Irrigation System DU and ROI Estimator Program Guide

August 22, 2024

Welcome to the Irrigation DU and ROI Estimator **Program Guide.** This Program Guide provides a brief overview of the Irrigation DU and ROI Estimator software program, also known as the DU Estimator. The Guide also lists items necessary to conduct an evaluation, and provides instructions on how to prepare for a field evaluation.

A comprehensive 200+ page description of how to use the program, including four detailed examples of drip/micro systems, is provided in the program's **User Manual.** Note that the User Manual is currently being updated and will soon be available with the inclusion of tape and sprinkler systems, fertigation costs, and a new aggregated reports feature.

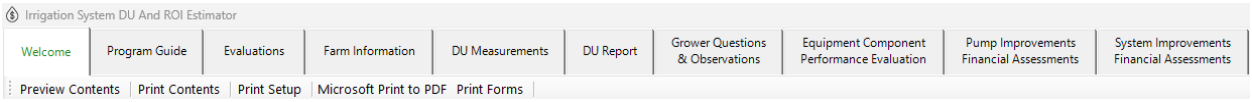
Program Overview

Once the DU Estimator program is launched, the program's ten tabs appear at the top of the screen along with the program's Welcome Screen as shown below:

Irrigation System DU and ROI Estimator Program Welcome Screen

The following is a brief description of the contents of each of the ten tabs:

1. **Welcome Tab:**



The Welcome tab highlighted in green above provides information about what the program does, why it was created, how it provides value, and who funded it, created it, and will use it.

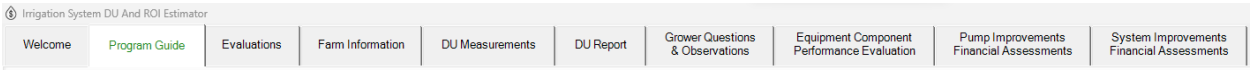
In short, the DU Estimator is a program that is available for free via a web site link that downloads onto the user's Windows based computer. It provides the methodology, instructions, forms, data entry screens, reports, background calculations and interpretive information necessary for a field technician with nominal training to:

1. Conduct an abbreviated distribution uniformity (DU) analysis on agricultural drip/micro, tape and stationary sprinkler irrigation systems by gathering flow and pressure data from specifically located emission devices within an irrigation block that is considered representative of the field's irrigation system;

2. Identify specific irrigation system deficiencies by interviewing farm personnel regarding the operation of the system and physically observing the status of irrigation system equipment components;
3. Translate the evaluation findings into reports estimating the economic value of improving the existing DU performance and equipment component deficiencies discovered, which includes the estimated cost of pumping unnecessary applications of water and fertigation, the estimated value of forgone yield potential, and the estimated cost of less than optimal pumping plant efficiency;
4. Provide an estimated Return on Investment (ROI) analysis, in $/Acre and $/field, based on the grower's preferred ROI timeframe, in years, to better inform and encourage the consideration of corrective action funding. Reports are provided by field, and field reports may then be aggregated by owner.

The initial focus of the of the DU Estimator was to evaluate drip/micro systems irrigating permanent crops in California's central valley but has since been expanded to include drip tape and stationary (non-mechanized) sprinkler systems irrigating nearly any crop. The purpose is to encourage the correction of discovered deficiencies by connecting the evaluation's results with its estimated on-farm economic impact, i.e. translating the cost of poor irrigation system DU into $/acre and $/field.

2. **Program Guide Tab**:

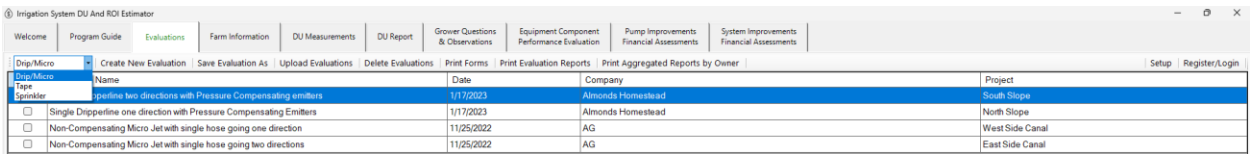


The Program Guide tab highlighted in green above provides a brief overview of the DU Estimator software program, a list of items necessary to conduct an evaluation, instructions on how to prepare for a field evaluation, and a list of additional useful resources.

