Before the Hearing Commissioners appointed by Hawke's Bay Regional Council & Hastings District Council

In the matter	of the Resource Management Act 1991 **(the Act)**
And in the matter	of an application by The Te Mata Mushroom Company Limited to discharge contaminants into air from a composting and mushroom growing operation and associated activities at 174-176 Brookvale Road, Havelock North
And in the matter	of an application by The Te Mata Mushroom Company Limited to expand an existing intensive rural production activity at 174-176 Brookvale Road, Hastings

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Statement of evidence of Bryan Holyoake, Chemical Engineer, BE (Hons) University of Auckland

17 July 2019

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LJB-120563-1-80-V1:KJC

INTRODUCTION

Qualifications and experience

1 I am a Chemical & Materials Engineer. I graduated with an Engineering degree with honours from the University of Auckland School of Engineering in 2005.

2 I own, lead, and am the principal consultant engineer at a New Zealand business, Armatec Environmental Ltd, that specialises in Air Pollution Control and Odour Control systems. Our range of services include advice & consultancy, design, manufacture & supply, installation & commissioning, and providing onsite support services to end operators. Our systems and technologies cover a wide range of the aspects of odour control including containment, extraction, treatment and discharge of odorous air including product ranges such as covers & hoods, ducting, fans, odour treatment system and stack discharge. We have over 25 staff, been in operation for over 35 years and designed and provided many successful odour control and air pollution control systems across New Zealand, Australia and internationally to satisfy many different air discharge resource consent permits and organisational process demands.

3 Our opinion, technology and solutions are frequently sought by many of the large-scale consultants, large contractors, councils and waste water utilities and industrial companies operating in this space around New Zealand regarding odour control and air pollution control solutions.

Expert witness Code of Conduct

4 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note dated 1 December 2014. I have read and agreed to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

PURPOSE AND SCOPE OF EVIDENCE

5 The purpose of my evidence is to:

5.1 Reaffirm my previous assessments in the Armatec reports dated 5 May 2017 and 5 July 2019;

5.2 Provide additional detail to assist in satisfying the request for more technical design information by parties;

5.3 Make suggestions to refine the recommended conditions of consent.

TECHNICAL REPORT – SUMMARY OF CONCLUSIONS

6 In early 2017 I was engaged to provide a considered opinion on the efficacy of odour capture provided by the eave and curtain design proposed for the Phase 1 bunkers.

7 Having visited the site and considered the concept, it was my opinion that the combination of an appropriately-designed and constructed extended eaves and curtains roof design coupled with appropriately sized ducted extraction design and rating, controls, implementation and operation will have a positive effect on gas and odour capture so that the majority of rising, evolved gases from the compost are captured within the Bunker for treatment whilst permitting operations to be performed in the manner intended.

8 A copy of my report dated 5 May 2017 was provided to Council.

9 Subsequent to that, I was engaged to assist in responding to the recent request for further information dated 29 May 2019, specifically item 1 as follows:

> 1. Our s92 request of 26 January 2017 requested more information on the extraction system for the proposed Phase 1 bunker extended eaves/hoods. We asked for details of the air extraction volumes required to achieve fugitive emission capture rates that will lead to a significant reduction in off-site odour impacts.
>
> As previously stated in my letter dated 30 August 2017, the Armatec information (provided 5 May 2017) did not fully provide the requested

information. The AECOM review (16 May 2017) lists the information that is required, being extraction rates, capture velocities, and exhaust point location/design.

This information is critical for showing that the proposed extended eave and increased extraction can be relied on to reduce fugitive odour. This was recognised by the odour experts in their joint witness statement (21 May 2019), which states (Item 4) that engineering information on the extraction and treatment system and how this proposed system will work should be provided prior to the hearing.

Please provide the information outlined above.

10 My report dated 5 July 2019 was provided as Attachment 1 of the response prepared by Strategy dated 9 July 2019 and is provided as **Attachment 1** to this evidence. This provided further information on extraction rates, capture velocities, ducting extraction design and functional description of the capture and extraction system. Additional comment and details are also provided below.

