Grace-Mar Farms Ltd Nutrient Management Plan

2017

1. Introduction

This is a Nutrient Management Plan (NMP) for Grace-Mar Farms Ltd., 5904 Salmon River Road, Spallumcheen BC for the 2017 cropping year (see Figure 1 for farm location). It contains information on all nitrogen sources on the farm, and nitrogen requirements for crops in 2017 based on estimated crop uptake and residual soil nitrate levels. It has been developed with the goal of a zero or negative nitrogen balance on all fields as per the requirements in the amendment to the Grace-Mar Farms Ltd. PAO #108389 of March 1, 2017. This means that the supply of crop-available nitrogen in manure (the only nitrogen source on the farm in 2017) will be equal to or less than the estimated crop requirement for nitrogen.

A summary of 2017 planned nitrogen applications is found in Table 1.

Livestock on farm 2017: Grace-Mar Farms Ltd. is a dairy farm located on Salmon River Road in Spallumcheen BC. It currently (as of April 1, 2017) houses only young stock consisting of approximately 300 heifers aged 7 to 24 months in age. This will be the livestock complement for 2017. Prior to April 1, 2017 it housed a 150-cow milking herd and approximately 50 calves. The farm is currently being used to house young stock from the operation's main farm in the Fraser Valley.

This plan considers nitrogen only. The combination of residual levels of phosphorus and potassium in the soil and the amount in the planned manure applications will meet crop needs for these nutrients for 2017. Some of the fields farmed by Grace-mar currently have very high levels of plant-available phosphorus. Elevated soil phosphorus is a concern where there is hydraulic conductivity between fields and surface water such as where fields are located next to surface water or where ditches or tile drainage connects to surface water. That is not the case at Grace-Mar farms. There is no surface water in the vicinity of the farm's fields. The farm's crop advisor is actively working with Grace-Mar farms to reduce residual soil phosphorus levels by increasing the acreage planted to alfalfa and by rotating alfalfa with corn silage.

This plan was prepared with the assistance of Doug Macfarlane, Certified Crop Advisor. He calculated nitrogen application rates based on crop requirements. His proposed application rates have been reviewed as part of preparation of this plan.

All calculated values used in this plan are derived from the Ministry of Agriculture's Nutrient Management Planner calculator Excel spreadsheet.

Disclaimer

This plan has been developed based on a combination of research and industry-standard estimates from BC Ministry of Agriculture nutrient management materials, and farm-specific information where available. It is understood that even when industry-standard estimates are used to calculate application rates of manure, there is considerable imprecision in the process. This plan has been prepared with the goal of a zero nitrogen balance in all fields, and to ensure that the level of residual nitrate-N in soil in fall 2017 is low. However, no guarantee is made that this will be achieved in 2017. Results of post-harvest

soil nitrate testing in fall 2017 will be used to further fine-tune manure application rates in 2018 as required.

Table 1. Summary of 2017 Planned Manure Nitrogen Applications

Field ID	Crop N requirement (Table 6)	Planned manure application rate		Crop-available N supplied in manure (Table 8)	N balance* (difference between crop requirement and supply) (Table 8)
	Lb/A	Liquid manure Imp. Gal/A	Solid manure Tons/A	Lb/A	N requirement less N supply
101 Pivot N	238	11,000	0	74	164
101 Pivot S	368	12,000	0	98	270
102 Bottom Back	65	0	0	0	65
105 Top Back	106	12,000	0	98	8
201 Reserve Pivot	96	8,000	<8	<86	>10

In 2017 all fields will receive less nitrogen than crop requirements. All are in negative nitrogen balance meaning that supply of nitrogen in 2017 will be less than crop requirements.

2. Acreage report - 2017

Grace-Mar Farms will farm 325 acres (132 hectares) of land in 2017. The fields are listed with areas and 2017 cropping information in Table 2 below. Fields are identified on Figure 2.

Cropping is summarized as follows:

- 100 acres (40 hectares) in corn silage (Fields 105 and 201).
- 178 acres (72 hectares) in alfalfa:grass, 109 acres (44 hectares) to be planted in spring 2017 (Fields 101 N and 102), remainder were planted in 2016 (Field 101 S).
- 46 acres (19 hectares) of pasture for hay production (Fields 103 and 104). These areas will not be grazed in 2017 and will receive no manure or fertilizer.

Table 2. 2017 Acreage Report

Field ID	Area		2017 Cropping Status	2017 Planned Nutrient Source
	ha	acres		
101 Pivot N	25	61.7	Alfalfa:grass, new seeding	Manure
101 Pivot S	28	70	Alfalfa:grass, 2nd yr stand	Manure
102 Bottom Back	19	47.3	Alfalfa:grass, new seeding	None
103 Corner	4	10	Grass hay, not grazed	None
104 Pasture	14.7	36	Grass hay, not grazed	None
105 Top Back	5.7	14	Silage corn	Manure

201 Reserve Pivot+Bottom	35	86	Silage corn	Manure
301 Matheson Rd	23	57	Not leased	n/a
302 Hideaway	23	57	Not leased	n/a

3. Results of Ministry of Agriculture 2016 Post-harvest Soil Nitrate Study

Table 3 contains the results of the fall 2017 post-harvest nitrate soil testing at Grace-Mar Farms for the fields that will be farmed in 2017 (lab data in Appendix 1). All fields had residual soil nitrate-N in fall 2016 in the medium to very high category of environmental risk based on the Kowalenko scale that is proposed for adoption by the BC Ministry of Agriculture and that was used to assess residual soil nitrate-N levels in the Hullcar area in fall 2016. Three fields (101A Pivot North, 105 Top Back and 201 Reserve Pivot) had residual nitrate-N in the medium environmental risk range, with the recommendation to 'consider changes to nitrogen management'. Field 101B Pivot (road or south) and field 102 Bottom Back had residual nitrate-N in the high and very high environmental risk range respectively with the recommendation to 'change nitrogen management' to reduce residual nitrate-N and environmental risk.

Bulk density conversions: Residual soil nitrate-N was converted from mg/kg to kg/ha assuming a soil bulk density of 1470 kg/m^3 to reflect the sandy texture of the soils in and around the Grace-Mar property. The original conversions from mg/kg to kg/ha of soil residual nitrate-N made by Ministry of Agriculture staff in fall 2016 following the 2016 post-harvest soil nitrate survey assumed a soil bulk density of 1150 kg/m^3 to allow comparison to the data from the 2007 Ministry of Agriculture Okanagan soil survey. The higher bulk density used in this NMP has resulted in slightly higher total residual nitrate-N levels which resulted in a higher environmental risk rating for two of five fields (Field 101B Pivot S environmental risk rating increased to high from medium, and 105 Top Back rating increased to medium from low). The Kowalenko environmental risk ratings have been calculated assuming a soil bulk density of 1150 kg/m^3 . To accurately rank the residual soil nitrate levels, the environmental risk ratings should be converted from mg/kg to kg/ha using the same bulk density. When this is done, Fields 101 N, 105 and 201 have low environmental risk ratings, 101 S is in the medium range, and only Field 102 Bottom back is in the high to very high range. However, out of an abundance of caution, the original risk rating values have been used in this NMP.

As a result of the high to very high residual nitrate-N in Field 102 Bottom Back it will receive no manure or nitrogen fertilizer in 2017 and until residual soil levels decline.

These residual soil nitrate-N levels have been included when calculating manure application rates for 2017 in all fields.

Residual soil ammonium-N data has not been included. Soil residual levels of ammonium-N were low in fall 2016, and there is currently no Ministry of Agriculture interpretation for residual soil ammonium-N.

Table 3. Soil residual nitrate-N levels from PHNT program – fall 2016

Field ID	Sample Depth	Nitrate-N NO_3-N	NO_3 by depth and Total NO_3 to 90 cm	Kowalenko rating*
	cm	mg/kg	kg/ha @BD 1470	
101A Home Pivot North	0-15	14	31	**Medium**
	15-30	5	11	
	30-60	4	18	
	60-90	6	26	
Total			**86**	
101B Home Pivot Road	0-15	36	79	**High**
	15-30	8	18	
	30-60	3	13	
	60-90	3	13	
Total			**123**	
102 Bottom Back	0-15	30	66	**Very high**
	15-30	28	62	
	30-60	17	75	
	60-90	13	57	
Total			**260**	
105 Top Back	0-15	10	22	**Medium**
	15-30	4	9	
	30-60	3	13	
	60-90	4	18	
Total			**62**	
201 Reserve Pivot	0-15	18	40	**Medium**
	15-30	4	9	
	30-60	2	9	
	60-90	2	9	
Total			**66**	

**Kowalenko environmental risk rating: 0-49 kg/ha low, 50-99 kg/ha medium, 100-199 kg/ha high, 200+ kg/ha very high. Note: Residual nitrate-N in soil was calculated at a soil BD of 1470 kg/m^3. Kowalenko environmental risk ratings are calculated assuming a soil BD of 1150 kg/m^3. This increases the risk rating in 4 of 5 fields; see section 3 for discussion.*

4. Nitrogen from all sources in 2017

Manure production – October 2016 to September 2017

Liquid manure (slurry): October 2016 to March 1 2017 manure production: manure to be applied in spring 2017 consists of the volume accumulated since October 2016 when the lagoon and pit were last emptied for winter. This consisted of manure from 150 milking cows. Calf manure was handled as solid manure.

March 1 2017 to September 2017: manure production during this time period will be from 300 heifers, 40% 7 to 15 months of age and 60% 16 to 26 months of age. All other livestock including all milking cows have been moved to the Fraser Valley operation.

