United States Department of Agriculture

Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

Movement of Plastic-baled Municipal Solid Waste from Hawaii to the Continental United States

Environmental Assessment, May 2005

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Appendix A: The Risk of Introduction of Pests to the Continental United States via Plastic-baled Municipal Solid Waste from Hawaii

I. What is this document and why has it been prepared and made available to the public?

This document is an environmental assessment that has been prepared, consistent with the Animal and Plant Health Inspection Service's National Environmental Policy Act implementing procedures (Title 7 of the Code of Federal Regulations, Part 372), for the purpose of discussing how the action described below could affect the quality of the human environment. This environmental assessment is being made available to the public. Written comments are welcome and should be sent to the contact person identified in the notice making this document available to the public on or before the comment due date.

II. What proposed action is examined in this document?

The Animal and Plant Health Inspection Service is considering amending its regulations[1] to provide for the movement of municipal solid waste[2] from Hawaii into the continental United States. The regulations that currently apply to "garbage" are designed to keep harmful pests and diseases from entering the continental United States from certain points outside of the continental United States. The regulations contain provisions that apply primarily to waste generated aboard ships and aircraft and do not specifically address municipal solid waste. APHIS is considering amending its regulations to allow municipal solid waste from Hawaii to be moved to the continental United States if it is pressed, packaged, shipped, and disposed of in a manner that the Administrator determines is adequate to prevent the introduction or dissemination of plant pests, and if it is moved in compliance with all applicable laws for environmental protection. If the regulations are changed in this manner, the Administrator will evaluate specific proposals to move municipal solid waste from Hawaii under these conditions. Movements would occur under a compliance agreement.

On its face, the regulatory change APHIS is considering is environmentally benign; indeed, it is intended to ensure that appropriate

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[1] *See* Title 7 of the Code of Federal Regulations, section 330.400.

[2] For purposes of this environmental assessment, municipal solid waste will not include ash (incinerated waste), which is not regulated by the Animal and Plant Health Inspection Service, nor will it include agricultural or yard waste, which will be diverted from the waste stream destined for transport to the continental United States.

safeguards are applied to municipal solid waste moved from Hawaii. If the regulations are changed as described above, any risks to the quality of the human environment may be associated with specific applications submitted thereunder, and thereafter will be examined in the context of the National Environmental Policy Act process.

The Center for Plant Health Science and Technology of the United States Department of Agriculture developed a risk assessment (attached as appendix A to this document) that evaluates the ability of the packing and pressing technology to keep plant pests and noxious weeds from entering the continental United States.[3] This environmental assessment builds on the plant-health risk assessment and discusses aspects of environmental quality that could be affected were the packing and pressing technology employed. Environmental issues discussed below in this assessment will likely be encompassed in specific proposals that may be submitted, should amendments to the regulations be adopted. This environmental assessment is intended, in part, to facilitate consideration of those issues in the context of such specific proposals.

III. What is the purpose of and need for the proposed action?

The major landfill on Oahu, Hawaii, Waimanalo Gulch Landfill, is reaching capacity. If the agency adopts the amendments to its regulations, thus providing an alternative method to move municipal solid waste from Hawaii to the mainland United States, then unnecessary restrictions would be lessened or deleted on APHIS' quarantine of Hawaiian garbage. By permitting municipal solid waste to be transported off-island to the continental United States using the special processing method, Hawaii will have other alternatives for dealing with disposal of its municipal solid waste. The amendments have been designed to meet Hawaii's need.

IV. Are there any alternatives to the proposed action that should be considered, and, if so, what are they?

Other alternative waste disposal options may be available to Hawaii to meet its need, but none are currently before the agency. There is room for

[3] Risks to animal health have not been considered in the context of the risk assessment process because there are currently no known exotic animal diseases in Hawaii that would pose a threat of entry into the continental United States.

consideration of alternatives involving conditions of specific movements of municipal solid waste from Hawaii into the continental United States. These alternatives, however, would be reflected in further environmental analyses of specific submitted requests for movement of municipal solid waste, and could be presented as safeguards established within compliance agreements. This document will explore potential environmental effects that may be associated with the packing and pressing technology and transportation of the packaged waste from Hawaii to landfill sites in the continental United States. A "no action" alternative, which assumes that Hawaii's municipal solid waste would not be shipped off-island to the continental United States, is also considered to establish the environmental risk baseline for both the continental United States, as well as Hawaii.[4] Since the amendments do not involve "unresolved conflicts concerning alternative uses of available resources,"[5] no other alternative is considered in this document. Comments that provide feasible alternatives with supporting documentation are welcome.

V. What are the environmental effects of the proposed action and alternatives?

A. What types of impacts[6] are considered?

Regulations implementing the National Environmental Policy Act require that several types of impacts to the human environment[7] be considered. Direct effects, which are caused by the action and occur at the same time and place, must be considered. Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable, must also be considered. Finally, cumulative impacts, which are impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions, must be considered.

