Your reference: APP-20171594
25 January 2018

The General Manager
Environment Southland
Private Bag 90116
INVERCARGILL

Attention: Ms A Grant

Dear Aurora

RE: Drop Test Results – Miraka Farms Ltd

Attached is a positive drop test for the existing pond on the farm and the pond will now be emptied and the structural inspection carried out and report provided.

We are looking into 3 options to address the issues raised by Ewan Rodway's Technical Comment.

Please contact me if you have any questions.

Yours faithfully
Civil Tech Ltd

Murray Gardyne
Director

RDAgritech
ENGINEERED BY NATURE

DAIRY EFFLUENT POND DROP TEST REPORT

JOB TITLE	MIRAKA DAIRY
ADDRESS	162 BOYLE ROAD, WINTON
JOB NUMBER	50596

Client: Miraka Farms Limited
162 Boyle Road
RD 3
Winton 9783

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Prepared by

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Environmental Engineer

1. INTRODUCTION

1.1. SCOPE

RDAgritech was engaged by Miraka Farms Limited to perform a drop test on an existing Dairy Farm's effluent storage pond.

Our methodology is based on and in accordance with IPENZ Practice Note 21 Section 8.7, and is consistent with Environment Southland's methodology described in Appendix P of the proposed Southland Water and Land Plan. The methodology is further discussed in the methodology section of this report.

The drop test as set out in IPENZ PN21 is not considered a suitable means of assessing liner permeability, however a carefully run drop test will indicate if there is gross leakage, being a large single-point leakage, or a number of smaller leaks in the liner.

1.2. SUMMARY OF RESULTS

	Value	Source
Maximum Allowable Pond Drop	2mm/day	*Proposed Southland Water & Land Plan Rule 35(b)*
Calculated Daily Pond Drop	+0.3mm/day	*RDAgritech Drop Test completed 23/05/2015*
Interpretation of Result	Pass	**within statistical error & test precision*

The calculated gross leakage rate derived from the above drop test is less than the maximum allowable pond level drop defined in the proposed Southland Water & Land Plan. This means that, for the purposes of compliance with Regional Council requirements, the pond is considered to meet the regional compliance limits for leakage and is considered acceptable by Environment Southland.

1.3. POND DROP TEST DESCRIPTION

Test start	14/12/2017 11:45
Test End	18/12/2017 6:30
Test Period	90.75 hours
Pond Location	162 Boyle Road, Winton GPS 1226849 4886386
Pond Description	Rectangle pond built from compacted gravels. Above ground
Liner Description	Earthen liner constructed from locally sourced material
Additional Pond Comments	Pond embankments were very solid and are estimated as being 10m wide. Pond was fenced off with no sign of stock damage to pond embankments.
Effluent Surface Area:	31m x 19.5m = 585m^2
Pond Catchment:	33m x 21.5m = 709.5m^2
Pond Depth (as % of design depth)	Total depth of pond is unknown however the pond was 300mm from the top of the embankment.
Pond Last De-sludged:	The pond was desludged two years ago and the weeping wall system appears to be effective in removing solids.
Wind Speed:	One breach which reached a peak of 16m/s on 15/12/2017.
Method of Pond Isolation	Pipe removed, and pump shut off.

1.4. DISCUSSION

The pond drop test returned a result indicating that a net rise of 1.3mm occurred during the test period however this result is within the statistical accuracy of the test equipment and therefore the test result is considered to be compliant with the standards set by Environment Southland. The total depth of the effluent pond is not known however the current discharge permit requires 1,797m^3 of storage, and based on the dimensions of the pond, it is estimated to be approximately 3m in depth.

This section discusses all changes in pond level during the test. The following events are shown on the charted data.

Event 1: Missing Weather Data:

The weather station data logger has failed to log data from the start of the test period and did not start logging weather data until 10:13pm on 14th December 2017. Based on weather data collected in Wreys Bush, wind speeds were approximately 9m/s at their peak during this period and the peak temperature was 22.8° C. This explains the slight reduction in logged pond level and evaporation tray due to evaporation, which can be seen under Event 1 in the charted data.

Event 2: Breach of Wind Speed Limit

Between 07:28am and 03:58pm wind speeds exceeded 10m/s, with the strongest wind speed recorded at 13.3m/s and the strongest wind gust at 16m/s with these peaks occurring at approximately 11:43am. In referring to the charted data under Event 2, it can be seen that the high wind speeds, along with temperatures of 27°C have resulted in both significant noise in the graphed data, and a significant evaporation event which has lowered the level in both the pond and evaporation tray.