Total liquid manure production during the October 2016 to September 2017 period including all runoff from roofs and areas around the barns and precipitation in manure storages (Table 4): **11,269 tons (approx. 2.24 million Imperial gallons).**

Solid manure: the solid manure to be land applied in spring 2017 consists of separated solids from the slurry stream, solid manure from calf housing and the shavings: manure blend that was removed from the lagoon overtopping event in February 2017. The solid manure produced between spring and fall 2017 will consist of separated solids from the heifer manure. This manure will be stored over winter 2017-18 and spread in spring 2018.

Total solid manure production October 2016 to September 2017 (Worksheet 7.1): **824 tons (does not include clean-up solids from February lagoon over-topping: see section 6 for tonnage of that material)**.

Note: because the number and type of dairy animals changed halfway through the year, half of the livestock numbers present during each half of the year have been entered in Worksheet 7.1 (Table 4) to estimate the manure production for the entire year.

Table 4. Calculation of manure production October 2016 to September 2017

Worksheet 7.1. Annual Manure Production for Dairy Cattle

Manure and Waste Generation

Type of Milk Cow: [illegible] | Number of Cows Milking: 75 | Days Grazing: 0
Average milk production per milked cow (lb/day): 65.0 (if unknown, use the default value provided)

Type of Animal	Typical Number	Your Number	Slurry	Primary Manure Type	Using Solid/Liq. Separation	% Slurry Separated to Solid fraction	Total Manure Generation Slurry (ft³/day)	Solid (ft³/day)
Milk Cow	75	75	☑	Slurry	☑	10	161	31
Dry Cow	15	0	☑	Slurry	☑	10	0	0
Heifers (16 to 26 months)	25	90	☑	Slurry	☑	10	140	27
Heifers (7 to 15 months)	21	60	☑	Slurry	☑	10	53	10
Calves (4 to 6 months)	8	25	☑	Slurry	☑	100	0	21
Calves (0 to 3 months)	8	25	☑	Slurry	☑	100	0	11
Total	151	275				**Total Daily Manure Production**	354	100

Milk House Effluent (typically 0.75 to 1.5 ft³/day/milk cow): 1.5 ft³/day/milk cow → 113 (ft³/day)
1000 L = 35.3 ft³
PLUS Other **Liquid** Wastes (silage effluent,etc.) → 60 (ft³/day)
PLUS Other **Solid** Wastes (spoiled feed, etc.) → 25 (ft³/day)
527 | 125 (ft³/day)

Assumed bulk density of solids:
580 (kg/m³) OR 0.488 (tons/yd³)

Manure and Waste Production: 7123 (yd³/year) | 1688 | 6003 | 824 (tons/year)

Rainwater Collection

This applies only to rainwater that *enters* liquid manure handling systems.

Size of Yard Areas That Runoff Needs to be Collected From: 125000 (ft²)
Size of Roof Area That Discharge to Yard Areas Listed Above or That Discharge Directly Into the Manure Storage: 80000 (ft²)
Unroofed Surface Area of Manure Storage Facilities: 40000 (ft²)
Floating crust on manure surface: ☐ No
Weather Data Site to be used: [illegible]

How is this calculated? **Total Rainwater Collection**: 6248.6 (yd³/year) | 5266.2 (tons/year)

Total Weight of Manure

Total Weight of Manure Produced: Slurry 11269.1 | Solid 824 (tons/year)

Nitrogen content in manure: samples of liquid and solid manure were collected in March 2017 from the lagoon and solid manure storages. The liquid manure contained 0.15% total nitrogen and 811 ppm of ammonium-N. The solid manure contained 0.415% total nitrogen and 498 ppm of ammonium-N. This lab data was entered into the NMP calculator and used to calculate the amount of nitrogen in the manure for 2017 (Table 5). Original lab data is found in Appendix 2.

Lagoon clean-up effluent: Following the lagoon topping in February, a quantity of effluent was removed from the lagoon to prevent further over-topping. This liquid, because it was primarily top-of-lagoon snowmelt water, had a lower nitrogen content than the mixed lagoon. This 'clean-up liquid' contained 0.069% total nitrogen, and 377.5 ppm ammonium-N (data in Appendix 2).

Nitrogen content calculations are based on the assumption that 35% of the organic nitrogen in the manure will be crop-available in 2017, and 70% of the ammonium-N will be retained following manure application (Table 5). These are BC Ministry of Agriculture assumptions and are based on the moisture content of the liquid manure and the length of time till manure incorporation.

Clean-up solids: There was also a quantity of 'clean-up' solids generated when wood shavings were mixed with manure that flowed out of the lagoon during the February overtopping of the lagoon. This material contained 0.326% total nitrogen and 99 ppm of ammonia-N (original lab data in Appendix 2). The mixture was stored in an empty concrete silage bunker until April 2017 when it was applied to the whole of field 105 and approx. 20% of field 201/202. Because the carbon: nitrogen ratio of this material was quite high (46:1) and because it contains fresh wood shavings, it is assumed that it will not contribute any available nitrogen to the crops in these fields in 2017 and may tie up some of the available nitrogen as the wood shavings break down in the soil.

Table 5. Calculation of Nitrogen Content of Manure

Worksheet 4. Calculate Crop Nutrients in the Manure Sources													
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Manure Source and Application Method	Manure Nitrogen (N) Availability Calculation									Manure P_2O_5 and K_2O			
	Total nitrogen content (lab report) (%)[a]	Ammonium content (NH_4-N) (lab report) (ppm)[a]	Organic nitrogen content (col. B – C / 10^4) x 20 (lb N/ton)	N Mineralization factor (Table 6) (select from drop-down list)	Organic nitrogen mineralized this cropping year (col. D x E) (lb N/ton)	Ammonia (NH_4-N) retention factor (Table 7)	Ammonia (NH_4-N) remaining after volatilization (col. C / 10^4 x 20) x col. G (lb N/ton)	Nitrate (NO3-N) content of manure (lab report) (ppm)[a,b]	First-year plant available nitrogen (col. F + H) + (col. I / 10^4) (lb N/ton)	Total P (lab report) (%)[a]	Total P_2O_5 (col. K x 20 x 2.3) (lb P_2O_5/ton)	Total K (lab report) (%)[a]	Total K_2O (col. M x 20 x 1.2) (lb K_2O/ton)
Liquid	*0.15*	*811*	*1.4*	*0.35*	*0.50*	*0.7*	*1.14*		*1.63*	*0.010*	*0.5*	*0.11*	*2.6*
Dairy Solids	*0.41*	*498*	*7.1*	*0.25*	*1.78*	*0.58*	*0.58*		*2.35*	*0.096*	*4.4*	*0.28*	*6.7*
Cleanup Liquid	*0.06*	*292*	*0.5*	*0.35*	*0.18*	*0.7*	*0.41*		*0.59*	*0.008*	*0.4*	*0.05*	*1.1*
			0.0		*0.00*		*0.00*		*0.00*		*0.0*		*0.0*
			0.0		*0.00*		*0.00*		*0.00*		*0.0*		*0.0*
			0.0		*0.00*		*0.00*		*0.00*		*0.0*		*0.0*
			0.0		*0.00*		*0.00*		*0.00*		*0.0*		*0.0*
			0.0		*0.00*		*0.00*		*0.00*		*0.0*		*0.0*

Other sources of nitrogen on farm

Fertilizer nitrogen: No nitrogen fertilizer is planned to be used at Grace-Mar farms in 2017 unless results of pre-sidedress nitrogen soil testing on fields 105 and 201/202 show that there is insufficient nitrogen in the soil to provide the nitrogen required by the corn crop till harvest. If there is insufficient nitrogen in mid-June when pre-sidedress samples are taken (if soil available N level is below 25-30 ppm), nitrogen fertilizer will be applied at the rate required to meet corn requirements for the remainder of the growing season. This decision will be made by the crop advisor.

Irrigation water: The farm irrigates with two wells. Lab analysis of well #4 in January 2016 showed nitrates below the lab's detection limit (data attached in Appendix 3). Irrigation water will be tested for nitrates in 2017 to confirm nitrates remain below detection levels. If the 2017 irrigation water test results show that the water contains nitrates, contribution in irrigation water will be calculated and considered when developing application rates of manure for 2018.

Composted mortalities: From fall 2016 to March 2017, Grace-Mar composted their mortalities in their solids storage area. This is a suitable place for composting mortalities; it has a concrete base and any runoff is collected in the liquid manure storages. These mortalities are still composting, and will not be land applied until spring 2018. The nitrogen in the mortalities will be accounted for at that time. Since

March 2017, all mortalities at Grace-Mar farms have been hauled away for disposal. This will continue for the foreseeable future; there will be no more mortality composting at Grace-Mar.

5. Cropping and nitrogen requirements of crops in 2017

Grace-Mar will be applying manure to 4 fields in 2017 (Table 7 and Figure 2). All other fields farmed by Grace-Mar will not receive manure in 2017 and therefore have not been discussed in this NMP (except field 102 Bottom back which has been included because it had elevated residual nitrates in fall 2016).

2017 Crops: 2017 cropping information is found in columns B, C and D of Table 6. Crop, estimated dry yield and protein content of crop have been provided by Doug Macfarlane.

- **Field 101** Home pivot north, planted to corn in 2016, will be seeded with a mix of alfalfa and orchard grass in spring 2017. This year's crop will be a new seeding of alfalfa and orchard grass.
- **Field 101B** Home pivot south was seeded to a mix of alfalfa and orchard grass in spring 2016, and is now a second year stand of alfalfa:grass.
- **Field 102** Bottom back, planted to corn in 2016, will be seeded with a mix of alfalfa and orchard grass in spring 2017. This year's crop will be a new seeding of alfalfa:grass. This field will receive no manure in 2017.
- **Field 105** Top back will be planted to silage corn in 2017. It also grew corn in 2016.
- **Fields 201/202** Reserve will both grow silage corn in 2017. These fields also grew silage corn in 2016.

