chemical or pathogen containing aggregates or particulate fines are critical for a comprehensive EIR for these projects. Equally, reduction or mitigation of enhanced attractant factors to vermin and vectors under the most challenging conditions associated with food waste and other post-consumer waste streams must be anticipated. This precautionary impact assessment is well supported and reasonably extrapolated from an abundance of available science-based authoritative and peer-reviewed published knowledge and practice.

The intent of this brief document, at this time, is not to provide a comprehensive literature review, but to support and encourage immediate efforts to develop an objective overview of potential food safety impacts associated with proximity to waste handling sites, with specific focus on large composting operations. The potential for demonstrable risk of contamination of edible horticultural crops as well as the issues of perceived hazard and negative economic affects or competitive market disadvantage are briefly addressed. The current situation in the production and marketing of fresh consumed, raw, or value-added agricultural products, especially leafy greens and herbaceous culinary herbs, necessitates that any broad analysis of the potential for local and adjacent land-use features to influence the real or perceived physical, chemical, and microbial hazards be carefully considered. Domestic and international wholesale, retail, foodservice, and mass merchant buyers, as well as public health regulators, are demanding increasingly complex and comprehensive documented food safety programs. To assess the potential impact of a composting operation expansion on local agricultural and ag-enterprise operations, it is important to evaluate the potential for unintended harm beyond the loss of farmlands, unique farmland, or forested and timberland resources.

Previous related experience by T. Suslow, Ph.D. involved the assessment of potentially contributing factors to a regional *E. coli* O157:H7 outbreak associated with Romaine lettuce produced adjacent to a compost facility which began accepting increased green waste and institutional and urban food scraps and food waste (Cheung, 2015). The implicated compost operation was well managed and had been in operation for many years as an immediate neighboring land use feature to mixed cool season vegetables. Though categorical proof was not obtained, the changed feedstock components to greater volumes of food waste which were associated with increased vector attractant potential, primarily birds, was a notable factor.

**Assessment of the Risk Associated with Composting Sites**

A preliminary digital literature search of scientific journals and related publications and a similar broad search of Internet-accessible public documents revealed extensive information on the risk potential of various hazards, including microbial contamination transfer, from compost operations to off-site lands, communities, and crop production. The uniform conclusion contained within multiple studies, issue briefs, and policy reviews, across global locations, are consistent in supporting the need for applying science-based containment measures, including dust abatement windbreaks, within effective operational design and governance. It is recognized that long established standards, regulated permit requirements, and precautionary measures are needed to protect both operators, the local environment, and agricultural enterprises.

A leading source of presumptive risk of transferable contamination from composting facilities, especially those receiving commercial food waste and post-consumer food waste is the direct and indirect vectoring of microbial pathogens by rodents, insects, and birds, particularly crows, pigeons, and gulls.

In summary, all studies and reports related to or scientifically addressing downstream public health concerns about infectious agents transmitted from waste handling siting decisions and facilities are consistent in defining a presumption of risk in the absence of a properly designed and operated containments and vector control programs.

**Negative Economic Impacts**

Scientific literature and science-based risk assessments cannot be adequately employed to dismiss legitimate concerns for potential economic impact to agricultural enterprises within proximity to a perceptual source of food safety hazards. It is not the purpose of this document to argue either side of this sensitive issue. However, it seems prudent that any compost facility expansion EIR identify and address the current realities of fresh produce processing and marketing, especially with regards to particulate deposition residues and microbial food safety issues. The needs inherent in retaining and improving consumer confidence in the safety of fresh produce, consumed without a terminal kill step, to mitigate the potential for contamination by fecal indicators, which are part of many buyer acceptance requirements, and pathogens mandates that adjacent land use risk factors be seriously and thoroughly evaluated. Once site-specific potential risks have been identified, risk assessment may be engaged as a productive action to determine the science-basis for the level of anticipated risk exposure. As the scientific basis for risk assessment is not yet available for every situation, risk perception tends to be sufficient cause for certain buyer-imposed food safety metrics, which has resulted in the loss of prime agricultural land for high value food crop production. Against this backdrop and the unknown potential for competitors to, unfairly, use proximity to expanded waste handling activities as a negative marketing influence on buyers, it is prudent and responsible to commission a more inclusive review to address concerns for significant negative impacts of site expansion and inadequacies of current prevention and containment measures on immediately surrounding agricultural viability.

**Prepared by Trevor V. Suslow, Ph.D.**
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**Literature accessed and reviewed 2/22-25/21**

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# EXHIBIT B

Jason S. Retterer
JRG Attorneys at Law
318 Cayuga St.
Salinas, CA 93908

**Re: Comments on Z-Best Recirculated Draft EIR** **20 June 2023**

Dear Jason:

You asked me to review and comment on the Recirculated Draft Environmental Impact Report ("RDEIR") that the County of Santa Clara has prepared for the Z-Best Composting Facility Modifications. I also reviewed the "Memorandum: Z-Best Composting Facility – Evaluation of potential bioaersol emissions from proposed operations compared to existing operations," dated December 9, 2022 and prepared by AECOM. Attached is a short biography relating to my expertise in evaluating the potential risks and hazards of adjacent land uses on farmland.

I had previously commented on the original Draft EIR and identified a number of potential hazards and impacts of Z-Best's proposed modifications to its current composting processes on adjacent agricultural land. Those comments are incorporated by reference herein.

While the County has endeavored to address these potential impacts in the RDEIR, the RDEIR still does not adequately address the project's potential impacts on surrounding farmland. My specific comments are as follows.

- The RDEIR still does not adequately address the likelihood of increased vector attraction, predominantly birds and specifically American Crow readily observed at and around the operations from viewpoints on the adjacent farmland. Due to increased volume of incoming materials and open-bunker composting, the bird activity observed by personal observation and readily observed on the Z-Best Virtual Tour of the Gilroy facility, notwithstanding a windrow format versus bunkers, the risk potential for bird movement between the diverse operational units from receiving to finished compost facility have not been sufficiently addressed. The increased risk potential is fundamentally a two-fold leading issue. Simply stated, an expanded volume of raw materials and in-process compost in combination with known and routine crop development and crop management inputs on the adjacent farm represents a greater risk of avian species of primary concern, such as cowbirds, gulls, and crows from the facility into farm (6).

  To mitigate the risk of increased bird vectors, I recommend that an assessment of correspondingly more substantial non-lethal bird harassment and diversion mitigation offset practices be undertaken by the County and addressed in the RDEIR. Considerations should include but not be limited to species-specific sonic wave technologies (e.g. Sonic Nets ) and strategic placement of modern laser-sentinel devices (e.g. Bird Control Group ) . Specialized laser devices have been effectively used in acute and chronic bird diversion tactics at airports and vineyards, for example.

- Irrespective of the development of the bulk bunkered pile with a 6-inch finished product layer, in-process pile basal "tail edges" will invariably be slow to (or potentially never) reach the 55 degrees Celsius inactivation temperature asserted as an enhanced process safety factor. 55 degrees Celsius is the minimal bulk temperature of this operational window for pathogen lethality, dependent on materials and environmental conditions. This basement level standard has been demonstrated to be operationally non-uniform in surveys conducted by the University of Florida in conjunction with Food and Drug Administration programs regarding the safety of soil amendments (1, 2).While these studies included aerated compost masses which incorporated animal manures in the feedstock, the studies do not obviate the prudent step of considering this potential source of contaminants. The RDEIR does not address this "tail edge" issue.

- Bacterial pathogens of concern have the potential to develop heat and other stress tolerance traits on the incoming materials prior to receiving and/or during pre-process hold times. The target "come-up" threshold of 55 degrees Celsius (131 Fahrenheit), or greater but less than 70 degrees Celsius (158 degrees Fahrenheit) in 48 hours is an enhancement to the current process. Consideration of pre-adaptive tolerance, rarely included as a composting process performance factor in most experimental risk assessment and validation studies, was not considered in this narrative. Pre-adaptive tolerance is a common terminology to describe the genetically determined response bacteria, as used here, can undergo following a non-lethal stress exposure which then adapts the surviving cells to greater tolerance for the same or more severe stress exposure, such as elevated temperature. This stress-tolerance induction response simultaneously conveys resistance to multiple stresses common to composting, as reported in several peer-reviewed reports (3, 5, 7, 8). A further enhancement to accelerate "come-up" time which has been studied uses heated forced aeration consistently or during periods of cool to cold seasonal weather conditions. This would better ensure an adequate and more uniform lethal temperature distribution.

- The potential for pooling water at these base layers with process water addition, as occurs with the current system, would also occur in open bunker arrays during seasonal rain. Such pooled moisture has the potential to provide an environment for amplification of bacterial pathogens. The RDEIR should consider the impact on pooled moisture to amplify bacterial pathogens and possible steps or measures that could be taken to eliminate any pooling. Elevated transference potential, due to greater populations and distribution of pathogens across the facility footprint, mediated by any of the recognized physical or biological vectors has the potential to result in a partial or complete loss of the adjacent crop.

- The assessment of fugitive dust and aerosolized particulates did not adequately address the full breadth of interacting factors which could result in sporadic but consequential release from diverse boundary layers within operational units as well as during handling and transfers. As just one example, the design and elevation of the proposed open-channel conveyance relative to wind speed and wind run, especially under extreme conditions, was not included in the RDEIR's analysis. Studies cited to establish likely distances of fugitive dust and bioaerosols do not adequately address the scale of the proposed expansion and predictable adverse conditions to containment of the materials likely to be experienced in a year-round operation.

To mitigate this risk, I recommend that the RDEIR require this project to implement risk reduction practices such as stopping certain high aerosol-generating operations during high wind conditions or seasonal periods when wind direction is counter to prevailing vectors.

- A robust dust dispersal survey across an extended timeframe coinciding with seasonal farming is a positive step and will benefit from an additional detailed design development effort. A comprehensive longitudinal study and granular documentation of site-specific "fugitive dust" dispersal characteristics is necessary to best develop data-informed decisions regarding the mitigations. Such a study would best inform whether and which design changes are warranted, and where, to optimize the mitigation of bioaerosolization and off-site movement of particulates. An example of impacts of off-site movement and impacts is provided in Frączek et. al. 2022 (4.)

Based on my review of the Recirculated Draft EIR and associated documents that you have provided, it is my opinion that additional analysis and assessments of additional or alternative preventive measures and mitigation practices or technologies to reduce and manage the inherent risk potential associated with any composting facility should be undertaken prior to any decision on expansion is made.

Trevor V. Suslow

Trevor Suslow, Ph.D.

