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engineering change

SPRINKLER IRRIGATION SELF-ASSESSMENT TOOL FOR:

Holland Marsh Growers' Association

January 12, 2022

HMGA-02-P01

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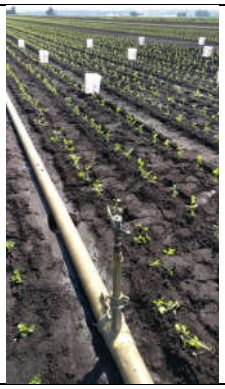
Sprinkler Irrigation System Self-Assessment Tool





Why Assess Your Sprinkler Irrigation System's Performance?

- Helps you visualize how uniformly water is applied & make adjustments to improve crop coverage;
- Allows you to determine the amount of water applied,
- The crop and your pocket book will benefit by a properly functioning irrigation system. Quality product + maximum yield = maximum profit.

How Often Should You Assess Your Irrigation System?

- At least once a growing season

How Do You Assess Your Irrigation System's Performance?

Observation: look for problems such as runoff, wet or dry patches in target and non-target areas.

Field tests:

- **Distribution Uniformity (Low Quarter) Test:** evaluates how evenly irrigation water is applied over a collection area. The target is 80% for a sprinkler system;
- **Nozzle Water Pressure Test:** measured at the sprinkler nozzle to determine the discharge water pressure. Helps identify problems potentially affecting distribution uniformity. The pressure differential should not exceed 20%;
- **Nozzle Flow Rate Test:** determines the amount of time to fill a bucket with water from the sprinkler nozzle. Helps identify problems potentially affecting distribution uniformity.

The nozzle pressure & flow rate tests can be done simultaneously. Perform these tests on the lateral where the uniformity test is being conducted. If possible, test every nozzle along the test lateral. If not, test a portion of the nozzles along the lateral's length:

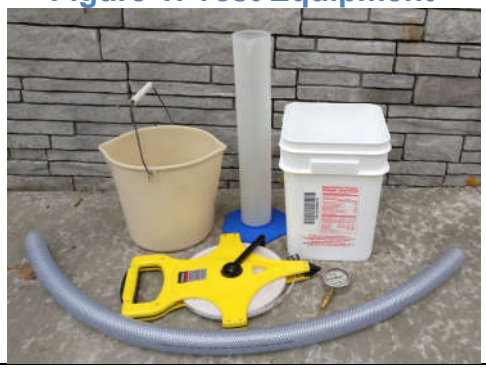
- First nozzle on the lateral;
- Both nozzles in the grid test area and;
- Last nozzle on the lateral.

Tools

- Identical rain gauges: 16 (grid on one side of lateral) or 32 (grid on both sides of lateral):
    - May need to mount on a stake so the gauge is above the crop.
- Measuring tape;
- Pressure gauge and pitot tube for pressure test;
- Large bucket: at least 17.5 litres for flow rate test;
- Large flexible pipe to direct water from nozzle into large bucket;
- Stop watch;
- Something to measure collected water; eg, large bucket with volume scale &/or graduated cylinder;
- Tablet or clipboard to record data;
- Clear plastic bag to cover & protect the tablet or clipboard from water;
- Boots;
- Rain gear: you will get wet;
- Towels: to wipe down equipment & dry off yourself.

Equipment used in these tests is presented in Figure 1.

Figure 1: Test Equipment



Distribution Uniformity (Low Quarter) Test

Setting up the grid:

You can set up the grid the night before if the irrigation system is going to operate over night or early in the morning.

- Choose a location midway along the lateral between 2 sprinklers to set up the grid;
- Inset the grid from the lateral and sprinkler.
    - The number of rain gauges needs to be divisible by 4 in order to determine distribution uniformity.
- Measurements are from the sprinkler;
- Set up the grid on one side of the lateral;
    - Optional: replicate this pattern on the opposite side of the lateral.
- Rain gauge spacing depends on:
    - Lateral pipe spacing;
    - Sprinkler spacing along lateral.
- Make sure the gauges are level;
- Make sure the gauges are above the plants;
- The tops of all gauges should be the same height:
    - Move a gauge if it is on top of a plant or hill so that it sits level & as close to the measured location as possible.