Crop nitrogen requirements for 2017: Table 6, Column H contains the nitrogen application rate recommendations for 2017. This number is the estimated crop nitrogen uptake (column E) less the amount of residual nitrate in the 0 to 60 cm depth of the soil (column F, from fall 2016 PHNT results) and less the amount of nitrogen that is estimated to be released from soil organic matter in 2017 for each field (column G).

Column E contains the estimated crop nitrogen uptake values by field for 2017. These values are the product of crop dry yield by crop protein corrected for %N in protein (16% of protein is nitrogen).

Column F contains the residual soil nitrate from fall 2017 soil test results to 60 cm depth. Even though the new seedings of alfalfa:grass may not root deeper than 30 cm in 2017, it was felt that this was a conservative assessment of available nitrogen in soil.

Column G contains the nitrogen fertility factors by field which are an estimate of the amount of nitrogen which will be released from soil organic matter over the 2017 growing season. All fields farmed by Grace-Mar have high fertility due to longterm application of manure to the land base. Field 102 was given a higher fertility factor than the other fields because, despite several years of low manure application and no chemical fertilizer, it still has very high organic matter and high fall residual nitrates, measurably higher than the other fields. The other fields were assumed to have high but not very high fertility because manure and fertilizer applications have been moderate for the past several years.

Management of lagoon over-topping area: The area where manure overflowed from the lagoon in February was cleaned up using shavings to absorb manure. Resulting solid material was removed from the area using a backhoe. This area will be allowed to grow back into grass which it was planted to prior to the spill, and will be harvested as hay in 2017. This will absorb any residual nitrogen from the spill.

Soil samples from the area will be taken in fall 2017 to assess residual nitrate levels. No manure or fertilizer will be applied in this area which is a part of field 104 Pasture. No livestock will be pastured in this area in 2017.

Table 6. Cropping and crop nitrogen requirements - 2017

Worksheet 1. Calculate the Crop Nitrogen Application Recommendations							
A	B	C	D	E	F	G	H
Field Description	Crop Information			Crop Nitrogen (N) Applicator Calculations			Crop Nitrogen Application Recommend'n
(name or number)	Crop type to be fertilized	Crop dry yield (estimated) (tons/ac)[a]	Protein content of crop[b] (estimated) (%)	Crop Nitrogen (N) Uptake (col. C x D x 1.6 x 2) (lb N/ac)	Available soil nitrogen (nitrate plus ammonia)[c] (lab report) (lb N/ac)	Nitrogen fertility factor (Table 1) (lb N/ac)	(col. E – F - G) (lb N/ac)
101 Home Pivot North	*Alf/Gra*	*5.0*	*21.0*	*336*	*53*	*45.0*	*238*
101B Home Pivot South Road	*Alf/Gra*	*8.0*	*20.0*	*512*	*99*	*45.0*	*368*
102 Bottom Back	*Alf/Gra*	*5.0*	*21.0*	*336*	*181*	*90.0*	*65*
105 Top Back	*corn sil*	*7.5*	*8.0*	*192*	*41*	*45.0*	*106*
201/202 Reserve	*corn sil*	*7.5*	*8.0*	*192*	*51*	*45.0*	*96*
				0			*0*
				0			*0*

6. Planned application rate of manure in 2017

Table 7 contains the planned manure applications by field for 2017. The manure application rate is determined on a weight basis (tons/A) and converted to a volume basis (gallons/A) in the NMP calculator. The application rate is calculated from the crop requirement and the nitrogen content of the manure. The table also summarizes the emergency manure applications that occurred between February and April 2017 before this NMP was completed.

Liquid manure (effluent): Will be applied to four fields in 2017 at or below the recommended application rates. There will be insufficient manure available to meet crop nitrogen recommendations as listed in Table 6 above. Liquid manure will be preferentially applied to fields 105 and 201/202 which will be planted to corn silage and therefore need sufficient nitrogen to meet growth expectations. Any extra manure will be applied to the other fields, beginning with field 101B which is a second year stand of alfalfa:grass. Any residual will be applied to field 101 (Pivot N) which will be planted to alfalfa:grass in spring 2017. Alfalfa:grass fields will receive small applications of manure after first, second and possibly third cut to provide up to the recommended maximum application rate of manure.

Field 103 (Bottom Back) will receive no manure or fertilizer in 2017 due to high residual soil nitrate in fall 2016 and very high soil organic matter.

Liquid manure applications pre-completion of NMP: Field 101 (Pivot N) received an emergency application of 3,000 gallons/acre of 'lagoon liquid' on the north half of the field in February 2017. In February 2017, the lagoon over-topped due to its capacity being exceeded, and a quantity of effluent spilled out of the lagoon. In order to prevent further over-topping, a quantity of effluent was removed

from the lagoon at this time and applied to the north half of Field 101 N as an emergency measure. The effluent was taken from the surface of the lagoon (without agitating the lagoon) and therefore had a lower nitrogen content than the remaining effluent. This application will be accounted for when applying additional manure to the field to ensure that the recommended nitrogen rate is not exceeded. As well, also due to lagoon at capacity, Field 105 (Top Back) received an application of liquid manure in March 2017 at the rate of 3,000 gallons/A; additional liquid manure in 2017 will be limited to no more than 9,000 gallons/A to ensure that nitrogen application recommendations are not exceeded.

A quantity of manure (approximately 360,000 gallons) was hauled off-site and stored in an available storage pit in March, also due to insufficient capacity in the lagoon. This manure will be utilized on land not owned or farmed by Grace-Mar Farms and not located over Hullcar aquifer 103.

Solid manure: Will be applied to the 201 Reserve Pivot field which will benefit from the high level of organic matter in the manure solids. The application rate will be less than 8.3 tons per acre because some of the manure solids will be generated during June-September 2017 and will be stored for application in spring 2018.

Lagoon clean-up solids: There was also a quantity of a sawdust:dirt:manure blend that was the result of cleanup of the material that flowed out of the lagoon in February. This material was applied to the entire area of Field 105 (Top Back) at the rate of 12.6 tons/A and was applied to approximately 20% of Field 201/202 (Reserve) at the rate of 10 tons/A. This resulted in application of approximately 21 lb/A of available N on Field 105, and 16.5 lb/A on 20% of Field 201/202. However, because the carbon:nitrogen ratio of this material was quite high at 46:1 and because it contains fresh wood shavings, it is not expected to contribute any available N to the crop in 2017. It may act to tie up some of the soil's available nitrogen in 2017. Therefore no credit has been given for the nitrogen in this material when calculating available nitrogen for 2017.

Table 7. Planned manure applications for 2017 including February-April pre-NMP applications

Field	Liquid Manure			Solid manure		
	2017 Planned application rate	Amount applied pre-NMP	Remaining 2017 application rate	2017 Planned application rate	Clean-up solids applied pre-NMP*	Remaining 2017 application rate
	Gallons/A			Tons/A		
101 Pivot N	11,000	N ½ of field (Feb): 3,000 S ½ of field: 0	N ½ of field: 8,000 S ½ of field: 11,000	0	0	0
101 Pivot S	12,000	0	12,000	0	0	0
102 Bottom Back	0	0	0	0	0	0
105 Top Back	12,000	(March) 3,000	9,000	0	(March) 12.6*	0
201/202 Reserve	8,000	0	8,000	<8.3	(April) 20% of field: 10* 80% of field: 0	<8.3

**Dirt, shavings and manure mixture from lagoon spill cleanup. Because of its high C/N ratio and low nitrogen content, it is assumed that this material will not contribute any available N in 2017.*

Pre-sidedress nitrate testing for corn: A pre-sidedress nitrate-N test will be done on Fields 105 and 201/202 in June to confirm that there is sufficient available nitrogen for the corn crop to achieve normal yields. If soil available nitrogen levels are insufficient to meet crop requirements for the remainder of the growing season, chemical fertilizer will be applied to meet the deficit. This decision will be made by Doug Macfarlane, crop advisor for Grace-Mar, and he will determine the application rate required.

7. Agronomic balance calculations – Crop requirements vs. nutrients to be applied

Table 8 shows the nitrogen balance for each field for 2017 (3rd from last column). Application rates for 2017 were planned to achieve a zero or better nitrogen balance. The table shows that, based on the assumptions used in the calculator, the available farm-specific data and the planned manure application rates, each field should have a zero or better nitrogen balance in 2017. Post-harvest soil nitrate testing in fall 2017 will show how close to nitrogen balance each field is, and further adjustments to manure application rates will be made in 2018 as required.

Fields 105 Top Back and 201/202 Reserve: These fields will grow silage corn in 2017. The planned nitrogen balance on these fields is 8 and 10 lb N/acre respectively which means that 8 and 10 lb/A less N will be provided in the manure than the crop is expected to require for normal growth.

Fields 101 Pivot N and S: These fields will be growing an alfalfa:grass mixture in 2017. The planned nitrogen balance on these fields is better than zero which means that the manure will provide

significantly less nitrogen than the crop requires for normal growth but, because alfalfa is a nitrogen-fixing crop, it will make up any deficiency with atmospheric nitrogen.

Field 102 Bottom Back: This field will be planted to a new stand of alfalfa and orchard grass in spring 2017 and will not receive any manure in 2017. The new stand will take up the residual nitrate-N in the soil.