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**Trevor Suslow, Ph.D. is transitioning from full time (Oct 1, 2018 to Dec 31, 2020) as VP of Produce Safety at the Produce Marketing Association and Emeritus Extension Research Specialist at the University of California, Davis, Department of Plant Sciences.** Trevor has formed Trevor Suslow Consulting, LLC and retains his Emeritus position. His former full-time position at UCD included statewide responsibilities in quality and safety of perishable horticultural commodities. Dr. Suslow's program spanned preharvest to postharvest research and outreach education on diverse whole fresh and minimally processed horticultural foods from annual row crops to tree and vine commodities. His past and current applied research combines lab and on-farm research on *E. coli, Salmonella, and Listeria* in conventional and organic production systems, for the purpose of identifying opportunities for optimal microbial reductions and delivery of safe food to the consumer. He served on the Center for Produce Safety Board of Directors from 2008 to 2014 and the CPS Technical Committee since its creation in 2008 to the present. Dr. Suslow received his BSc. in Agricultural Sciences with honors and his Ph.D. in Plant Pathology from the University of California, Berkeley. Before joining UC Davis, he was a Research Scientist and Director of Product Research for DNA Plant Technologies, Inc. for 15 years. Trevor received the United Fresh Produce Association Technical Award in 2012 and was named to and to The Packer 25 *Profiles in Leadership* award in 2014. He was named to Food Safety News list of *The Best of Food Safety in Education* and honored with the National Steinbeck Center's Valley of the World Award in Education in 2017. He is a Lead Instructor for the FDA FSMA Produce Safety Alliance, Food Safety Preventive Controls Alliance, and the Sprout Safety Alliance. Trevor served as Faculty Director for the UC Postharvest Technology Center from 2016 to October 2018. Dr. Suslow was recently recognized by the International Association of Food Protection (IAFP) with the 2018 Elmer Marth Educator Award and in 2019 the IAFP President's Award for extension and outreach to the food safety community.

**Academic Preparation**

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|---|---|---|---|
| **University of California, Berkeley** | **B.Sc. (High Honors)** | **1975** | **Agricultural Sciences** |
| **University of California, Berkeley** | **M.Sc.** | **1977** | **Plant Pathology** |
| **University of California, Berkeley** | **Ph.D.** | **1980** | **Plant Pathology** |

**Employment History**

| | | |
|---|---|---|
| **1980- 1981** | **Postdoctoral Research** | **Hilleshög, Inc. Sweden**<br>**MAFF at Leeds, Eng.** |
| **1981 -1995** | **DNA Plant Technology, Inc.**<br>**(1990-1995)** | **Staff Sci.-Microbial R&D**<br>**Dir. of Product Research** |
| **Feb-Oct 1995** | **Visiting Scientist** | **UC Berkeley, Plant Mol.Bio.** |
| **Nov. 1995 – Oct 2018** | **University of CA at Davis** | **Extension Research Specialist** |
| **Oct 2018 – present** | **University of CA at Davis** | **Emeritus Specialist Faculty** |
| **Oct 15, 2018 – Dec 31 20** | **Produce Marketing Assoc.** | **VP Produce Safety based in Davis, CA** |
| **Jan 1, 2021 -** | **Trevor Suslow Consulting LLC** | |

**Recent Activities**

Over 400 national and international technical, extension education, training, and outreach presentations on microbial food safety of fresh produce in the past five years in diverse forums to diverse industry, regulatory, academic, and technology workshop audiences.

Served on multiple panels and USDA SCRI Advisory Boards, including USDA NIFA *Food Safety Innovations and Preventive Controls during Fresh-cut Produce Washing and Retail Display*; Fresh Express Blue Ribbon Panel on Cyclospora (2019); GFSI Leafy Greens Technical Working Group; USDA SCRI Cornell and Multistate Produce Safety Grant Advisory Council; CPS PI on *STEC: Romaine Seasonality Project* and Industry Romaine Rally Technical Advisory Panel

Recent webinars to global audiences on preharvest and postharvest water quality management issues and systems, coronavirus impacts and response in produce industry, WGS, Listeria and Salmonella EMPs, microbial community analysis in produce safety, and diverse topics in FSMA and FDA New Era awareness.

**Recent Peer-Reviewed Publications –past 5 years**

Gil, M. Selma, M., **Suslow, T.** , Jacxsens, L. , Uyttendaele, M., and Allende, A. 2015. Pre- and Post-harvest Preventive Measures and Intervention Strategies to Control Microbial Food Safety Hazards of Fresh Leafy Vegetables. Critical Reviews in Food Science and Nutrition. 55:453–468

Bech, T.B. Sbodio, A., Jacobsen, C., and **T. Suslow**. 2015. Adhesion of *Escherichia coli* and *Salmonella enterica* to soil in runoff as influenced by polyacrylamide. Journal of Environmental Quality. 43:2002–2008

Lopez-Velasco, Gabriela, Alejandro Tomas-Callejas, Adrian O. Sbodio, Xuan Pham, Polly Wei, Dawit Diribsa, and **Trevor V. Suslow**. 2015. Factors affecting cell population density during enrichment and subsequent molecular detection of *Salmonella enterica* and *Escherichia coli* O157:H7 on lettuce contaminated during field production, *Food Control*, Volume 54, August 2015, Pages 165–175

Berry, E. D., Wells, J. E., Bono, J. L., Woodbury, B. L., Kalchayan and, N., Norman, K. N., **Suslow, T. V.**, Lopez-Velasco, G., & Millner, P. D. 2015. Effect of proximity to a cattle feedlot on *Escherichia coli* O157:H7 contamination of leafy greens and evaluation of the potential for airborne transmission. Appl Environ Microbiol, 81, 1101-1110.

Burch, A., Do, P., Sbodio, A., **Suslow,** T. and Steven Lindow. 2016. High culturability of epiphytic bacteria and frequency of biosurfactant producers on leaves. AEM 82: 5997-6009
Allende, A, Truchado, P., **Suslow T.**, and M.I. Gil. 2018. Impact of chlorine dioxide sanitization of irrigation water on the epiphytic bacterial community of baby spinach and underlying soil. PLoS ONE 13(7): e0199291.

Gutiérrez, Gundersen., Sbodio, Koike, and **T. V. Suslow**. EPub 2018. Quantitative and qualitative recovery of on-farm applied attenuated *E. coli* O157:H7 and qualitative detection of naturally-contaminating *E. coli* O157:H7from spinach under field conditions. Food Microbiol. 2019 .Feb;77:173-184.

Shen X, Sheng L, Gao H, Hanrahan I, **Suslow TV** and Zhu M-J (2019) Enhanced Efficacy of Peroxyacetic Acid Against Listeria monocytogenes on Fresh Apples at Elevated Temperature. Front. Microbiol. 10:1196. doi: 10.3389/fmicb.2019.01196

Berry, E. D., J. E. Wells, L. M. Durso, K. M. Friesen, J. L. Bono, and **T. V. Suslow**. Occurrence of *Escherichia coli* O157:H7 in Pest Flies Captured in Leafy Greens Plots Grown Near a Beef Cattle Feedlot. Journal of Food Protection: August 2019, Vol. 82, No. 8, pp. 1300-1307.

Sheng L, Shen X, Ulloa O, **Suslow TV**, Hanrahan I and Zhu M-J (2020) Evaluation of JC9450 and Neutral Electrolyzed Water in Controlling Listeria monocytogenes on Fresh Apples and Preventing Cross-Contamination. Front. Microbiol. 10:3128. doi: 10.3389/fmicb.2019.03128

N. Navarro-Gonzalez, S. Wright, P. Aminabadi, A. Gwinn, T. V. Suslow, M. T. Jay-Russell
Carriage and Subtypes of Foodborne Pathogens Identified in Wild Birds Residing near Agricultural Lands in California: a Repeated Cross-Sectional Study
Applied and Environmental Microbiology Jan 2020, 86 (3) e01678-19; **DOI:** 10.1128/AEM.01678-19

K. Phan-Thien M.H. Metaferia T.L. Bell M.I. Bradbury H.P. Sassi F.F. van Ogtrop **T.V. Suslow** R. McConchie. 2020. Effect of soil type and temperature on survival of *Salmonella enterica* in poultry manure-amended soils. Letters in Applied Microbiology 71, 210—217 https://doi.org/10.1111/lam.13302

Shen, Xiaoye; Su, Yuan; Hua, Zi; Cong, Jian; Dhowlaghar, Nitin; Sun, Qi; Lin, Shengnan; Green, Tonia; Perrault, Mackenzie; Galeni, Marcella; Hanrahan, Ines; Suslow, Trevor V; Zhu, Mei-Jun.2020.
Verification of peroxyacetic acid treatment against L. monocytogenes on fresh apples using E. faecium NRRL B-2354 as a surrogate in commercial spray-bar operations. Food Microbiology 92:103590: DOI: 10.1016/j.fm.2020.103590

Belias AM, Sbodio A, Truchado P, Weller D, Pinzon J, Skots M, Allende A, Munther D, **Suslow T**, Wiedmann M, Ivanek R. 2020. Effect of weather on the die-off of Escherichia coli and attenuated Salmonella enterica serovar Typhimurium on preharvest leafy greens following irrigation with contaminated water. Appl Environ Microbiol 86:e00899-20. https:// doi.org/10.1128/AEM.00899-20.

**Recent Abstracts**

**International Association for Food Protection 2020**

Mathilde J. Rivera, Dave Murray, **Trevor Suslow**. Root cause analysis of on-farm EHEC contamination of Brussel Sprouts

Janneth Pinzon, Mariya Skots, **Trevor V Suslow**. Genomic characterization of a subset of *Listeria monocytogenes* isolates from fresh produce packing facilities in California

**International Association for Food Protection 2019**
Kerry Cooper, Janneth Pinzon, Margarethe Cooper, Mariya Skots, Gilberto Flores, Rachel Mackelprang, **Trevor Suslow**. Characterization of Tree Fruit Bacterial Communities during Harvest

**T. Suslow**. Sanitization Efficacy and Impact of Sanitary Design for Control of *L. monocytogenes* in the Processing Plant.

**Trevor Suslow**, Adrian Sbodio, Janneth Pinzon, David Hill, Mariya Skots. Survival and Inactivation of *Listeria monocytogenes* from Common Specialty Crop Food Contact and Non-Food Contact Surfaces Using Different Antimicrobials.

**ICPP 2018**
**T. Suslow**. Collateral benefits of preventive controls for FSMA implementation in postharvest decay management

# EXHIBIT D

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June 26, 2024

**Via Electronic Mail**
Planning Commission
County of Santa Clara
70 West Hedding Street
San Jose, CA 95110
planning.commission@pln.sccgov.org

**Re: Item 6 - PLN17-6498 – Use Permit, Architectural and Site Approval, and Grading Approval to Upgrade the Z-Best Facility, SR 25, Gilroy**

Dear Members of the Planning Commission:

We are writing on behalf of Dorado Leasing ("Dorado"), who owns the 570-acre farm that is immediately south of the Z-Best facility. Dorado submitted comments on the original 2021 draft EIR ("DEIR") and the 2023 recirculated Draft EIR ("RDEIR"). For your ease of reference, attached are (1) Dorado's comments on the Draft EIR, dated March 1, 2021 ("DEIR Comment Letter") in **Exhibit A** and (2) Dorado's comments on the Recirculated Draft EIR, dated June 20, 2023 ("RDEIR Comment Letter") in **Exhibit B**.