Event 3: Significant Evaporation 16th December

Between approximately 8:30am and 07:30pm on the 16th of December a significant evaporation event took place, as shown under Event 3 on the charted data. It can be seen that during this event the level in both the pond, and the evaporation tray dropped 10mm. During this event the dominant wind direction was Southerly which turned easterly at approximately 10:00pm, and then turned northerly at approximately 11:20pm.

Event 4: Spike in Pond Level

On the 17th of December, there was a spike in pond level, followed by a drop and then another larger spike, which was then followed by a second drop, and this is shown as Event 4 on the charted data. This event occurred at the same time as two small spikes in temperature and it is suspected that this has caused condensation to build up on the capacitance logger cable which resulted in a false spike occurring.

Event 5: Rainfall

All rainfall during the test period occurred between 10:30pm on 17th December, and the end of the test, with a total of 8mm recorded in the tipping bucket rain gauge. The rainfall event is shown in the charted data as Event 5, and it can be seen that the pond level increased by approximately 9mm during this period. The rainfall event coincided with moderate to strong Southwest winds which have masked the increase by creating noise in the logged data in both the evaporation tray and the pond. At 10:00pm on the 17th of December the wind speed dropped off and the graphed data shows both the evaporation tray and pond level flattening out.

General Comments:

Evaporation ratios can vary widely and have been observed between 1:1 and 1:3 in various other ponds, depending on weather conditions, pond geometry and effluent characteristics. For this test, based on observations of weather data and level observations of pond and evaporation pan levels, we have estimated an evaporation ratio of 1:1.9 which corresponds to evaporation of 4.7mm.

The above results in a nett rise of 1,0mm or 0.3mm/day, which is within the overall accuracy limit of the test.

Observed pond level changes overnight during cool temperatures, (when evaporation loss is minimal) showed no loss or gain in pond level. In ponds that are exhibiting infiltration, this is usually most evident during the night when it cannot be offset by evaporation.

This pond is mostly above ground level, and in view of the low groundwater and soil moisture levels during the test, combined with the high effluent level in the pond, infiltration is considered to be unlikely.

2. PHOTOGRAPHS

Photograph of pond before test

Photograph of pond level logger and evaporation logger

Photograph of floating evaporation tray at start of test.

Photograph of the floating evaporation tray at end of test

3. METHODOLOGY

3.1. TEST LIMITATIONS

The drop test will determine if gross leakage occurs, i.e. a single large hole or multiple smaller holes or if the liner permeability is above the required standard. The drop test is not suitable to verify whether a liner has achieved the recommended maximum leakage level due to the limitations in measuring very small changes in level accurately.

3.2. POND INFLOWS & OUTFLOWS

Ideally, no effluent or stormwater should be allowed to flow into or out from the pond during the test period. The pond was fully isolated from any inflows or outflows for the duration of the test.

3.3. RAINFALL

An Odyssey Tipping Bucket Rain Gauge Logger was used to measure total rainfall and rainfall intensity over the test period.

The Odyssey Rain Gauge logger operates based on event-triggered logging. In event triggered logging, the data will be logged only when the sensor triggers an event. In the context of this logger, an "event" is 0.2mm of rainfall. The data has been converted into 5-minute intervals in order to align with the pond level data and allow comparison.

3.4. EVAPORATION

Two evaporation pans were used for this test. One was placed on the pond embankment in the location shown on the test location plan, the other was floated in the pond as required by IPENZ PN21. The on-shore pan measures 362.5mm long x 240mm wide x 210mm high, while the floating pan measures 410mm long x 270mm wide x 210mm high. We estimate the precision of manual water level measurement in the pans as ±0.5 mm.

The floating pan is used as the reference for evaporation, as it most closely represents evaporation conditions in the pond. The second pan on the embankment is used as a back-up and to identify trends in level fluctuation, however is less representative of overall evaporation conditions in the pond due to its' different thermal mass.

Water level in the floating pan was recorded at the start and end of the test period. The on-shore pan is logged with a capacitive logger. Capacitive loggers are further discussed below.

3.5. EFFLUENT LEVEL MEASUREMENT

A capacitive water level logger was installed in the pond, to determine the overall change in pond level over time. The logger is protected within a PVC tube covered with filter fabric to prevent fouling of the sensor. Pond level measurements were taken every 10 seconds throughout the test period.