Table 8. Agronomic balance calculations for 2017 cropping year

Field Description (Worksheet 1, col. A) (name or number)	Crop type (Worksheet 1, col. B)	Field Size (ac)	Manure Source and Application Method (select from drop-down list)	Manure Application Rate (tons/ac)	Available Nutrients in the Year of Application – Manure Sources: N (Col E x Worksheet 4, col. J) (lb N/ac)	Manure Sources: P_2O_5 First-year P availability coefficient * -	Manure Sources: P_2O_5 (Col E x G x Worksheet 4, col. L) (lb P_2O_5/ac)	Manure Sources: K_2O (Col E x Worksheet 4, col. N) (lb K_2O/ac)	Fertilizer: N (lb N/ac)	Fertilizer: P_2O_5 (lb P_2O_5/ac)	Fertilizer: K_2O (lb K_2O/ac)	Crop Nutrient Recommendation (based on estimated soil nutrient supply): N (Worksheet 1, col. H) (lb N/ac)	P_2O_5 (Worksheet 2, col. I) (lb P_2O_5/ac)	K_2O (Worksheet 3, col. I) (lb K_2O/ac)	Agronomic Balance (crop nutrient recommendation minus available nutrients in the year of application): N* (col. M – F – J) (lb N/ac)	P_2O_5* (col. N – H – K) (lb P_2O_5/ac)	K_2O* (col. O – I – L) (lb K_2O/ac)
101 Home Pivot North	Alf/Gra	61.7	Liquid	40	65	0.75	14	106									
			Dairy Solids	0	0	0.75	0	0									
			Cleanup Liquid	15	9	0.75	4	17									
			all manures		74	n/a	18	123				238	17	0	164	-1	-123
101B Home Pivot South Road	Alf/Gra	69.5	Liquid	60	98	0.85	23	158									
			Dairy Solids		0	0.85	0	0									
			Cleanup Liquid		0	0.85	0	0									
			all manures		98	n/a	23	158				368	0	0	270	-23	-158
102 Bottom Back	Alf/Gra	47.3	Liquid	0	0	0.65	0	0									
			Dairy Solids		0	0.65	0	0									
			Cleanup Liquid		0	0.65	0	0									
			all manures		0	n/a	0	0				65	43	0	65	43	0
105 Top Back	corn sil	14.0	Liquid	60	98	0.75	21	158									
			Dairy Solids	0	0	0.75	0	0									
			Cleanup Liquid		0	0.75	0	0									
			all manures		98	n/a	21	158				106	14	0	8	-7	-158
201/202 Reserve	corn sil	86.1	Liquid	40	65	0.65	12	106									
			Dairy Solids	9	21	0.65	26	60									
			Cleanup Liquid		0	0.65	0	0									
			all manures		86	n/a	38	166				96	35	54	10	-3	-112

8. Timing of manure applications

All manure applications on all fields are scheduled to occur in spring 2017 (April-May) with the exception of Field 101 pivot south (and possibly 101 N if required) which will receive three applications during the cropping season, 6000 gallons/A after the first cut of alfalfa and 3000 gallons/A after each of the second and third cuts of alfalfa for a total of 12,000 gallons/A. All manure applications on this field will be complete by October 31st , the BC Ministry of Agriculture recommended deadline for manure application on perennial cropped land. Less than 50% of the annual nutrient demand will be applied during the September –October period on this field.

Emergency manure applications February-April 2017: Due to insufficient storage capacity for liquid manure and a wetter than normal 2016/2017 fall winter and spring, Grace-Mar farms had a manure spill from their lagoon in February 2017. They made emergency applications of liquid manure in February and March, and applied the clean-up manure solids in March-April before this NMP was written. These applications have been described in section 6.

9. Method of manure application

Liquid manure will be applied by vacuum tanker, either by a custom manure application company or with the farm's vacuum tanker. Solid manure will be applied by solid manure spreader. Both of these manure application methods allow accurate tracking of volumes of manure applied for record keeping.

10. Tracking of manure applications

All manure applications made to Grace-Mar's land base during 2017 will be tracked by the farm manager. Loads and volumes on each field will be recorded and made available to the Director on request. This information will be used to confirm 2017 manure application rates.

11. Setbacks

Manure application setbacks as detailed in the March 1, 2017 Amendment to the PAO will be adhered to when applying manure. There are 4 active wells on the Grace-Mar property, marked with yellow stars on Figure 2. Two are considered drinking water wells because they are used for livestock watering and for washing in the milking parlour and barns (well in barnyard and well south west of pond in Field 102). These wells need a 30 metre manure application buffer (marked on map). The other two wells are in Field 102 as well but are irrigation wells and require only a 3.5 m manure application buffer (not marked on map). As Field 102 Bottom Back will not be receiving any manure or other fertilizer in 2017, this buffer requirement is described only for completeness.

12. Other fertilizer application in 2017

No non-nitrogen fertilizer is scheduled to be applied at Grace-Mar Farms in 2017. Application of gypsum with boron was contemplated earlier in the season but this has been delayed until 2018.

13. Irrigation rate

Grace-Mar Farms Ltd is situated on soils with a texture of sand, sandy loam or loamy sand. These soils are rapidly permeable and have low moisture and nutrient holding capacity. Nitrate leaching can occur easily from these soils if irrigation water moves down below the crop rooting depth. For this reason, Grace-Mar will irrigate according to soil moisture sensors to ensure that irrigation water does not move deeper than 60 cm in the soil, the approximate crop rooting depth. The Action Plan derived from the 2016 EIA describes the soil moisture monitoring to be done in 2017.

14. Manure storage capacity

Grace-Mar Farms has two manure storage facilities for liquid manure (effluent) and two storage areas for separated manure solids (identified on Figure 3). In this section, manure storage capacity has been calculated based on the livestock currently on site, namely young stock only, which represents the situation at the farm going forward.

Liquid storage: The farm has a circular concrete manure storage tank of dimensions 25 m in diameter by 3.7 m deep with effective storage capacity of 1473 m^3, and an in-ground lined lagoon of dimensions 38 m by 54 m by 3.7 m deep with approximate effective storage capacity of 4400 m^3. Total storage capacity estimated to be **5873 m^3**. Both of these storage capacities allow for a minimum 0.5 m freeboard.

The farm currently has 300 young stock on site, approximately 120 age 7 to 16 months and 180 age 16 to 26 months. This number of livestock plus rainwater from roof, manure storages and yard areas is expected to produce 10,360 tons (9400 m^3) of manure effluent per year (calculated using the NMP calculator, see Table 9). During the 6-month winter storage period (mid-October through mid-April), 55% of the annual precipitation in the Hullcar area falls which will result in a total liquid manure production of approximately **5170 m^3** during these months.

Based on these calculations, the farm appears to have sufficient storage to hold manure plus rainwater and runoff for a 6 month over-winter storage period. The farm appears to have sufficient storage for up to 7 months of manure plus precipitation and runoff. However, this is based on estimates of the area from which runoff from precipitation enters the lagoon and pit and does not consider any extra water used in the barns for cleaning or flushing as these amounts are not known.

Solid manure storage: The farm has a concrete storage area with lock-block walls outside the barns which holds 167 m^3 of solids (14x9.8x1.22m), and a concrete bunker which holds 1438 m^3 (15.2x45.7x1.83m). Total solids storage capacity is 1605 m^3. Leachate from the lock-block storage area enters the concrete manure storage tank. Leachate from the concrete bunker flows into the farm's runoff catchment system which flows into the concrete storage tank.

For the 6-month overwinter storage period as above, solids production is estimated at half of the annual production of 654 tons per year or 327 tons of solid manure (544 m^3 based on BD of 600 kg/m^3).

Based on these calculations, the farm appears to have sufficient storage capacity for solid manure for a 6-month over-winter storage period. The farm appears to have sufficient storage for up to 17 months of solids.

Table 9. Manure production from young stock – 2017 and beyond

Worksheet 7.1. Annual Manure Production for Dairy Cattle

Manure and Waste Generation

Type of Milk Cow | Number of Cows Milking: 0 | Days Grazing: 0
Average milk production per milked cow (lb/day): 65.0 (if unknown, use the default value provided)

Type of Animal	Typical Number	Your Number	Slurry	Primary Manure Type	Using Solid/Liq. Separation	% Slurry Separated to Solid fraction	Total Manure Generation Slurry (ft^3/day)	Solid (ft^3/day)
Milk Cow	0	0	☑	Slurry	☑	10	0	0
Dry Cow	0	0	☑	Slurry	☑	10	0	0
Heifers (16 to 26 months)	0	180	☑	Slurry	☑	10	280	54
Heifers (7 to 15 months)	0	120	☑	Slurry	☑	10	107	20
Calves (4 to 6 months)	0	0	☑	Slurry	☑	100	0	0
Calves (0 to 3 months)	0	0	☑	Slurry	☑	100	0	0
Total	0	300			**Total Daily Manure Production**		387	74

Milk House Effluent (typically 0.75 to 1.5 ft^3/day/milk cow): 1.5 ft^3/day/milk cow → 0 (ft^3/day)
1000 L = 35.3 ft^3 | PLUS Other **Liquid** Wastes (silage effluent,etc.): 60 (ft^3/day)
PLUS Other **Solid** Wastes (spoiled feed, etc.): 25 (ft^3/day)
447 | 99 (ft^3/day)

Assumed bulk density of solids: 580 (kg/m^3) OR 0.488 (tons/yd^3)
Manure and Waste Production: 6044 | 1341 (yd^3/year) | 5094 | 654 (tons/year)

Rainwater Collection

This applies only to rainwater that *enters* liquid manure handling systems.