Notwithstanding CEQA's requirement to prepare written responses to all written comments raising significant environmental issues, the County only responded to Dorado's RDEIR comment letter. The County has taken the position that the County was not legally obligated to respond to Dorado's DEIR Comment Letter. However, Dorado's RDEIR Comment Letter made clear that the recirculated Draft EIR suffered the same deficiencies as the original Draft EIR and specifically incorporated by reference the comments in that letter and requested a response to those comments. The CEQA Guidelines specifically allow CEQA documents to incorporate other documents by reference and states "where all or part of another document is incorporated by reference, the incorporated language shall be considered to be set forth in full as part of the text of the CEQA document." (14 Cal. Code Regs. Section 15150(a)). If an agency can incorporate by reference other documents in CEQA, surely a commenter on a Draft EIR could do the same. The County's failure to respond to Dorado's DEIR Comment Letter violates CEQA.

Collectively, Dorado's comment letters requested that the DEIR and RDEIR analyze certain specified agricultural and air quality impacts and implement mitigation measures to address the project's potentially significant impact on surrounding prime agricultural land. However, not all potential environmental impacts have been analyzed and addressed. Dorado continues to have concerns about converting the existing enclosed aerated bag process to an exposed aerated static pile system and nearly doubling the amount of material that is currently being composted daily and increasing that amount to 3,500 tons per day for up to 20 days per year. In addition to significantly increasing the volume of material being processed at the facility, the new composting system replaces the **enclosed** aerated bag process with open air bunker style composting process that will be exposed to the elements during the primary composting process until the bio-layer cover is applied and the entirety of the secondary composting process. Accordingly, and as Dorado repeatedly pointed out in its comment letters, this composting material will attract birds, which can consume the material and then defecate on the surrounding ag fields or simply carry this composting material over to the adjacent row crop fields, which will make it impossible farm row crops due to stringent food safety protocols.

The other concerning project feature is detention basin #1 that is right on the edge of Dorado's farm. According to the staff report, "stormwater that moves through MSW results in leachate, a contaminant with high biological oxygen demand, low pH, and nutrients including nitrogen, phosphorous, and salts." Like the open-air bunkers used during the composting process, this detention pond has no cover and will be exposed to the elements with the potential for birds wading in the contaminated leachate and then landing on the surrounding crop fields and contaminating crops pre-harvest.

Rather than addressing the bird vector and transmission issue head on and undertaking any meaningful analysis of this potential impact, the Final EIR simply dismisses Dorado's concerns. The Final EIR states that "the commenter does not provide any evidence to suggest that an increase in birds at the facility would result in significant environmental impacts that would require mitigation via the suggested bird deterrent measures." (See Final EIR, p. 35) However, Dorado did provide such evidence in the form of photographs of current bird activity at Dorado's facility and bird droppings on Dorado's farmland. See **Exhibit C** to the DEIR Comment Letter. The significant environmental impact is the potential loss of more prime and productive agricultural land that has already been decimated and converted throughout the County due to urban development. As we have previously explained, the increase in bird activity will lead to an increase in bird activity on adjacent farmland. This increase in activity will inevitably lead to more active prime farmland being taken out of production based on the strict food safety protocols.

Despite Dorado alerting the County to the EIR's ongoing oversight this potentially significant environmental impact and suggesting reasonable mitigation measure in the form of a bird control plan, the Final EIR simply states that "if the Project were to result in neighboring landowners deciding that the growth of crops for human consumption were unviable beyond the areas that are already fallowed…, this would not preclude those properties from being used for other agricultural purposes consistent with the agricultural zoning of the land, such as grazing or non-edible crops." (See Final EIR, p. 35) This response to Dorado's violates CEQA's mandate that the County impose all feasible mitigation measures on the project to minimize or reduce a project's significant environmental impacts. CEQA does not require an adjacent owner being impacted by project to modify their practices to avoid an impact.

In addition, one of Dorado's primary concerns is the potential for dangerous pathogens to become airborne and contaminate surrounding agricultural land. Dorado requested that the DEIR undertake a detailed analysis of a fully enclosed composting facility to address this potential impact. In response to Dorado's comments, the RDEIR analyzed the potential impact of an increase in bioaerosol impacts on adjacent agricultural land and concluded that the impact would be less than significant. (See RDEIR, Section 6.4.3) However, the same EIR concludes that the impact of bioaerosols would be "significant and unavoidable" air quality impact. (See RDEIR, Section 7.4.7) Both sections of the RDEIR discuss the potential for bioaerosol emissions to affect nearby food crops, however, the RDEIR inexplicably arrives at conflicting conclusions. The RDEIR also states "...since regulatory exposure limits have not been established, and due to the uncertainties explained above [in Section 7.4.7] and detailed in Appendix B-6, potential health and environmental impacts due to bioaerosol emissions cannot be ruled out." (RDEIR, p. 146) Even with implementation of the dust monitoring protocol in MM-AIR-7a and equipment maintenance and biofilter replacement in MMM-AIR-7b, the impact remains significant and unavoidable.

Based on the significant and unavoidable bioaerosol impacts, the County should more seriously consider a fully enclosed composting design to protect the public health and safety and surrounding agricultural land. Currently, the RDEIR fails to undertake a more detailed analysis of this alternative because the RDEIR dismissed it as infeasible based on the applicant's representation that such an alternative would be more costly. Dorado requests that the Planning Commission continue any decision and recommend that the County independently investigate the feasibility of such an alternative, or at a minimum, direct staff to analyze this alternative with the same level of vigor and detail as the EIR's analysis of the other alternatives that are described in the RDEIR. Currently, the RDEIR only analyzes two project alternatives and both were conceived to address significant traffic impacts. Such a limited analysis of alternative fails to comply with CEQA's requirement to study a reasonable range of project alternatives for the reasons set forth in the Dorado's RDEIR Comment Letter.

Because Dorado's concerns have not been fully analyzed and addressed, we respectfully request that the Planning Commission deny the entitlements or continue the matter until the above issues are adequately addressed in accordance with CEQA. If the Planning Commission intends to conditionally approve the entitlements, Dorado requests that the Planning Commission require that Z-Best prepare and implement a plan to control the inevitable increase in the number of birds.

Respectfully Submitted,

Jason Retterer

cc: Valerie Negrete

# EXHIBIT E

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COLLEGE OF AGRICULTURAL AND
ENVIRONMENTAL SCIENCES
AGRICULTURAL EXPERIMENT STATION
COOPERATIVE EXTENSION

July 12, 2024

Jason Retterer, Partner
JRG Attorneys at Law
318 Cayuga St.
Salinas, CA 9390

Jason,

I have reviewed the documents you had recently provided, including

- Z-Best's Response to Dorado Leasing's Comments to the Recirculated Draft EIR (RDEIR): Santa Clara County Planning Commission Hearing June 21 2024
- The Planning Commission Staff Report and related documents for Item 6 - PLN17-6498 – Use Permit, Architectural and Site Approval, and Grading Approval to Upgrade the Z-Best Facility, SR 25, Gilroy
- Dorado Leasing Comments on Z-Best RDEIR
- Accessed SWIS Facility/Site Inspection Details Z-Best Composting Facility

In addition to these documents, and with reference to my prior comments on Draft EIR and RDEIR, I have incorporated the most recent research reports and regionally relevant on-going longitudinal risk assessment studies environmental, landscape and farmscape to assess and properly position the potential impacts of Z-Best's expanded and environmentally exposed composting operation on surrounding farmland. It is essential to appreciate that these high value farmlands are currently used for human food crop production subject to compliance with US Food and Drug Administration, California marketing agreement standards, and increasingly stringent private audit requirements for food safety and public health protection.

Based on my extensive on-farm research and extension outreach experience in California and this region, spanning more than 40 years, I feel highly qualified to comment and provide both technical and practical opinions on this matter. In brief, this very short Biosketch excerpt provides a snapshot of my qualifications:

I formed Trevor Suslow Consulting, LLC in 2021 and hold an Emeritus faculty position at UC Davis with an emphasis on preharvest to postharvest quality and safety of fresh consumed specialty crops. I still devote substantial time in Extension service and effort across the U.S. and internationally. My former full-time position at UCD included statewide responsibilities in quality and safety on diverse whole fresh and minimally processed horticultural foods from annual row crops to tree and vine commodities. Prior to my tenure at UCD, I held a Senior Director of R&D position at DNA Plant Technology, Inc in Berkeley, CA for 15+ years. I served in a technical committee role at the Center for Produce Safety Technical Committee from its creation in 2008. I transitioned to a CPS technical advisory role to the CPS Executive Director in 2021. I received the United Fresh Produce Association Technical Award in 2012 and received The Packer 25 *Profiles in Leadership* award in 2014. I was named to Food Safety News list of *The Best of Food Safety in Education* and honored with the National Steinbeck Center's Valley of the World *Award in Education* in 2017. I served as Faculty Director for the UC Postharvest Technology Center from 2016 to October 2018. I was recognized by the International Association of Food Protection (IAFP) with the *2018 Elmer Marth Educator Award* and in 2019 the *IAFP President's Award*. Most recently, I was selected as one of AFDO The Food Safety Set: 16 People Who Have Shaped the Last 30 Years of Food Safety.

A sampling of some of my recently published articles are as follows:

- Leaman, S., Salas, S., Mandrell, R., **Suslow, T**, Jay-Russell, M.T., and D, Davis. 2022. Environmental Risk Factors in The Human Pathogen Transmission Pathways between Animal Operations and Produce Crops. Food Protection Trends. 42: 362-376

- **Suslow. T.V**. 2022. Romaine Lettuce Seasonal Risk - A Hypothesis Assembly Project Issue Briefs. STEC Issue Brief 1: Hypothesis Risk Matrix; STEC Issue Brief 2: Leafy Greens Production Patterns and Practices; STEC Issue Brief 3: Regional Cattle Management Profile; STEC Issue Brief 4: Genomics and SNPs; Issue Brief 5: Bioaerosol Risk and Crop Setback Distances. https://www.centerforproducesafety.org/

- Brandl,M., Ivanek,R., Zekaj,N., Belias, A., Wiedmann,M., **Suslow,T**., Allende, A., and D. Munther. 2022. Environmental stressors correlate with the formation of *Escherichia coli* and *Salmonella enterica* persister populations in the lettuce and spinach phyllosphere: A mathematical modeling study. IMSE. COMMUN. **2**, 91. https://doi.org/10.1038/s43705-022-00170-z

- Leaman, S.,Kerr, J.Sonia Salas,S, Malik, A., **Suslow,T**., Wiedmann, M., and De Ann Davis. 2023. Fresh Produce Harvesting Equipment – A Review of Cleaning and Sanitizing Practices and Related Science. Food Protection Trends. 43: 126-143

- Goforth M, Cooper MA, Oliver AS, Pinzon J, Skots M, Obergh V, Suslow TV, Flores GE, Huynh S, Parker CT, Mackelprang R, Cooper KK. Bacterial community shifts of commercial apples, oranges, and peaches at different harvest points across multiple growing seasons. PLoS One. 2024 Apr 16;19(4):e0297453. doi: 10.1371/journal.pone.0297453. PMID: 38625898; PMCID: PMC11020611.