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[4] Under the current regulatory requirements, regulated garbage from Hawaii could be moved to the continental United States on a means of conveyance only if such garbage is contained in leak proof receptacles and is disposed of in an approved facility for incineration, sterilization, or grinding into an approved sewage system. *See* Title 7 of the Code of Federal Regulations, § 330.400(f). It appears that the volume of municipal solid waste needed to move off island makes the current regulatory requirements economically infeasible for private entities to assume the fiscal burden of such movement.

[5] Section 102(2)(E) of the National Environmental Policy Act, codified at Title 42 of the United States Code, Section 4332(2)(E). An environmental assessment must include a brief discussion "of alternatives as required by section 102(2)(E)," among other topics listed. *See* Title 40 of the Code of Federal Regulations, § 1508.9(b).

[6] The terms "effects" and "impacts," as used in this document, are synonymous.

[7] The "human environment" is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." Title 40 of the Code of Federal Regulations, section 1508.14.

Pest risks associated with movement of Hawaii's municipal solid waste to the continental United States should be considered together with any closely related actions or reasonably anticipated future actions involving similar pest risks to satisfy cumulative impacts analysis requirements. Likewise, effects on the environment from pesticides and other measures that may be used to eradicate or control introduced pests in the continental United States should not be considered apart from the effects of other pesticides or measures being used in the affected area for whatever purpose.

B. How can the amendments to the regulations, including alternatives, affect the quality of the human environment?

A threat to environmental quality in the continental United States associated with transporting municipal solid waste from Hawaii is the entry and establishment of harmful non-indigenous plant pests and noxious weeds that might accompany such waste. Harmful non-indigenous plant pests and noxious weeds that might accompany Hawaii's municipal solid waste may include noxious weed seeds, for example, that could affect an ecological niche by overtaking an area previously populated by domestic plants.

Were harmful non-indigenous species to find their way into the continental United States and become established, actions to eradicate or control these pests or weeds would be required. Such actions usually involve the use of pesticides, the potential effects of which on the quality of the human environment represent indirect impacts.

Other potential impacts that should be considered involve an increase in barge traffic and either rail or truck transport of the bales to a landfill. Increases in traffic are often associated with increased accident rates, as well as increased air and water pollution. The degree to which the increased traffic resulting from movements of municipal solid waste would have on the current accident rate or level of air and water pollution is unknown at this time, and can only be analyzed based on specific proposals to move such waste into the continental United States.

C. What aspects of environmental quality could be affected by amendments to the regulations, how, and to what degree?

In determining whether or not an environmental impact statement should be prepared for the regulatory amendments, the decisionmaker should

evaluate certain intensity factors regarding environmental quality issues. This subsection of the environmental assessment will be developed in the context of those factors and issues, which are enumerated in regulations implementing the National Environmental Policy Act.[8] Only those factors and issues that may apply will be discussed below.

To better understand the action's magnitude of impact on the quality of the human environment, the "no action" alternative establishes an environmental risk baseline. For purposes of this environmental assessment, "no action" means that APHIS would not amend its regulations to provide for the movement of municipal solid waste from Hawaii using this pressing and packaging technology. The environmental risk baseline for the continental United States, therefore, would be zero. For Hawaii, the "no action" alternative may involve an environmental risk due to the impending absence of garbage disposal options in the State of Hawaii.

Many of the potential environmental impacts discussed below arise from a scenario that assumes accidental introduction into the continental United States and potential establishment of harmful non-indigenous plant pests that could accompany Hawaii's municipal solid waste. The likelihood of such an occurrence has been evaluated for municipal solid waste that has been processed prior to shipment using a special packing and pressing technology,[9] and transported from Hawaii to the continental United States. Agency risk assessors have concluded in a plant pest risk assessment that, with certain safeguards, transportation of municipal solid waste from Hawaii to landfills in the continental United States does not pose a significant risk that harmful plant pests or noxious weeds will become established in the continental United States. Those safeguards include diversion of yard and agricultural waste from the municipal solid waste stream, monitoring of bales at certain locations by Federal inspectors, patching and re-wrapping of bales with breaches, deep burial of bales in a landfill within 75 days of wrapping, and proper chemical treatment at the site of accidental breaches, spills, and leaks. Specifically, the plant pest risk assessment found that transportation of municipal solid waste from Hawaii in plastic-wrapped, ". . .airtight bales poses an insignificant risk of pest establishment."[10] Accidental introductions would only occur in the event of a breach in the wrapping since, ". . .[a]irtight enclosure from

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[8] *See* Title 40 of the Code of Federal Regulations, § 1508.27(b). Under § 1508.27(a), the decisionmaker is also required to consider context, which "means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality."

[9] The technology involves wrapping waste bales with adhesive backed plastic film barriers made of low density polyethylene.