11 In summary:

11.1 The proposed volumetric extraction rates per bunker was preliminarily based on taking the existing air extraction per square metre of bunker floor area, and applying this to the new, larger bunker floor area(s). This results on a total potential maximum air volumetric extraction rate up to 120% higher than current rates – to up to 9.175 m^3/s when both the extensions and third bunker is added. This volumetric air extraction dictates the sizing and design of the central plenum ducting, extraction fan and final biofilter to match this total airflow. Later design iterations to take account of operational subtlety may lower this final total extraction and treatment rate.

11.2 The proposed duct network and nominal, equalised extraction flowrates from each bunker and eave curtain is shown in the report, namely ~1.5 m^3/s volumetric extraction per bunker "half" – 3 m^3/s for a full bunker. The exact balance of air extraction per bunker and bunker "halves" will vary depending on the operational status of each bunker.

11.3 Ducting will be sized such that nominal air velocity rates are below 10 m/s which is as per standard air ducting design.

11.4 Extraction velocities around the eave inlets can be site manipulated with appropriate inlet grill design to between 0.5 to 10 m/s to best optimise these extraction airflows, positions and capture velocities around the eave perimeter.

11.5 While nominal extraction rates are provided at ~1.5 m^3/s per bunker half, the ducting will be designed such that the extraction rate per bunker can be 90% ramped up to a max of ~2.85 m^3/s per bunker half, with other "closed" bunkers having a reduced air extraction rate to balance the volumetric difference, whilst still maintaining odour capture. Flexibility of operation is key here.

11.6 When the full-length bunker mouth curtain is closed on each end and a bunker is therefore "closed" then the extraction from a bunker will be completely from the distributed intake points within that bunker located at distributed positions along the ceiling, and none from the curtain eave intake grills of that bunker. The extraction rate from bunkers will be such that at any discrete opening at the facility envelope, air will flow into the openings (i.e. between the edges of the curtain and the wall) at a velocity equal to or greater than 0.5 m/s (as mentioned in the previous report dated 5 May 2017). This shows odour capture is being achieved. This has been demonstrated onsite during "worst case scenarios" of the air blower operating in the bunker, and shown in the Armatec report dated 5 May 2017. Note that this "intake of velocity of at least 0.5 m/s at openings" is considered a more appropriate measure for odour capture efficacy than achieving a negative vacuum within the bunker, and is a recommended change in the Conditions of Consent discussed later in this evidence.

11.7 The core purpose of the eave extraction vents is to extract the rising steam from the bunker ceiling prior to it escaping beyond the eave curtain and rising out into the atmosphere.

11.8 When the full-length bunker mouth curtain is open for bunker-to-bunker transfer, then the curtain eave extraction vents are opened and designed for a nominal 1 m^3/s volumetric air extraction, with openings to the duct equally spaced along the perimeter of the eave curtain. Design sizing will permit extraction rates to be increased up to 90% greater (ie 1.9 m^3/s) than nominal design to accommodate flexibility and safety factor in design. While this eave extraction is happening, air continues to be extracted from the main bunker area at the distributed locations along the ceiling of the bunker.

12 My report dated 5 May 2017 also noted that the planned extraction design is to have "Increased controls on extraction rates at the provided points to better direct/prioritise the total extraction airflow to maximise gas capture prior to escape." This is noted in Condition 17 of the Council's Section 42A report dated 9 July 2019. These proposed extraction control design measures include:

12.1 Dampers on all bunker air extraction duct branches to alter & rebalance total airflow from individual bunkers and bunker halves, to appropriately match current bunker operation and status.

12.2 Dampers on all eave curtain extraction vents to turn air extraction from these ducts and intakes on and off.

12.3 Vent grill dampers at the eave intake points to optimise the extraction velocity and distribution of extraction across the perimeter of the eave curtain vents.

12.4 Dampers on the multiple ceiling extraction intake points per bunker to balance intake rates per position inside that bunker.

13 Having completed this exercise, it is still my opinion that the combination of an appropriately-designed and constructed extended eaves and curtains roof design coupled with appropriately designed and sized ducted extraction design and implementation and operation will have a positive effect on gas and odour capture so that the majority of evolved gases are captured for treatment.

RESPONSE TO MATTERS RAISED IN THE SECTION 42A REPORT

14 I have reviewed the Council's Section 42A report and the evidence of Mr Curtis. I acknowledge that both are yet to consider my report dated 5 July 2019 and additional comments above and below.