Due to the relatively short timeline for providing comments, response, and opinions on the analysis contained in the Final EIR (released a few weeks ago) and the deadline to appeal the Planning Commission's decision, I have limited the full scope of my continuing concerns for the omissions and minimization of potential negative impacts on prime adjacent farmlands beyond the current impactful extended fallowed setback buffers adopted by the farming operations. As I will describe, consistent with my earlier comments, there remains a reasonable and problematic uncertainty surrounding proposed expectations for risk mitigations addressing receiving, holding, handling, and other site and process improvements due to the planned substantial increase in incoming materials. While the Z-Best Final EIR attempts to address the previous environmental concerns and issues that I raised, I feel strongly that its analysis is very peripheral to the issue of legitimate concerns for potential negative impacts on actual produce safety but much more certain negative consequences from customer audit programs, which will assess the risk of Z-Best's composting operation and the adjacent farmland and will likely lead to a greater proportion of the farmland (beyond any existing fallowed areas) from its intended use for horticultural food crop.

One statement I found particularly alarming was the suggestion that additional fallowed land or the full ranch may simply be converted to non-food crops or grazing. However, it is unreasonable to require a landowner/grower to modify its business due to a potential nuisance situation created by a neighboring enterprise rather than the enterprise ensuring that these impacts are fully mitigated.

You should also be aware that in light of the various outbreaks that have occurred as a result of contaminated food crops, the focus on perceived risk from adjacent and nearby land use to food crops has changed dramatically and irreversibly in the past few years due to **qualitative and quantitative data development**. Some of the data specifically analyzed or reviewed the risk of compositing operations to food crop production This recent data is discussed below and is the basis for my concern that this expanded composting operation could result in more farmland being taken out of production adjacent to the Z-Best operation. I also recommend that Z-Best incorporate certain mitigation measures to further reduce the potential risk of this facility to adjacent food crops. Measures such as increased, elevated, and routinely inspected dust abatement screens, a minimal 2 year robust pathogen prevalence testing program for pre-composting organic inputs, stage-1 cross-sectional pathogen testing of in-process compost at the open bunkers (before applying a 6-inch finished compost layer and at the "feet" of the pile adjacent to bunker walls (especially during periods of pooled water from any source), a 2-year dust monitoring program, and a comprehensive risk mitigation performance verification program to assess operational adherence to expected outcomes of the proposed EIR measures for expansion.

**U.S. Food and Drug Administration (FDA) Adjacent and Nearby Land Use and its Impact on Produce Safety (see attached)**
**(04/08/2024)**

The FDA is hyper-focused on the known, suspected, and potential for the contribution of contaminants generated and dispersed from adjacent and nearby lands and operations to outbreaks and unacceptable conditions for covered produce (Food Safety Modernization Act - FSMA Final Rule on Produce Safety *Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption;* FSMA PSR). Covered produce includes the key fresh consumed produce commodities which fit the economic sustainability of the land in the region. FDA, USDA produce safety inspectors and authorized state inspectors, (including for the California Leafy Greens Marketing Agreement – LGMA), and 3rd-party auditors commissioned by have substantially shifted their compliance focus to a much greater stringency in review of adjacent land use risk potential and mitigations, especially as indicated by sources of bioaerosols. These heightened awareness began with Hypothesis Generation and now supported by science-based data development, rather than resting on expectations.

FDA states:

> "Several recent produce outbreak investigations have demonstrated that conditions and practices on adjacent and nearby land can play a critical role in contributing to produce contamination. Microbial hazards, such as *Salmonella* or *E. coli* O157:H7, can originate from areas outside the farm - areas often referred to as adjacent and nearby land. "Adjacent" land refers to land sharing a common border with the farm. "Nearby" land includes land that does not adjoin the farm but has the potential to affect the farm based on the land's location.... These outbreaks include:
>
> - *Salmonella* Newport in red onions in 2020 [1];
> - *Salmonella* Enteritidis linked to peaches in 2020 [2]; and
> - Six Shiga-Toxin Producing *E. coli* (STEC) outbreaks associated with leafy greens, including four outbreaks between 2018 – 2020 [3].
> - *Salmonella* Typhimurium outbreak involving cantaloupe grown during 2022 [4].

Most recently, the FDA released the results of a longitudinal study which provided strong evidence for the impacts of bioaerosol dispersal and deposition to adjacent and nearby farmlands previously growing winter seasonal leafy greens (**Southwest Agricultural Region Environmental Microbiology Study (2019 – 2024) 06/05/2024) (See Attached).**

**Key findings from this study include**

- **Airborne Pathogens:** Airborne transmission of viable STEC [Shiga toxin-producing E. coli] was documented on numerous occasions at several locations adjacent to and at incremental distances from a nearby large livestock and composting operation (80,000+ cattle).
- ...findings indicate that STEC can survive in the air and that dust can act as a transfer mechanism for both pathogens and indicator organisms (e.g. generic *E. coli*) from adjacent and nearby land to water, soil, and plant tissue.
    - The dispersal and detection distances reported to the food safety community, while diminishing with distance from the point-source, far exceeded current LGMA setback standards and some produce retailers 'qualified and approved supplier' audit criteria.

- Whole genome sequencing results: More than 40 different STEC serotypes were recovered from roughly 500 different samples representing all the matrices examined in this study. STEC strains detected in water, sediment, and plant tissue harvested from our research plots genetically matched strains isolated in air samples providing evidence that bacteria in air can transfer to other locations and surfaces.

The critical relevance to the Z-Best expansion is that very simple dust transport monitoring protocols used in the FDA longitudinal study are now deployed in other similar studies, including in California. The method is referred to as 'passive monitoring' and uses a frame-supported section of simple cheesecloth deployed in various vector locations relative to a point-source. The cheesecloth is tested for targets such as STEC and Salmonella by extraction and standard qPCR. For the purpose I am suggesting for Z-Best, viability is not a required confirmation as the purpose is simply evidence of containment versus dispersal. These are not excessively expensive protocols and may be conducted with straightforward commercially available concentration options and digital drop PCR analysis to answer the question "Are Z-Best composting operations and dust containment measures consistently effective in prevention of transport of foodborne pathogens towards adjacent farmlands?" While not an actual mitigation of concerns, committing to a program of data collection across a comprehensive time course, with weather monitoring, would represent a good faith effort to collect highly relevant data for on-going risk assessment and management.

Regardless that the key bioaerosol and "fugitive dust" source factor is a very large CAFO [Concentrated Animal Feeding Operation] , the general reaction to this report among the strongly influential buyer side of the fresh produce supply chain has predictably been an increased level of risk aversion for any adjacent animal feeding operation and composting facility, irrespective of whether animal manures, livestock and poultry mortality, or biosolids are included in the incoming materials. The LGMA Adjacent Lands Subcommittee, originally formed in 2020, and setback metrics revised in 2021, is currently reviewing this new information towards data-based revisions to setbacks, monitoring requirements, and standard metrics.

In addition, a similar FDA-sponsored longitudinal study, California Longitudinal Study (2020 – present) (See Attached), is nearing completion and the linked progress report was posted on 08/24/2023. While study details and findings for this study, conducted within the CA Central Coast Region, have not been shared publicly the objectives include... "Samples will be collected from agricultural water, surface water, sediment, soil and soil components **including compost and dust**, animal fecal material, and other sources. Attention will also be given to the geography, topography, and meteorological conditions of the study region and the types and locations of agricultural and other land use activities relative to produce production areas."

While the root cause of most outbreaks, regardless of the number of known/reported clinical cases may be few, the economic impact on individual growers and handlers due to settlements in litigation may be very costly. These events often result in the closure of small and midsize farming operations. For example, from a recent outbreak attributed to a regional (San Benito County) shelled walnut distributor, the Centers for Disease Control cited 13 clinical cases of *E. coli* O157:H7 resulting in 7 hospitalizations. The FDA traceback to Gibson Farms resulted in a multistate recall, which is expensive to execute on its own, but experience with foodborne illness litigation would indicate that personal injury and medical cost recovery settlements would likely exceed $ 10 million. While there is no information available to identify the source of contamination, past studies on CA walnuts and other tree nuts would support environmental sources as a plausible candidate. The key point, regardless, is that growers and harvesters are impacted by contamination transference from adjacent and nearby lands and operations over which they have no control.

The California Agricultural Neighbors initiative, led by CDFA and the Monterey County Farm Bureau was formed in recognition of these challenges and has multiple workgroups (Suslow has been involved since its inception) working to resolve cooperative and collaborative solutions to regional produce safety issues. These Action Report products (**California Agricultural Neighbors: Neighbor-to-Neighbor Best Practices to Help Enhance Localized Food Safety Efforts**) and continuing risk assessments include regional both animal manure inclusive and green waste MSW compost operations.

The Final EIR does not adequately address the issue of viable pathogen containing particulate transport off-site. For example, the Final EIR (Section 7.4.7 Bioaersol Emissions, p. 145) states, as responsive to comments of concern about rates of indicator and pathogen inactivation:

> *"For example, the proposed ECS system is expected to reach pathogen reduction temperatures of 55 degrees Celsius in the primary composting phase after 48 hours, whereas the existing CTI system has been documented to take up to 6 days to reach the same temperature. Attainment of pathogen reduction temperatures over a shorter period of time is expected to reduce the number of viable organisms, particularly pathogenic enteric bacteria. Similarly, the leachate and stormwater capture improvements associated with the proposed ECS system are expected to reduce bioaerosol production and distribution and the installation of a liner on the existing Detention Basin #1 would also reduce the potential risk of microbiological contamination of the groundwater."*

The premise may be acknowledged while still providing limited assurance of freedom from acute and chronic harm to local specialty food crop producers. The "expected" risk reduction does not alleviate reasonable and predictable concerns for deposition of bioaerosols during temporal periods much shorter than 48h. This is especially concerning for a crop at scheduled harvest or bioaerosols/fugitive dust deposition during harvest, on harvest equipment during use or during overnight staging, and on packing containers or packaging materials. These are long-standing, common, and necessary practices and the full burden for risk mitigation should not be borne by the grower. Bioaerosol generation is acknowledged to occur at multiple stages of facility handling, from incoming materials, during sorting, turning, and during transport to and from primary composting bunkers. While prevailing wind direction may be important, as a required consideration under FSMA PSR and LGMA risk assessments, intervals of reverse wind run vectors occur seasonally, especially during evening and pre-dawn hours when survivability of pathogens in aerosolized particulates and following deposition would be greatest. While not published, due to issues of proprietary and confidential business to business resolution between a leafy green grower and adjacent compost producer, I have personal experience with tracking the movement of compost-generated dust harboring viable STEC from open-facility windrows to leafy greens.

In addition to microbiological hazards, FSMA PSR specifies and mandates prevention and control of physical hazards. Publicly available inspection reports **SWIS Facility/Site Inspection Details Z-Best Composting Facility** note multiple repeat observations of plastic films and other lightweight fragments prone to windborne dispersal. Small fragments generated by the operational handling, sorting, and separation may also be dispersed to farmland under seasonal conditions and would be negatively noted as a risk in FDA-authorized inspections and private 3rd party audits.