Size of Yard Areas That Runoff Needs to be Collected From: 125000 (ft^2)
Size of Roof Area That Discharge to Yard Areas Listed Above or That Discharge Directly Into the Manure Storage: 80000 (ft^2)
Unroofed Surface Area of Manure Storage Facilities: 40000 (ft^2)
Floating crust on manure surface: ☐ No
Weather Data Site to be used:

How is this calculated? **Total Rainwater Collection**: 6248.6 (yd^3/year) | 5266.2 (tons/year)

Total Weight of Manure

Total Weight of Manure Produced: Slurry 10360.3 | Solid 654 (tons/year)

15. Post-harvest soil nitrate testing – fall 2017

After crop harvest in fall 2017, soil sampling will be done in each field including 102 Bottom Back to at least 60 cm depth to assess the accuracy of 2017 manure application rates. At this time, the 2017 manure application rates will be reviewed based on residual soil nitrate-N levels, and adjustments made to rates and timing as required for 2018.

Plan prepared by:

Ruth McDougall, M.Sc., PAg.

Consulting Agrologist

May 4, 2017

Figure 1. Location Map – Grace-Mar Farms Ltd.

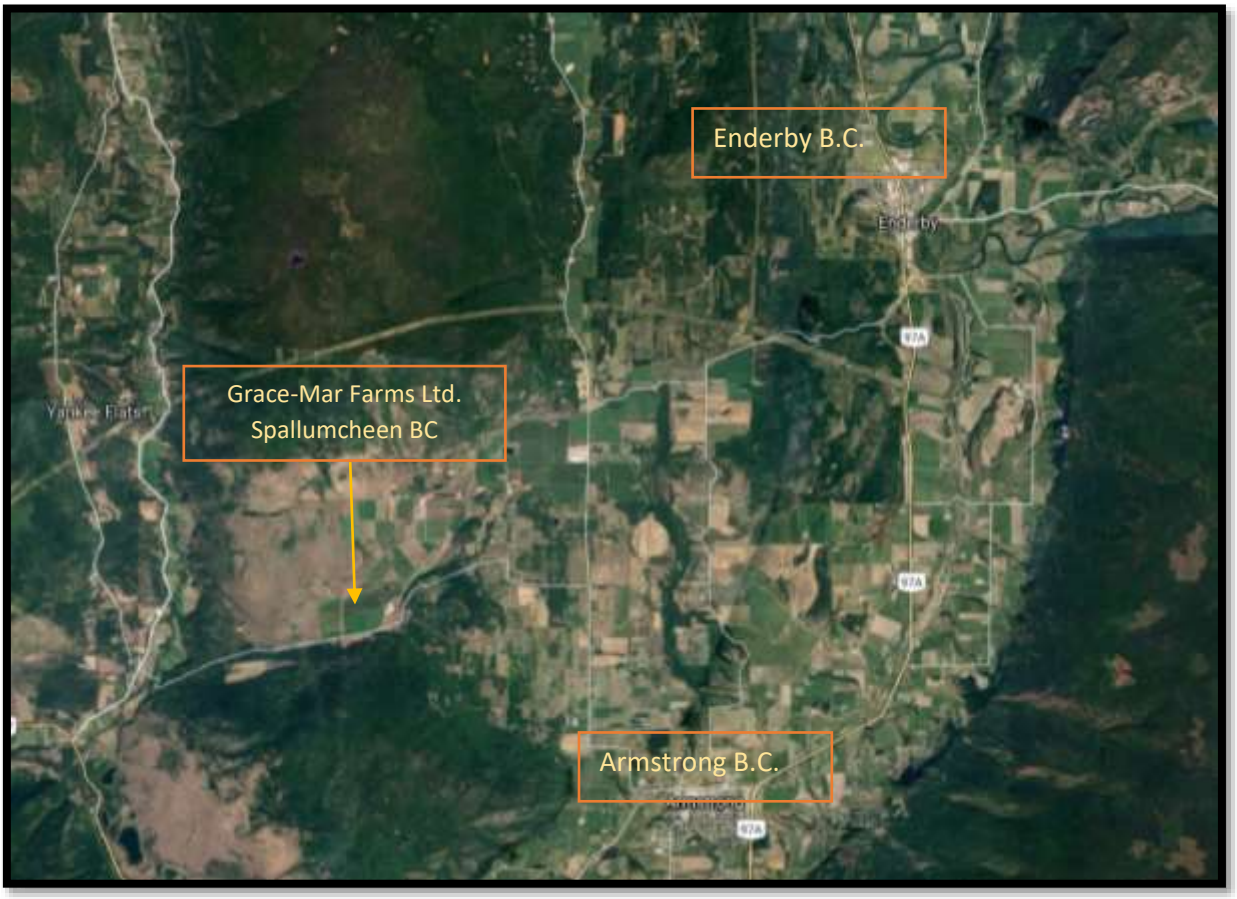
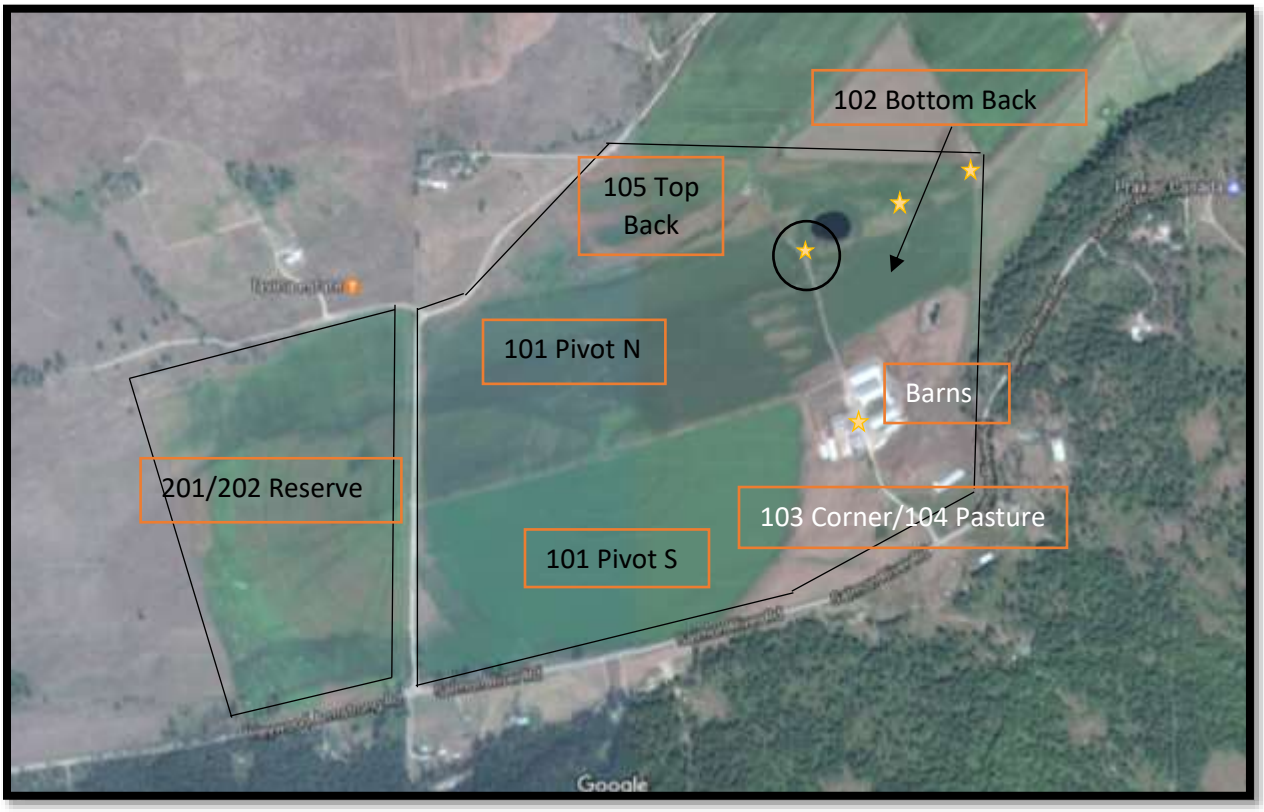


Figure 2. Map of Grace-Mar Property and Fields, Livestock Watering, Irrigation Wells and Setbacks (wells identified by star)

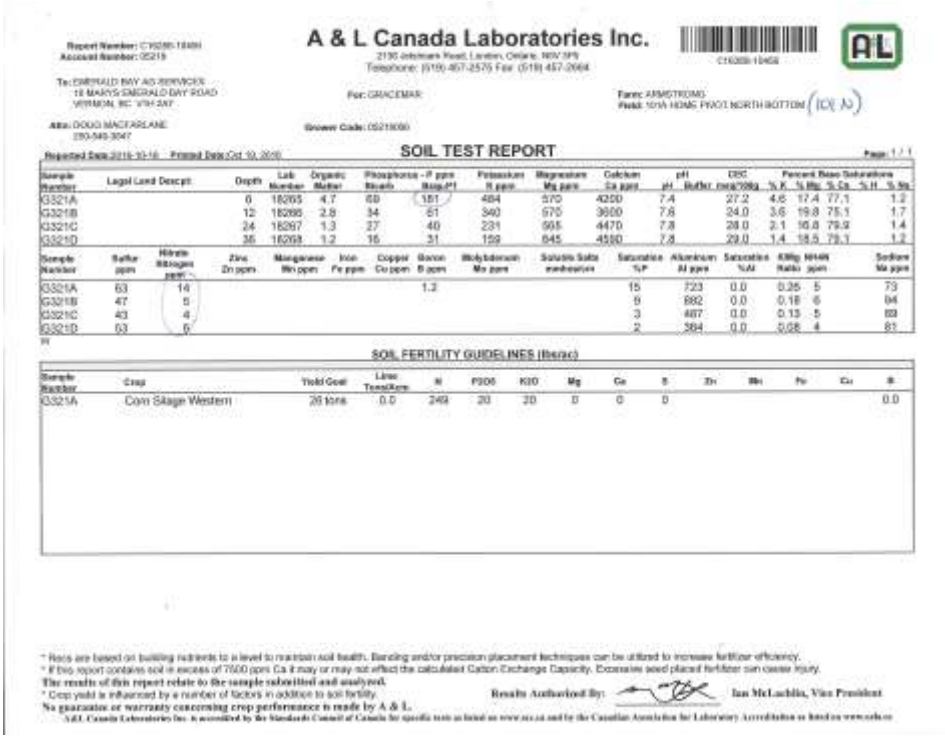


Note: Two wells are considered domestic wells. These wells must have a 30 m setback between the well head and edge of manure application area. This has been marked for one well as a circle around the well. The second domestic well is located in the farmyard and there is sufficient buffer around it from farm buildings. Other wells and the pond located in 102 Bottom back must have a 3.5 m setback for manure application.