Things to avoid:

- Windy conditions;
- Rain;
- Leaving the gauges out on sunny, hot days to avoid evaporative losses of collected water;
- A location where there is a risk of vandalism or loss of the rain gauges if the site is left unsupervised;
- Obstructions that will interfere with the movement of the water.

Irrigation system operation:

- Run a normal set duration.
- Record the duration of test area irrigation.

Example Grid Layouts

Grid layouts are provided for the following typical lateral – sprinkler spacing.

For other lateral – sprinkler spacing, please contact:

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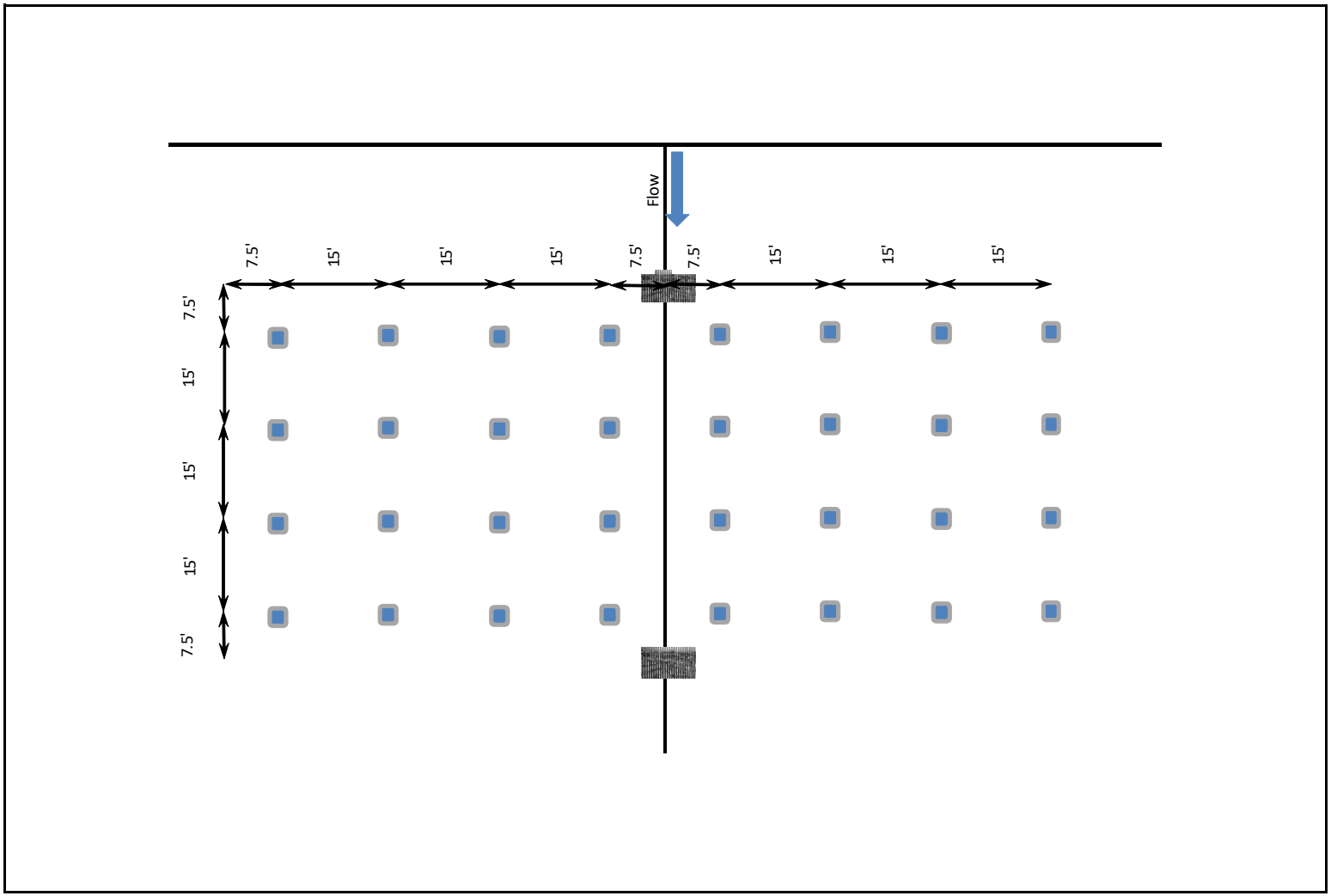
60’ lateral x 60’ sprinkler spacing