The revised composting process offers several improvements in rates of pathogen inactivation. However, it is well established that a temperature basement of 55C (131F) is not comprehensively lethal to stress pre-adapted pathogens, such as Salmonella spp., especially in complex organic matrices (Inactivation of Salmonella Senftenberg strain W 775 during composting of biowastes and garden waste. A. Ceustermans, D. De Clercq, A. Aertsen, C. Michiels, J. Coosemans and J. Ryckeboer. 2007. J Appl Microbiol103(1):53-64. doi: 10.1111/j.1365-2672.2006.03224.x).In addition, while process control models and assurances of maximal uniformity predict the rapid attainment of critical lethality in validated Time: Temperature parameters, practical knowledge and experience dictates that failures will occur. Even with reasonable efforts and redundant control point monitoring, these inadequacies may not be discovered or responded to in a timely manner.

The response within the RDEIR has its dominant aerosol risks consideration focused on environmental degradation and residential, rural, and adjacent farm labor health risks. Most of the included Cary Oshins analysis, while not disputing the facts and lack of established VOC, odors, and other constituents of bioaerosols on farm labor exposure, is not germane to the issues raised by Dorado Leasing. C. Oshins correctly suggests that these concerns are a predominantly unaddressed and unresolved departure from "...contemporary understanding of risk from compost-generated bioaerosols." While consistent with statutory requirements, this substantially deflects and does not specifically address the concerns expressed by Dorado Leasing. It would seem to be the opposite. While the separation distance from the farm to the facility operations remains unchanged the volume of MSW and other current, planned, and likely unplanned or future opportunistic materials will logically elevate the risk potential. Therefore, the issue of relief from further erosion of farmable lands due to the planned expansion has not been adequately resolved.

Similarly, while acknowledged and beneficial to addressing vector concerns, what does not appear to be appreciated or addressed is the issue of perception of risk among those key players which contract for or otherwise purchase edible horticultural products exclusively or typically consumed with a lethal kill step (i.e. cooking). Reducing the prevalence of vectors to received and in-process feed sources has yet to provide predictable or consistent relief from negative audit reports and scores. The approach requested from Z-Best would be to transparently quantify pre- and post-expansion populations by engaging a qualified expert. Passing routine inspections (**SWIS Facility/Site Inspection Details Z-Best Composting Facility (43-AA-0015)** is not sufficient relief from concerns under provisions of the FDA Produce Safety Rule expectations for growers in addressing adjacent and nearby land vector management as there would be no control over the effectiveness and establishment of verifiable quantitative performance criteria, regardless of whether a numerical standard is currently prescribed.

In summary, my opinion remains that the EIR has not adequately and specifically addressed legitimate concerns detailed in documents provided by Dorado Leasing. The absence of specific tolerances or citable research-based data for impacts of adjacency to large composting operations on the economic viability of farms producing food crops covered, regulated, and subject to enforceable on-farm inspections by FDA or their authorized state agencies should not be the basis for dismissal or inaction of these concerns.

Trevor V. Suslow

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Attachments

FDA U.S. FOOD & DRUG ADMINISTRATION

# FDA FACT SHEET

## Produce Safety Rule (21 CFR 112)
## Adjacent and Nearby Land Use and its Impact on Produce Safety

Several recent produce outbreak investigations have demonstrated that conditions and practices on adjacent and nearby land can play a critical role in contributing to produce contamination. Microbial hazards, such as *Salmonella* or *E.coli* O157:H7, can originate from areas outside the farm - areas often referred to as adjacent and nearby land. "Adjacent" land refers to land sharing a common border with the farm. "Nearby" land includes land that does not adjoin the farm, but has the potential to affect the farm based on the land's location.

This fact sheet is intended to help produce farms understand how conditions and practices on adjacent or nearby land can impact produce safety, and how the Produce Safety Rule requirements can address identified hazards.

**Question 1. Why is it important to evaluate potential hazards associated with conditions and practices on adjacent or nearby lands?**

Conditions and practices on adjacent and nearby land can impact the safety of all types of produce, whether grown domestically or internationally. Pathogens can be transferred from sources on adjacent or nearby lands to produce farms in several ways, including through the movement of animals, equipment and tools, water, wind, or people.

Several recent produce outbreak investigations have identified conditions and practices on adjacent or nearby lands as a potential contributing factor. These outbreaks include:

- *Salmonella* Newport in red onions in 2020 [1];
- *Salmonella* Enteritidis linked to peaches in 2020 [2]; and
- Six Shiga-Toxin Producing *E. coli* (STEC) outbreaks associated with leafy greens, including four outbreaks between 2018 – 2020 [3].
- *Salmonella* Typhimurium outbreak involving cantaloupe grown during 2022 [4].

**Q.2 What are potential sources of common pathogens that cause foodborne illness?**

Understanding the potential sources of pathogens that cause foodborne illness (i.e., the pathogen's natural habitat or where it prefers to live) is important to help you identify potential hazards to your covered produce, including those that may be associated with adjacent and nearby land use, practices, and conditions. Some commonly occurring foodborne pathogens and their sources are outlined in Table 1; another helpful source of information is FDA's webpage for Foodborne Pathogens.

**Table 1. Selected foodborne pathogens and their potential sources.**

| Selected Foodborne Pathogens | Potential Sources Include: |
|---|---|
| *Salmonella spp.* | Domesticated and wild animals and their feces; humans and their feces[5] |
| Shiga-Toxin Producing *Escherichia coli* (STEC) | Domesticated and wild animals, particularly ruminant animals (e.g., cattle, sheep, goats and deer), and their feces[6] |
| *Listeria monocytogenes* | Soil, decaying vegetation, water, and domesticated and wild animals and their feces[7] |
| *Cyclospora cayetanensis* | Humans and their feces[8] |

**Question 3. What conditions and practices on adjacent or nearby lands can contribute to potential contamination of my produce?**

Conditions or practices associated with adjacent or nearby lands, including those that may not be under your farms control, may serve as a source of known or reasonably foreseeable hazards that can introduce contamination to the produce you grow or handle. Many factors can impact conditions on the farm, including the types of potential hazards on adjacent and nearby land, the types of activities on adjacent and nearby land, and environmental factors.

Factors to consider when evaluating potential sources or routes of contamination from adjacent and nearby land include:

- Presence of domesticated animals, animal housing, animal waste, and related practices;
- Presence of wild animals, or presence of animal attractants or habitats;
- Practices related to storage or applications of soil amendments, manure or biosolids;
- Presence of waste or trash storage areas;
- Presence or evidence of recreational activities (e.g., camping, boating, swimming);
- Proximity to urban areas, housing or recreational areas (e.g., houses, apartment buildings, businesses, RV sites, golf courses, and parks);
- Proximity to toilet facilities, sewage or septic systems, or wastewater treatment facilities;
- Agricultural water sources or systems, and related practices;
- Susceptibility of produce growing and handling areas and water systems to runoff, waste water drainage or other drainage;
- Worker practices and traffic patterns;
- Equipment and transport vehicle handling and traffic patterns;
- Presence of untreated or improperly treated human waste;
- Land features (e.g., topography, vegetation) and land use;
- Weather events;
- Historical observations and other information.

**Question 4. How does the Produce Safety Rule apply to preventing contamination of covered produce from hazards associated with adjacent and nearby lands?**

Several requirements of the Produce Safety Rule apply to preventing contamination of covered produce with hazards associated with adjacent and nearby lands. Covered farms must take appropriate measures to minimize the risk of serious adverse health consequences or death from the use of, or exposure to, covered produce, including those measures reasonably necessary to prevent the introduction of known or reasonably foreseeable hazards into covered produce and to provide reasonable assurances that the produce is not adulterated under section 402 of the Federal Food, Drug, and Cosmetic Act on account of such hazards (21 CFR 112.11). This includes known or reasonably foreseeable hazards introduced from conditions and practices on adjacent and nearby land.

As applicable, requirements include, but are not limited to:

- domesticated and wild animals (see applicable requirements of Subpart I);
- growing, packing, harvesting and holding activities (see applicable requirements of Subpart K);
- agricultural water [9]; and
- equipment and tools, including food packing materials, buildings, and sanitation (see applicable requirements of Subpart L).

More information on these requirements can be found in the Produce Safety Rule and related chapters of the draft guidance, specifically:

- Draft Guidance Chapter 5: Domesticated and Wild Animals (Subpart I)
    - At a Glance: Key Points in Chapter 5; Descripción General: Capitulo 5
- Draft Guidance Chapter 6: Growing, Harvesting, Packing, and Holding Activities (Subpart K)
    - At a Glance: Key Points in Chapter 6; Descripción General: Capitulo 6
- Draft Guidance Chapter 7: Equipment, Tools, Buildings, and Sanitation (subpart L)
    - At a Glance: Key Points in Chapter 7; Descripción General: Capitulo 7

**For more information:**

***•FSMA Final Rule on Produce Safety.***
**https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-produce-safety**

***•Produce Safety Network:***
**https://www.fda.gov/food/food-safety-modernization-act-fsma/produce-safety-network**

***ProduceSafetyNetwork@fda.hhs.gov***

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[1] - Factors Potentially Contributing to the Contamination of Red Onions Implicated in the Summer 2020 Outbreak of Salmonella Newport
[2] - Factors Potentially Contributing to the Contamination of Peaches Implicated in the Summer 2020 Outbreak of Salmonella Enteritidis
[3] - Outbreak Investigation Reports
[4] - FDA Issues Report Highlighting Salmonella Outbreak in Cantaloupe During Summer of 2022
[5] - Jay, J.M. et al. 2005. "Chapter 26. Foodborne Gastroenteritis Caused by Salmonella and Shigella in Modern Food Microbiology", 619-636, New York, New York. Springer.
[6] - Meng, J. et. al. 2007. "Chapter 12. Enterohemorrhagic Escherichia coli in Food Microbiology", 249-269, Washington, DC. ASM Press.
[7] - Jay, J.M. et al. 2005. "Chapter 25. Foodborne Listeriosis in Modern Food Microbiology", 591-617, New York, New York. Springer.
[8] - Ortega, Y.R. 2007. "Chapter 31. Protozoan Parasites in Food Microbiology", 663-681, Washington, DC. ASM Press.
[9] - Subpart E of the Produce Safety Rule also applies to preventing contamination of covered produce from potential hazards associated with adjacent and nearby lands. In December 2021, we published a proposed rule which would revise subpart E of the FDA Food Safety Modernization Act (FSMA) Produce Safety Regulation to change the pre-harvest agricultural water requirements for covered produce (other than sprouts). The proposal includes expedited mitigation measures that would be required for specific types of hazards related to certain activities associated with adjacent and nearby lands.

