IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application for resource consent by Fulton Hogan to establish Roydon Quarry

SUPPLEMENTARY STATEMENT OF LOUISE FLEUR WICKHAM (AIR QUALITY)

CALLED BY CANTERBURY DISTRICT HEALTH BOARD

21 November 2019

1.0 INTRODUCTION

1. My full name is Louise Fleur Wickham. I am a Director and Senior Air Quality Specialist at Emission Impossible Ltd. I have previously provided a submission dated 17 October 2019. I confirm my qualifications and experience as set out in that submission.

2. I confirm I have read and complied with the following Codes of Conduct in preparing this supplementary statement:

   - the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014; and
   - the Code of Ethics and Professional Conduct for members of the Clean Air Society of Australia and New Zealand.

   I agree to comply with these codes while appearing before the Hearing Panel.

3. In preparing this statement I reviewed the following additional documents:

   - Rebuttal Statement of Mr Roger Cudmore of Golders Associates (New Zealand) on behalf of Fulton Hogan Ltd dated 6 November 2019
   - Joint Witness Statement of the air quality experts in relation to the Roydon Quarry proposal dated 14 November 2019.

4. I have also reviewed PM_{10} monitoring data (only, not meteorological data) collected at the proposed site between 1 July 2018 and 30 June 2019, made available courtesy of Fulton Hogan.

5. My submission will address:

   - Changes to proposal
   - Changes to my submission dated 17 October 2019
   - Additional/new information
   - Recommendations

6. I further wish to correct an error in my submission dated 17 October 2019. At [95] I stated that the proposal was for a maximum of 1,500 trucks per day entering and exiting the quarry. This should have been 1,500 truck *movements* per day (i.e. a maximum of 750 trucks).

2.0 CHANGES TO PROPOSAL

7. Fulton Hogan and Mr Cudmore have clarified the following details that were different to, or not included in, data used to prepare my submission dated 17 October 2019:[1]

   (i) Maximum proposed throughput 750,000 tonnes per annum, Mr Cudmore has assessed 600,000 tonnes per annum (previously assumed to be 400,000 tonnes per annum);

   (ii) There will be two tertiary crushers with a combined maximum throughput of 500 tonnes per hour (previously assumed to be 250 tonnes per hour);

   (iii) The mobile crusher will operate a maximum of 120 days per year and be located a minimum of 500 m from the eastern boundary (previously assumed to be 250 m);

   (iv) Product will be transported (around site and to market) in 20 tonne trucks (previously assumed to be 5 tonne trucks); and

   (v) Around 30% of the trucks entering the site will be bringing in clean fill.

3.0 CHANGES TO MY SUBMISSION

8. I wish to acknowledge the quantified estimate of discharges to air provided by Mr Cudmore in his rebuttal statement dated 6 November 2019. This goes some way to addressing my concerns regarding adequacy of assessment.

[1] Joint Witness Statement by the air quality experts dated 14 November 2019

However, Mr Cudmore's estimate lacks conservatism and as a result is likely to significantly underestimate potential effects.

9. For example, Mr Cudmore has assessed 600,000 tonnes per annum, whereas the proposal is for a maximum throughput of 750,000 tonnes per annum. With the exception of windblown dust from active areas, increasing throughput will proportionately increase all PM_{10} discharges to air arising from excavation, loading, transport, unloading, screening, crushing, storage and handling by 25%;

10. Mr Cudmore has also double counted some emissions reductions;

    (i) Application of an <u>additional</u> 80% reduction in PM_{10} emissions from screening, crushing and conveyor transfer points on the basis that "Roydon only has wet top coarse production with no Barmac/APS crusher onsite". This does not appear relevant to the selected emission factors used to estimate emissions being for screening, tertiary crushing and conveyor transfer points as controlled processes (i.e. processes employing water sprays for emissions reduction).

    (ii) Application of an <u>additional</u> 70% reduction in PM_{10} emissions from loading and handling aggregate due to water control despite the applicant stating that no additional water sprays will be needed due to the high moisture content of the aggregate (and this high moisture content being integral in the emission factor already used in the emission calculation).

    Removing this double counting increases site emissions from these sources by 326% (i.e. PM_{10} emissions increase from 0.4 tonnes/year to 1.7 tonnes/year for his assessed 600,000 tonnes/year throughput).