[10] *See "*The Risk of Introduction of Pests to the Continental United States via Plastic-Baled Municipal Solid Waste from Hawaii," United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, March 2005, at p. 8.

creation to burial would completely mitigate the risks of establishment by any plant pest."[11]

While it is unlikely that any insect pest will survive the packing and pressing process, potential threats involving weed seeds, bacteria, and nematodes could remain an issue were the wrapping to be breached. The risk assessment for moving Hawaii's municipal solid waste to the continental United States considered the likelihood of establishment of insects, plant pathogens, and weeds to be low.

Since the pest risk associated with moving municipal solid waste from Hawaii to the continental United States has been determined to be insignificant,[12] but not zero, the following discussion assumes that harmful non-indigenous plant pests associated with transportation of Hawaii's municipal solid waste will gain entry into the continental United States and threaten to or become established. The magnitude of potential impacts—direct, indirect, and cumulative—stemming from introduction of pests of concern will depend largely on how quickly those pests that have been introduced into the mainland are detected and treated. If quickly detected and treated, the pests, as well as treatments to eradicate or control them, are likely to do very little, if any, damage to the quality of the environment. The longer such pests go undetected and untreated, the greater the likelihood that they could become established.[13] If such pest establishment were to occur, the event may be capable of causing, directly and indirectly, substantial harm to the quality of the environment.

1. Public Health and Safety

In Hawaii, public health could be affected directly under the no action alternative because a buildup of municipal solid waste, due to the lack of disposal options, could result in the possibility of increased encroachment of vermin such as rats, fleas, and other pests and their associated diseases, into the human population. Illness could also arise as a result of inhaling foul air, which may also contain human pathogens, or as a result of ingesting pathogens that might leak from contaminated waste into water bodies or groundwater.

In the continental United States, public safety could be directly affected by a potential increase in waterway and rail or highway traffic arising through movement of municipal solid waste from Hawaii—an increase in barges

[11] *Id.* at p. 1
[12] *Id* at p. 8
[13] Introductions of pest species into the environment, whether unintended or intended, have the potential to result in localized infestations. If enough viable pest species of the proper life stage are transported along a pathway to a site with favorable habitat, the likelihood of an infestation there is high, and damage to the local environment is probable. The potential expansion of pest populations (and the associated expansion of damage to native hosts) poses a greater threat to the environment than the initial introduction of the pest.

arriving at ports in the continental United States and the potential for congestion at those ports, an increase in barges traveling up and down rivers in the continental United States, and an increase in rail or truck traffic carrying municipal solid waste in wrapped bales from a receiving facility to a landfill. An indirect effect could include the possibility of water pollution that could be caused by additional barge traffic and the potential for more accidents on the waterways, some of which could result in ruptures of the baled municipal solid waste or loss of cargo.[14]

Public health in the continental United States also could be affected indirectly through the use of pesticides to eradicate or control any plant pests or noxious weeds that gain entry into the continental United States and threaten to become established. According to the risk assessment, the most likely pests to gain such entry are some plant pathogens and noxious weed seeds, but the risk of entry has been determined to be low. Animal health issues are not involved in this action because there are no known exotic animal diseases in Hawaii that would pose a threat of entry into the continental United States.

The United States Environmental Protection Agency has determined that the use of registered pesticides, consistent with directions contained on the label, poses no undue risk to human health or the environment. The greatest potential health risk involved with pesticide use is often to applicators. Such risks are minimized, however, by requirements for applicators to adhere to published program guidance and by carefully following label instructions. Any applications of pesticides by APHIS would be conducted consistent with label directions and program guidance.

The likelihood for pathogens and weed seeds from Hawaii to become established in the continental United States is remote because, according to the risk assessment, ". . .[d]ispersal to a susceptible host by pathogens or to a suitable site for growth by weeds is highly unlikely, assuming clean up procedures are followed scrupulously."[15]

Upon detection of harmful non-indigenous pests or noxious weeds, and before any action is taken, the agency conducts a thorough investigation of

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[14] The risk assessment states that ". . .the accident rate for trucks carrying hazardous materials based on 1996 data was 0.32 accidents per million vehicle-miles. . ."and". . .for non-hazardous materials. . . [it was]. . . 0.73 accidents per million vehicle-miles. If we assume the average one-way (loaded) truck trip to a landfill will be 25 miles and use the rate for trucks carrying hazardous materials, then on average one accident would occur every 125,000 trips. Using the rate for trucks carrying non-hazardous materials gives an average of one accident every 55,000 trips." *See* "The Risk of Introduction of Pests to the Continental United States via Plastic-baled Municipal Solid Waste from Hawaii," United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, April 2005, at p. 6.

[15] *Id*. at p. 7.

the affected area and ensures that environmental impact issues are addressed appropriately, often through the preparation of an environmental assessment.

2. Unique Characteristics of the Geographic Area

Barge and truck transportation routes may pass through areas that possess unique characteristics, including, but not limited to, ecologically critical areas and scenic areas. If bales of municipal solid waste in transit along the route through an area possessing unique characteristics were accidentally breached, pest or weed species of concern could conceivably escape into the environment. Were pest or weed species of concern to be introduced into such an area and become established, potentially adverse effects on ecosystem components of the area could be experienced. Impacted ecosystem components, especially non-target organisms, could be further stressed indirectly by actions to eradicate or control the introduced pests using pesticides.