Check the grid & adjust gauges to square it up. An example 60’ x 60’ layout is presented in Figure 2.

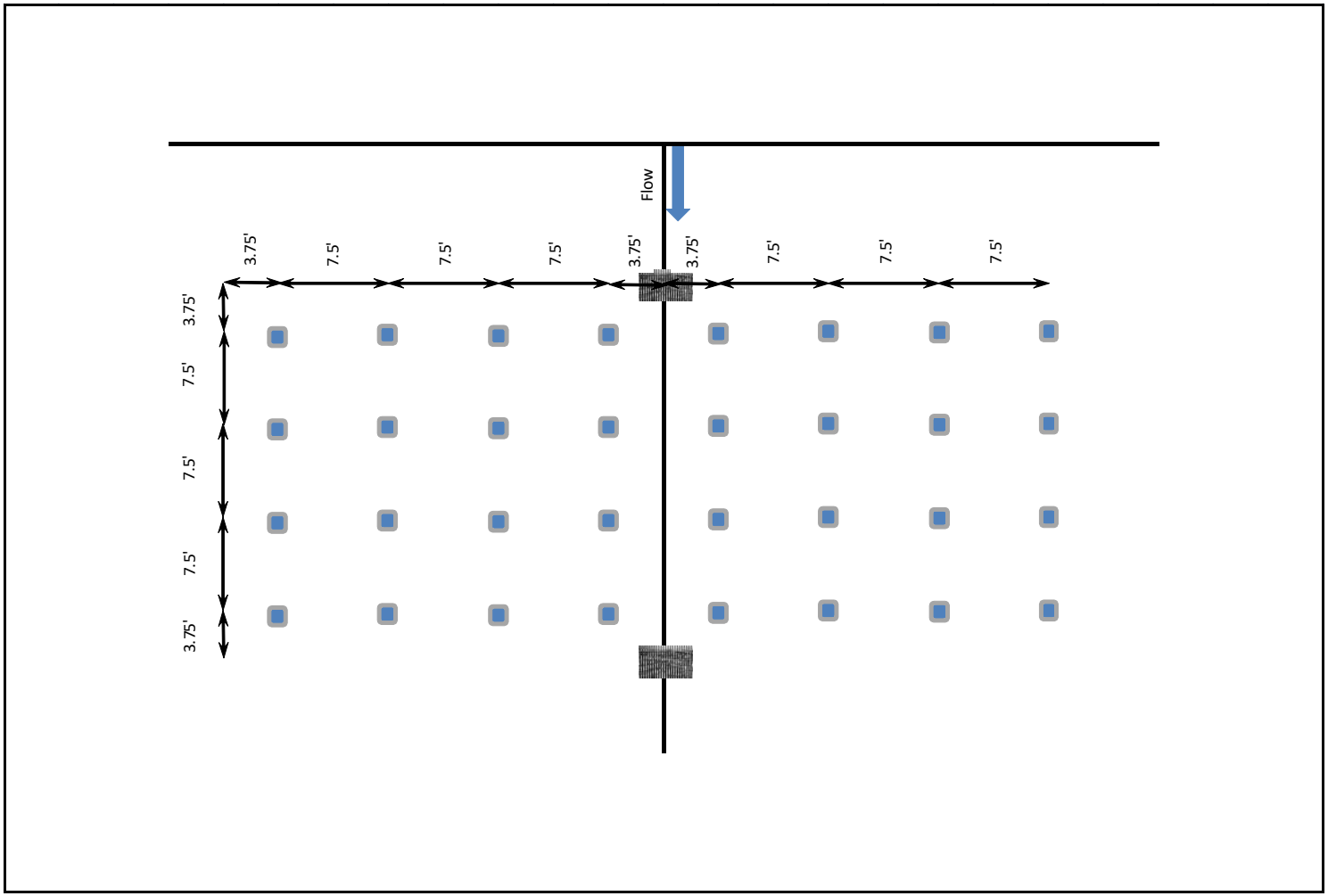
Figure 2: 60’ lateral x 60’ sprinkler grid layout