11. I am unclear how to treat the difference between what the applicant has applied for (maximum throughput 750,000 tonnes per year) and what has

been assessed (maximum 600,000 tonnes per year). This could be addressed either through:

(i) Requesting Mr Cudmore update his assessment to reflect the increased throughput. However, I note this approach may have implications for other parties making submissions on the proposal; or

(ii) Reducing the maximum throughput to that assessed (i.e. 600,000 tonnes per year) as a condition of consent.

12. Following the changes to the proposal I have updated my indicative estimate of discharges to air (refer **Attachment A**) using the maximum throughput of 750,000 tonnes per year sought by the applicant. My calculations remove the double counting of emissions reduction and make slightly more conservative assumptions regarding the amount of distance travelled by trucks on unsealed areas.[2] This is discussed further at [19].

13. I have not queried Mr Cudmore's assumption of 26 ha being reduced to 6 ha on the basis that this is readily addressed through recommended consent conditions (i.e. limiting the activity in practice to that assessed).

14. Whilst the mobile crusher will now be located to the west of the site (and a minimum of 500 m from the eastern boundary), it will still be less than the 500 metres recommended by the Vic EPA from sensitive receptors located to the north, west and south of the site. I understand from Mr Kirkby, air quality expert called by the residents, that there will be around 9 or 10 sensitive receptors (people with houses and/or businesses) within 500 m of the mobile crushing plant. I also note that the Vic EPA 500 m separation distance applies to active working areas, not just the crusher. This includes sources of respirable crystalline silica (**RCS**) discharges to air such as unsealed trafficked areas.

[2] I have, however, used Mr Cudmore's assumption of 84% emission reduction through the use of reject material (pea gravel) on haul roads in the absence of any published data.

15. I reiterate my recommendation for RCS monitoring as a condition of consent to inform the public who have expressed concerns about discharges of RCS.

16. I further suggest regular reporting to the public on key consent matters be included as a condition of consent. Specifically, I recommend regular reporting to the public on actual annual throughput, actual active areas, numbers of trucks per day, meteorological monitoring, PM_{10} and RCS monitoring.

4.0 ADDITIONAL/NEW INFORMATION

4.1 Characterisation of existing environment

17. **Table 1** presents summary data for PM_{10} concentrations measured at the proposed site for the year ended 30 June 2019.

18. The annual average was 14 µg/m^3. This is slightly higher than the annual averages measured at Patumahoe, Auckland (12 µg/m^3) and Pongakawa, Bay of Plenty (9 µg/m^3) in 2018.[3] I retain my view that the background air quality in rural Canterbury is less pristine than other rural areas in New Zealand, with occasionally high daily PM_{10} during summer months.

Table 1 Summary (BAM) PM_{10} data from Proposed Roydon Quarry Site for year ended 30 Jun 2019

PM_{10} Concentration	**Daily (µg/m^3)**	**Hourly (µg/m^3)**
Maximum	37	130
99%ile	32	42
95%ile	24	31
Annual average	14	14
Standard deviation	5.5	8.7
No. days >50.5 µg/m^3 No. hrs > 65 µg/m^3	0 -	- 11
Valid data	97%	95%

[3] PM_{10} data are not available for the exact same monitoring period

4.2 Assessment of proposal vis a vis existing Yaldhurst Quarries

19. Mr Cudmore has provided operational information on the existing Yaldhurst Quarries to support his view that the proposal will have one tenth of the impact of the existing Yaldhurst quarries.[4] **Table 2** below summarises key operational parameters, along with:

    (i) Mr Cudmore's estimates of annual PM_{10} emissions from the proposal based on maximum throughput 600,000 tonnes/year;

    (ii) Mr Cudmore's estimates of annual PM_{10} emissions from the existing Yaldhurst quarries assuming a throughput of 2,000,000 tonnes/year.

    (iii) My own updated PM_{10} estimates. These use the same emissions factors as Mr Cudmore but assume a maximum throughput of 750,000 tonnes/year, do not double count mitigation measures and use slightly more conservative estimates of truck movements.