15 In relation to the request for further information to demonstrate that the Phase 1 extended eaves, ventilation system and extraction rates can adequately capture and treat odour, the underlying design logic is provided in the following paragraphs.

Extraction Rates

16 When compost is maturing in the bunkers, steam is produced by the compost heap. This steam production rate per square metre footprint of compost is approximately the same when piled, and makes more steam when disturbed mechanically, or when air is blown through the compost.

17 To speed up the compost maturing and achieve the designed high temperature of the compost, air is blown via fans into the base of the compost across the overall footprint of the compost and bunker for short time periods regularly and at custom, patterned intervals. This is done via an air vent and duct network built into the concrete floor of each of the bunkers during their construction, with operators and control software turning these fans on and off and varying the fan and motor speed via the electrical Hz (between 20 to 45 Hz) delivered to the 30kW air blower motor to suit the processing conditions of the compost at that time.

18 The air blowers only operate when the bunker doors are fully closed and the air extraction rate to the biofilter is high.

19 One fan blower services one bunker on one side, and another fan blower services the other bunker independently; however it is timed so that the two fans do not blow at the same time. The air rates of these air blowers were not directly measurable but is significant as each of the fans are larger than the biofilter fan, the motor on each of the fans are a 3-phase 30kW motor, and the motor is run between 20 to 45 Hz when the fan is in operation. In comparison the biofilter fan motor is rated for 22 kW. The reason for the high power needs of the air blowers is that each has a high back-pressure to overcome to firstly distribute within a complicated duct network built into the concrete slab plus push its way out from under the compost heaps.

20 The current extraction for the bunker steam and odour is a single extraction point in the centre of each of the long bunkers. No extraction points are currently located in the ceiling nearer the openings of the bunker mouths. There is a dividing wall in the middle of each bunker, with an air opening at the top.

21 When both ends of the bunker doors are closed and an air blower is on I have observed that air extraction rates to the biofilter are sufficient to achieve high quality odour containment in both that bunker and the other non-aerated bunker.

22 The existing biofilter fan was measured by BECA in 2011 at 4.1 m^3/s at 50 Hz at the biofilter fan motor, and 2.2 m^3/s at 25 Hz.

23 The nominated max airflow of the biofilter is 3.5 m^3/s for its current consented loading.

24 Therefore this demonstrates that the bulk airflow to biofilter extraction rate (usually set at 30 Hz during maturing, which is approx. 2.6 m^3/s airflow through simplified interpolation) comfortably exceeds a blower inflow rate (which is therefore less than approx. 2.6 m^3/s) in one bunker plus any additional gas volumes generated by the steaming compost in 2 bunkers.

25 The floor area of a single bunker currently is 225 m^2. In total both current bunkers are 450 m^2. Air currently gets extracted from both bunkers (with a total 450 m^2 footprint), which is equivalent to approx. 20.8 m^3/h per m^2. These numbers are similar to the 32.8 m^3/h per m^2 estimation described in my Extraction Preliminary Design report dated 5 July 2019, therefore suggests 32.8 m^3/h per m^2 is a reasonable "nominal" and conservative figure for these circumstances.

26 The bunker design arrangement proposed by Te Mata Mushrooms is to have each of the two existing long bunkers to be first elongated and with eaves added to this extension to fit the mixer within the bunkers to capture this steam evolved during mixing, and later to add a third identical bunker in parallel with its own new air blower. With the dividing wall inside each of the 3 bunkers, this results in 6 bunker "halves" total, with 3 each end, and as noted by Andrew Curtis, means that the front end loaders do not need to make a trip from one end of the bunker building to the other in the open, therefore largely remain near to or under the eaves during bunker-to-bunker transfers. This will further minimise steam evolution. Each bunker "half" will have an area of approx. 167m^2 each.

27 It is worth clarifying that eaves and extraction ducting are being proposed for both ends of the bunkers to provide the same service on both sides, rather than just one end.

28 At a conservative extraction rate of between ~33 m^3/h per m^2, this equates to 5511 m^3/h – which is 1.5 m^3/s per bunker half, as shown in my Preliminary Design Report.

29 Therefore it is shown that this extraction rate per bunker is adequate as a maximum flowrate during compost maturing.

30 Because the total six bunkers will not all be maturing compost at once, and that air blower timing will ensure that only one blower will be operational at one time, then during later stages of design optimisation it may be found that the total air exhaust to be treated via biofilter could be in fact lower than the nominated 9.2 m^3/s.