3. **Evaluations Tab**:

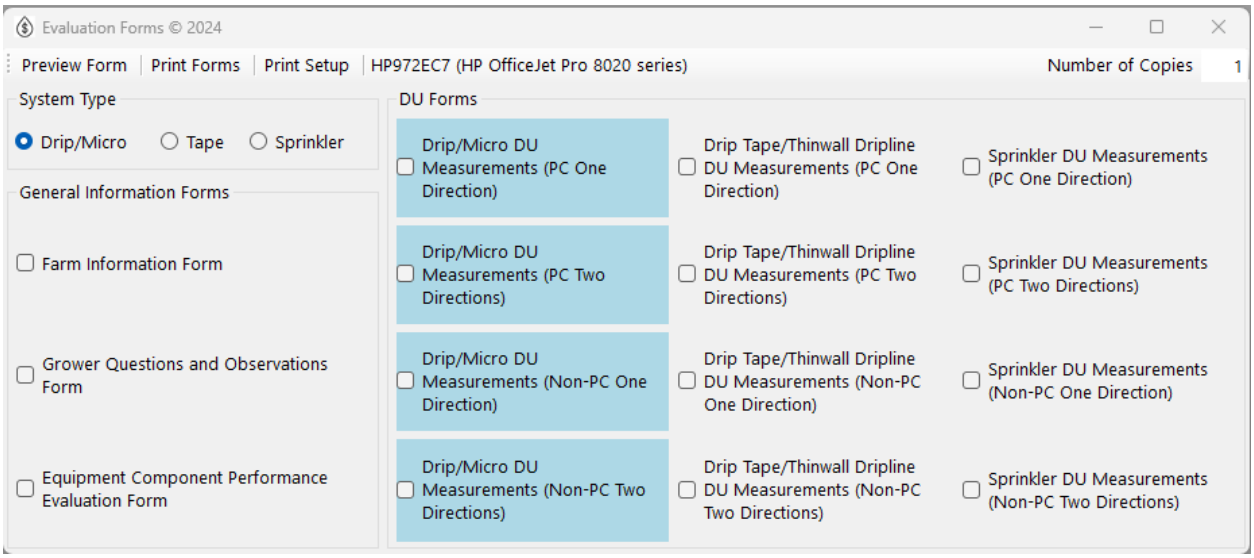
The Evaluations Tab highlighted in green above is where, via the sub-tabs below it, users may choose system type and then store, create, save, upload and delete Evaluations, print Forms and Reports, view version information in Setup, and Register/Login with the evaluator's name, email address and password.

To open an evaluation, select the system type sub-tab on the far left (Drip/Micro, Tape or Sprinkler) and then double click on one of the evaluations listed in the menu as highlighted in blue below for Drip/Micro.