30’ lateral x 30’ sprinkler spacing

Check the grid & adjust gauges to square it up. An example 30’ x 30’ layout is presented in Figure 3.

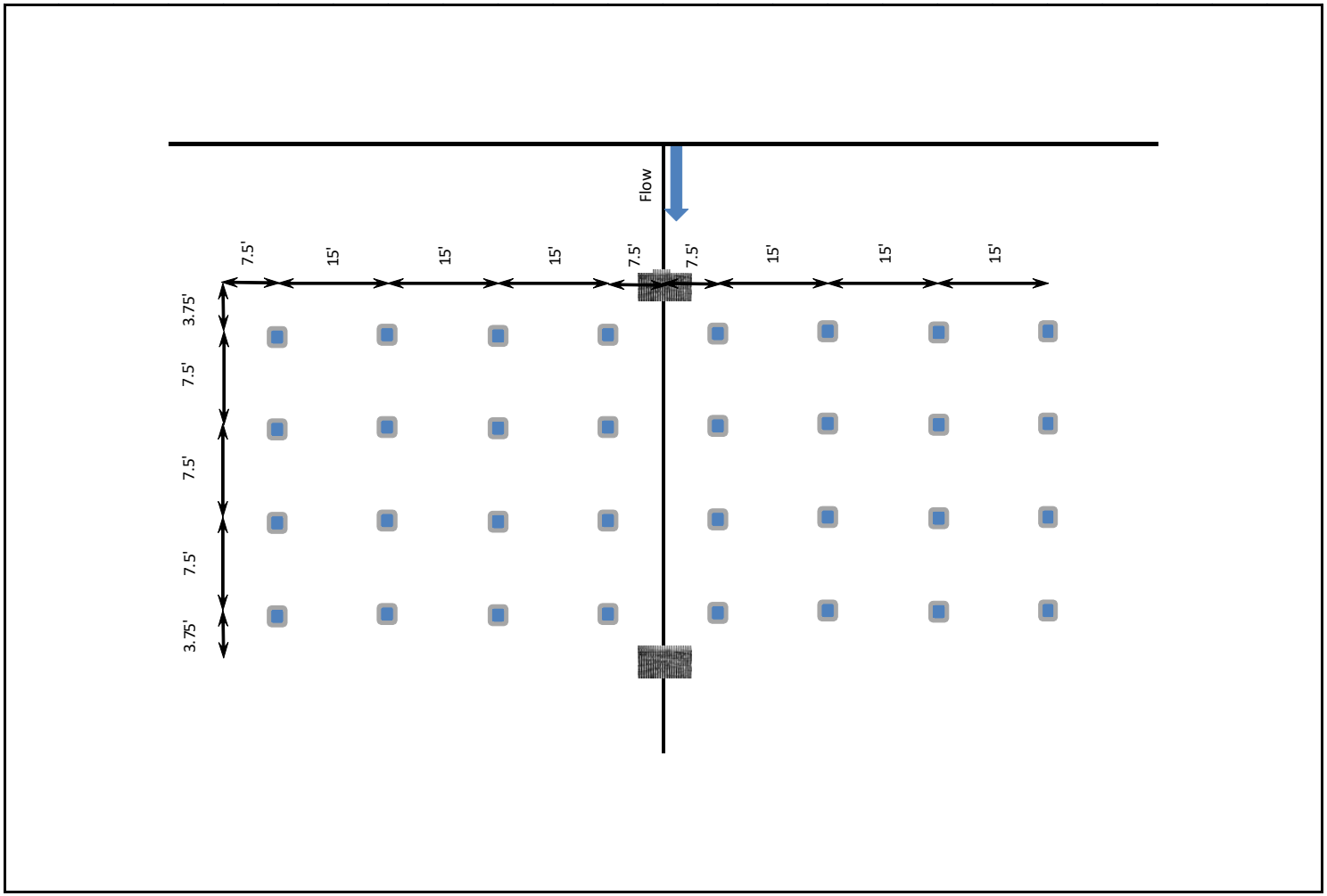
Figure 3: 30’ lateral x 30’ sprinkler grid layout