Upon receipt of specific proposals to move packed and pressed municipal waste into specific areas of the continental United States, the decisionmaker will analyze measures, during the environmental assessment process, designed to reduce the potential risks to a specific area's unique characteristics. Those measures will be documented as possible mitigation strategies. Following public comment, the decisionmaker will direct in its decision on the proposal that all measures necessary and appropriate to protect, insofar as possible, any unique characteristics of an affected area be taken. Any such measures would be reflected in a compliance agreement.

3. Precedent for Future Actions

If the regulations are amended to provide for the conditional movement of municipal solid waste from Hawaii to points in the continental United States, any qualified waste handler could submit a proposal to move municipal solid waste from Hawaii under the regulations. The likelihood that plant pests or noxious weeds not indigenous to the continental United States could be introduced into the continental United States as a result has been considered. The risk assessment concludes that, as "long as the proposed procedures are followed—including diversion of yard and agricultural waste, staging and prompt shipment, monitoring and inspection of bales, and thorough clean up of any ruptures that do occur—establishment of plant pests from Hawaii via this pathway is highly unlikely."[16] Potential risks associated with any proposals submitted to the Administrator will be examined and environmental assessments will be prepared. Thus, notwithstanding the precedent established in the regulations, if amended, the quality of the human environment in the continental United States will be adequately safeguarded.

[16] *Id.*, at p. 8.

4. Significant Cumulative Impacts

There is potential for environmental quality to be adversely affected whenever materials and goods with which harmful non-indigenous pests or noxious weeds may be associated are permitted entry into the continental United States. Many such entries are authorized each year for many different kinds of materials and goods with which a wide variety of pests or noxious weeds not indigenous to the continental United States may be associated. These authorizations may be viewed cumulatively as increasing somewhat the risk that harmful pests or noxious weeds will be introduced into the continental United States, infest an area, and directly, or indirectly through eradication or control programs, adversely affect environmental quality. But safeguards currently in place, together with measures that may be required to be taken on a case-by-case basis to keep harmful non-indigenous pests from entering the continental United States, are designed in every case to collectively reduce pest risks to a minimum.

There is also potential for cumulative harm to the environment from the use of pesticides to treat infestations that may occur. The nature and extent of cumulative risks depend upon the proximity in time and space of pesticide applications to other pesticide-type treatments that impact the human environment in a similar manner. Some pesticide residues persist for extended periods in the environment, such that recovery of non-target species populations from previous treatments in the area may be hindered by any additional program treatments. Private or commercial pesticide applications, often beyond control of the agency, in or near a program treatment area can serve to exacerbate the potential for harm to the affected environment. Finally, some pesticides are known to interact chemically with other agrochemicals to produce substances that pose an even greater risk to the human environment. This synergism is often difficult to measure, but should be considered nevertheless.

Whereas it is difficult for the decisionmaker to analyze such impacts without proposals for specific movements into the continental United States, cumulative and synergistic impacts associated with pesticide use and other measures to deal with pest or noxious weed infestations will be considered in the context of site-specific environmental assessments.

5. Endangered or Threatened Species and Critical Habitat

It is unlikely, according to the risk assessment, that any insect pest will survive the packing and pressing process, although it has been determined that some weed seeds and plant pathogens could survive the process. Thus, endangered or threatened species and critical habitat could be potentially affected by plant pest species, if at all, in the event of a breach in the wrapping. Should that happen, the potential exists for weed seeds and plant pathogens to escape into the environment and adversely affect protected species and critical habitats, were any located in the area.

Actions taken to eradicate or control infestations in areas in which endangered or threatened species or critical habitat may be located, such as use of pesticides or removal of weed species, could also adversely affect such species and habitat.

A potential source of noxious weed seeds and plant pathogens in Hawaii is yard and agricultural waste, which may contain plant parts. Weed seeds and plant pathogens are the only plant pests that could survive in the anoxic environment of packed and pressed municipal solid waste. For this reason, yard and agricultural waste will be excluded from the waste stream destined for shipment from Hawaii to the mainland, so that the possibility that noxious weed seeds or plant pathogens are within the municipal solid waste is minimized. Therefore, the potential threat to endangered or threatened species and critical habitat from noxious weed establishment or plant pathogen infestation is mitigated. Remaining waste, consisting mainly of paper, discarded cans and bottles, food scraps, and other items would be unlikely to harbor weed seeds or plant pathogens. Accordingly, listed endangered or threatened species and critical habitat in the continental United States are unlikely to experience ill effects from plant pests as a result of municipal solid waste in packed and pressed bales from Hawaii.

Listed endangered or threatened aquatic organisms and their habitat, located in the environments traversed by transport barges, should also be considered. A risk to listed species, especially aquatic species, could stem from the increase in barge traffic, and from transferring bales of municipal solid waste from one mode of conveyance to another at some point along the waterway transportation route. Transfer of bales from barges to the on-ground receiving facility increases the chances that a breach in the bale wrap might occur, thereby allowing weed seeds or plant pathogens that may be contained in the municipal solid waste to escape into the environment.