# Southwest Agricultural Region Environmental Microbiology Study (2019 – 2024)

<< Environmental Studies Main Page (/food/microbiology-research-food/environmental-studies)

In 2019, the FDA, in collaboration with the University of Arizona, the Wellton-Mohawk Irrigation and Drainage District, local growers, industry groups, and others, began a multi-year study in Yuma County, Arizona – which grows many of the leafy greens sold in the United States. The study was designed to improve understanding of the environmental factors that may impact the presence of foodborne pathogens in the Southwest agricultural region. The research team was particularly interested in identifying new information about factors that significantly contribute to the introduction, persistence, growth, spread, and die-off of pathogens that could contaminate produce prior to harvest in this region.

The study involved collecting environmental samples throughout a five-year period. Samples were collected from irrigation waters, soil, sediments, air/dust, animal fecal material, wildlife scat, and other sources across approximately a 54 mile (7,000 acres) area of the southwest growing region, which also represents about 12% of the Wellton-Mohawk Irrigation and Drainage District's agricultural production area. Water sampling occurred from the headworks of the Wellton-Mohawk canal and at multiple points as the canal splits and flows thru the Gila Valley and Texas Hill area. Other select surface water sites were also sampled. Special attention was given to the geography of the study region and the types and locations of agricultural and other adjacent and nearby land use activities (/food/food-safety-modernization-act-fsma/adjacent-and-nearby-land-use-and-its-impact-produce-safety) relative to produce production areas. For example, there is a Concentrated Animal Feeding Operation (CAFO) with more than 80,000 head of cattle and an associated compost operation in proximity to some of the produce production areas studied. In addition, research plots of romaine lettuce were grown within the study area over several seasons to capture data on pathogen prevalence and persistence as well as to evaluate the influence of specific growing and harvesting practices. Pertinent meteorological information (air temperature, wind speed and direction, rainfall, etc.) was also logged.

Collected samples were analyzed using microbial culture methods, metagenomics, and whole genome sequencing to identify pathogens and microorganisms that can be indicators of unhygienic conditions. Through repeated sample collection, testing, measurement, and analysis, we observed fluctuations in the types and prevalence of pathogens and indicator organisms over time and location, including variability across different seasons.

The findings of this study contribute to a better understanding of the impact various environmental factors can have on food safety and may be used to refine best practices for growers to continually improve produce safety.

## Key Findings

The research team conducted over 100 sampling events at 55 sites resulting in more than 5,000 unique samples collected and 15,000 individual tests for detection of generic *E. coli*, *Salmonella*, and Shiga toxin-producing *E. coli* (STEC), including *E. coli* O157:H7. The research team then performed whole genome sequencing and analyzed isolated strains to determine their genetic relatedness as well as distribution across the study region. The research scientists are continuing to analyze data from this study, however preliminary key findings include:

- **Airborne Pathogens:** Airborne transmission of viable STEC was documented on numerous occasions at several locations adjacent to and at incremental distances from a nearby large livestock and composting operation (80,000+ cattle). In addition, air, water, and lettuce leaf microbiome analysis demonstrated deposition of dust from cattle pens to the nearby water and land, suggesting that dust from CAFOs may play a role in STEC transmission in this part of the region. These findings indicate that STEC can survive in the air and that dust can act as a transfer mechanism for both pathogens and indicator organisms (e.g. generic *E. coli*) from adjacent and nearby land to water, soil, and plant tissue. Additionally, distance played an important factor in the likelihood of STEC being detected in collected airborne dust, with percentage of positive samples declining steadily as air sampling moved in an incremental manner away from concentrated animal operations.
- **Water Quality:** The research team repeatedly observed that generic *E. coli* concentrations and STEC prevalence and isolation frequency increased as irrigation canal water flowed past an adjacent livestock and compost operation. In addition, these changes in water quality occurred absent other explanations such as surface run-off or other direct contamination, which indicates that airborne disposition of dust from a nearby CAFO was potentially a factor in the contamination of the irrigation water. Similar findings were not observed from samples obtained concurrently from a different nearby irrigation canal that flows south of the CAFO and associated compost operation suggesting the important role of localized southerly winds in transferring CAFO-associated dust in northward directions.
- **Wildlife Contributions:** Over 1,000 samples of wildlife fecal material, including from a wide variety of mammals and birds, were collected to study the role wildlife in this region may contribute to pathogen dissemination. A special emphasis was placed on birds, both native and migratory, given their presence and ability to access both terrestrial areas including produce fields and livestock areas, and various surface water locations including

irrigation canals. In total, over 40 different bird species were sampled, with red-winged black birds being the only species testing positive for STEC in very few of the nearly 60 samples collected from this bird species. Therefore, birds and other wildlife do not appear to be significant sources of STEC or *E. coli* O157:H7 in or around the part of the Southwest growing region evaluated. However, continued monitoring is warranted to reduce potential risk to produce, the environment and water sources.

- **Whole genome sequencing results:** More than 40 different STEC serotypes were recovered from roughly 500 different samples representing all the matrices examined in this study. STEC strains detected in water, sediment, and plant tissue harvested from our research plots genetically matched strains isolated in air samples providing evidence that bacteria in air can transfer to other locations and surfaces.

The research team is continuing to analyze data from the study. For instance, meteorological data were collected at the time of sampling and are being used to evaluate whether factors such as wind speed and direction are drivers for both the positive and negative results obtained. As more information and findings become available this page will be updated.

## Post-Study Actions

The preliminary results of this study stress the interconnectedness between people, animals and the environment and serve as an important model for how to foster productive dialogue among diverse stakeholders to improve food safety. Just as collaboration across the Southwest agricultural community was key to the development and execution of this study, continued collaboration among stakeholders including livestock managers/producers, fresh produce growers, academia, extension, retailers, and federal, state, and local government partners will be important to help control and mitigate potential contamination via environmental transmission including air/dust from adjacent and nearby land.

Members of the Arizona leafy greens industry will be working through the Desert Food Safety Coalition to continue to collaborate with the Arizona Department of Agriculture, University of Arizona Extension, Yuma Fresh Vegetable Association, Yuma Safe Produce Council, Arizona Farm Bureau, Arizona Leafy Green Marketing Agreement (AZ LGMA), Western Growers, USDA-APHIS Wildlife Services, Arizona Cattle Feeders' Association, additional grower and landowner coalition members and other agricultural community stakeholders to engage the industry and inform best practices to improve food safety in the region.

While the results are regionally specific, the findings may also help us to address some knowledge gaps identified in the Leafy Green STEC Action Plan (/food/foodborne-pathogens/leafy-greens-stec-action-plan), particularly concerning adjacent and nearby land use

(/food/food-safety-modernization-act-fsma/adjacent-and-nearby-land-use-and-its-impact-produce-safety). As additional data analysis is completed, FDA plans to engage with stakeholders to further explore the data and information gathered from this study.

The research team intends to present additional details about this study during the International Association for Food Protection annual meeting July 14-17, 2024. As final data analysis occur, we intend to publish manuscripts on this in the scientific literature. Additional information and publications will be added to this page as they become available.

## Study Collaborators

The FDA would like to acknowledge and thank the collaborators that contributed to this study.

- FDA
- Arizona Department of Agriculture
- Arizona Game & Fish Department
- The Desert Food Safety Coalition
- The University of Arizona, Department of Environmental Science
- The University of Arizona, Maricopa Agricultural Center
- The University of Arizona, Yuma Agricultural Center
- USDA APHIS Wildlife Services
- Wellton-Mohawk Irrigation and Drainage District
- Yuma Fresh Vegetable Association
- Yuma Safe Produce Council
- Arizona Leafy Green Marketing Agreement
- Local growers and industry members

## Study Related Announcements

- FDA Partners with the University of Arizona, Wellton-Mohawk Irrigation and Drainage District, and Yuma Area Leafy Greens Stakeholders to Enhance Food Safety (/food/cfsan-constituent-updates/fda-partners-university-arizona-wellton-mohawk-irrigation-and-drainage-district-and-yuma-area-leafy)

Was this helpful? Yes No

# California Longitudinal Study (2020 – present)

<< Environmental Studies Main Page (/food/microbiology-research-food/environmental-studies)

FDA, in collaboration with the California Department of Food and Agriculture, the University of California, Davis' Western Center for Food Safety, and agricultural stakeholders in the Central Coast of California, is conducting a multi-year study in the Central Coast agricultural region to identify environmental factors that significantly contribute to the introduction, persistence, growth, and spread of foodborne pathogens that could contaminate produce during production and harvest. We are also interested in identifying factors that lead to pathogen die-off.

The Central Coast of California is farmed year-round and supplies a large portion of the nation's leafy greens. It also produces artichokes, broccoli, cauliflower, celery, strawberries, tomatoes, wine grapes, and other crops. It is precisely because the region, sometimes called the "salad bowl of the world," grows so much produce, that researchers are interested in studying it. There have been periodic foodborne illness outbreaks associated with produce grown in California, including three outbreaks in the Fall of 2019 tied to leafy greens from the Central Coast, so increasing our understanding of the ecology of this growing region as it pertains to foodborne pathogen persistence is of great benefit to growers, cooperative extension specialists, and food safety officials.

This study involves collecting environmental samples from the Central Coast of California's agricultural region throughout the year. Samples will be collected from agricultural water, surface water, sediment, soil and soil components including compost and dust, animal fecal material, and other sources. Attention will also be given to the geography, topography, and meteorological conditions of the study region and the types and locations of agricultural and other land use activities relative to produce production areas. Samples will be analyzed using molecular diagnostic and microbial culture methods, metagenomics, and whole genome sequencing to identify pathogens and microbiological organisms that can be indicators of unhygienic conditions. Through repeated sample collection, testing, measurement, and observation, we hope to gain insight into fluctuations in the types and prevalence of pathogens and indicator organisms over time, including variability across different seasons. Complementing the environmental surveillance, laboratory studies will explore how the pathogens collected from the study area adapt to different growing conditions and interact with host produce plants, which also may lead to new approaches for limiting or eliminating pathogens in growing areas.

The findings of this study will contribute to a better understanding of the impact various environmental factors can have on food safety. This information, in combination with the findings from studies like it, can be used to refine best practices for growers, so they may continually improve the safety of their products.

## Study Related Announcements

- FDA Partners with the California Department of Food and Agriculture, Western Center for Food Safety, and California Agricultural Stakeholders to Enhance Food Safety (/food/cfsan-constituent-updates/fda-partners-california-department-food-and-agriculture-western-center-food-safety-and-california)

## Study Collaborators

- FDA
- California Department of Food and Agriculture
- University of California, Davis, Western Center for Food Safety
- Local members of the produce, viticulture, cattle, and compost industries

Was this helpful? Yes No

# EXHIBIT F

# SWIS Facility/Site Inspection Details

## Z-Best Composting Facility (43-AA-0015)



**Enforcement Agency**
County of Santa Clara

**Local Inspection ID**
--

**Activity**
Composting Facility (Mixed)

**Operational Status**
Active

**Regulatory Status**
Permitted

**Inspection Date**
1/29/2024

**Inspected By**
Santa Clara County

**Inspection Type**
Periodic

**Inspection Frequency**
Monthly

**Received By (Operator)**
John Doyle, Operations Manager

**CalRecycle Received**
2/27/2024

**Inspector**
Jaymar Elen, LEA, REHS

Violations

| Regulation | Title | Comment |
|---|---|---|
| There are no Violations. | | |

## Areas of Concern

| Regulation | Title | Comment |
|---|---|---|
| There are no Areas of Concerns. | | |

## Inspection Report Comments

1. The training records, load checking logs, log of special occurrences and complaint log were reviewed for December and are up to date.