60’ lateral x 30’ sprinkler spacing

Check the grid & adjust gauges to square it up. An example 60’ x 30’ layout is presented in Figure 4.

Figure 4: 60’ lateral x 30’ sprinkler grid layout



Record Observations

Record any issues observed during system operation & while walking the irrigated area (Table 1):

- While the system is operating look for:
  - Malfunctioning sprinklers: not rotating, dribbling, improper angle of throw;
  - Leaks: main pipe, lateral pipe, pipe connections, sprinkler heads;
- After the system is finished look for:
  - Ponded water or spongy patches;
  - Runoff;
  - Dry patches;
  - Wet patches: indicating overwatering or leaks;
  - Non-target land is wet; e.g., non-cropped or adjacent irrigated areas;
  - Water flowing out of the drainage system.

Table 1: Record Observations During & After System Operation

Date	Location	Issue	Initials

Measure Water in Rain Gauges

If the grid was set up on both sides of the lateral, one side will be right (R#) & the other left (L#). Record the depth of water in Table 2 & Table 3.

Number the rain gauges as indicated in Figure 5.

Table 2: Right Side of Lateral - Enter the inches in each gauge

Rain Gauge #	Inches	Rain Gauge #	Inches	Rain Gauge #	Inches	Rain Gauge #	Inches
R1		R5		R9		R13	
R2		R6		R10		R14	
R3		R7		R11		R15	
R4		R8		R12		R16	

Table 3: Left Side of Lateral - Enter the inches in each gauge

Rain Gauge #	Inches	Rain Gauge #	Inches	Rain Gauge #	Inches	Rain Gauge #	Inches
L13		L9		L5		L1	
L14		L10		L6		L2	
L15		L11		L7		L3	
L16		L12		L8		L4	

What do These Measured Water Volumes Reveal?

