ENVIRO – STEWARDS

engineering change

IRRIGATION WATER USE ASSESSMENT REPORT FOR:

Holland Marsh Growers' Association

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Executive summary.

Project overview & findings.

Enviro-Stewards worked with Holland Marsh Growers' Association to conduct site specific projects that will be used to develop a sector template for future assessments based on cost-benefit principles. This irrigation assessment identifies site-specific opportunities to reduce water use without impacting the crop.

Enviro-Stewards Inc. conducted an irrigation assessment on a sprinkler system on August 4-5, 2021.

Major Findings

- The assessment revealed a distribution uniformity of 69%, which is fair.
- A sprinkler in the test area was malfunctioning, which contributed to this uneven coverage.
- The flow and pressure data were obtained from sprinklers on a different lateral, but are believed to be representative of sprinkler performance on the test lateral.
- The pressure drop along the lateral did not appear to be significant.
- Flow did not appear to be related to pressure or distance from the main.
- Leaks were observed at pipe connections along the lateral and the main.
- The system does not have a flow meter.

Summary of Major Opportunities

- Continue sprinkler replacement program to replace failed sprinklers or worn nozzles;
- Repair leaks at pipe connections;
- Install a flow meter on the pump's supply to measure the amount of water being delivered to irrigated areas, or install a vibration sensor on the pump to record pump operation and calculate water delivered to irrigated areas;
- Appoint a person dedicated to checking the irrigation system while it is operating and to walk the irrigated area after irrigating, looking for issues;
- Annual staff training to teach them:
    - How to look for issues (observations);
    - How to report observations;
    - How to make repairs; and,
    - Explain why it is important to maintain irrigation system performance.

Estimated Costs to Implement Major Opportunities

Recommendation	Details	Estimated Installed Cost ($)
Repair or Replace Sprinklers	30 min/sprinkler $20/hr + cost of sprinkler	$10/sprinkler (labour) + Cost of sprinkler
Repair Leaks	30 min/leak $20/hr Assume 1 leak/ week * 8 weeks	$80/leak
Install a Flow Meter or Vibration Sensor	Non-data logging flow meter on a 6" pipe with 100 micron strainer * 4 hrs * $100/hr Or Vibration logger & software package	$3,000 (Flow Meter Pkg) $310 (Vibration Package)

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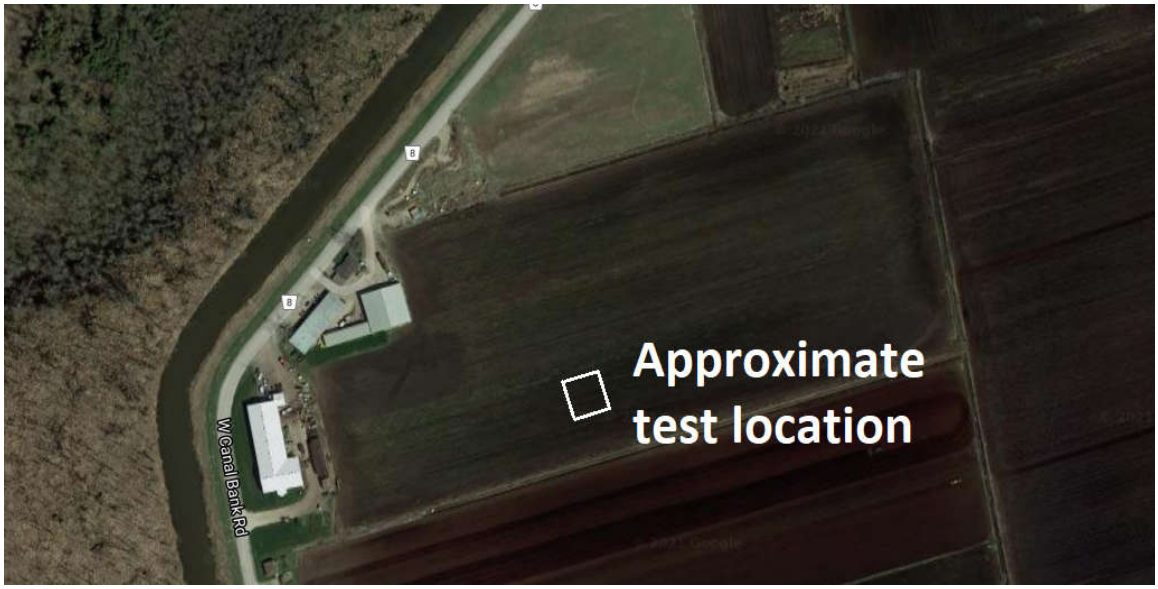
1.0 Introduction.