Potential effects on endangered or threatened species or critical habitat of pesticides and other measures that may be used to deal with pests or noxious weeds of concern, if and when they are introduced into areas of the continental United States, will be considered in the context of site-specific investigations and studies.

6. Other Considerations

Some executive orders, such as Executive Order No. 13175, Consultation and Coordination with Indian Tribal Governments, as well as departmental or agency directives, call for special reviews and consultation in certain circumstances. Some Native American Tribes have expressed concerns regarding the proposal to move municipal solid waste from Hawaii to

points in the continental United States. This document is intended, in part, to stimulate exchanges about issues of concern.

VI. What agencies and persons have been consulted?

Washington State Department of Agriculture

United States Coast Guard

United States Army Corps of Engineers

Hawaii Department of Environmental Health

Appendix A: The Risk of Introduction of Pests to the Continental United States via Plastic-baled Municipal Solid Waste from Hawaii

United States Department of Agriculture

Animal and Plant Health Inspection Service

April 2005

The Risk of Introduction of Pests to the Continental United States via Plastic-Baled Municipal Solid Waste from Hawaii

Executive Summary

Large volumes of municipal solid waste may be transported in airtight bales from Hawaii to landfills in the continental United States. The bales are created by shredding, compressing, and wrapping waste in adhesive-backed, plastic film barriers. Because garbage from Hawaii cannot enter the continental U.S. under federal regulations for plant pests, we assessed the risks of plant pest establishment via this pathway.

Airtight enclosure from creation to burial would completely mitigate the risks of establishment by any plant pests. Therefore, this pest risk assessment focused upon the soundness of baling technology and the safety of the general pathway, considering here only those processes likely to apply to all proposals to transport baled solid waste from Hawaii. Some processes, such as where landfills are located and which types of transport will be used on the mainland, will be evaluated separately for each particular proposal to identify any exceptionally significant risk factors.

Manufacturer and independent research indicated that the baling technology performs well. It seems likely to mitigate the risk from all types of plant pests. In particular, insects and some pathogens are unlikely to survive in the bales because of compression, anoxia, and the absence of hosts. Other procedures, such as bale construction, monitoring during transport, and burial in regulated landfills, should adequately protect against escapes via accidental ruptures and punctures during handling and transport. Compliance with general procedures, such as diversion of yard and agricultural waste, and staging and prompt shipment of bales, is also important. We concluded that if these procedures are followed, transportation of municipal solid waste from Hawaii in bales poses an insignificant risk of pest establishment. In addition, we recommend that the pathway be monitored to ensure that pathway processes and compliance do not differ significantly from what was described here.

I. Introduction

The State of Hawaii has requested an assessment of the feasibility of transporting baled municipal solid waste from Hawaii to landfills in the continental United States. The garbage will be baled by compressing and wrapping in adhesive-backed, plastic film barriers made of low density polyethylene (LDPE), creating airtight packages. Bales would be transported by barge to the mainland and then perhaps by other means, and ultimately buried intact in landfills in accordance with regulations for solid waste disposal (40CFR§258; EPA (1993)). The potential volume of waste to be transported may be about 200,000 tons per year per company. Garbage from Hawaii is not enterable under current federal regulations for plant pests (7CFR§330.400). Therefore, an assessment of the risks of plant pest establishment via baled solid waste from Hawaii to the continental U.S. is needed. The federal agency in charge of such assessments is the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA). This assessment was done by the Center for Plant Health Science and Technology (CPHST).

The objective of this report is to evaluate whether the baling technology effectively mitigates potential pest risks for urban solid waste from Hawaii. The assessment focuses upon the unique baling technology to be used, because airtight enclosure from creation to burial would completely mitigate the risks of establishment by any plant pests. Thus, the main questions of interest here are "Does the baling technology provide a strong, airtight barrier?" and "How likely are ruptures or punctures?" We also assess whether general pathway procedures would reduce pest incidence in the bales or the chances of escape in the event of accidental ruptures or punctures. A qualitative recommendation is given based on the likelihood of introduction. Only those pathway processes likely to be common to all company proposals to transport baled waste from Hawaii were considered. Separate assessments for particular company proposals will address factors such as the destination landfill, type of transportation to be used on the mainland, and pest species that may pose particular threats.

II. Definitions

Garbage is defined as urban (commercial and residential) solid waste from the municipality of Honolulu, Hawaii. Based on proposals to move baled waste (not shown), this analysis assumes that yard and agricultural waste will be actively excluded from the waste stream. Therefore, the relative volume of any such waste accidentally entering the pathway should be very small. If it was found that such waste was not typically excluded, a revised assessment might be necessary.

A spill is defined as the escape of waste material from a bale and contact with the ground, truck, tractor, barge, or other terrestrial feature.