Eave & Curtain Design & Extraction

31 During bunker-to-bunker transfer, the air blowers are currently turned off and one bunker door is opened, and the extraction rates of a bunker are maintained and often raised higher to minimise steam release.

32 During these times, the compost continues to produce steam, however less steam than during air blowing, and this steam rises to the top of the bunker ceiling.

33 Some steam continues to be captured by the one single extraction point in the middle of the bunker (which is at the "end" of the bunker half in question), but some steam currently escapes the bunker door opening, mainly at the ceiling of the door opening.

34 The core intention of the additional extraction points in the bunkers nearer the doors, and the extended eaves and drop curtains of these bunker openings are to extend beyond the compost locations and bunker doors, and significantly reduce the volumes of steam reaching the door, and further capturing the remaining odorous steam clouds that form on the top air space of bunkers near the opening from escaping, and fundamentally allow the extraction of these steam clouds prior to their escape from the bunker.

35 A secondary benefit is that the eaves provide an extended hood to capture steam evolving off the carried compost that is sitting in the bucket of the front end loader when it is under the eaves as part of its bunker-to-bunker transfer. This will be of most benefit when the third parallel bunker is completed and there are no "end to end" journeys by front end loader during mixing.

36 Therefore the eave and drop curtain must be designed to ensure there is a continuous air entrapment in the ceiling and drop curtains and does not permit steam to escape through edges and "seams". For example, in corners the drop curtains will need to be air-sealed together to ensure no escape, and at the eave-to-drop curtain connection similarly an air-sealed connection is

required. Both the curtains and eave roof (and bunker roof) must be made of impervious materials. This prevents any top-side steam discharge.

37 The drop curtains will likely be made of a flexible, impervious PVC "thick tent" material with a steel pipe sewn into the base to ensure the curtains hang vertically down and are not blown by wind whilst avoiding any major damage to incidental contact on machinery.

38 Side PVC panelling will also be provided so as to minimise the impact of external wind forcing out steam sideways from a bunker. Additionally only one end of a bunker will ever be open at one time, therefore there will never be a chance for a bunker to be "blown through" by wind.

39 The drop curtain will go down as low as practically possible without interfering with the front-end loaders.

40 The nominal length of the eave extensions horizontally beyond the bunker mouths are provided in the drawings provided in 2017, but will have provision for adjustment to optimise this depth.

41 As described earlier, the extraction ducting inlets for the eaves and curtain is to be provided around the perimeter of the bunker openings. Air intake grills in this perimeter ducting will ensure that the rate of air extraction is faster than steam moves towards the bunker doors. Additional extraction points along the bunker will reduce steam volumes that reach the door. It is intended that the eave extraction inlets will cause air to be drawn from around the eave perimeter and up the internal face of the eave design so that any steam in the direct area is extracted through the ducting.

42 As noted earlier in this evidence, the exact extraction rates per position of intakes will vary according to damper controls that are modified by the operators to maintain the optimum extraction design at all times.

43 This design will work best during still days with little wind, as there will not be strong external forces creating a strong "billowing" effect to disturb air and steam within the bunkers and suck odorous steam out of the bunker.

This is good as during these still, low-wind times are also when the risk of odour complaints are at their highest as odour dispersion is at its lowest. Operators of the front end loaders moving in and out of the bunker mouths and mechanically disturbing compost will need to ensure their methodology minimises their impact on bunker mouth discharge beyond the eaves.

44 When winds are higher and atmospheric conditions are more dispersive, there will be some losses of steam and odour from the bunker that the eave, curtain and duct extraction system does not contain. This will be proportional to the strength of the wind and affected by the humidity, direction and consistency of that wind. During these times the risk of odour complaints are likely lower as higher winds equal higher dispersion rates, so these perceived odour impacts due to loss from the bunkers will be generally lowered.

45 If it is found post-implementation that losses due to wind are excessive during high wind events and still cause odour complaints at specific times, then options exist to resolve specific atmospheric conditions by extending the eave horizontal length and extending the drop length of the PVC curtains to further shelter the bunker air steam from wind interference and steam losses, and further mitigate the wind "billowing" effect and draw the bunker eave and curtain approach closer to a "fully enclosed" design. This design element is beyond the current proposed design but is a potential future optimisation.