1.1 BACKGROUND

Enviro-Stewards worked with Holland Marsh Growers' Association to conduct site specific projects that will be used to develop a sector template for future assessments based on cost-benefit principles. This irrigation assessment identifies site-specific opportunities to reduce water use without impacting the crop.

An irrigation system assessment was completed on August 5, 2021 on a sprinkler system. Newly transplanted celery was in the test area. The approximate location of the test location is outlined in white in the following figure.

Figure 1: Approximate Location of Test Area



Typical sprinkler system operation is between 1 to 2 hours in the evening or early morning as required to irrigate the new transplants. Water for the irrigation system is pumped from a surface water source to a 6” main. The 6” main supplies 4” diameter lateral pipes. Most of the laterals remain in place until they are no longer required. There are insufficient laterals to cover the entire planting area, so two of the 8 laterals are moved manually to irrigate the southern portion of the field. The lateral connections have a 60’ spacing. The lateral has 22 solid set sprinklers on 60’ spacing. The sprinklers are 18” above the ground. The maximum crop height does not interfere with the sprinklers.

The Scova diesel pump is 75 hp. The supplied system maximum rated pressure at the pump is 100 PSI. The pump can deliver up to 800 gpm or 15 l/sec. The irrigation system does not have a flow meter.

A system overview is provided in the following table.

Table 1: Irrigation System Overview

Typical Set Duration	1 – 2 hours, evening or early morning
Water Source	Surface
Irrigation System	6" main to moveable 4" lateral pipes, some permanent, some moved
Lateral Spacing	60'
Lateral Pipe Diameter	4"
Number of Sprinklers Along Lateral	22
Sprinkler Spacing Along Lateral	60'
Sprinkler Height Above Ground	18"
Sprinkler Nozzle Type	Rain Bird 14070 double nozzle: 7/32"
Main Irrigation Pump	Scova -diesel
Irrigation Season	Aug - Sept (8 weeks)
System Operation	Daily for first month As needed after that
Crop	Celery transplants
Crop Maximum Height	4"
Crop Interference with Sprinklers	No
Flow Meter	No

2.0 Methodology.

Three tests were conducted to determine irrigation system performance:

- **Distribution Uniformity Test:** evaluates how evenly irrigation water was applied over the test area;
- **Nozzle Water Pressure Test:** measured at the sprinkler nozzle to determine the pressure of the water discharging from the nozzle;

- **Nozzle Flow Rate Test:** determines the amount of time to fill a bucket with water from the nozzle.

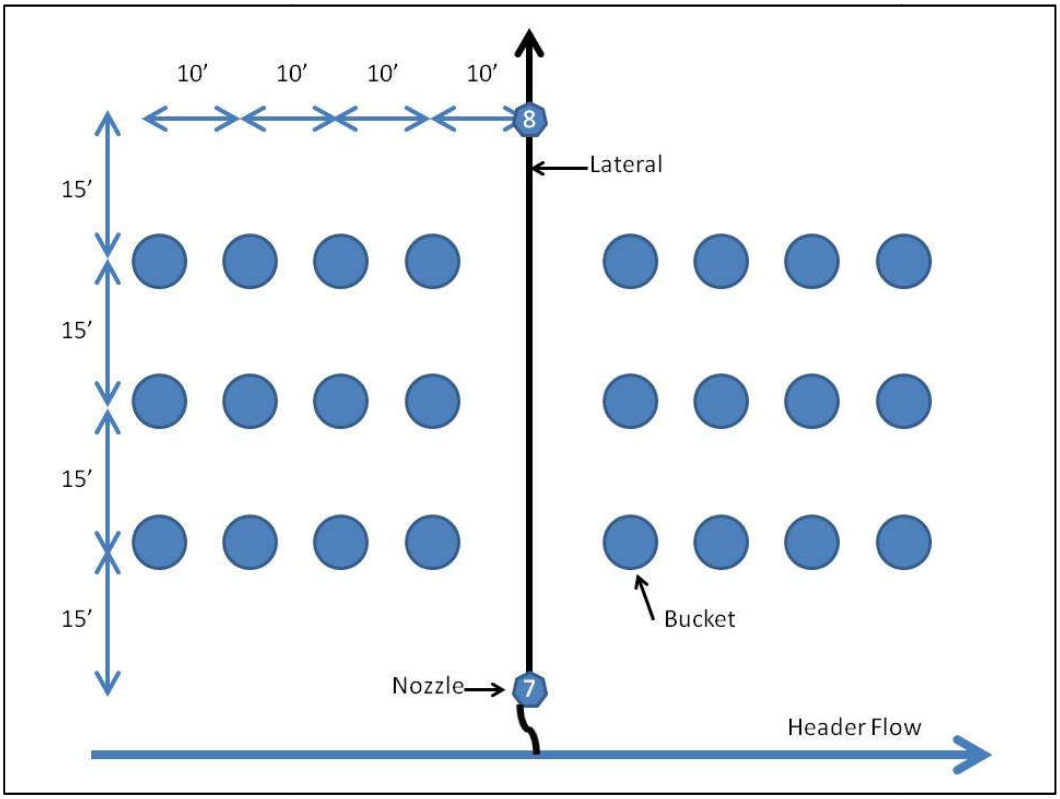
The water pressure and nozzle flow rate tests help identify potential problems that may affect distribution uniformity.