Other important terms are defined as follows, in alphabetic order (Merriam-Webster, 2004):

Anoxia: hypoxia especially of such severity as to result in permanent damage
Anoxic: greatly deficient in oxygen
Hypoxia: a deficiency of oxygen reaching the tissues of the body

Anaerobic means living, active, occurring, or existing in the absence of free oxygen. Thus, the term anaerobic is only correctly applied to organisms, not non-living things like bales or the conditions within them.

III. Detailed overview

Some details will be specific to each company proposal, such as the landfill site and means of transport within the continental U.S., but probable general characteristics related to the pathway include the following:

1) The material to be transported is urban solid waste;
2) Agricultural and yard waste will be diverted to other transfer stations and waste streams;
3) A baling system will be used to create high-density (ca. 1000 pounds per cubic yard) bales wrapped with at least four layers of adhesive-backed plastic;
4) The shape and weight of the bales depends on the technology used but weights from 2 to 12 tons might be expected;
5) Bales will be stored, or 'staged,' for some time before transport to allow bales to become anoxic (e.g., five days in PRER (2004));
6) Manifested bales will be moved on barges to the mainland, a trip of about 12 to 18 days;
7) Bales will eventually be unloaded and moved by truck to a landfill;
8) In procedures likely to be specified in compliance agreements, companies will monitor bales to detect ruptures and punctures during transport, with particular regard for handling operations (loading and unloading), and reporting to PPQ and State authorities as appropriate;
9) Bales placed in the landfill will be covered with at least six inches of soil within 24 hours (EPA, 1993); and
10) Landfilled bales will ultimately be covered by at least seven feet of material if placed on the top (final) waste layer but many more feet if placed closer to the bottom layer.

Other important points include the following:

- Hazardous and liquid wastes will be diverted or removed before shredding and baling;
- Waste and bales will not contact bare ground after collection or wrapping;
- imperfectly sealed bales found during staging in Hawaii will be rewrapped and re-staged;
- Fewer ruptures of bales seem likely to occur with tractors that have grabbing rather than forked lift arms (Figure 1);
- Companies will deal appropriately with punctures and small ruptures detected after shipment;
- companies will handle larger ruptures by collecting spilled waste, storing all waste in sealed containers, and rewrapping and re-staging waste;
- spills will be cleaned up and disinfected according to USDA guidelines for spills of international garbage (PPQ, 2004);
- All ruptures will be documented and reported regularly to PPQ and State officials;
- destination landfills will be modern facilities that meet all regulations for design and operation (e.g., EPA, 1993).

Figure 1. Example tractor with 'grabbing' lift arms for handling bales.

IV. Validity of the baling technology

Information about the waste-baling technology came from DEKRA Umwelt, Germany (DEKRA, 1996), an original manufacturer of baling and wrapping technology, and from independent research (see below) that corroborated and extended those findings. The original DEKRA study (in German) was requested but was unavailable; the contents of the translated report (provided in Pacific Rim Environmental Resources, 2004) were substantiated by independent descriptions (e.g., Baldasano et al., 2003). Additional information on procedures and safety for baled garbage came from Roll Press Pack International, Ltd. (2004), RPP America (2004), and Cross Wrap (2004), which all manufacture and use the baling technology similarly.

The basics of the baling technology are that waste material is shredded if necessary, compressed to a high density, wrapped with bands or netting to maintain shape, and then wrapped with adhesive-coated LDPE. At least four layers of plastic are used, forming a strong, airtight barrier. Bale shape depends on the process, with cylinders created in "roll-press" systems and rectangles created in ramming systems (e.g., Baldasano et al., 2003). Roll-press systems tend to result in bales with less trapped air (Sieger and Kewitz, 1997). The degree of compression is typically greater with rectangular bales, and more liquid is pressed out as well. Bale densities are expected to be in the range of 800 to 1100 kg/m^3 (ca. 1300 to 1800 lbs/yd^3) (Baldasano et al., 2003).

The bales become anoxic within a few days after wrapping (Paillat and Gaillard, 2001; Robles-Martinez and Gourdon, 1999). Normal O_2 concentrations are 21% (21 kPa) but were near 2% (ca. 2 kPa) in the bales. Because of that and other factors, very little biodegradation or production of gases occurs.

The wrapping is strong as well as airtight. According to Baldasano et al. (2003), the LDPE "...has a high, although not total, degree of resistance to perforation and tearing." Pre-stretching helps maintain bale shape, increases adhesion, and helps prevent ruptures. Bales weighing less

than 1000 kg did not rupture when dropped from a height of 3 m (DEKRA, 1996). A user in Utah confirmed that larger bales rupture when dropped 10 to 25 feet onto the vertical sides of railroad cars (pers. comm., Barry Edwards, North Pointe Waste Transfer Station, Lindon, UT). USDA will not allow baled municipal solid waste to be handled that way. Pointed or sharp objects within the bales can perforate the plastic (Baldasano et al., 2003) but we found no indication that this has commonly occurred.