Table 2 Summary Operational Parameters and Estimated PM_{10} Emissions for Proposed Roydon and Yaldhurst Quarries

Site	**Roydon Proposal**		**Yaldhurst Quarries**
Estimated	(Cudmore)	(Wickham)	(Cudmore)
Maximum throughput (t/yr)	600,000	750,000	2,000,000
Estimated active area (ha)	2.2	2.2	115
Estimated PM_{10} (t/yr)			
Erosion	0.1	0.1	8.4
Bulk handling	0.5	0.9	1.5
Trucks (unpaved)	0.3	2.6	22
Processing	0.2	1.3	3.9
Topsoil*	-	0.1	-
Total	**1.1**	**5.0**	**35.4**

*NB: Not estimated by Mr Cudmore

[4] Rebuttal statement of Mr Roger Cudmore dated 6 November 2019. Table 1 at page 13.

20. I retain my view that a scalar reduction based on comparing emissions from the proposal with emissions from existing quarries is subject to significant limitations. This is because;

(i) Key variables (throughput, truck numbers, key sources) have not been verified by the Yaldhurst Quarries. (This may be able to be undertaken by Environment Canterbury who licence discharges to air from the existing Yaldhurst Quarries).

(ii) Some key sources with the potential for significant impacts close to neighbours at the edge of the site (notably bund formation) are not included in the above estimates. I address this separately below at [26].

(iii) Similarly, the key source that I consider responsible for the largest increase in PM_{10} measured in the Yaldhurst study (tracked material on the main highway near site 3) was also not included in the above estimates. In my view should any dust be tracked from the site entrance onto the main highway, then similar increases (i.e. up to 39 $\mu g/m^3$ increase in the 99th percentile PM_{10} as a 24-hour average) may similarly occur.

21. However, in the absence of any emissions modelling an assumed scalar reduction is a practical approach to assessing emissions. My estimates of PM_{10} emissions in **Table 2** do not support a ten-fold reduction. In light of the seven-fold decrease in my estimated emissions (only), I suggest a five-fold reduction in emissions may be more appropriate.

22. My previous submission estimated that the Yaldhurst quarries contribute up to 37 $\mu g/m^3$ (within 100 m), 21 $\mu g/m^3$ within 200 m and around 12 $\mu g/m^3$ out to 350 metres to the 99th percentile PM_{10} as a 24-hour average.[5] Applying a one-fifth scalar to these contributions suggests emissions from the proposal

[5] Submission of L Wickham dated 17 October 2019. [83] – [89].

would add around 2.4 – 7.4 µg/m^3 to the 99th percentile PM_{10} as a 24-hour average.

23. I note the 99th percentile daily PM_{10} concentration is not conservative, but I am reasonably comfortable that assuming a five-fold reduction for comparison with the existing Yaldhurst quarries should ensure there are no underestimated impacts.

24. The daily background concentration of PM_{10} at the site was 32 µg/m^3 as a 99th percentile (refer **Table 1**). An increase of this order of magnitude, whilst significant in terms of Regulation 17, should not increase daily PM_{10} concentrations in the vicinity (<350 m) of the proposal above the national environmental standard (**NES**) for PM_{10} (50 µg/m^3 as a 24-hour average).

25. However, when background concentrations are elevated as during summer months (and noting the Yaldhurst study measured a maximum daily PM_{10} concentration of 45 µg/m^3 at the proposed site), the quarry contribution will increase daily PM_{10} to concentrations close to, or just over, the NES for PM_{10}.

26. There are further still likely to be occasions when the NES for PM_{10} is breached offsite. This is because it's a quarry and particulate emissions are highly dependent on two things that are themselves highly variable:

    (i) site management, which in turn, depends on people; and
    (ii) meteorology (high wind and no rain lead to high particulate emissions).

27. I also consider that bund formation, which is not included in any of the estimates provided by Mr Cudmore or myself, is likely to cause both dust nuisance and (if coinciding with elevated background concentrations) a breach of the NES for PM_{10} offsite. The bund requires the transport of over 200,000 tonnes of clean fill and topsoil for formation into a bund <u>at the edge of the site</u>, closest to neighbours. In such circumstances, mitigation can only go so far. This is why best practice is to provide reasonable separation between incompatible activities such as quarrying and residences.

28. As an aside, I understand the intent of Regulation 17 was that the existing PM_{10} emissions being offset (i.e. taken out of the airshed) genuinely match the new PM_{10} emissions being consented (i.e. put into the airshed). As such, the increased PM_{10} emissions during the first year (from topsoil stripping, bund formation, etc.) will need to be matched in the offsets used.