The south end of the field was being planted during grid set up the evening of August 4. The area identified for the test had just been planted & was being irrigated. The nozzle pressure and flow tests were done on all 22 sprinklers on this lateral in the test area. After running the system, the lateral was moved and another lateral brought into the test area. It was not possible to do the flow and pressure tests on the new lateral in the test area because the new transplants did not need additional water. The area where the original lateral had been moved was being planted, so it was not possible to set up the grid before dusk set in. Consequently, the Distribution Uniformity test was conducted in the original test area between sprinklers 7 and 8. The irrigation system ran from 6 to 8 am August 5. As a result, the catch can data represented different nozzles than the flow and pressure tests.

2.1 DISTRIBUTION UNIFORMITY

The collection area for the distribution uniformity test was between sprinklers 7 and 8 on either side of the lateral located at the seventh connection along the main. The collection area was to the east of the header (Figure 2).

Figure 2: Sketch of Test Area



A total of 24 catch cans were placed in the collection area. Three rows of four cans were spaced 15 feet by 10 feet apart respectively in a grid pattern on either side of the lateral (12 cans to the left of the lateral and 12 to the right). The catch can layout is presented in Figure 3.

Figure 3: Catch Can Layout.

2.2 NOZZLE PRESSURE MEASUREMENT

A pressure gauge was inserted into the end of the nozzle to obtain the discharge pressure. The pressure test determines whether pressure changes along the lateral may affect distribution uniformity.

2.3 NOZZLE FLOW RATE

The time to fill a 17.5 L bucket was measured by directing the flow from the nozzle into the test bucket. Variations in flow may be caused by pressure differences or blockages or other mechanical reasons and can affect distribution uniformity.

3.0 Results.

3.1 DISTRIBUTION UNIFORMITY (LOW QUARTER)

The distribution uniformity describes how evenly irrigation water is applied over the collection area. It is a measure of irrigation system performance. Lowest Quarter Distribution Uniformity (DUlq), which is expressed as a percentage, was used in this test to describe the application uniformity of the system.

DUlq = average of lowest ¼ of intercepted flows / average of all intercepted flows

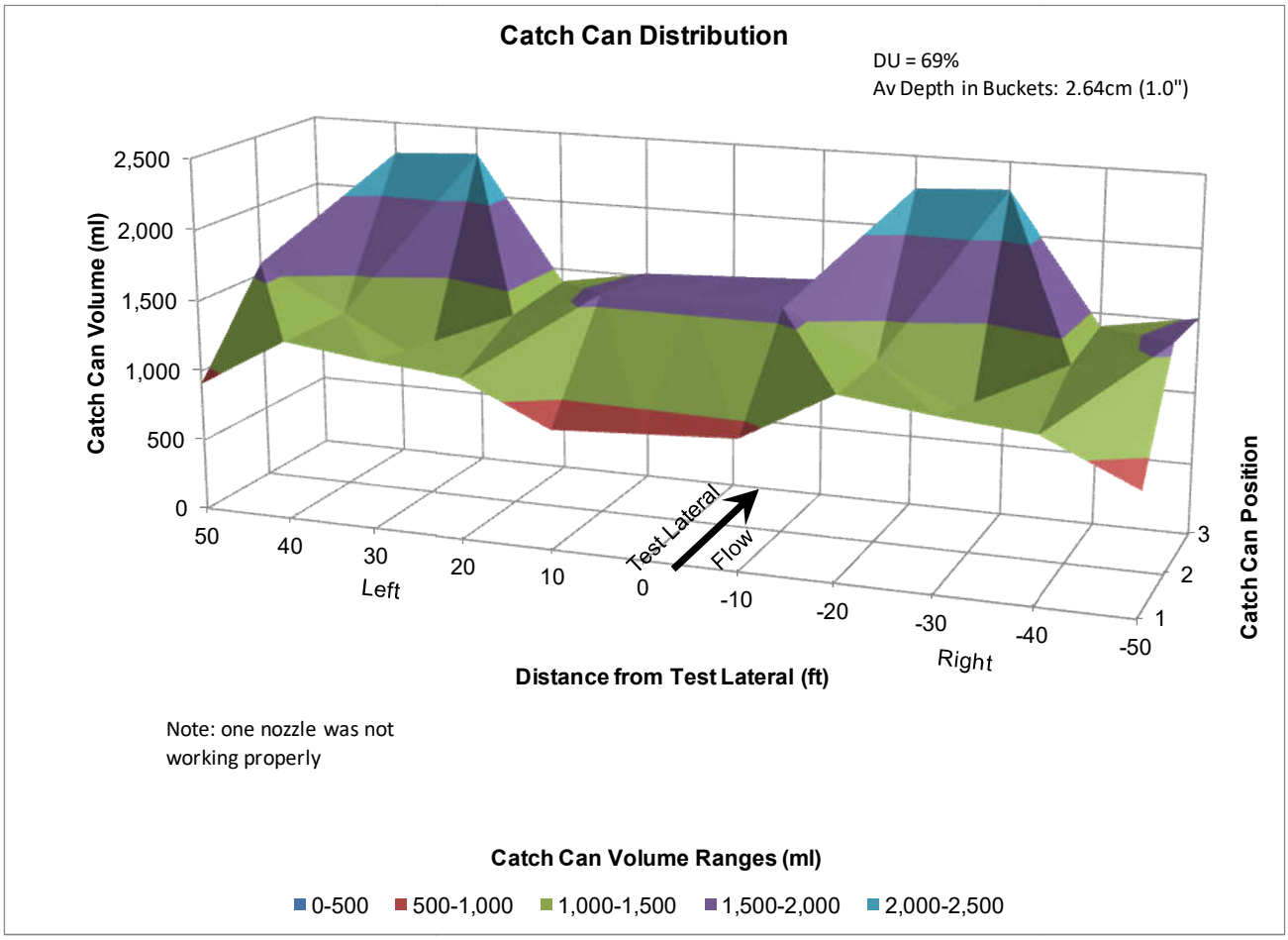
The higher the DUlq, the more even the application is. If the amount of water collected in each of the catch cans was the same, the DUlq would be 100%. It is generally accepted that a value of 80% or more is considered acceptable for a sprinkler system.