Biofilter

46 Treatment of the quantum of extracted air is to be treated via biofilter with similar design parameters as considered in the Council s42A report Conditions.

PROPOSED AMENDMENT TO CONDITIONS

47 As mentioned at paragraph 11.6 above and for the reasons set out there, I consider that condition 16 proposed by the reporting officer should read as follows:

> The consent holder shall ensure that air intake of velocity ~~at least 0.5 m/s at all openings around the building envelope~~ is maintained for the facilities required by ~~paragraph~~ Condition 9 and for the Phase 1 bunkers and Phase 2 tunnels to reduce fugitive odour emissions to the extent that condition 3B can be complied with~~, and for Phase 1 bunkers and Phase 2 tunnels, it is maintained at all times when the doors are closed while composting activities are being carried out.~~
>
> Note: An air intake of velocity of at least 0.5 m/s at all openings around the building envelopes would be considered a means of compliance.

48 To maintain consistency across other conditions due to the above alteration, I consider that condition 18 proposed by the reporting officer should read as follows:

> No part of the composting process shall be operated without the associated emissions control equipment being fully operational and functioning correctly. This includes ensuring that all ducting to odour control equipment shall draw sufficient ~~negative pressure~~ airflow during operation to ensure that fugitive emissions are kept to a practical minimum.

RESPONSE TO MATTERS RAISED IN SUBMISSIONS

49 No specific matters were raised in submissions relating to my report dated 5 May 2017 apart from the request for more information regarding the design details of the extraction, eave and treatment, which has now been provided in the above paragraphs.

CONCLUSIONS AND RECOMMENDATIONS

50 As per above, following further detailing of the above proposed odour capture system, it remains my opinion that the combination of an appropriately-designed and constructed extended eaves and curtains roof design coupled with appropriately sized ducted extraction design and rating, controls, implementation and operation as described above will have a reliable and positive effect on gas and odour capture so that the majority of rising, evolved gases from the compost are captured within the Bunkers for treatment whilst permitting operations to be performed in the manner intended, significantly contributing to the adequate control of odours at The Te Mata Mushroom Company site at 174-176 Brookvale Road, Hastings.

51 Further from an engineering standpoint there is sufficient robustness in the proposed design approach to enable practical site optimisations and (if necessary) improvements to be carried out to achieve improved capture and extraction of odours in the bunkers.

Bryan Holyoake

17 July 2019

Attachment 1 – 5 July 2019 Armatech Report

RESTRICTED

Extraction Prelim Design

for Bunkers

Te Mata Mushrooms

TO	**Michael Whittaker** Michael@tag.co.nz
FROM	**Bryan Holyoake** Chemical Engineer | Business Manager +64 21 440850 | bryan.holyoake@armatec.co.nz
DETAILS	**5th July 2019**; E3899;
OUTLINE	**DESIGN MEMO**

The extraction of the proposed bunker enclosure is based on the extraction design of the existing one with a dropped curtain eave.

Existing bunkers

The existing bunkers are 35m long x 13m wide = 450 m^2 area for 2 bunkers in total. Each bunker is approx. 35m x 6m each, by 5.5m high approx = 1155 m^3 airspace per bunker.

2x bunkers @ 1155 m^3 = 2310 m^3

Existing extraction rates are 3.5 to 4.1 m^3/s – which is treated by the biofilter alongside.

4.1 m^3/s = 246 m^3/min = 14,760 m^3/hr

This extraction rate has been shown to be effective in maintaining odour within the bunkers with the doors closed, even while air blowing (below the compost) is occurring. This extraction rate therefore on a per square metre basis is to be taken as the starting approach.

14,760 m^3/h / 2310 m^3 = 6.4 m^3/h per m^3 of bunker air.