The loggers are both calibrated every time they are used, using effluent from the pond being tested. The precision of pond level measurement is estimated at ±0.8 mm. The pond level data is shown in the site investigation log.

3.6. WEATHER CONDITIONS AND WIND SPEED

An Aercus WS2083 weather station was set up near the pond. The weather station records wind direction, average wind speed, maximum wind gust, temperature, air pressure, humidity. The weather station records a data point every 5 minutes and in the case of maximum wind gust, the value recorded is the maximum obtained over the 5-minute period.

The primary purpose of the weather station is to verify the wind speed during the test period, however other data is useful in providing context to any fluctuations on pond level, or seiche effects.

3.7. POND DROP CALCULATION

Total water level drop was estimated from the pond level change over the test period. The pond level drop due to gross leakage (Δh) is determined by the following formula:

$$\Delta h = Total\ precipitation + Change\ in\ pond\ level - Total\ open\ water\ evaporation$$

4. APPLICABILITY

This report has been prepared based on data and observations collected from a Pond Drop Test conducted in accordance with IPENZ Practice Note 21 Section 8.7 and, where relevant, information provided by the Client or their representative.

While we have exercised due care in assessing the leakage rate through the pond liner, we take no responsibility for the actual rate of leakage that may be occurring and any environmental contamination that may result.

The scope of the pond drop test does not include determination of groundwater levels or assessment of the pond's structural integrity.

This report is only to be used by the parties named above for the purpose that it was prepared and shall not be relied upon or used for any other purpose without the express written consent of RDAgritech Ltd.

APPENDIX A – DROP SITE TEST LOGS

DROP TEST SITE LOGS

Calibration Data
Odyssey Capacitive Water Level Logger

Calibration Data:

CALIBRATION DATA SHEET

SENSOR Sn: 11098
CAPACITIVE WATER LEVEL
LINEAR CALIBRATION

Units Of Measurement	mm		
Calibration Unit 1	839	**Measured Value**	200 mm
Calibration Unit 2	1375	**Measured Value**	500 mm
Calculated Slope	1.78666666666667		
Calculated Offset	481.666666666667		
Relative Value	0		
Number of decimal places	1		

Dataflow Systems Pty Ltd
20 December 2017

CALIBRATION DATA SHEET

SENSOR Sn: 10433
CAPACITIVE WATER LEVEL
LINEAR CALIBRATION

Units Of Measurement	mm		
Calibration Unit 1	1301	**Measured Value**	200 mm
Calibration Unit 2	2419	**Measured Value**	800 mm
Calculated Slope	1.86333333333333		
Calculated Offset	928.333333333333		
Relative Value	0		
Number of decimal places	1		

Dataflow Systems Pty Ltd
20 December 2017

The formula used in the datalogger software to generate calibrated data is:

$$RES = \frac{DATA - OFF}{SL} + RL$$

Where: -

RES	=	Resultant calibrated water level value
SL	=	Slope of sensor data values
OFF	=	Offset value for sensor
RL	=	Relative value from collar to sensor position
DATA	=	The uncalibrated value read by the probe

Calibration procedures are as specified in the Odyssey Capacitive Water Level Logger Manual, available from Dataflow Systems Pty Ltd, www.odysseydatarecording.com

Odyssey Tipping Bucket Rain Gauge Logger

The orifice of the rain gauge is 6.5 inches or 165.1 millimeters. The Davis Tipping Bucket Rain Gauge is factory calibrated and should not normally require any attention other than keeping it clean.