The distribution uniformity was 69% or fair in this assessment.

What this means is that the irrigation water was not applied evenly over the collection area; therefore, some sections of the collection area received too much water and others not enough. Uneven distribution can have an impact on produce quality, quantity and on the maturation rate.

The water distribution over the collection area is graphically presented in Figure 4. The test lateral is in the middle of the graph. One of the nozzles was not working properly according to the farm owner. It was obvious while walking through the test area to collect water in the catch cans that there were some very wet patches.

Figure 4: Distribution Uniformity of Irrigation Water Application



The amount of water collected in each of the catch cans is presented in the following table.

Table 2: Catch Can - Measured Volumes of Intercepted Water

	Distance from Lateral (ft)										
	50	40	30	20	10	0	-10	-20	-30	-40	-50
Catch Can Volume (ml)	910	1270	1190	1135	840	875	910	1270	1190	1135	840
	1580	1270	950	1365	1570	1575	1580	1270	950	1365	1570
	1580	2275	2310	1411	1520	1550	1580	2275	2310	1411	1520

The average amount of water intercepted by all the catch cans was 2.64 cm or 1" over the 2 hour collection period. The depth in the cans ranged from 0.61" to 1.68". None of the catch cans was empty.

In order to apply 1" of water to the driest areas, 0.39" of additional water would have to be applied, which would result in operating the irrigation system for approximately 30

more minutes. Additional system operation to achieve the target application in the driest areas will result in significant overwatering in the already wet areas.

The collection grid was set up the night before the system operated. The test area was irrigated from 6 to 8am the next day. The water measurements were taken from 11am to 12pm the same day. An example of measuring the water from a catch can at the end of the test is presented in Figure 5.

According to the operator, one of the nozzles in the test area was malfunctioning. The night before during grid setup, other laterals were operating. No other malfunctioning nozzles were observed. Based on these observations, it is believed that the results from the collection area are not representative of the distribution along the entire lateral.

Figure 5: Example of Measuring Catch Can Intercepted Water

3.2 PRESSURE & FLOW MEASUREMENTS

Pressure and flow measurements were taken at 22 sprinkler heads along a non-test lateral. Flow from each nozzle was measured by timing how long it took to fill a 17.5 litre pail.

Figure 6: Test Sprinkler Head #7

Figure 7 shows the pressure and flow measurements at each nozzle. Pressure appears to drop along the length of the lateral. Pressure is highest at the nozzles closest to the main and lowest at those furthest from the main. This drop is not considered significant.

Flow does not appear to be related to distance from the main; in fact, it appeared to improve with distance from the header.