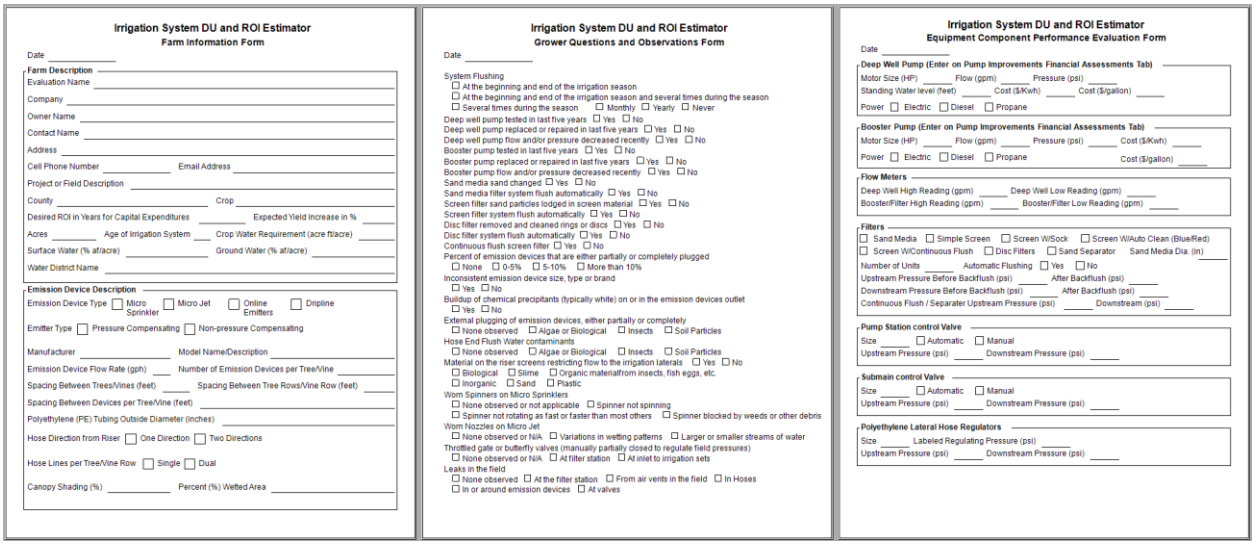
The adjacent “Create New Evaluation” sub-tab is used to begin a new evaluation by opening the Farm Information tab. The adjacent “Save Evaluation As” sub-tab may be used to save an existing evaluation with a new name such that specific data may be changed without reentering data that the user wishes to remain unchanged. The adjacent “Upload Evaluations” sub-tab allows select, non-personal technical data to be uploaded to a central database. The adjacent “Delete Evaluations” sub-tab may be used to delete evaluations from the menu.

The adjacent “Print Forms” sub-tab provides the following menu to access all the various forms that are needed to conduct an evaluation:



First choose the type of system that will be evaluated (Drip/Micro, Tape or Sprinkler). Second, select the General Information forms: Farm Information, Observations, and Equipment Performance Evaluation. All three are required for any evaluation, however, they differ slightly depending on the type of system selected. Third, select one of the four DU Forms for the selected system type depending on whether the irrigation system uses pressure compensating (PC) or Non-PC emission devices, and whether the hoses are fed in one or two directions from the lateral. In the image above, the system type is Drip/Micro, and one of the four Drip/Micro DU Form options that are highlighted in blue need to be selected for a given evaluation. For illustration purposes, the following three pages show all three General Forms and all four DU Forms for Drip/Micro, Tape and Sprinkler system evaluations.

Evaluation Forms for Drip/Micro: General Forms (3 pages), PC (2 pages); Non-PC (4 pages)



Irrigation System DU and ROI Estimator
Farm Information Form

Date _____

Farm Description
Evaluation Name _____
Company _____
Owner Name _____
Contact Name _____
Address _____
Cell Phone Number _____ Email Address _____
Project or Field Description _____
County _____ Crop _____
Desired ROI in Years for Capital Expenditures _____ Expected Yield Increase in % _____
Acres _____ Age of Irrigation System ___ Crop Water Requirement (acre ft/acre) _____
Surface Water (% af/acre) _____ Ground Water (% af/acre) _____
Water District Name _____

Emission Device Description
Emission Device Type ☐ Micro Sprinkler ☐ Micro Jet ☐ Online Emitters ☐ Dripline
Emitter Type ☐ Pressure Compensating ☐ Non-pressure Compensating
Manufacturer _____ Model Name/Description _____
Emission Device Flow Rate (gph) ___ Number of Emission Devices per Tree/Vine _____
Spacing Between Trees/Vines (feet) _____ Spacing Between Tree Rows/Vine Row (feet) _____
Spacing Between Devices per Tree/Vine (feet) _____
Polyethylene (PE) Tubing Outside Diameter (inches) _____
Hose Direction from Riser ☐ One Direction ☐ Two Directions
Hose Lines per Tree/Vine Row ☐ Single ☐ Dual
Canopy Shading (%) _____ Percent (%) Wetted Area _____