4.3 Suggested Trigger Thresholds

29. **Table 1** shows that the maximum hourly PM_{10} concentration measured at the proposal site for the year ending 30 June 2019 was 130 µg/m^3. **Table 1** also indicates that a proposed dust trigger threshold of 65 µg/m^3 as a 1-hour average would be exceeded regularly even in the absence of the proposed quarry. However, my review of the data indicates that hourly concentrations at this level (65 µg/m^3) were not common and there were no incidences of two successive hours of PM_{10} concentrations exceeding 65 µg/m^3.

30. I offer the following suggested trigger thresholds for consideration by Commissioners (and other air quality experts):

    (i) **Alert threshold** to result in heightened dust visual monitoring and site dust mitigation measures. These are based on the maximum measured concentrations in the absence of the quarry (i.e. background) and allowing for an additional 5% (significance threshold):

    - Ten-minute average > 150 µg/m^3; or
    - 1-hour average > 135 µg/m^3; or
    - Two successive 1-hour averages > 65 µg/m^3; or

    (ii) **Action threshold** to result in stop works. This is based on the maximum measured concentrations in the absence of the quarry and allowing for an additional 20%:

    - Ten-minute average > 170 µg/m^3; or
    - 1-hour average > 155 µg/m^3; or
    - Two successive 1-hour averages > 80 µg/m^3;

(iii) I further suggest works may re-commence once the PM_{10} concentration is below the action threshold (155 µg/m^3 as a 1-hour average) for three successive hours.

5.0 RECOMMENDATIONS

31. During joint witness conferencing I amended my recommendations for RCS monitoring to a campaign monitoring approach, with input from the local community. I still think this should include ongoing, long-term (monthly) and intermittent, short-term (daily) RCS monitoring at sensitive locations closest to working areas, which includes trafficked areas and not just the processing sites, on a precautionary basis.

32. I would like to draw Commissioners attention to the air quality joint witness comments on proposed conditions of consent.[6] This recommended at least two PM_{10} (non-reference) monitors in addition to a reference PM_{10} monitor to be co-located with a non-reference method.

33. I further repeat my recommendation that if using non-reference methods for monitoring PM_{10}, the data be calibrated carefully using co-location of non-reference instruments with reference instruments to provide robust data for the purposes of demonstrating compliance with the NES for PM_{10}. This does not appear to have been adopted as a condition of consent as yet.

34. Finally, I note that Mr Cudmore has estimated PM_{10} emissions that are significantly reduced through the application of watering controls that I cannot yet see reflected in consent conditions. Specifically:

    (i) Trucks moving aggregate to the mobile plant
    (ii) Trucks bringing clean fill to site
    (iii) Trucks dumping clean fill
    (iv) Loader moving clean fill around site

[6] This was provided as a tracked changes word document dated 14 November 2019.

I recommend the consent conditions be updated to reflect the application as assessed by Mr Cudmore.

Louise Wickham

21 November 2019

ATTACHMENT A US EPA AP-42 EMISSIONS ESTIMATES

1.0 Topsoil stripping (2.2 ha/yr)			
1.1 Topsoil removal	77	kg	
1.2 Loading of topsoil	15	kg	
1.3 Dumping of topsoil	15	kg	
1.4 Travelling by scraper	*Not estimated*		
1.5 Trucks carrying topsoil	*129*	kg	
1.6 Topsoil stockpiles	*Not estimated*		
1.7 Bund formation	*Not estimated*		
2.0 Wind erosion			
2.1 Dust pickup	98	kg/yr	
3.0 Gravel loading/unloading/transfer			
3.1 Excavation	245	kg/yr	
3.2 Loading of gravel	245	kg/yr	
3.3 Unload of gravel	245	kg/yr	
3.4 Conveyor (controlled)	173	kg/yr	
4.0 Gravel processing			
4.1 Screening (controlled)	833	kg/yr	
4.2 Crushing (controlled)	405	kg/yr	
4.3 Truck loading	38	kg/yr	
5.0 Trucks/Loader on unsealed areas of site			
5.1 Trucks moving material to mobile plant	773	kg/yr	NB: Need to include watering as condition of consent (not currently included)
5.2 Trucks bringing clean fill to site	1,219	kg/yr	
5.3 Trucks dumping clean fill	233	kg/yr	
5.4 Loader moving clean fill around site	233	kg/yr	
Total PM_{10}	**5.0**	**T/yr**	