SENSOR Sn: 5228
TIPPING BUCKET RAIN GAUGE
LINEAR CALIBRATION

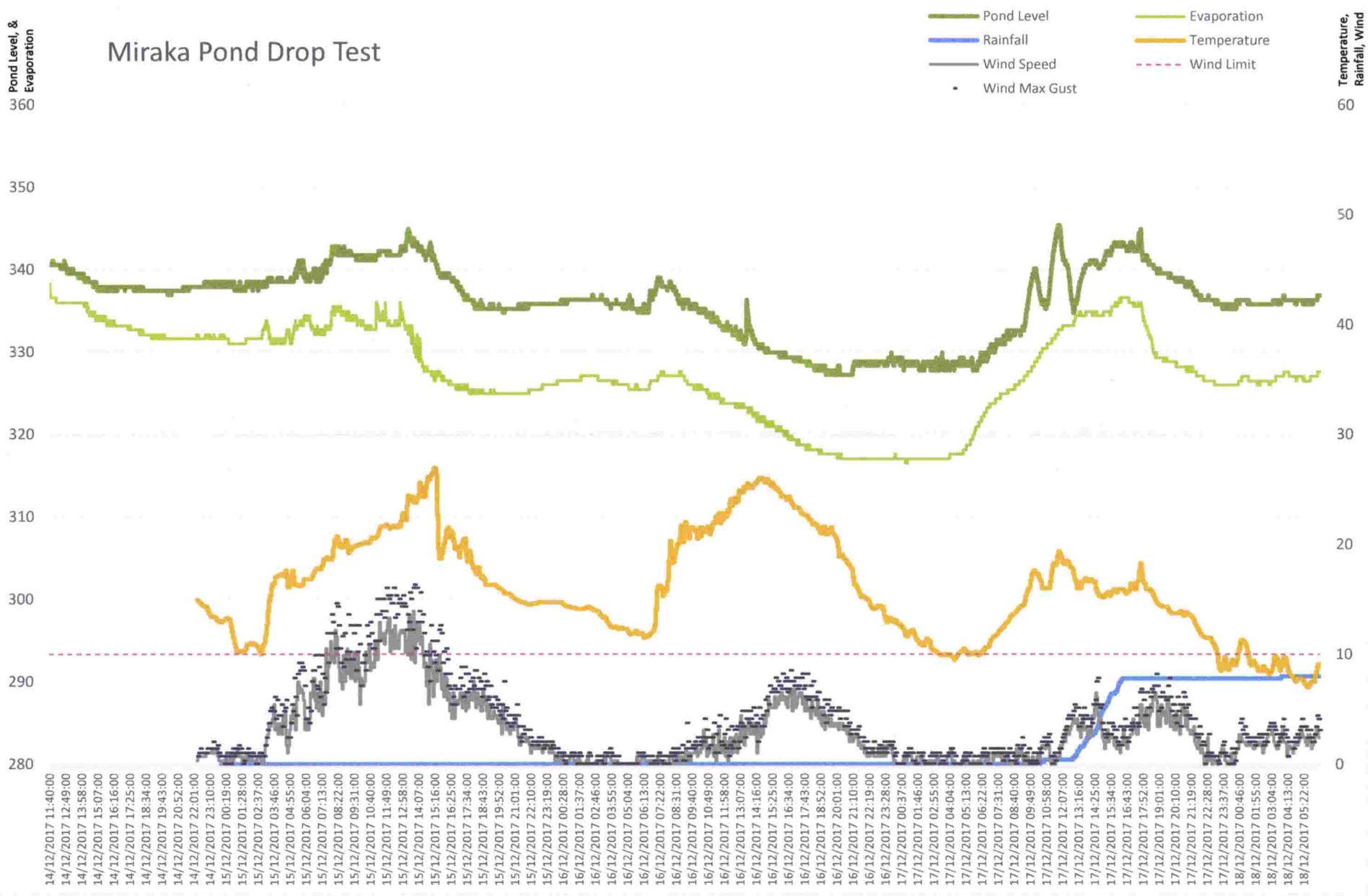
Units Of Measurement	mm		
Calibration Unit 1	0	Measured Value	0 mm
Calibration Unit 2	233	Measured Value	46.6 mm
Calculated Slope	5		
Calculated Offset	0		
Relative Value	0		
Number of decimal places	1		

If the calibration appears to be significantly in error, a calibrated rain gauge located within 600 mm of the tipping bucket logger may be used to compare the readings over a period of time. A significant rainfall event will give the best results.

Calibration procedures are as specified in the Odyssey Tipping Bucket Rain Gauge Logger, available from Dataflow Systems Pty Ltd, www.odysseydatarecording.com