2. The roadway at the entrance to the facility and the adjacent Highway 25 were observed with some tracked mud as expected due to the current wet, rainy weather. Observed flooding on the open road area by the office building and transfer facility. Continue to control flooding/ponding to ensure proper drainage, control odors and vectors.

3. Management of inadvertent film plastic and debris has improved on Highway 25. Most of the site was observed free of windswept film plastic litter and well maintained.

4. Most site roadways were observed well maintained. Continue to ensure that a 20-foot perimeter road clearance is always maintained for fire safety and accessibility.

5. Odors were detected from the Area 1 storm water retention pond and Area 2 detention basin. Observed moderate levels of operational water in the pond, and moderate levels of operational water contained within the basin. Continue to monitor and mitigate the potential for mosquito propagation at drainage facilities, and liquids and storm water at pond and basins.

6. Scrap metal as well as disassembled processing equipment was observed stockpiled at the scrapyard in Area 2. New tarping material appears to be installed to cover processing equipment. Other scrap metal and disassembled processing equipment appear to be partially covered with damaged or missing tarping material at the east side of Area 2. Per operator, this material is required by RWQCB to be covered with tarps during the rainy season. Continue to maintain the coverings of scrap metal and disassembled processing equipment.

7. Chipping and grinding activities were being conducted during the inspection.

8. Large stockpiles of unscreened compost were observed stored in Area 1 adjacent to the CTI bags. Continue to ensure sufficient aisle space is provided for fire prevention.

9. The temperature probe readings from three sampled organic compost windrows of Lot #2330, C15, C16, and C17 were 164-166F. Continue to ensure proper windrow management for fire prevention, handling, and pathogen reduction. Pathogen reduction data for the 3 windrows was reviewed and found to be compliant.

10. Pathogen reduction data for CTI bags D3 (12-13-2023), D4 (12-15-2023), D5 (12-16-2023) was reviewed and found to be compliant.

11. Mulch was observed being utilized in some mudded areas around the CTI bags with ponded contact water. Continue to ensure that mulch is added to all other ponded areas to control odors, vectors, and absorb water or any leachate that may seep from CTI system composting bags.

12. A decrease in fly population was observed during the inspection. Fly population was low throughout the facility.

13. Blackbirds were observed at various locations on the site during the inspection. Continue to ensure that measures are employed to control vectors.

14. The area between the hammer mill and the processing building were observed to be wet and muddy due to the acclimate weather at the time of the inspection. Some windswept film plastic was observed. Continue to ensure that windswept litter in this area is managed to prevent offsite migration and prevent safety hazards.

15. Litter fences site-wide were observed generally in good condition.

16. The wind was not measured during the time of this inspection.

17. Pre-screened stockpiles observed to be well-managed and lower than previous months. Per operator, two “Powerscreen” mobile trommel screen machines are currently being used in the interim to support the repair of the two original trommel screen machines.

18. ‘GKD’ Proximity Warning System sensor devices were implemented as a safety mechanism to signal to heavy equipment drivers to avoid collisions with other workers wearing sensor devices.

REPORTING:

2023 December Pathogen Concentrations:

Samples received on 1/30/2023 for Landscape Compost, 1/3/2024 for Organic Mulch, and on 1/3/2024 for Organic Compost were reviewed and found to be within acceptable pathogen concentrations. Samples received on 1/3/2024 for Lot#2323, Windrows C11-C18 and Lot #2322, Windrows C1-C10, were reviewed and found to be within acceptable pathogen concentrations.

2023 December Metal Concentrations:

1/3/2024 for Landscape Compost, 1/3/2024 for Organic Mulch, and on 1/3/2024 for Organic Compost were reviewed and found to be within acceptable metals concentrations. Samples received on 1/3/2024 for Lot#2323, Windrows C11-C18 and Lot #2322, Windrows C1-C10, were reviewed and found to be within acceptable metal concentrations.

2023 December Physical Contamination Limits:

Samples received on 1/3/2024 for Landscape Compost, 1/3/2024 for Organic Compost, and 1/3/2024 for Organic Mulch were reviewed and found to be within the required Physical Contamination Limits.

2023 December Tonnage:

Total Month Inbound Materials: 42,345.69 tons.

Total Month Outbound Materials: 24,887.40 tons.

Total Peak compostable (MSW + green waste) inbound materials = 1994.21 tons on 12/13/2023.

This amount is part of the allowed peak totals. The allowed peak totals not more than 15 days/year is 2,500 tons/day.

MSW material peak = 699.84 tons on 12/21/2023. The allowed subset peak is 700 tons per day for MSW.

Green material peak = 1296.23 tons on 12/13/2023. The allowed subset peak is 1300 tons per day for green material.

Inert Material peak = No Inert Material Reported for December 2023.The allowed subset peak is 500 tons per day for inert material.

Total outbound organic compost: 4,208.01 tons.

Peak traffic = 197 Vehicles on 12/04/2023

Permitted Traffic Volume is 356 Vehicles per day and Peak Traffic Volume (15-Day limit peaks) is 448 Vehicles per day.

Inspection Attachments

| Title | Type |
|---|---|
| **There are no Inspection Attachments.** | |

SWIS Documents

The Solid Waste Information System (Document) application provides access to all published documents available on CalRecycle's SWIS public pages. All users on the SWIS Document application will be required to sign-in with a WebPass or CalRecycle email and password.

To create a WebPass account click CalRecycle WebPass: Create Account.

If you do not wish to create a WebPass account, note the document you desire and create a California Public Records Act Request

CalRecycle Contact: Lauren Grant (916) 341-6115

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# SWIS Facility/Site Inspection Details

## Z-Best Composting Facility (43-AA-0015)

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**Enforcement Agency**
County of Santa Clara

**Local Inspection ID**
--

**Activity**
Large Volume Transfer/Processing Facility

**Operational Status**
Active

**Regulatory Status**
Permitted

**Inspection Date**
2/26/2024

**Inspected By**
Santa Clara County

**Inspection Type**
Periodic

**Inspection Frequency**
Monthly

**Received By (Operator)**
John Doyle, Operations Manager

**CalRecycle Received**
3/21/2024

**Inspector**
Jaymar Elen, LEA, REHS

Violations

| Regulation | Title | Comment |
|---|---|---|
| **There are no Violations.** | | |

## Areas of Concern

| Regulation | Title | Comment |
|---|---|---|
| **There are no Areas of Concerns.** | | |

## Inspection Report Comments

1. Sorting of mixed solid waste (MSW) in the material processing facility was not being conducted during the inspection.

2. The misting system was not in operation during the inspection.

3. Fly population in the processing building was low. Observed approximately 100 blackbirds in the processing building. Continue to ensure that measures are employed to control vectors.

4. 'GKD' Proximity Warning System sensor devices were implemented as a safety mechanism to signal to heavy equipment drivers to avoid collisions with other workers wearing sensor devices.

January 2024 Tonnage:

Peak MSW (Inbound Food Waste) received was 699.89 tons on 1/11/2024. The allowed subset peak is 700 tons per day for MSW at this facility.

Total monthly MSW (Inbound Food Waste) feedstock received was 20702.45 tons..

Total outbound MSW (Landscape) Compost: 782.57 tons.

Total outbound recyclables/ADC: 11869.54 tons.

Total outbound compost overs: 16.06 tons.
Total outbound trash: 7572.97 tons.

Peak traffic = 152 Vehicles on 01/17/2024.

Permitted Traffic Volume is 356 Vehicles per day and Peak Traffic Volume (15-Day limit peaks) is 448 Vehicles per day.

Inspection Attachments

| Title | Type |
| --- | --- |
| There are no Inspection Attachments. | |

SWIS Documents

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# SWIS Facility/Site Inspection Details

## Z-Best Composting Facility (43-AA-0015)

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**Enforcement Agency**
County of Santa Clara

**Local Inspection ID**
--

**Activity**
Composting Facility (Mixed)

**Operational Status**
Active

**Regulatory Status**
Permitted

**Inspection Date**
3/13/2024

**Inspected By**
Santa Clara County

**Inspection Type**
Periodic

**Inspection Frequency**
Monthly

**Received By (Operator)**
John Doyle, General Manager & Jorge Roacho

**CalRecycle Received**
3/27/2024

**Inspector**
Jaymar Elen, LEA, REHS

Violations

| Regulation | Title | Comment |
|---|---|---|
| **There are no Violations.** | | |

## Areas of Concern

| Regulation | Title | Comment |
|---|---|---|
| **There are no Areas of Concerns.** | | |

## Inspection Report Comments

Notes:

1. The training records, load checking logs, log of special occurrences and complaint log were reviewed for December and are up to date.

2. The roadway at the entrance to the facility and the adjacent Highway 25 were observed with some tracked mud as expected due to the current wet, rainy weather. Observed flooding on the open road area by the office building and transfer facility. Continue to control flooding/ponding to ensure proper drainage, control odors and vectors.

3. Management of inadvertent film plastic and debris has improved on Highway 25. Most of the site was observed free of windswept film plastic litter and well maintained.

4. Most site roadways were observed well maintained. Continue to ensure that a 20-foot perimeter road clearance is always maintained for fire safety and accessibility.

5. Odors were detected from the Area 1 storm water retention pond and Area 2 detention basin. Observed moderate levels of operational water in the pond, and moderate levels of operational water contained within the basin from recent rainstorms. Continue to monitor and mitigate the potential for mosquito propagation at drainage facilities, and liquids and storm water at pond and basins.

6. Scrap metal as well as disassembled processing equipment was observed stockpiled at the scrapyard in Area 2. It is observed that the amount of stockpiled scrap metal has reduced compared to previous inspections and being actively managed by a worker. New tarping material appears to be installed to cover processing equipment. Other scrap metal and disassembled processing equipment appear to be partially covered with damaged or missing tarping material at the east side of Area 2. Per operator, this material is required by RWQCB to be covered with tarps during the rainy season. Continue to maintain the coverings of scrap metal and disassembled processing equipment.

7. Chipping and grinding activities were being conducted during the inspection.

8. Large stockpiles of unscreened compost were observed stored in Area 1 adjacent to the CTI bags. Continue to ensure sufficient aisle space is provided for fire prevention.

9. The temperature probe readings from three sampled organic compost windrows of

Lot #2222, B8, B9, and B10 were 160-168F. Continue to ensure proper windrow management for fire prevention, handling, and pathogen reduction. Pathogen reduction data for the 3 windrows was reviewed and found to be compliant.