Figure 7: Pressure versus Flow Measurements at Each Nozzle

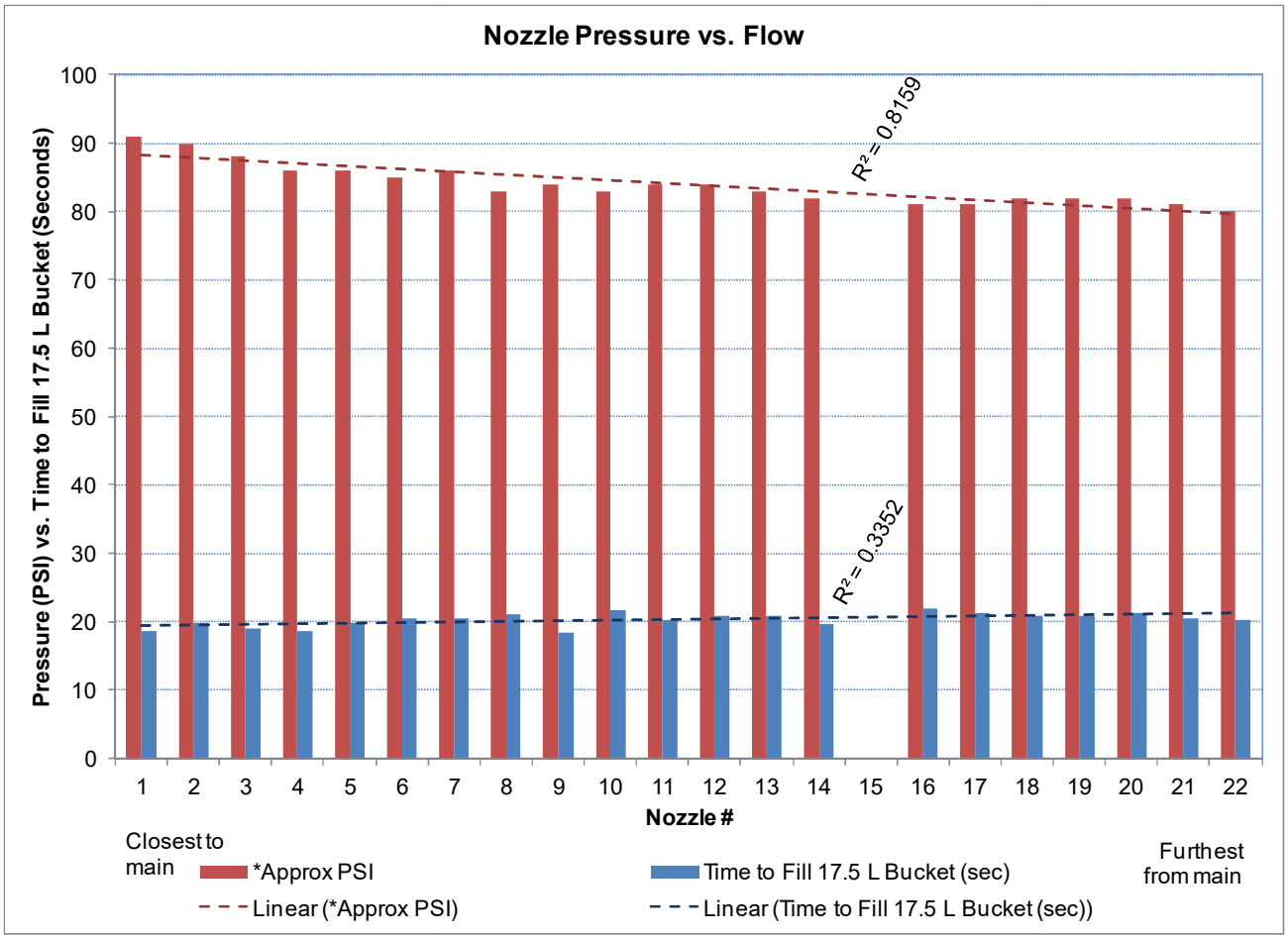
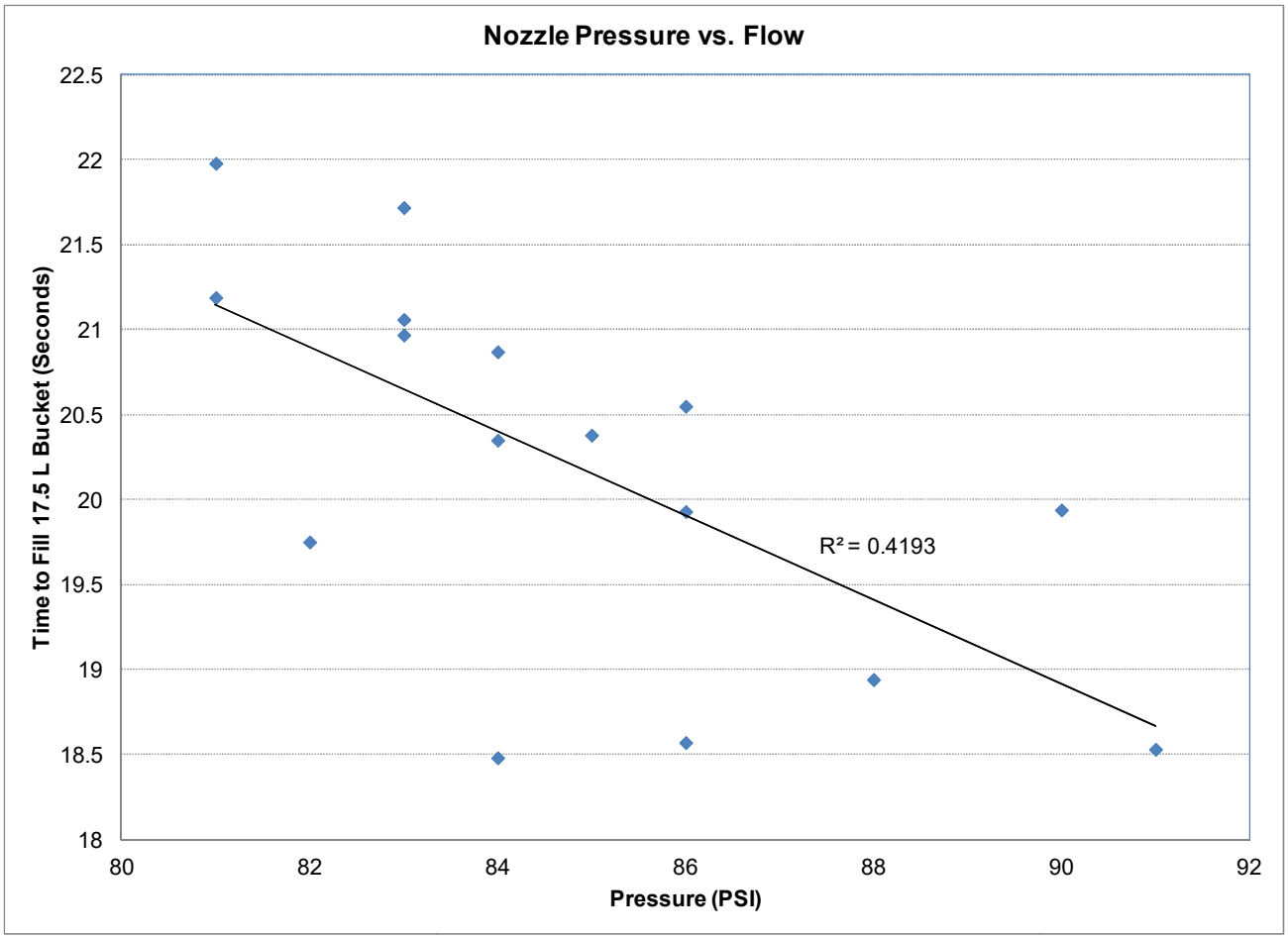