APPENDIX B – DATALOGGER RESULTS

POND LEVEL CHART


Miraka Pond Drop Test
Pond Level, & Evaporation
Temperature, Rainfall, Wind
Pond Level
Evaporation
Rainfall
Temperature
Wind Speed
Wind Limit
Wind Max Gust
360
350
340
330
320
310
300
290
280
60
50
40
30
20
10
0
14/12/2017 11:40:00
14/12/2017 12:49:00
14/12/2017 13:58:00
14/12/2017 15:07:00
14/12/2017 16:16:00
14/12/2017 17:25:00
14/12/2017 18:34:00
14/12/2017 19:43:00
14/12/2017 20:52:00
14/12/2017 22:01:00
14/12/2017 23:10:00
15/12/2017 00:19:00
15/12/2017 01:28:00
15/12/2017 02:37:00
15/12/2017 03:46:00
15/12/2017 04:55:00
15/12/2017 06:04:00
15/12/2017 07:13:00
15/12/2017 08:22:00
15/12/2017 09:31:00
15/12/2017 10:40:00
15/12/2017 11:49:00
15/12/2017 12:58:00
15/12/2017 14:07:00
15/12/2017 15:16:00
15/12/2017 16:25:00
15/12/2017 17:34:00
15/12/2017 18:43:00
15/12/2017 19:52:00
15/12/2017 21:01:00
15/12/2017 22:10:00
15/12/2017 23:19:00
16/12/2017 00:28:00
16/12/2017 01:37:00
16/12/2017 02:46:00
16/12/2017 03:55:00
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16/12/2017 06:13:00
16/12/2017 07:22:00
16/12/2017 08:31:00
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16/12/2017 15:25:00
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16/12/2017 17:43:00
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16/12/2017 23:28:00
17/12/2017 00:37:00
17/12/2017 01:46:00
17/12/2017 02:55:00
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17/12/2017 06:22:00
17/12/2017 07:31:00
17/12/2017 08:40:00
17/12/2017 09:49:00
17/12/2017 10:58:00
17/12/2017 12:07:00
17/12/2017 13:16:00
17/12/2017 14:25:00
17/12/2017 15:34:00
17/12/2017 16:43:00
17/12/2017 17:52:00
17/12/2017 19:01:00
17/12/2017 20:10:00
17/12/2017 21:19:00
17/12/2017 22:28:00
17/12/2017 23:37:00
18/12/2017 00:46:00
18/12/2017 01:55:00
18/12/2017 03:04:00
18/12/2017 04:13:00
18/12/2017 05:22:00

DROP TEST LOG

Drop Test Log

RDAgritech
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Job Number:	50596
Project:	Miraka Dairy
Location:	
Test Technician:	

Test Period: **Start:** 14/12/2017 11:45 **Finish:** 18/12/2017 6:30
Duration: 90.75 hours

Rain Gauge

Rainfall measured over test period:	8	mm
Rainfall Added to Effluent Surface:	8.8	mm

Evaporation Pans

	Start Level (mm)	End Level (mm)	Change in Level (mm)	
Evaporation Pan 1	336.6	327.6	-9.0	On-shore Pan
Evaporation Pan 2	200	224	24.0	Floating Pan

Evaporation Ratio 1: N/A *(ratio of pond evaporation to on-shore pan evaporation)*

Evaporation Calculation -4.7 Pan level change -13.5 **Total evaporation**

Weather

At test start:		**At test end:**	
Sun:	full sun	**Sun:**	Cloud, no sun
Temperature:	20	**Temperature:**	14
Wind:	1m/ws	**Wind:**	1m/s
Rain:	no	**Rain:**	slight drizzle

Pond

Effluent Surface Length:	31.8	m	**Depth of effluent:**	2.7	m
Pond Length:	33.0	m	**Pond Design Depth:**	2.5	m
Effluent Surface Width:	19.7	m	**Pond Total Depth:**	3	
Pond Width:	20.9	m	**Side slopes angle:**	2	?(H):1(v)
Effluent Surface Area:	626.5	m^2	Wetted surface area	678	m^2
Pond Surface Area:	689.7	m^2	Base bottom length	21	m
Height @ start of test:	340.6	mm	Base bottom width	8.9	m
Height @ end of test:	336.9	mm	**Effluent Volume:**		m^3
			Pond Volume (ex. Freeboard):		m^3
			Percentage of Design Depth	108%	

Measured Change in pond level:	-3.7	mm
Angle of Datalogger:	0	º (degrees)
Actual Change in Pond Level:	-3.7	mm
Nett Change in Pond Level over test:	1.0	mm (excluding evaporation/rainfall)