Under normal storage conditions, the bales typically remain airtight for many months (Robles-Martinez and Gourdon, 2000). Sunlight degrades plastic films but even then useful life exceeds 100 days (Paillat and Gaillard, 2001). Baldasano et al. (2003) estimated a safe storage time in sunlight of 12 months. It is unlikely that the combined storage and transit time from Hawaii to the mainland would exceed 100 days (see below).

In addition, the adhesive-backing gives some self-sealing capability to the plastic film (Paillat and Gaillard, 2001). Small ruptures (size unspecified) tend to become airtight again after some time. That, and the density of the waste itself, should help mitigate the chance of material escaping through punctures and small ruptures but cannot be relied upon exclusively. The plastic or metal netting used in some baling technologies to maintain shape would also limit the ability of plant pests to escape through ruptures but the rectangular bale system apparently uses straps rather than netting.

Overall, the waste baling technology using adhesive-backed plastics seems very sound, providing a strong, airtight bale that can be safely stored, transported, and handled.

V. Pest risk mitigations

Mitigations considered here either result from the baling technology itself or features of the proposed pathway, including the waste type, and how bales are staged, handled, transported, and buried.

Mitigations from the baling technology

Bales that remain airtight from creation until burial completely mitigate the risk from all plant pests because the pests and pest propagules cannot escape. That mitigation is universal, i.e. it does not depend on pest type or taxonomy, and probably applies equally to both current and future pests that establish in Hawaii. Because of the possibility of accidental ruptures or punctures, however, we also consider pest mortality and the effects of other pathway factors.

Shredding and compaction would likely kill most insects (see Montgomery and Manning, 2004), regardless of stage, since the achieved density should be in excess of 800 kg/m^3 (above). This would therefore greatly reduce the possibility of boring-type insects chewing through the plastic wrapping, which, moreover, would only be possible if those insects ended up on the outermost surface of the compacted waste. Shredding and compaction may also neutralize some weed seeds and nematodes.

Anoxia would kill any insects and insect propagules that remain viable in the bales, probably within a few days (Hinton, 1981; Hoback and Stanley, 2001; Montgomery and Manning, 2004; Woods and Hill, 2004). This idea has been used for centuries for pest-free food storage (e.g., De Lima, 1990). Adults and eggs are probably most sensitive to hypoxia (Hoback and Stanley, 2001). Insect mortality is important because, of the pest organisms considered here, only insects actively disperse.

Anoxia by itself would not kill most weed seeds (Paillat and Gaillard, 2001). Some pathogens would be killed by persistent anoxia, such as some bacteria and nematodes, but many others could be unaffected (pers. comm., L.M. Ferguson, CPHST).

Mitigation from pathway procedures

Waste stream – Diversion of yard and agricultural waste to other facilities should reduce the number of potential pests and pest propagules in this pathway to very low levels. Plant pests or pest propagules are highly unlikely to be present in municipal waste shipments. Any potential hosts or contaminants, such as discarded fruits and flowers, will likely be an extremely small proportion of the total volume of waste.

Staging – The minimum staging plus transport time is about 15 days (not shown), which is more than enough time for the bales to become anoxic. The maximum staging plus trip time is unknown. We recommend a waiting period before transport of less than 75 days (ca. two and one-half months) to avoid nearing the 100-day period for the earliest possible degradation by sunlight (above).

Handling – Ruptures and punctures of bales are most likely to occur during loading and unloading; moving accidents will probably be even rarer. Rates are as yet unknown. Punctures seem very unlikely to occur if tractors have grabbing lift arms rather than forks. Moderately-sized bales can rupture when dropped from heights of about 3 m (above). That probably depends upon bale weight and shape and other factors. Using tractors like that in Fig. 1 will greatly reduce the risk of drops from significant heights, even if bales are occasionally stacked 3 m high or more, such as might happen during staging.

Transport on the mainland – Specific transportation means will be evaluated more fully in assessments for specific proposals. We note, however, that in general the accident rates are low for transport of cargo by truck (see below), barge (Bureau of Transportation Statistics, 2004), and rail (Federal Railroad Administration, 2004).

Transport by truck to the landfill – The risk of catastrophic rupture of bales because of truck accidents is likely to be very low. For example, the accident rate for trucks carrying hazardous materials based on 1996 data was 0.32 accidents per million vehicle-miles (Federal Motor Carrier Safety Administration, 2002). The same rate for non-hazardous materials was still very small: 0.73 accidents per million vehicle-miles. If we assume the average one-way (loaded) truck trip to a landfill will be 25 miles and use the rate for trucks carrying hazardous materials, then on average one accident would occur every 125,000 trips. Using the rate for trucks carrying non-hazardous materials gives an average of one accident every 55,000 trips.

Monitoring – Companies will likely be responsible for monitoring to detect punctures and ruptures, with compliance monitored by PPQ and/or State personnel. Ruptures are highly likely to be detected, since they will probably result from drops, and we expect any dropped bales to be inspected carefully at that time. Punctures are less likely to be detected but, if fork-type lift arms are not used, are also much less likely to occur and more likely to self-seal (above). As discussed above, escapes are highly unlikely unless significant amounts of waste are ejected in a rupture.