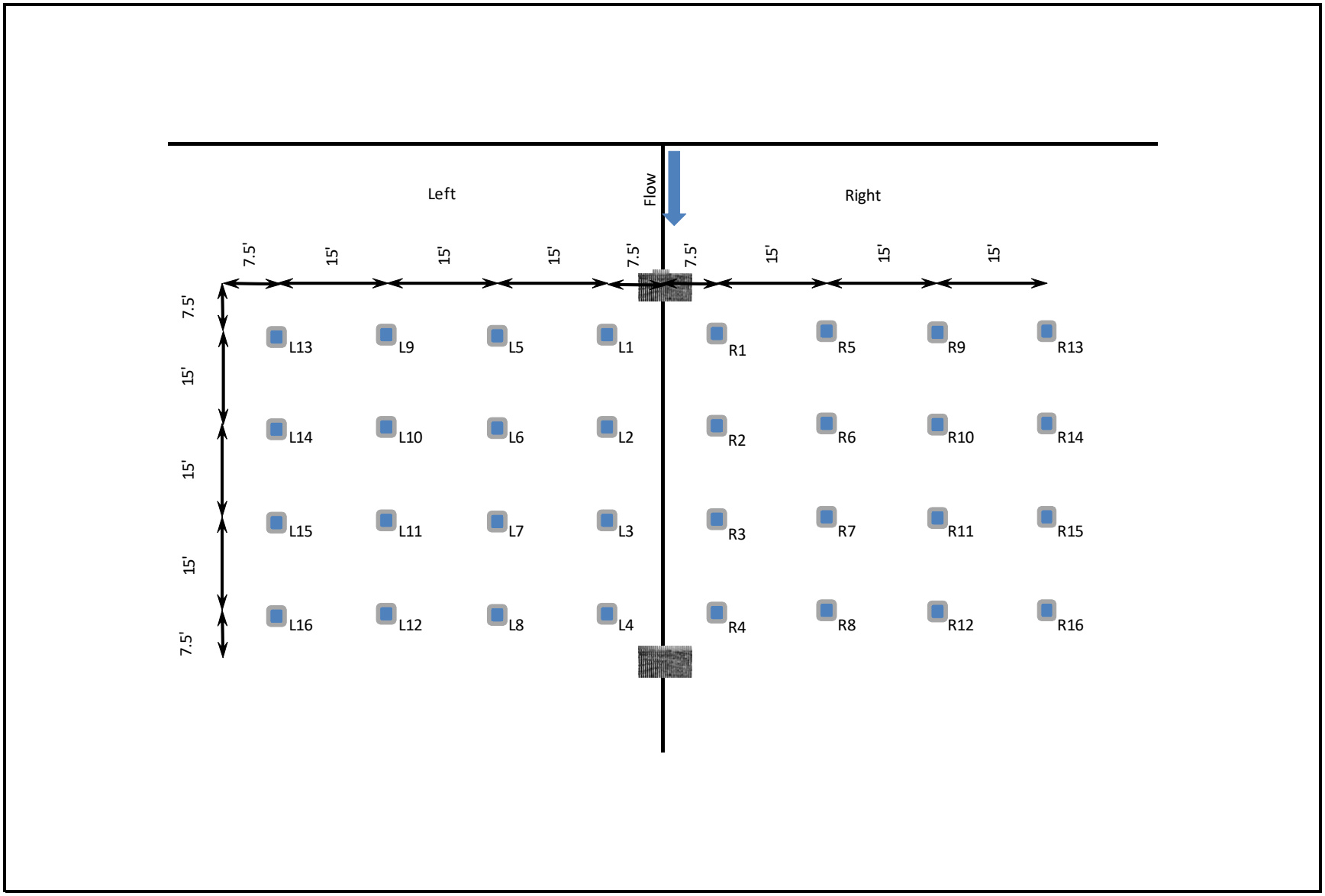
Observations:

- Looking at the amount of water in the gauges gives a good indication how evenly the water was distributed over the test area;
- Watching the system operate & walking the irrigated area after the system is finished, allow you to identify and correct issues quickly.

Grid recorded depths:

- Tell you how much water was applied over the area and how evenly it was distributed;
- If the volumes are uneven:
  - Replace clogged or worn nozzles;
  - Repair sprinkler rotation issues;
  - Adjust sprinkler angle;
  - Standardize sprinkler heads types (single or double), make & model;
  - Standardize riser heights;
  - Repair leaks;
  - Adjust pressure;
  - Contact an irrigation system professional to discuss other potential solutions.