Figure 8 looks at the relationship between pressure and flow. This relationship is quite weak.

Based on the analyses presented in these two figures, it would seem that flow is not related to distance from the main or to nozzle pressure. Nozzle wear did not appear to be an issue.

Figure 8: Relationship between Nozzle Pressure & Flow



A summary of the pressure and flow measurements, nozzle make and model, along with other observations is presented in Table 3.

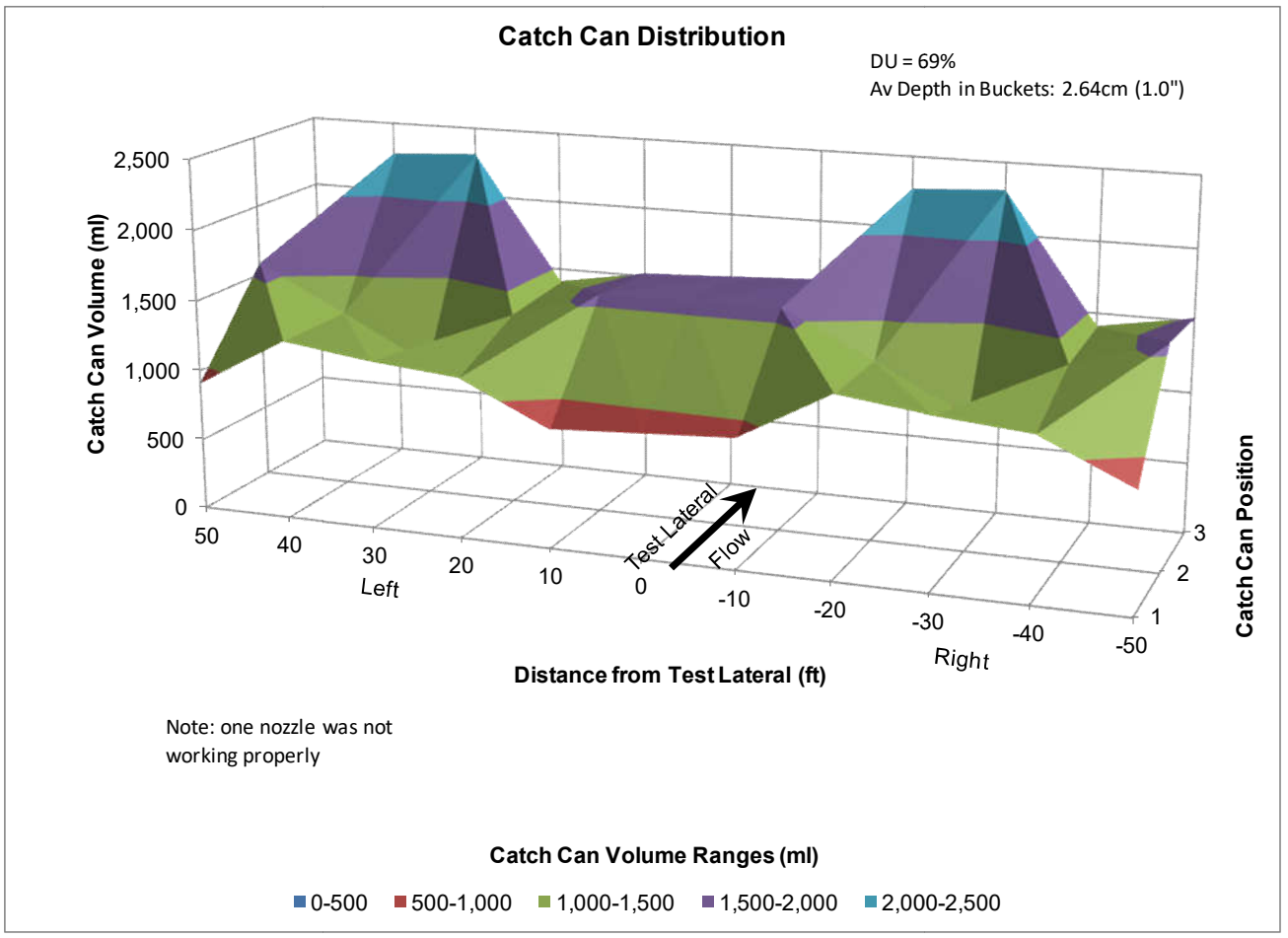
Table 3: Pressure & Flow Measurements & Other Observations

Sprinkler #	# of Sprinkler Heads	Nozzle Make & Type	Pressure (PSI)	Time to Fill 17.5 L Bucket (sec)	Notes
1	2	Rain Bird 7/32 14070	91	18.53	Nozzles not in test area. This lateral was moved & a different lateral moved into test area. Unable to measure nozzles on new lateral.
2	2	Rain Bird 7/32 14070	90	19.94	
3	2	Rain Bird 7/32 14070	88	18.94	
4	2	Rain Bird 7/32 14070	86	18.57	
5	2	Rain Bird 7/32 14070	86	19.93	
6	2	Rain Bird 7/32 14070	85	20.38	
7	2	Rain Bird 7/32 14070	86	20.55	
8	2	Rain Bird 7/32 14070	83	21.06	
9	2	Rain Bird 7/32 14070	84	18.48	
10	2	Rain Bird 7/32 14070	83	21.72	
11	2	Rain Bird 7/32 14070	84	20.35	
12	2	Rain Bird 7/32 14070	84	20.87	
13	2	Rain Bird 7/32 14070	83	20.97	
14	2	Rain Bird 7/32 14070	82	19.75	
15	2	Rain Bird 7/32 14070			
16	2	Rain Bird 7/32 14070	81	21.98	
17	2	Rain Bird 7/32 14070	81	21.19	
18	2	Rain Bird 7/32 14070	82	20.88	
19	2	Rain Bird 7/32 14070	82	20.96	
20	2	Rain Bird 7/32 14070	82	21.36	
21	2	Rain Bird 7/32 14070	81	20.4	
22	2	Rain Bird 7/32 14070	80	20.27	

4.0 Discussion & Recommendations.

DUlq of 69% (0.69) is fair compared to sprinkler evaluations conducted in California. A fair DUlq means the uneven distribution will overwater some areas of the field and leave other areas with too little water (Figure 9). It also means that additional water is required to ensure that the driest areas (those with poor or no overlap) receive the desired amount of water. This uneven distribution can affect produce quality, quantity and maturation time.