Clean up – Bale density, binding materials, and the self-sealing ability of the LDPE should all limit the amount of escaping material. Most weed seeds and plant pathogens will have little or no ability to disperse after a spill. One exception may be spores which are small enough for wind-dispersal. Dispersal to a susceptible host by pathogens or to a suitable site for growth by weeds is highly unlikely, assuming clean up procedures are followed scrupulously. Thorough cleaning should capture nearly all waste material (except under exceptional circumstances), and proper use of approved disinfectants (PPQ, 2004) will likely control any escaped pathogens.

Landfill – Only airtight bales are likely to enter the landfill, and, assuming similar handling equipment to that used previously, ruptures during placement will be unlikely. Covering with a 6-inch barrier of soil or other material (see 40CFR§258.21) within 24 hours will further mitigate the possibility of dispersal of plant pests or propagules, by both natural and vector-caused means. Baled waste is unlikely to be attractive to vectors because of its makeup and the lack of odorous biodegradation (above). In addition, we do not know whether bales can rupture due to tractor activity on top of them, but it seems unlikely given bale density, wrapping strength, and dispersal of tractor weight across treads. Ultimately, landfilled bales will be covered with from seven to dozens of feet of materials (see 40 CFR §258.60), depending upon the layer in which they are placed. In addition, the final cover has water-impermeable layers.

VI. Potential plant pests

Specific pests are not addressed here because the species of interest will depend upon the destination, and because the baling technology is universally effective against all types of pests if bales remain airtight (above).

VII. Qualitative risk assessment

The waste-baling technology is sound and should ensure that waste is shipped only in strong, airtight bales. The baling technology probably does not kill most plant pathogens and weed seeds in the bales but does make their escape extremely unlikely. It especially mitigates against insect pests because of anoxia-induced mortality within a few days. Pathogens and weed seeds cannot actively disperse and except for significant ruptures would have little chance of escaping to contact acceptable hosts or suitable growth sites. Because of the structure of the bales, only catastrophic ruptures—which should always be detected—might facilitate significant dispersal of pests or pest propagules. The handling technology, strength of the plastic wrapping and strapping materials, and the probable small accident rate for final transport to the landfill (above) reduce the likelihood of ruptures. Other procedures, such as patching or re-wrapping bales, cleanup and disinfection, and restaging bales will provide further mitigation.

These factors were codified qualitatively for the likelihood of introduction (PPQ, 2000). Some subelements were removed because they did not apply to this pathway, and totals were revised accordingly. Only the general pest classes of insects, pathogens, and weeds were scored, because the baling technology is so broadly effective, and the very small likelihood of introduction for any particular species or pathogen. For each subelement a score of either none = 0, low = 1, moderate = 2, or high = 3, was given. Values of zero are not usually possible but were reasonable here because of the effectiveness of the technology. Cumulative risk rating intervals were low = 0 to 6, moderate = 7 to 9, and high = 10 to 12 (after PPQ, 2000).

The likelihood of introduction of plant pests via this pathway was lowest for insects (Table 1), as expected due to mortality in the anoxic bales. Cumulative ratings for pathogens and weeds were greater because of the increased likelihood of survival inside the bales, but were still low overall. Even if we assumed a moderate rate for accidental ruptures of bales, the likelihood of pests dispersing and coming in contact with a suitable host or site would still be low (= 1; see above), and therefore the overall risk would still be low (total = 6 for pathogens and weeds).

Table 1. Qualitative risk ratings for the likelihood of introduction into the continental U.S. for three pest types from municipal solid waste from Hawaii in airtight bales.

Pests	Risk subelements				Cumulative risk ratings
	1 Annual quantity imported	2 Survive baling and shipment	3 Moved to suitable habitat	4 Contact suitable host or site	
Insects	1	0	0	0	1
Pathogens	1	2	2	0	5
Weeds	1	2	2	0	5

VIII. Conclusions

Transportation of urban solid waste from Hawaii to the continental U.S. in airtight bales poses an insignificant risk of pest establishment. That is because the baling technology mitigates the risk from all types of plant pests and the other pathway procedures should adequately protect against accidental ruptures and punctures in bales during the handling and transport process and subsequent escapes. So long as the proposed procedures are followed—including diversion of yard and agricultural waste, staging and prompt shipment, monitoring and inspection of bales, and thorough clean up of any ruptures that do occur—establishment of plant pests from Hawaii via this pathway is highly unlikely. As this is a new pathway, we recommend that it be monitored for some time to ensure compliance with the procedures described here and that no pathway characteristics differ dramatically from those described here.

Last, only the pest risk associated with the pathway was addressed here. Although we concluded that the overall pest risk was low, complete approval by USDA for the pathway or particular procedures should not be inferred. The pathway, in whole or in part, may still be subject to denial or modification based upon other constraints (pest or non-pest related), such as logistics, available resources, or other Federal regulations.

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