Figure 5: Rain Gauge Numbering



Calculate Distribution Uniformity (Low Quarter)

- Arrange the collected depths from lowest to highest
- Calculate the average depth for the 4 lowest depths (in a 16 gauge grid) = Average Low Quarter (inches)
- Calculate the average volume for all the rain gauges = Total Average (inches)
- *Distribution Uniformity Low Quarter* = $\frac{Average\ Low\ Quarter\ (inches)}{Total\ Average\ (inches)}$
- The **target is 0.8 (80%) or greater**, anything less indicates a problem

Calculate Average Amount of Water Applied Over the Grid Area

- Calculate the average amount of water collected in the rain gauges:
  - Sum water depth in rain gauges (4 x 4 grid, add R1 to R16) = Total Depth Collected (inches);
  - Average Water Depth Collected (inches):

$$\frac{Total\ Depth\ Collected\ in\ all\ Gauges(inches)}{\#\ of\ Guages}$$

- Calculate the amount of water applied to the collection area in an hour:

$$\frac{Average\ Water\ Depth\ (inches)}{\#\ Hours\ of\ Irrigation\ System\ Operation}$$

Nozzle Water Pressure & Flow Tests

It is easier with 2 people, one recording, one taking pressure and flow measurements

Tools:

- Pressure gauge & pitot tube;
- Large bucket: at least 17.5 litres;
- Large flexible pipe to direct water from the nozzle into large bucket;
- Stopwatch;
- Tablet or clipboard to record data;
- Clear plastic bag to cover & protect the tablet or clipboard from water.

Measuring nozzle water pressure & flow:

Steps 1 to 3: Irrigation system is off:

Step 1: Number the sprinklers in the direction of flow, with #1 being at the first sprinkler on the lateral;

Step 2: Record the # of sprinkler heads on each sprinkler. They may vary;

Step 3: Record make & model # of each sprinkler. They may not be the same.

Steps 4 to 11: Irrigation system is operating:

Step 4: Measure sprinkler pressure by holding the pitot tube and pressure gauge in the orifice of the sprinkler;

Step 5: Record pressure;

Step 6: Measure the flow rate of the sprinkler by timing how long it takes to fill a large bucket;

Step 7: Place end of flexible pipe in bucket;

Step 8: Place opposite end of flexible pipe over nozzle & start timing;

Step 9: When bucket is full, stop timer and remove flexible pipe from end of nozzle;

Step 10: Record time to fill bucket to the rim;

Step 11: Move to next nozzle & repeat steps 1 to 10.

- The data may show variations or a drop in pressure & flow along the length of the lateral, which can affect the application uniformity. The **pressure differential from first to last sprinkler should not exceed 20%**;
- Variation in the number of heads per sprinkler along a lateral typically results in uneven application rates;
- Variations in sprinkler makes & models may result in uneven application rates;
- Variations in riser heights will affect distribution uniformity.

A record keeping sheet to capture nozzle flow & pressure, nozzle characteristics, and other observations is provided in Table 4.

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Table 4: Nozzle Specifications, Pressure, Flow & Notes Record Sheet

Sprinkler #	# of Sprinkler Heads	Nozzle Make & Model	Pressure (PSI)	Time to Fill Bucket (sec)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Potential System Improvements

- Adjust lateral spacing; e.g., reduce spacing to improve distribution uniformity;
- Adjust sprinkler spacing;
- Implement or continue nozzle replacement program to:
    - Standardize the number of heads/sprinkler;
    - Standardize sprinkler make & model;
    - Replace or repair failed units;
    - Replace worn units.
- Repair leaks;
- Standardize riser height.

The estimated costs to implement the suggested improvements are presented in Table 5.