Irrigation System DU and ROI Estimator
Grower Questions and Observations Form

Date _____

System Flushing
☐ At the beginning and end of the irrigation season
☐ At the beginning and end of the irrigation season and several times during the season
☐ Several times during the season ☐ Monthly ☐ Yearly ☐ Never
Deep well pump tested in last five years ☐ Yes ☐ No
Deep well pump replaced or repaired in last five years ☐ Yes ☐ No
Deep well pump flow and/or pressure decreased recently ☐ Yes ☐ No
Booster pump tested in last five years ☐ Yes ☐ No
Booster pump replaced or repaired in last five years ☐ Yes ☐ No
Booster pump flow and/or pressure decreased recently ☐ Yes ☐ No
Sand media sand changed ☐ Yes ☐ No
Sand media filter system flush automatically ☐ Yes ☐ No
Screen filter sand particles lodged in screen material ☐ Yes ☐ No
Screen filter system flush automatically ☐ Yes ☐ No
Disc filter removed and cleaned rings or discs ☐ Yes ☐ No
Disc filter system flush automatically ☐ Yes ☐ No
Continuous flush screen filter ☐ Yes ☐ No
Percent of emission devices that are either partially or completely plugged
☐ None ☐ 0-5% ☐ 5-10% ☐ More than 10%
Inconsistent emission device size, type or brand
☐ Yes ☐ No
Buildup of chemical precipitants (typically white) on or in the emission devices outlet
☐ Yes ☐ No
External plugging of emission devices, either partially or completely
☐ None observed ☐ Algae or Biological ☐ Insects ☐ Soil Particles
Hose End Flush Water contaminants
☐ None observed ☐ Algae or Biological ☐ Insects ☐ Soil Particles
Material on the riser screens restricting flow to the irrigation laterals ☐ Yes ☐ No
☐ Biological ☐ Slime ☐ Organic materialfrom insects, fish eggs, etc.
☐ Inorganic ☐ Sand ☐ Plastic
Worn Spinners on Micro Sprinklers
☐ None observed or not applicable ☐ Spinner not spinning
☐ Spinner not rotating as fast or faster than most others ☐ Spinner blocked by weeds or other debris
Worn Nozzles on Micro Jet
☐ None observed or N/A ☐ Variations in wetting patterns ☐ Larger or smaller streams of water
Throttled gate or butterfly valves (manually partially closed to regulate field pressures)
☐ None observed or N/A ☐ At filter station ☐ At inlet to irrigation sets
Leaks in the field
☐ None observed ☐ At the filter station ☐ From air vents in the field ☐ In Hoses
☐ In or around emission devices ☐ At valves

Irrigation System DU and ROI Estimator
Equipment Component Performance Evaluation Form

Date _____

Deep Well Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____
Standing Water level (feet) _____ Cost ($/Kwh) _____ Cost ($/gallon) _____
Power ☐ Electric ☐ Diesel ☐ Propane

Booster Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____ Cost ($/Kwh) _____
Power ☐ Electric ☐ Diesel ☐ Propane Cost ($/gallon) _____