Figure 3. Close-up of Grace-Mar barns and manure storages

Appendix 1. Fall 2016 PHNT Soil Data

Field 101 N (Pivot N)



A & L Canada Laboratories Inc.
2136 Jetstream Road, London, Ontario, N5V 3P5
Telephone: (519) 457-2575 Fax: (519) 457-2664

Report Number: C16293-10434
Account Number: 05219

To: EMERALD BAY AG SERVICES
10 MARYS EMERALD BAY ROAD
VERNON, BC V1H 2M7

Attn: DOUG MACFARLANE
250-545-3947

For: GRACEMAR

Grower Code: 05219000

Farm: ARMSTRONG
Field: 101A HOME PIVOT NORTH BOTTOM (101 N)

Reported Date: 2016-10-18 Printed Date: Oct 19, 2016

SOIL TEST REPORT

Page: 1 / 1

Sample Number	Legal Land Descpt	Depth	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	pH	Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
G321A		0	18265	4.7	69	181	484	570	4250	7.4		27.2	4.6	17.4	77.1		1.2
G321B		12	18266	2.8	34	61	340	570	3600	7.6		24.0	3.6	19.8	75.1		1.7
G321C		24	18267	1.3	27	40	231	595	4470	7.8		28.0	2.1	16.8	79.9		1.4
G321D		36	18268	1.2	16	31	159	645	4530	7.8		29.0	1.4	18.5	79.1		1.2

Sample Number	Sulfur ppm	Nitrate Nitrogen ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Molybdenum Mo ppm	Soluble Salts mmhos/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	NH4N ppm	Sodium Na ppm
G321A	63	14					1.2			15	723	0.0	0.35	5	73
G321B	47	5								9	882	0.0	0.18	6	84
G321C	43	4								3	487	0.0	0.13	5	89
G321D	63	6								2	384	0.0	0.08	4	81

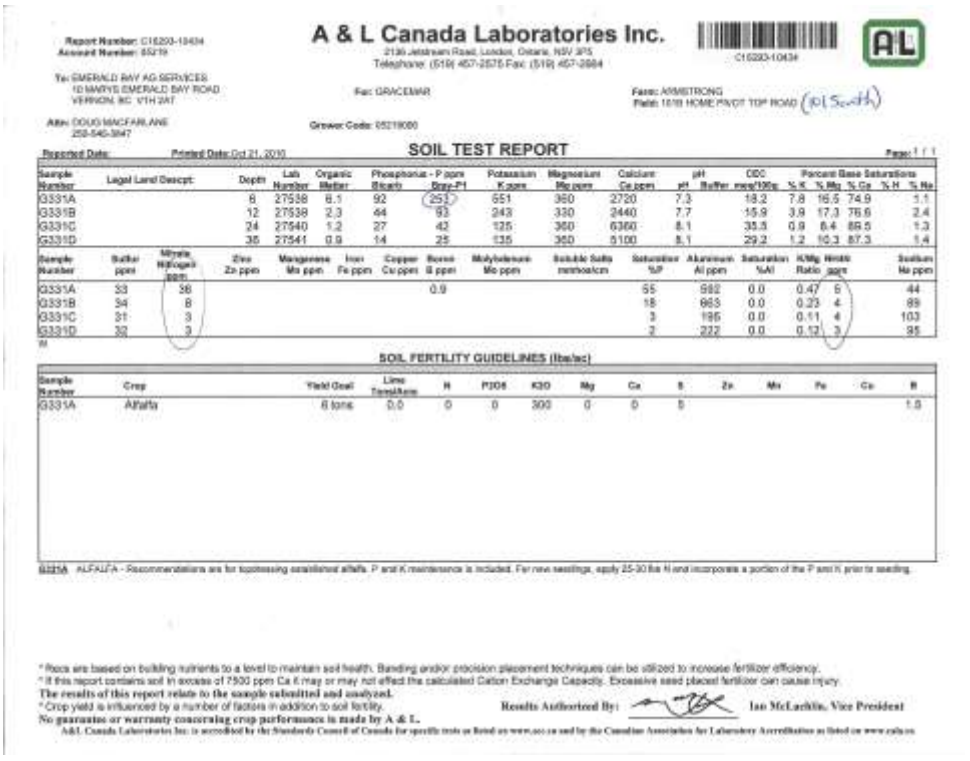
SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B
G321A	Corn Silage Western	28 tons	0.0	249	20	20	0	0	0					0.0

* Recs are based on building nutrients to a level to maintain soil health. Banding and/or precision placement techniques can be utilized to increase fertilizer efficiency.
* If this report contains soil in excess of 7500 ppm Ca it may or may not effect the calculated Cation Exchange Capacity. Excessive seed placed fertilizer can cause injury.
The results of this report relate to the sample submitted and analyzed.
* Crop yield is influenced by a number of factors in addition to soil fertility.
No guarantee or warranty concerning crop performance is made by A & L.
A&L Canada Laboratories Inc. is accredited by the Standards Council of Canada for specific tests as listed on www.scc.ca and by the Canadian Association for Laboratory Accreditation as listed on www.cala.ca

Results Authorized By: Ian McLachlin, Vice President

Field 101 S (Pivot S or road)



A & L Canada Laboratories Inc.
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Report Number: C16293-10434
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10 MARYS EMERALD BAY ROAD
VERNON, BC V1H 2M7

Attn: DOUG MACFARLANE
250-545-3947

For: GRACEMAR

Grower Code: 05219000

Farm: ARMSTRONG
Field: 101S HOME PIVOT TOP ROAD (101 South)

Reported Date: Printed Date: Oct 21, 2016

SOIL TEST REPORT

Page: 1 / 1

Sample Number	Legal Land Descpt	Depth	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	pH	Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
G331A		6	27538	6.1	92	251	551	360	2720	7.3		18.2	7.8	16.5	74.9		1.1
G331B		12	27539	2.3	44	93	343	330	2440	7.7		15.9	3.9	17.3	76.6		2.4
G331C		24	27540	1.2	27	42	125	360	6360	8.1		35.5	0.9	8.4	89.5		1.3
G331D		36	27541	0.9	14	25	135	360	5100	8.1		29.2	1.2	10.3	87.3		1.4

Sample Number	Sulfur ppm	Nitrate Nitrogen ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Molybdenum Mo ppm	Soluble Salts mmhos/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	NH4N ppm	Sodium Na ppm
G331A	33	38					0.9			55	982	0.0	0.47	5	44
G331B	34	8								18	665	0.0	0.23	4	89
G331C	31	3								3	195	0.0	0.11	4	103
G331D	32	3								2	222	0.0	0.12	3	95

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B
G331A	Alfalfa	6 tons	0.0	0	0	300	0	0	0					1.0

G331A ALFALFA - Recommendations are for topdressing established alfalfa. P and K maintenance is included. For new seedings, apply 25-30 lbs N and incorporate a portion of the P and N prior to seeding.

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The results of this report relate to the sample submitted and analyzed.
* Crop yield is influenced by a number of factors in addition to soil fertility.
No guarantee or warranty concerning crop performance is made by A & L.
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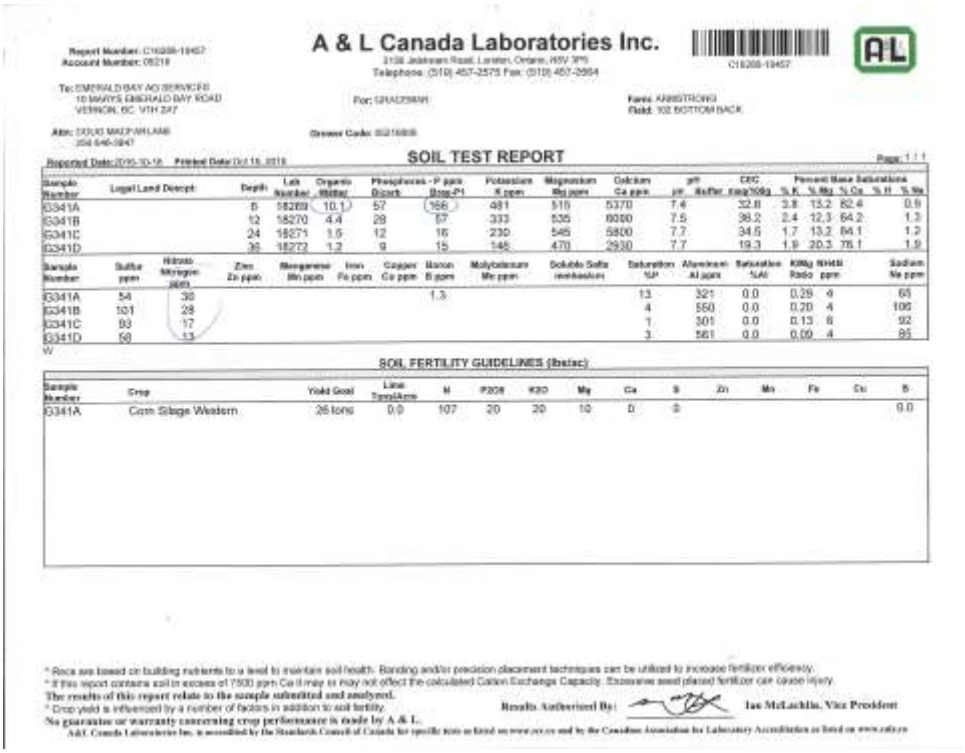
Results Authorized By: Ian McLachlin, Vice President

Field 102 (Bottom back)



A & L Canada Laboratories Inc.