Table 5: Estimated Costs to Implement Potential Recommendations

Recommendation	Details	Estimated Installed Cost ($)
Rain Gauges for Distribution Uniformity Test	$10/gauge, assume 16-32 gauges required	$160 - $320
Distribution Uniformity , Nozzle Pressure & Flow Tests (once/yr)	2 people * $20/hr * 1 hr for grid set up + 1 hr nozzle flow & pressure measurements + 1 hr measure water in gauges & remove grid	$120
Reduce Lateral Spacing [for example by 2 Beds (13')]	Approximately 2 additional moves required (2 moves @ 30 min/move * 4 people * $20/hr * 80 hr/season).	$6,400
	Approximately 2 extra lines required at roughly $3,000 / line.	$6,000
Replace Nozzles under Nozzle Replacement Program	$25 / nozzle Labour 30 minutes / head @ $20/hr	$250
Repair Leaks	30 min/leak $20/hr Assume 1 leak/ week * 10 weeks	$100
Standardize Riser Height	Replace risers (15 minutes/riser * $20/hr)	$5
Irrigate at Night or Early Morning	Requires discussions with labourers to obtain agreement	TBD (Labour Cost)
Install a Flow Meter or Vibration Sensor	Non-data logging flow meter on a 6" pipe with1 00 micron strainer * 4 hrs * $100/hr Or Vibration logger & software package	$3,000 (Flow Meter Package) $310 (Vibration Package)

Good Irrigation Practices

- Have the system designed by a professional irrigation system designer;
- Staff training: issues to look for (observations), report observations, make repairs;
- Appoint a dedicated person to observe the system every time it operates looking for clues indicating potential problems such as:
    - Ponded water or spongy, suck your boots off, patches;
    - Runoff;
    - Dry patches;
    - Non-target land that has been irrigated; e.g., non-cropped areas or adjacent irrigated areas;
    - Malfunctioning sprinklers: not rotating, dribbling, improper angle of throw;
    - Sprinkler orifice clogging or wear;
    - Variations in sprinkler head types (single or double);
    - Variations in sprinkler head make & models along lateral;
    - Non-standard riser pipe heights;
    - Leaks: main pipe, lateral pipe, pipe connections, hydrants, sprinkler heads;
    - Spread interference by plants;
    - Improper equipment installation;
    - Water running out of drainage system during or after irrigation system operation.
- Pre-season inspection includes checking for:
    - Obstructions or plugging of the intake screen on systems using surface water to irrigate;
    - Sprinkler head & lateral spacing that do not match the original design specifications;
    - Variations in sprinkler head types (single or double);
    - Variations in sprinkler head make & models;
    - Sprinkler orifice wear;
    - Non-standard riser pipe heights;
    - Non-uniform sprinkler & lateral spacing;
    - Improper equipment installation.
- Irrigate cropped surfaces only;
- Irrigate at night, early morning or when it is overcast. Avoid the heat of the day if possible to reduce evaporation losses;
- Irrigate when it is still, wind speed less than 5 km/hr;
- Based on the results of the irrigation assessment, make upgrades, repairs, changes;
- Install a flow meter to manage application rate & identify problems:
    - After upgrades, repairs or changes have been made to the irrigation system, record the value on the flow meter (Start Value);

    - Record the time to run the irrigation system for one set;
    - Record the value on the flow meter (End Value);
    - Total Water Use = End value - Start value.
    - Total Water Use/Hour = $\frac{End\ Value - Start\ Value}{Hours\ of\ Operation}$
    - Every time the system runs, calculate the hourly water use;
    - If this value begins to shift, look for potential issues, including pump operation.
- System winterization:
    - Check for nozzle wear;
    - Hydrants: blow out with compressed air or suck water out;
    - Buried pipe work: blow out with compressed air or suck water out;
    - Check for obstructions or plugging of the intake screen on systems using surface water to irrigate;
    - Service pump motor.
- Additional practices:
    - Utilize a soil moisture meter & irrigate based on soil moisture level;
    - A drone may be an effective tool for some operations to help identify non-uniform application of irrigation water.

Resources

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Water Efficiency and Conservation Practices for Irrigation

http://www.omafra.gov.on.ca/english/engineer/facts/12-013.htm

Best Management Practices: Irrigation Management

https://bmpbooks.com/publications/irrigation-management/