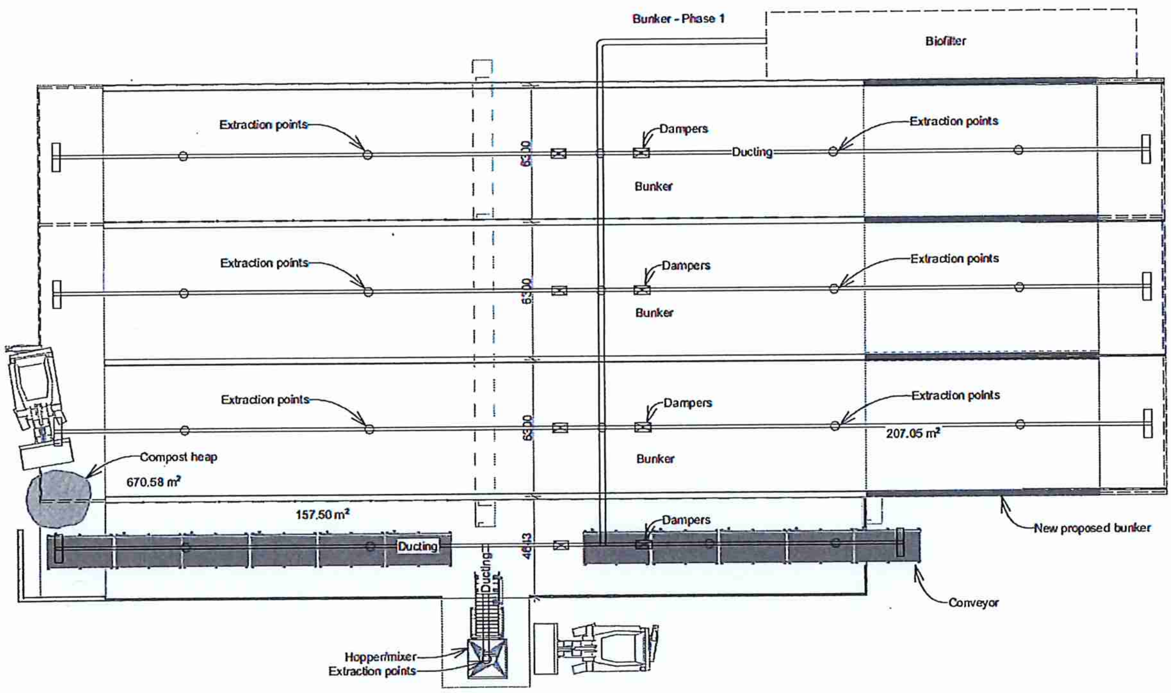
14,760 m3/h / 450 m^2 = 32.8 m^3/hr per m^2 of bunker.

Therefore for the expanded bunkers, this per m^2 extraction rate can be applied.

Future bunker total extraction rates

The future bunker sizing is 53m x 19m = 1007m^2. Therefore the air extraction rate requirements are 1007 * 32.8 = 33,029 m^3/hr. This does not include the hoppers as discussed.

33,029 m^3/h = 550 m^3/min = 9.175 m^3/s



Future bunker ducting extraction position design

See previous Armatec (May 2017) with regards to the curtain and eave design approach.

As stated in the earlier report:

"PROPOSED EXTRACTION LOCATIONS

Currently there is a single, central duct extraction point on the bunkers – drawing air from the centre of the bunkers. This is effective for gas extraction and odour control during times when the doors are closed, but suboptimal during times when the doors are open. Therefore adjustments are planned for.

The planned extraction design is to have:

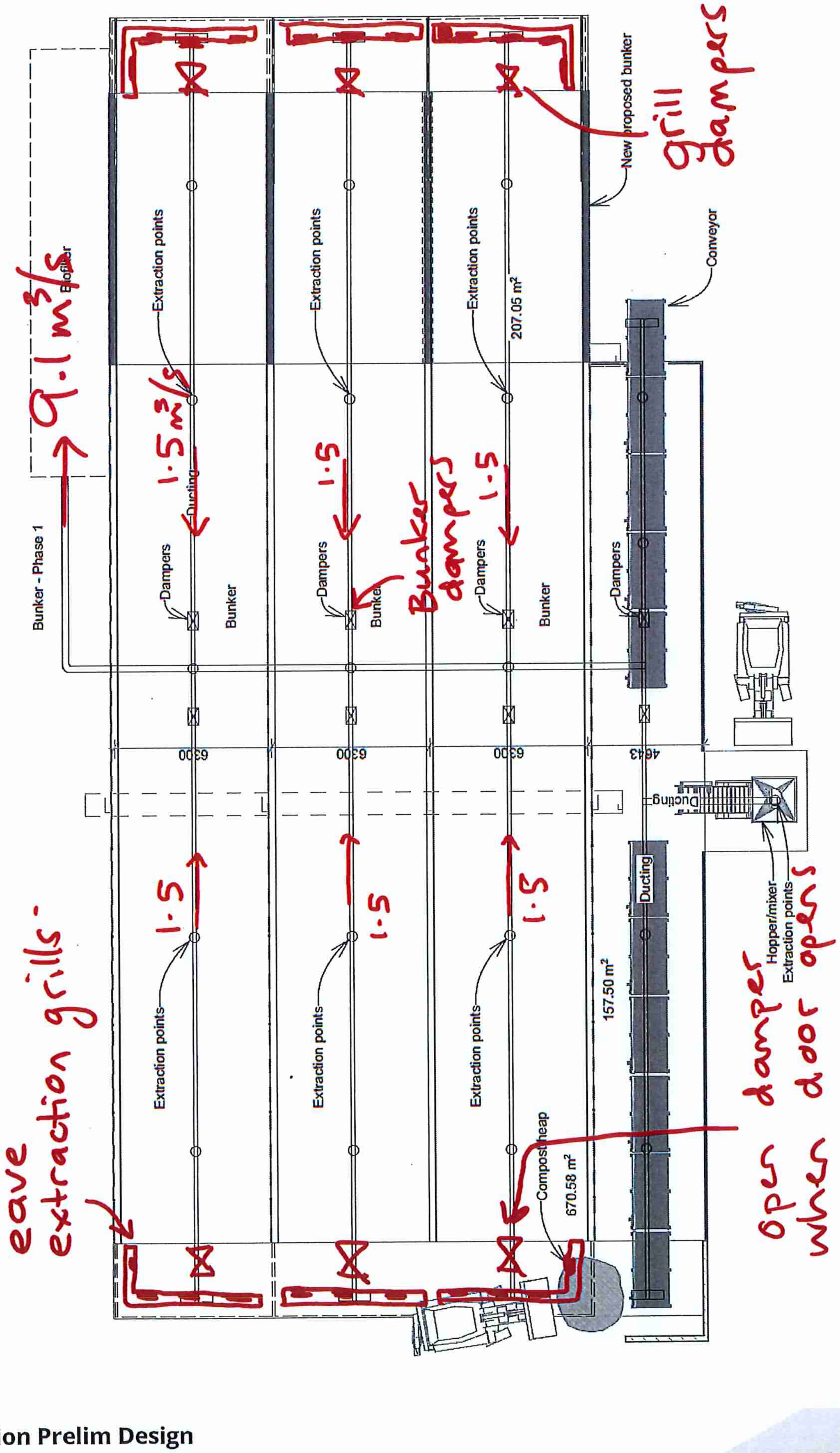
a. More extraction points along the ceiling of the bunker(s) for more equalised removal along the bunkers
b. Extraction points along the width of the bunker eave behind the curtain to optimise the extraction of the built-up hot gases during the times that the doors are open.
c. Increased controls on extraction rates at the provided points to better direct/prioritise the total extraction airflow to maximise gas capture prior to escape. For example, when a door is open, then controls will be adjusted so the maximum possible extraction rate is achieved in those bunkers near the openings to minimise gas escape."