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Report Number: C16208-19457
Account Number: 05219

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Attn: DOUG MACFARLANE
250-546-3847

For: GRACEMAR

Farm: ARMSTRONG
Field: 102 BOTTOM BACK

Grower Code: 05219008

Reported Date: 2016-10-19 Printed Date: Oct 19, 2016

SOIL TEST REPORT

Page: 1 / 1

Sample Number	Legal Land Descpt	Depth	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	pH	Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
G341A		6	18269	10.1	57	166	481	515	5370	7.4		32.8	3.8	13.2	82.4		0.9
G341B		12	18270	4.4	28	57	333	535	6080	7.5		36.2	2.4	12.3	84.2		1.3
G341C		24	18271	1.5	12	16	230	545	5800	7.7		34.5	1.7	13.2	84.1		1.2
G341D		36	18272	1.2	9	15	146	470	2930	7.7		19.3	1.9	20.3	75.1		1.9

Sample Number	Sulfur ppm	Nitrate Nitrogen ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Molybdenum Mo ppm	Soluble Salts mmhos/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	KMg Ratio	NH4N ppm	Sodium Na ppm
G341A	54	30					1.3			13	321	0.0	0.29	9	65
G341B	101	28								4	550	0.0	0.20	4	106
G341C	93	17								1	301	0.0	0.13	6	92
G341D	58	13								3	561	0.0	0.09	4	85

W

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B
G341A	Corn Silage Western	26 tons	0.0	107	20	20	10	0	0					0.0

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* Crop yield is influenced by a number of factors in addition to soil fertility.
No guarantee or warranty concerning crop performance is made by A & L.
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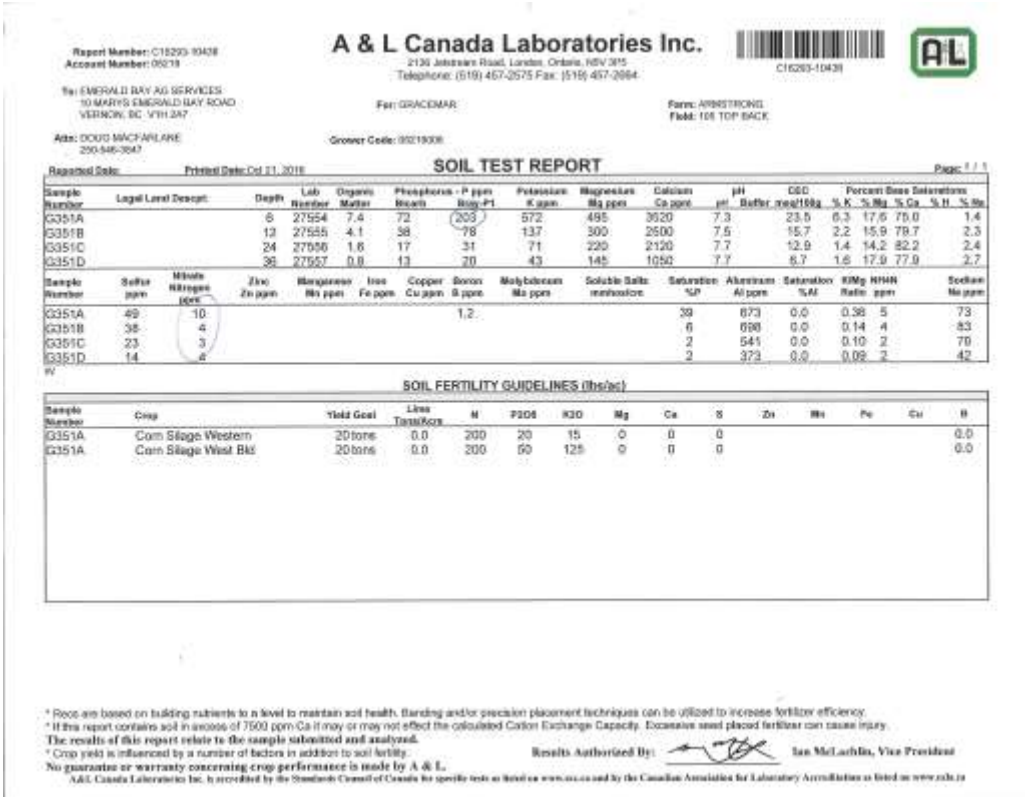
Results Authorized By: Ian McLachlin, Vice President

Field 105 (Top back)



A & L Canada Laboratories Inc.

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Account Number: 05219

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Attn: DOUG MACFARLANE
250-546-3847

For: GRACEMAR

Farm: ARMSTRONG
Field: 105 TOP BACK

Grower Code: 05219008

Reported Date: Printed Date: Oct 21, 2016

SOIL TEST REPORT

Page: 1 / 1

Sample Number	Legal Land Descpt	Depth	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	pH	Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
G351A		6	27554	7.4	72	203	572	495	3520	7.3		23.5	6.3	17.6	75.0		1.4
G351B		12	27555	4.1	38	78	137	300	2500	7.5		15.7	2.2	15.9	79.7		2.3
G351C		24	27556	1.6	17	31	71	220	2120	7.7		12.9	1.4	14.2	82.2		2.4
G351D		36	27557	0.8	13	20	43	145	1050	7.7		8.7	1.6	17.9	77.9		2.7

Sample Number	Sulfur ppm	Nitrate Nitrogen ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Molybdenum Mo ppm	Soluble Salts mmhos/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	KMg Ratio	NH4N ppm	Sodium Na ppm
G351A	49	10					1.2			39	673	0.0	0.38	5	73
G351B	36	4								6	698	0.0	0.14	4	83
G351C	23	3								2	641	0.0	0.10	2	70
G351D	14	4								2	373	0.0	0.09	2	42

W

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B
G351A	Corn Silage Western	20 tons	0.0	200	20	15	0	0	0					0.0
G351A	Corn Silage West Bkt	20 tons	0.0	200	50	125	0	0	0					0.0

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No guarantee or warranty concerning crop performance is made by A & L.
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Results Authorized By: Ian McLachlin, Vice President

Field 201/202 (Reserve, Reserve Pivot)

Report Number: C16288-10455
Account Number: 05219

A & L Canada Laboratories Inc.

2136 Jetstream Road, London, Ontario, N5V 3P5
Telephone: (519) 457-2575 Fax: (519) 457-2664

C16288-10455

To: EMERALD BAY AG SERVICES
10 MARYS EMERALD BAY ROAD
VERNON, BC V1H 2A7

For: GRACEMAR

Farm: ARMSTRONG
Field: 201 RESERVE TOP

Attn: DOUG MACFARLANE
250-545-3847

Grower Code: 05219006

Reported Date: 2016-10-18 Printed Date: Oct 19, 2016

SOIL TEST REPORT

Page: 1 / 1

Sample Number	Legal Land Descpt:	Depth	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	pH pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
G361A		6	18261	7.4	48	128	298	390	3220	7.2		21.4	3.6	15.2	75.3	4.8	1.4
G361B		12	18262	3.0	28	53	115	285	2420	7.3		15.1	2.0	15.8	80.3		2.2
G361C		24	18263	1.3	20	32	125	275	2010	7.3		12.9	2.5	17.8	78.1		1.8
G361D		36	18264	0.9	21	34	141	315	2210	7.3		14.2	2.5	18.5	77.8		1.4

Sample Number	Sulfur ppm	Nitrate Nitrogen ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Molybdenum Mo ppm	Soluble Salts mmhos/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	NH4N ppm	Sodium Na ppm
G361A	58	18					1.0			21	773	0.1	0.24	6	70
G361B	37	4								4	902	0.1	0.13	5	75
G361C	27	2								3	718	0.1	0.14	5	54
G361D	16	2								3	601	0.1	0.14	4	47

W

SOIL FERTILITY GUIDELINES (lbs/ac)

Sample Number	Crop	Yield Goal	Lime Tons/Acre	N	P2O5	K2O	Mg	Ca	S	Zn	Mn	Fe	Cu	B
G361A	Corn Silage Western	24 tons	0.0	242	20	20	5	0	0					0.0

* Recs are based on building nutrients to a level to maintain soil health. Banding and/or precision placement techniques can be utilized to increase fertilizer efficiency.
* If this report contains soil in excess of 7500 ppm Ca it may or may not effect the calculated Cation Exchange Capacity. Excessive seed placed fertilizer can cause injury.

The results of this report relate to the sample submitted and analyzed.

* Crop yield is influenced by a number of factors in addition to soil fertility.