1.0 Site Preparation

1.1 Topsoil removal by scraper

Area excavated each year	2.2	ha	Updated from evidence of R Cudmore dated 6 Nov 2019
	22,000	m^2	
PM_{30} EF	0.029	kg/Mg	Table 11.9-4
Average depth	0.75	m	Previous value insufficient; average 0.5 - 1 m = 0.75 m
Topsoil to remove	16,500	m^3	
	1.6	Mg/m^3	Updated from evidence of R Cudmore dated 6 Nov 2019
	26,400	Mg	
PM_{30}	765.6	kg	
Assume PM_{10}	10%	PM_{30}	
PM_{10}	**77**	**kg**	

1.2 Loading of excavated material into trucks

Topsoil to load	26,400	Mg	
$PM_{10} = k \times 0.0016 \times (U/2.2)^{1.3} / (M/2)^{1.4}$			AP42 section 13.2 Aggregate Handling
k	0.35		AP42 section 13.2 Aggregate Handling
U	3.9	m/s	Mean wind speed, annual average Golders met set
M	3.4	%	Moisture content, Table 13.2.4-1 (exposed ground)
PM_{10} EF	0.00056	kg/Mg	
PM_{10}	**15**	**kg**	

1.3 Truck dumping of topsoil

$PM_{10} = k \times 0.0016 \times (U/2.2)^{1.3} / (M/2)^{1.4}$			AP42 section 13.2 Aggregate Handling
PM_{10}	**15**	**kg**	

1.4 Travelling by scraper

Not estimated

1.5 Travelling by haul trucks carrying topsoil to central processing area

Topsoil to move	26,400	Mg/year	
Truck capacity	20	tonnes	
No. trucks	1,320	trucks/yr	
1 lb/VMT =	281.9	g/VKT	
s	7.1	%	Table 13.2.2-1 Sand and gravel, material storage area
W	30	tonnes	Updated from evidence of R Cudmore dated 6 Nov 2019
	27	tons	
k	1.5		
a	0.9		
b	0.45		
PM_{10}	712	g/VKT	

Annual PM_{10} EF = E*((365-P)/365) AP42 13.2.2 Unpaved Roads

Where:

Annual PM_{10} EF = size specific emission factor extrapolated for natural mitigation (g/VKT)

EF = size specific emission factor (PM_{10})

P = number of days per year with at least 0.254mm of precipitation

P =	31.6	days >0.254 mm rain, Chch Aero 10-yr average 2008-2018
PM_{10} EF =	650	g/VKT

Assume these trucks travel 250 m each way over unsealed ground with watering @ 70% efficient emissions reduction

Assumed distance travelled	500	m	
PM_{10} EF	0.65	kg/VKT	
	429	kg	
Watering control reduction	70%		
PM_{10}	**129**	**kg/yr**	NB: Need to include watering as condition of consent (not currently included)

1.6 Topsoil stockpiles

Not estimated

1.7 Bund formation

Not estimated

2.0 Wind erosion of exposed areas

2.1 Dust pickup

TSP EF	0.85	Mg/ha/yr	Table 11.9-4
			Updated from evidence of R Cudmore dated 6 Nov 2019
	2.45	ha	with 84% reduction due to reject material as base grade
	2.55	ha	with 70% reduction due to watering
	0.98	T/yr	
Assume PM_{10}	10%	PM_{30}	
PM_{10}	**98**	**kg/yr**	

3.0 Gravel loading/unloading

3.1 Excavation

$PM_{10} = k \times 0.0016 \times (U/2.2)^{1.3} / (M/2)^{1.4}$			AP42 section 13.2 Aggregate Handling
k	0.35		AP42 section 13.2 Aggregate Handling
U	3.9	m/s	Mean wind speed, annual average Golders met set
M	5	%	Updated from evidence of R Cudmore dated 6 Nov 2019
PM_{10} EF	0.0003	kg/Mg	
	750,000	Mg/year	Advised by Fulton Hogan 13 Nov, refer JWS (Air) dated 14 Nov
PM_{10}	**245**	**kg/year**	NB: No watering during excavation as per AEE