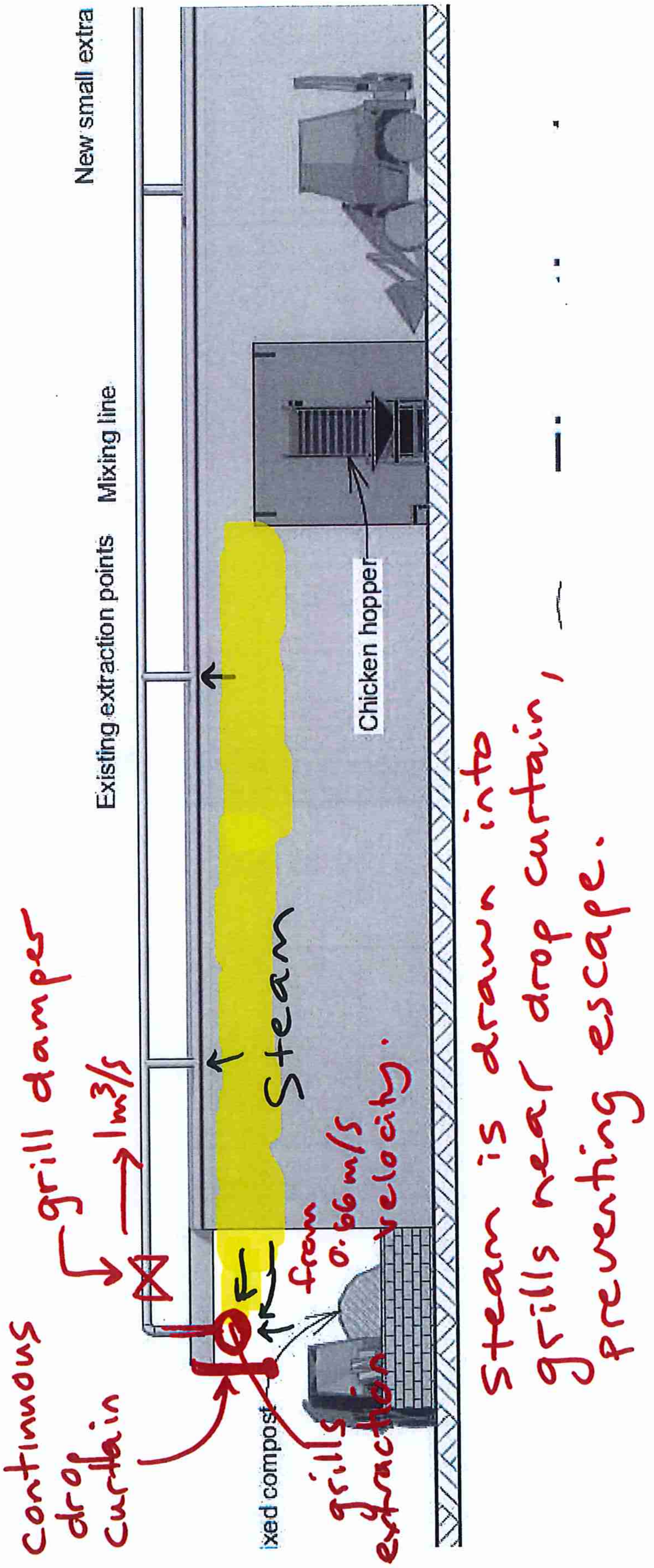
Duct extraction design is done in a way to enable appropriate extraction control. Therefore dampers play their part in appropriate balancing of the overall design following implementation.

The following page provides the design concept of the extraction positions around the bunkers and the door eaves. Grills will be on the extraction ducting around the complete perimeter of the eaves and drop curtains. This will give added protection when the doors are open. The grills will be on approx 500NB duct, with adjustable grills built in.

When the doors are closed, the grills will not be in operation. When a bunker is not in operation the bunker damper will be shut off, allowing additional airflow to come from other bunkers.

When the doors are open, per bunker, the "grill damper" controlling extraction from that grill will open, allowing air to be extracted from that point. The extraction rate will be up to 1m^3/s per bunker (with the remaining 0.5m^3/s being extracted from the rest of the bunker. The middle bunker has a 6m eave length. Therefore at 500mm height, over 3m, this is a 1.5m2 area, and this will pull at a rate of 1 m^3/s and 0.66 m/s velocity, although that could be increased up to 10m/s depending on the grill opening position.


Bunker - Phase 1
Biofilter
Extraction points
Ducting
Dampers
Bunker
207.05 m²
New proposed bunker
Conveyor
6300
4643
Ducting
Hopper/mixer
Extraction points
157.50 m²
Compost heap
670.58 m²
9.1 m³/s
1.5 m³/s
1.5
Bunker dampers
grill dampers
eave extraction grills
damper
open when door opens


New small extra
Mixing line
Existing extraction points
Chicken hopper
ixed compost
grill damper
1m³/s
continuous drop curtain
grills extraction
Steam
from 0.66 m/s velocity.
Steam is drawn into grills near drop curtain, preventing escape.

Below are examples of grill design as part of a duct manifold. The sliding sections permits balancing of the grill size and extraction velocities and extraction areas to best suit the site conditions.