No guarantee or warranty concerning crop performance is made by A & L.

Results Authorized By: **Ian McLachlin, Vice President**

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Appendix 2. Manure analyses – Winter and spring 2017

Lagoon liquid effluent (after pit agitation) March 2017

Manure lagoon March'17

REPORT NO. C17081-60001
ACCOUNT NO. 05219

A&L CANADA LABORATORIES INC.

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CANADA
ATTN: DOUG MACFARLANE

FOR: GRACEMAR FARMS

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MANURE ANALYSIS

LAB NUMBER: 818003
SAMPLE ID: LAGOON

DATE RECEIVED: 2017-03-22
DATE REPORTED: 2017-03-28
DATE PRINTED: 2017-03-29

PARAMETER	ANALYSIS RESULT	POUNDS PER 1,000 GAL	ESTIMATED AVAILABILITY PER 1,000 GAL
Dry Matter	2.6 %		
Nitrogen (Total)	0.152 %	15.2	
NH4-N	811 ppm	8.1	
Phosphorus (Total)	0.0362 %		
Phosphate (P as P2O5) **	0.0879 %	8.8	3.5
Potassium (Total)	0.1329 %		
Potash (K as K2O) **	0.1595 %	15.9	14.3
Organic Matter *	1.9 %		
Carbon:Nitrogen Ratio (C:N)	7 : 1		
Calcium	0.1106 %	11.1	
Magnesium	0.0378 %	3.8	

* All Parameters are reported on an as is basis.
**Available nutrients are reported as total available. Only a portion of these nutrients will be available the year of application.
For information on nitrogen availability, see reverse side of page.
More information available: http://www.alcanada.com/files/Manure_Analysis.pdf

C17081-60001

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Manure solids March 2017

Manure Solids Mar.'17

REPORT NO. C17081-60001
ACCOUNT NO. 05219

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PAGE: 1 / 2

MANURE ANALYSIS

LAB NUMBER: 818002
SAMPLE ID: 1 SOLID

DATE RECEIVED: 2017-03-22
DATE REPORTED: 2017-03-28
DATE PRINTED: 2017-03-29

PARAMETER	ANALYSIS RESULT	POUNDS PER TON	ESTIMATED AVAILABILITY PER TON
Dry Matter	19.3 %		
Nitrogen (Total)	0.405 %	8.1	
NH4-N	488 ppm	1.0	
Phosphorus (Total)	0.0960 %		
Phosphate (P as P2O5) **	0.2208 %	4.4	1.8
Potassium (Total)	0.2775 %		
Potash (K as K2O) **	0.3330 %	6.7	6.0
Organic Matter *	15.7 %		
Carbon:Nitrogen Ratio (C:N)	21 : 1		
Calcium	0.4258 %	8.5	
Magnesium	0.1285 %	2.6	

* All Parameters are reported on an as is basis.
**Available nutrients are reported as total available. Only a portion of these nutrients will be available the year of application.
For information on nitrogen availability, see reverse side of page.
More information available: http://www.alcanada.com/files/Manure_Analysis.pdf

C17081-60001

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Manure liquid (surface of lagoon without agitation) February 2017

Grace Mar Feb 2017 Manure Spill - Anal FRI 17th

REPORT NO. C17054-80000
ACCOUNT NO. 05219

A&L CANADA LABORATORIES INC.
2136 Jetstream Rd, London, ON, N5V 3P5 Tel (519) 457-2575 Fax (519) 457-2664

Liquid

TO: EMERALD BAY AG SERVICES
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FOR: GRACEMAR FARM

PAGE: 1 / 2

MANURE ANALYSIS

LAB NUMBER: 548001
SAMPLE ID: FRI 17TH

DATE RECEIVED: 2017-02-23
DATE REPORTED:
DATE PRINTED: 2017-03-08

PARAMETER	ANALYSIS RESULT	POUNDS PER 1,000 GAL	ESTIMATED AVAILABILITY PER 1,000 GAL
Dry Matter	1 %		
Nitrogen (Total)	0.055 %	5.5	
NH4-N	292 ppm	2.9	
Phosphorus (Total)	0.0084 %		
Phosphate (P as P2O5) **	0.0193 %	1.9	0.8
Potassium (Total)	0.0476 %		
Potash (K as K2O) **	0.0571 %	5.7	5.1
Organic Matter *	0.5 %		
Carbon:Nitrogen Ratio (C:N)	5 : 1		
Calcium	0.0380 %	3.8	
Magnesium	0.0125 %	1.3	

* All Parameters are reported on an as is basis.
**Available nutrients are reported as total available. Only a portion of these nutrients will be available the year of application.
For information on nitrogen availability, see reverse side of page.
More information available: http://www.alcanada.com/files/Manure_Analysis.pdf

C17054-80000

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Clean-up solids (shavings:manure:dirt mixture) April 2017

Grace Mar Clean up Solids Apr. 2017

REPORT NO. C17111-80001
ACCOUNT NO. 05219

A&L CANADA LABORATORIES INC.
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Sawdust dirt manure

TO: EMERALD BAY AG SERVICES
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FOR: GRACEMAR FARMS

PAGE: 1 / 1

MANURE ANALYSIS

LAB NUMBER: 1118002
SAMPLE ID: CLUP

DATE RECEIVED: 2017-04-21
DATE REPORTED: 2017-04-28
DATE PRINTED: 2017-04-28

PARAMETER	ANALYSIS RESULT	POUNDS PER TON	ESTIMATED AVAILABILITY PER TON
Dry Matter	40.6 %		
Nitrogen (Total)	0.326 %	6.6	
NH4-N	99 ppm		
Phosphorus (Total)	0.0299 %		
Phosphate (P as P2O5) **	0.0688 %	1.4	0.6
Potassium (Total)	0.1007 %		
Potash (K as K2O) **	0.1208 %	2.4	2.2
Organic Matter *	29.9 %		
Carbon:Nitrogen Ratio (C:N)	46 : 1		
Calcium	0.3059 %	6.1	
Magnesium	0.1334 %	2.7	

* All Parameters are reported on an as is basis.
**Available nutrients are reported as total available. Only a portion of these nutrients will be available the year of application.
For information on nitrogen availability, see reverse side of page.
More information available: http://www.alcanada.com/files/Manure_Analysis.pdf

C17111-80001

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Appendix 3. Irrigation water quality – 2016

REPORT NO.
C16012-60000

ACCOUNT NUMBER
05219

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Canada
ATTN:Doug Macfarlane
Phone:250-546-3847
Fax:250-546-3847

FOR:GRACMAR FARMS

CERTIFICATE OF ANALYSIS

PAGE: 1

PROJECT NO:
PO#:
LAB NUMBER:126001
SAMPLE ID:#4 IRRIGATION WELL

SAMPLE MATRIX:WATER
DATE SAMPLED:NONE GIVEN
DATE RECEIVED:2016-01-12
DATE REPORTED:2016-01-13
DATE PRINTED:2016-01-13

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	301.0	ug/ml	10.0	Titration
Bicarbonate	301.0	ug/ml	10.0	Titration
Carbonate	BDL*	ug/ml	10.00	Titration
Aluminum	6.08	ug/ml	0.10	ICP
Boron	BDL*	ug/ml	0.02	ICP
Calcium	327.10	ug/ml	0.10	ICP
Beryllium	BDL*	ug/ml	0.02	ICP
Copper	BDL*	ug/ml	0.02	ICP
Iron	10.53	ug/ml	0.10	ICP
Magnesium	60.41	ug/ml	0.10	ICP
Cadmium	BDL*	ug/ml	0.005	ICP
Manganese	0.71	ug/ml	0.02	ICP
Cobalt	BDL*	ug/ml	0.02	ICP
Phosphorus	1.37	ug/ml	0.10	ICP
Chromium	BDL*	ug/ml	0.02	ICP
Potassium	21.97	ug/ml	0.10	ICP
Silicon	12.61	ug/ml	0.10	ICP
Sodium	24.33	ug/ml	0.10	ICP
Sulphur (as SO4)	595.20	ug/ml	0.10	ICP
Zinc	BDL*	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	1.45	ms/cm	0.02	Conductivity Meter
pH	7.3		0.1	pH Meter
Total Dissolved Solids	940.7	ug/ml	10.0	TDS Meter
Hardness	1065.43	ug/ml	1.00	ICP/Calculation

* - accredited test
BDL - Below detectable levels

The results of this report relate to the sample submitted and analyzed.

C16012-60000

Results Authorized By:

Haifeng Song, Senior Chemist / Agriculture Supervisor

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REPORT NO.
C16012-60000

ACCOUNT NUMBER
05219

A & L Canada Laboratories Inc.

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FOR:GRACMAR FARMS

CERTIFICATE OF ANALYSIS

PAGE: 2

PROJECT NO:
PO#:
LAB NUMBER:126001
SAMPLE ID:#4 IRRIGATION WELL

SAMPLE MATRIX:WATER
DATE SAMPLED:NONE GIVEN
DATE RECEIVED:2016-01-12
DATE REPORTED:2016-01-13
DATE PRINTED:2016-01-13

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Nickel	BDL*	ug/ml	0.02	ICP
Lead	BDL*	ug/ml	0.01	ICP
Sulphur	198.40	ug/ml	0.10	ICP
Vanadium	BDL*	ug/ml	0.02	ICP
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Chloride	41.4	ug/ml	1.0	ISE

* - accredited test
BDL - Below detectable levels

The results of this report relate to the sample submitted and analyzed.

C16012-60000

Results Authorized By:

Haifeng Song, Senior Chemist / Agriculture Supervisor

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