10. Pathogen reduction data for CTI bagsA19(3-1-24), A18 (2-29-24), A1 (2-14-24) was reviewed and found to be compliant.

11. Mulch was observed being utilized in some ponded areas around the CTI bags with ponded contact water. Continue to ensure that mulch is added to all other ponded areas to control odors, vectors, and absorb water or any leachate that may seep from CTI system composting bags.

12. A decrease in fly population was observed during the inspection. Fly population was low throughout the facility.

13. Blackbirds were observed at various locations on the site during the inspection. Continue to ensure that measures are employed to control vectors.

14. The area between the hammer mill and the processing building were observed to be wet and muddy due to the Inclement weather at the time of the inspection. Some windswept film plastic was observed. Continue to ensure that windswept litter in this area is managed to prevent offsite migration and prevent safety hazards.

15. Litter fences site-wide were observed generally in good condition.

16. The wind was not measured during the time of this inspection.

17. Pre-screened stockpiles observed to be well-managed and lower than previous months. Per operator, two “Powerscreen” mobile trommel screen machines are currently being used in the interim to support the repair of the two original trommel screen machines.

18. ‘GKD’ Proximity Warning System sensor devices were implemented as a safety mechanism to signal to heavy equipment drivers to avoid collisions with other workers wearing sensor devices.

19. Observed active excavating and screening of large mound of dirt and unscreened material located by the processing transfer station and screening area. Per operator,

material is being screened and processed into product.

20. Observed sampling of organic vs. incompatibles or organic vs. non-organic material during time of inspection. LEA will schedule to observe measurements to ensure measurements accurately reflect records and are being performance in accordance with the specific regulations. Continue SB1383 requirements in Title 14 relating to Compostable Material Handling Facilities & Operations and In-Vessel Digestion Facilities & Operations and Transfer/Processing Facilities and Operations become effective. Operators are required to conduct measures of source separated organic or mixed organic waste materials received and processed. These measurements are used to determine the sum of organic waste recovered and the sum of organic waste in materials sent to disposal from source separated or mixed organics waste streets.

Refer to Title 14 of the CCR for further regulator requirements, as well as the CalRecycle website: https://calrecycle.ca.gov/lea/regs/implement/

REPORTING:

2024 February Pathogen Concentrations:

Samples received on 2/23/2024 for Landscape Compost, 2/23/2024 for Organic Mulch, and on 2/23/2024 for Organic Compost were reviewed and found to be within acceptable pathogen concentrations. Samples received on 2/23/2024 for Lot#2328, Windrows B25-28 and Lot #2329, Windrows C1-C10, were reviewed and found to be within acceptable pathogen concentrations.

2024 February Metal Concentrations:

2/23/2024 for Landscape Compost, 2/23/2024 for Organic Mulch, and on 2/23/2024 for Organic Compost were reviewed and found to be within acceptable metals concentrations. Samples received on 2/23/2024 for Lot#2328, Windrows B25-28 and Lot #2329, Windrows C1-C10, were reviewed and found to be within acceptable metal concentrations.

2024 February Physical Contamination Limits:

Samples received on 1/3/2024 for Landscape Compost, 2/23/2024 for Organic Compost, and 2/23/2024 for Natural Mulch were reviewed and found to be within the required

Physical Contamination Limits.

2024 February Tonnage:

Total Month Inbound Materials: 39,979.17 tons.

Total Month Outbound Materials: 23,243.41 tons.

Total Peak compostable (MSW + green waste) inbound materials = 2074.15 tons on 02/27/2024.

This amount is part of the allowed peak totals. The allowed peak totals not more than 15 days/year is 2,500 tons/day.

MSW material peak = 699.79 tons on 2/18/2024. The allowed subset peak is 700 tons per day for MSW.

Green material peak = 1291.72 tons on 2/27/2024. The allowed subset peak is 1300 tons per day for green material.

Inert Material peak = 93.13 Tons for 2/27/2024 and 1/23/2024. The allowed subset peak is 500 tons per day for inert material.

Total outbound organic compost: 3790.22 tons.

Peak traffic = 167 Vehicles on 2/12/2024.

Permitted Traffic Volume is 356 Vehicles per day and Peak Traffic Volume (15-Day limit peaks) is 448 Vehicles per day.

Inspection Attachments

| Title | Type |
| --- | --- |
| **There are no Inspection Attachments.** | |

SWIS Documents

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# SWIS Facility/Site Inspection Details

## Z-Best Composting Facility (43-AA-0015)

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**Enforcement Agency**
County of Santa Clara

**Local Inspection ID**
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**Activity**
Composting Facility (Mixed)

**Operational Status**
Active

**Regulatory Status**
Permitted

**Inspection Date**
4/29/2024

**Inspected By**
Santa Clara County

**Inspection Type**
Periodic

**Inspection Frequency**
Monthly

**Received By (Operator)**
John Doyle, General Manager

**CalRecycle Received**
5/28/2024

**Inspector**
Jaymar Elen, LEA, REHS

Violations

| Regulation | Title | Comment |
|---|---|---|
| **There are no Violations.** | | |

## Areas of Concern

| Regulation | Title | Comment |
|---|---|---|
| **There are no Areas of Concerns.** | | |

## Inspection Report Comments

1. The training records, load checking logs, log of special occurrences and complaint log were reviewed for March 2024 and are up to date.

2. The roadway at the entrance to the facility and the adjacent Highway 25 were observed with some tracked mud as expected due to the current wet, rainy weather. Observed flooding on the open road area by the office building and transfer facility. Continue to control flooding/ponding to ensure proper drainage, control odors and vectors.

3. Management of inadvertent film plastic and debris has improved on Highway 25. Most of the site was observed free of windswept film plastic litter and well maintained.

4. Most site roadways were observed well maintained. Continue to ensure that a 20-foot perimeter road clearance is always maintained for fire safety and accessibility.

5. Odors were detected from the Area 1 storm water retention pond and Area 2 detention basin. Observed moderate levels of operational water in the pond, and moderate levels of operational water contained within the basin from recent rainstorms. Continue to monitor and mitigate the potential for mosquito propagation at drainage facilities, and liquids and storm water at pond and basins.

6. Scrap metal as well as disassembled processing equipment was observed stockpiled at the scrapyard in Area 2. It is observed that the amount of stockpiled scrap metal has reduced compared to previous inspections and being actively managed by a worker. New tarping material appears to be installed to cover processing equipment. Other scrap metal and disassembled processing equipment appear to be partially covered with damaged or missing tarping material at the east side of Area 2. Per operator, this material is required by RWQCB to be covered with tarps during the rainy season. Continue to maintain the coverings of scrap metal and disassembled processing equipment. Per operator, the scrap metal is sent to Pacific Coast Recycling for recycling.

7. Chipping and grinding activities were being conducted during the inspection.

8. Large stockpiles of unscreened compost were observed stored in Area 1 adjacent to the CTI bags. Continue to ensure sufficient aisle space is provided for fire prevention.

9. The temperature probe readings from three sampled organic compost windrows of Lot #2407, B14, B15, and B16 were 150-164F. Continue to ensure proper windrow management for fire prevention, handling, and pathogen reduction. Pathogen

reduction data for the 3 windrows was reviewed and found to be compliant. The operator has also installed windrow markers at the end of each windrow for reference and improved recordkeeping.

10. Pathogen reduction data for CTI bags A21(3-4-2024), A22 (3-5-2024), A23 (3-6-2024) was reviewed and found to be compliant.

11. Mulch was observed being utilized in some ponded areas around the CTI bags with ponded contact water. Continue to ensure that mulch is added to all other ponded areas to control odors, vectors, and absorb water or any leachate that may seep from CTI system composting bags.

12. A decrease in fly population was observed during the inspection. Fly population was low throughout the facility.

13. Blackbirds were observed at various locations on the site during the inspection. Continue to ensure that measures are employed to control vectors.

14. Some windswept film plastic was observed between the hammer mill and the processing building. Continue to ensure that windswept litter in this area is managed to prevent offsite migration and prevent safety hazards.

15. Litter fences site-wide were observed generally in good condition.

16. The wind was not measured during the time of this inspection.

17. Pre-screened stockpiles observed to be well-managed and lower than previous months. Per operator, two "Powerscreen" mobile trommel screen machines are currently being used in the interim to support the repair of the two original trommel screen machines.

18. 'GKD' Proximity Warning System sensor devices were implemented as a safety mechanism to signal to heavy equipment drivers to avoid collisions with other workers wearing sensor devices.

19. Observed active excavating and screening of large mound of dirt and unscreened material located by the processing transfer station and screening area. Per operator, material is being screened for product or sorted and sent to Kirby Canyon landfill.

20. Observed a mound of shredded U.S. dollar bills at the green/yard waste area. Per operator, the currency notes were accepted from a contractor who works with the Federal Reserve and will be composted.

REPORTING:

2024 March Pathogen Concentrations:

Samples received on 3/28/2024 for Landscape Compost, 3/28/2024 for Organic Mulch, and on 3/28/2024 for Organic Compost were reviewed and found to be within acceptable pathogen concentrations. Samples received on 3/28/2024 for Lot#2334, Windrows B19-20, B13-B18, and Lot #2332 – Windrows B7-B12, Lot# 2331 Windrows B1-B6, Lot# 2330 Windrows C11-C21 were reviewed and found to be within acceptable pathogen concentrations.

2024 March Metal Concentrations:

3/28/2024 for Landscape Compost, 3/28/2024 for Organic Mulch, and on 3/28/2024 for Organic Compost were reviewed and found to be within acceptable metals concentrations. Samples received on 3/28/2024 for Lot#2334 Windrows B19-B20, Lot#2333 Windows B13-B18, Lot 2332 Windrows B7-B12, Lot#2331 Windows B1-B6, Lot#2330 Windows C11-C21 were reviewed and found to be within acceptable metal concentrations.

2024 March Physical Contamination Limits:

Samples received on 3/28/2024 for Landscape Compost, 3/28/2024 for Organic Compost, and 3/28/2024 for Natural Mulch were reviewed and found to be within the required Physical Contamination Limits.

2024 March Tonnage:

Total Month Inbound Materials: 38960.84 tons.

Total Month Outbound Materials: 29513.02 tons.

Total Peak compostable (MSW + green waste) inbound materials = 1498.26 tons on 03/12/2024.

This amount is part of the allowed peak totals. The allowed peak totals not more than 15 days/year is 2,500 tons/day.

MSW material peak = 699.08 tons on 03/20/2024. The allowed subset peak is 700 tons per day for MSW.

Green material peak = 856.16 tons on 3/25/2024. The allowed subset peak is 1300 tons per day for green material.

Inert Material peak = 121.98 Tons for 3/02/2024. The allowed subset peak is 500 tons per day for inert material.

Total outbound organic compost: 8059.69 tons.

Peak traffic = 163 Vehicles on 3/28/2024.

Permitted Traffic Volume is 356 Vehicles per day and Peak Traffic Volume (15-Day limit peaks) is 448 Vehicles per day.

Inspection Attachments

| Title | Type |
| --- | --- |

**There are no Inspection Attachments.**

SWIS Documents

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