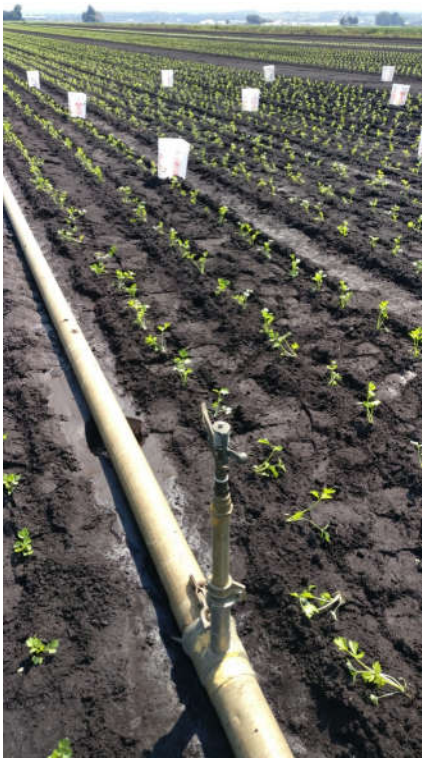
Figure 9: Distribution Uniformity of Current Irrigation System's Water Application



Very moist patches were observed in the collection area after the irrigation system was turned off as can be seen in Figure 10.

Some leaks at pipe connections along the lateral and the header were observed and should be repaired.

Figure 10: Moist Patch in the Collection Area



A nozzle replacement program is in place and should continue in order to help improve the irrigation water application uniformity over the field.

Repair any leaks as quickly as possible to prevent standing water or runoff from the field.

A flow meter should be installed at the pump or somewhere on the supply line to the irrigated fields. The flow meter will allow the operator(s) to determine how much water has been applied to irrigated areas. It should be installed somewhere that is accessible for the operator(s) to check.

The flow meter itself has a strainer to prevent particulates from damaging the impeller. In addition, a 100 micron stainless steel strainer should be installed on the supply line before the flow meter to provide the first line of protection.

A non-data logging flow meter with 100 micron screen for a 6" line costs approximately $3,000 installed. An irrigation equipment supplier can help in the selection of a meter specific to the water conditions and flow rates.

An alternative to a flow meter is a vibration data logger mounted on the pump. The sensor will pick up pump vibration during operation, recording and storing pump start and stop dates and times. The downloaded data can be stored. The amount of water applied can be calculated based on the pump's flow rate. A vibration kit (data logger and software) costs approximately $310.

A summary of the irrigation assessment results is presented in Table 4.

Table 4: Assessment Results Summary

Test Duration	2 hours
DUlq	69% (Fair)
Average Water Depth	1.0” (2.64 cm)
Nozzle Pressure	Decreases slightly along lateral from main to end of lateral Pressure drop not significant
Nozzle Flow	No apparent relationship to distance from main No apparent relationship to pressure Nozzles do not show significant wear
Nozzle Types	Consistent make & model
Other Considerations	Sprinkler in test area malfunctioning Leaking connections along lateral and header
Recommended DUlq Improvements	Continue nozzle replacement program to: • Replace failed or worn units Repair leaks at connections
Improved Water Depth	Average 1.0 “ in 2 hours set duration Approximately 2.5 hours set duration to achieve 1” in driest areas
Additional Recommendations	Install a flow meter on the supply from the pump to measure the amount of water being delivered to irrigated fields. Flow meter alternative: Vibration sensor mounted on pump to record pump start and stop times and dates. Use pump supply flow rate to calculate amount of water delivered to irrigated area. Appoint a person dedicated to checking the irrigation system while it is operating and to walk the irrigated area, looking for: • Ponded water, wet areas,

	• Runoff & erosion, • Dry patches, • Malfunctioning sprinklers, • Leaks, • Nozzle wear, • Over-spray onto non-cropped areas or adjacent irrigated areas, • Water running out of drainage system during or after irrigation, Staff training: to look for issues (observations), report observations, make repairs.

The estimated costs to implement some of the recommendations are presented in Table 5. The estimates provided are rough budget figures only. Actual costs should be confirmed with qualified vendors and/or contractors prior to implementation.

Table 5: Estimated Costs to Implement Recommendations

Recommendation	Details	Estimated Installed Cost ($)
Repair or Replace Sprinklers	30 min/sprinkler $20/hr + cost of sprinkler	$10/sprinkler (labour) + Cost of sprinkler
Repair Leaks	30 min/leak $20/hr Assume 1 leak/ week * 8 weeks	$80/leak
Install a Flow Meter or Vibration Sensor	Non-data logging flow meter on a 6" pipe with 100 micron strainer * 4 hrs * $100/hr Or Vibration logger & software package	$3,000 (Flow Meter Pkg) $310 (Vibration Package)