3.2 Loading of gravel into trucks/conveyor

Using same assumptions as above

PM_{10}	**245**	**kg/year**	NB: No watering during loading as per AEE

3.3 Unloading of gravel from trucks/conveyor

Using same assumptions as above

PM_{10}	**245**	**kg/year**	NB: No watering during unloading as per AEE

3.4 Conveyor transfer points (controlled)

PM_{10} EF	0.000023	kg/Mg	Table 11.19.2-1
Assume	10	transfer points	
PM_{10}	**173**	**kg/year**	NB: This is a controlled emission factor (assumes watering at source)

4.0 Gravel processing

Maximum Throughput	50,000	Mg/year	Advised by Fulton Hogan 13 Nov, refer JWS (Air) dated 14 Nov

4.1 Screening (controlled)

PM_{10} EF	0.00037	kg/Mg	Table 11.19.2-1
	3	Screens	NB: This is a controlled emission factor (assumes watering at source)
PM_{10}	**833**	**kg/year**	

4.2 Crushing (controlled)

PM_{10} EF	0.00027	kg/Mg	Table 11.19.2-1
	2	Crushers	
PM_{10}	**405**	**kg/year**	NB: This is a controlled emission factor (assumes watering at source)

4.3 Truck loading - Conveyor crushed

PM_{10} EF	0.00005	kg/Mg	Table 11.19.2-1 (EF from one source only)
PM_{10}	**38**	**kg/year**	NB: much lower than aggregate which appears counterintuitive

5.0 Trucks/Loader on unsealed areas of site

5.1 Trucks moving material to mobile plant

NB: No trucks to fixed plant (all by conveyor)

	158,400	Mg/year	Updated from evidence of R Cudmore dated 6 Nov 2019
Truck capacity	20	tonnes	
No. trucks	7,920	trucks/yr	

Assume these trucks travel 250 m each way over unsealed ground with watering @ 70% efficient emissions reduction

Assumed distance travelled	500	m	NB: Mr Cudmore has assumed only 100m travel
PM_{10} EF	0.65	kg/VKT	AP42 13.2.2 Unpaved Roads, annualised for Chch
	2,575	kg	
Watering control reduction	70%		
PM_{10}	**773**	**kg/yr**	NB: Need to include watering as condition of consent (not currently included)

5.2 Trucks bringing cleanfill to site

Approx 30% vehicle movements entering site bring topsoil on gravelled roads

Cleanfill to move	250,000	tonnes	Assume a busy year (i.e. 30% of 750,000 tonnes)
Truck capacity	20	tonnes	
No. trucks	12,500	trucks/yr	

Assume these trucks travel 250 m each way over unsealed ground with watering @ 70% efficient emissions reduction

Assumed distance travelled	500	m	NB: Mr Cudmore has assumed only 100m distance travelled
PM_{10}	0.65	kg/VKT	AP42 13.2.2 Unpaved Roads, annualised for Chch
	4,064	kg	
Watering control reduction	70%		
PM_{10}	**1,219**	**kg/yr**	NB: Need to include watering as condition of consent (not currently included)

5.3 Trucks dumping cleanfill

$PM_{10} = k \times 0.0016 \times (U/2.2)^{1.3} / (M/2)^{1.4}$	kg/Mg	AP42 section 13.2 Aggregate Handling

k	0.35		AP42 section 13.2 Aggregate Handling
U	3.9	m/s	Mean wind speed, annual average Golders met set
M	1	%	Updated from evidence of R Cudmore dated 6 Nov 2019
PM_{10} EF	0.0031	kg/Mg	
Clean fill to move	250,000	Mg/year	Assume a busy year (i.e. 30% of 750,000 tonnes)
PM_{10}	778	kg/year	
Watering control reduction	70%		
PM_{10}	**233**	**kg/yr**	NB: Need to include watering as condition of consent (not currently included)

5.4 Loader moving clean fill around site

Using same assumptions as above

PM_{10} EF	0.0031	kg/Mg	
Clean fill to move	250,000	Mg/year	Assume a busy year (i.e. 30% of 750,000 tonnes)
PM_{10}	778	kg/year	
Watering control reduction	70%		
PM_{10}	**233**	**kg/yr**	NB: Need to include watering as condition of consent (not currently included)