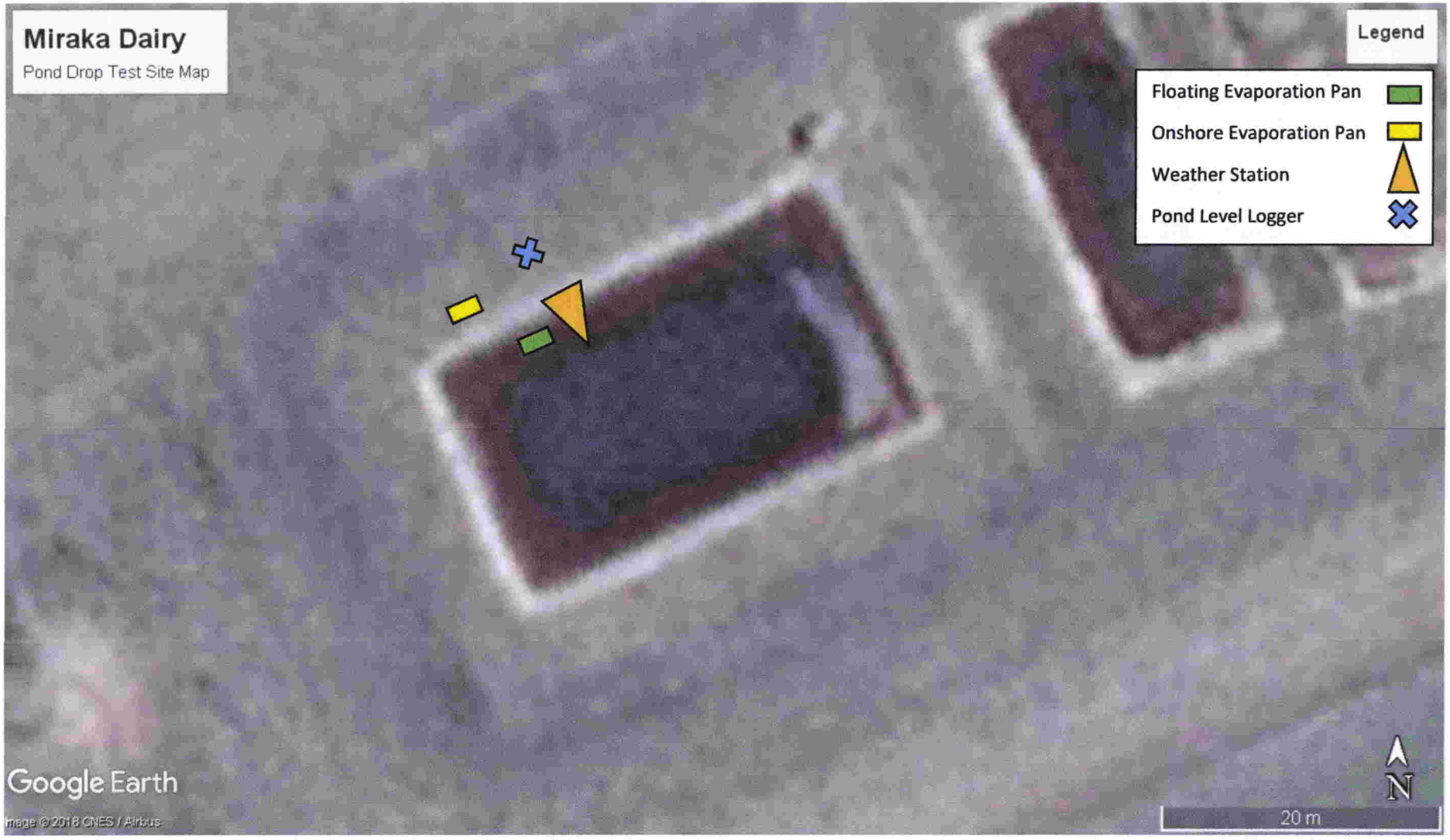
ES Max. Allowable Drop	**2.0**	**mm/day**
Daily drop recorded	N/A	**mm/day**
	0.3	

Notes:

1) Effluent was excluded from entering the pond for the duration of the test.

2) Pond depth and % full are calculated on the best available data, which may include: measurements taken from above effluent level, any plans or specifications available and the pond owner's knowledge. It is not possible to confirm pond dimensions without first emptying the pond.
RDAgritech do not take any responsibility for the accuracy of pond dimensions used.

APPENDIX C – TEST SITE PLAN


Miraka Dairy
Pond Drop Test Site Map
Legend
Floating Evaporation Pan
Onshore Evaporation Pan
Weather Station
Pond Level Logger
Google Earth
Image © 2018 CNES / Airbus
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