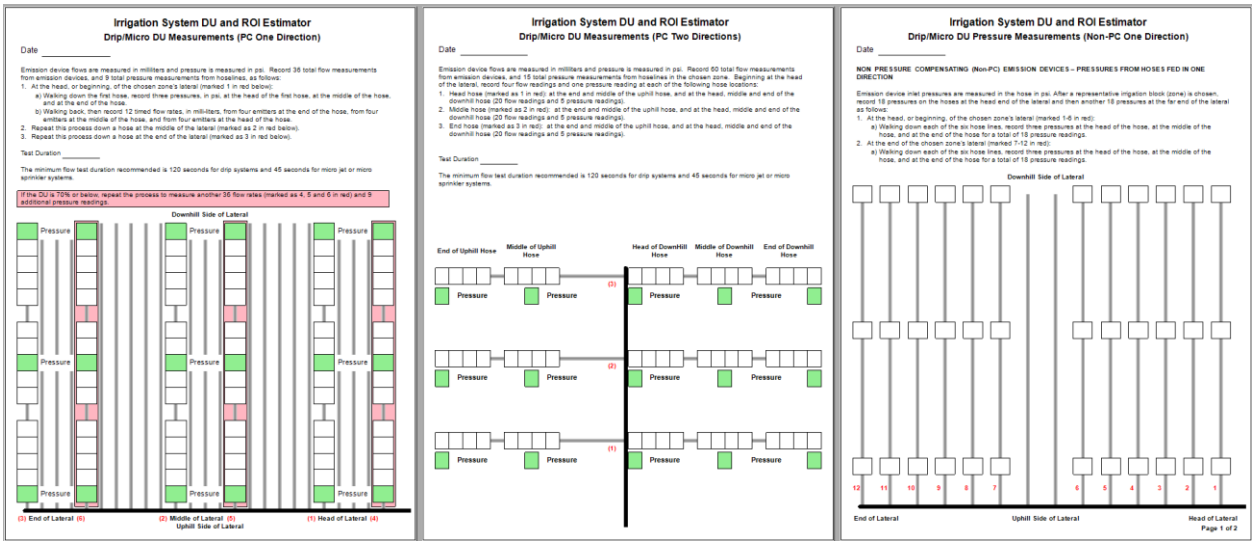
Flow Meters
Deep Well High Reading (gpm) _____ Deep Well Low Reading (gpm) _____
Booster/Filter High Reading (gpm) _____ Booster/Filter Low Reading (gpm) _____

Filters
☐ Sand Media ☐ Simple Screen ☐ Screen W/Sock ☐ Screen W/Auto Clean (Blue/Red)
☐ Screen W/Continuous Flush ☐ Disc Filters ☐ Sand Separator Sand Media Dia. (in) _____
Number of Units _____ Automatic Flushing ☐ Yes ☐ No
Upstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Downstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Continuous Flush / Separater Upstream Pressure (psi) _____ Downstream (psi) _____

Pump Station control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____

Submain control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____

Polyethylene Lateral Hose Regulators
Size _____ Labeled Regulating Pressure (psi) _____
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____



Irrigation System DU and ROI Estimator
Drip/Micro DU Measurements (PC One Direction)

Date _____

Emission device flows are measured in milliliters and pressure is measured in psi. Record 36 total flow measurements from emission devices, and 9 total pressure measurements from hoselines, as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1 in red below):
   a) Walking down the first hose, record three pressures, in psi, at the head of the first hose, at the middle of the hose, and at the end of the hose.
   b) Walking back, then record 12 timed flow rates, in milliliters, from four emitters at the end of the hose, from four emitters at the middle of the hose, and from four emitters at the head of the hose.
2. Repeat this process down a hose at the middle of the lateral (marked as 2 in red below).
3. Repeat this process down a hose at the end of the lateral (marked as 3 in red below).

Test Duration _____

The minimum flow test duration recommended is 120 seconds for drip systems and 45 seconds for micro jet or micro sprinkler systems.

If the DU is 70% or below, repeat the process to measure another 36 flow rates (marked as 4, 5 and 6 in red) and 9 additional pressure readings.

Downhill Side of Lateral
Pressure
(3) End of Lateral (6) (2) Middle of Lateral (5) (1) Head of Lateral (4)
Uphill Side of Lateral

Irrigation System DU and ROI Estimator
Drip/Micro DU Measurements (PC Two Directions)

Date _____

Emission device flows are measured in milliliters and pressure is measured in psi. Record 60 total flow measurements from emission devices, and 15 total pressure measurements from hoselines in the chosen zone. Beginning at the head of the lateral, record four flow readings and one pressure reading at each of the following hose locations:
1. Head hose (marked as 1 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).
2. Middle hose (marked as 2 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).
3. End hose (marked as 3 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).

Test Duration _____

The minimum flow test duration recommended is 120 seconds for drip systems and 45 seconds for micro jet or micro sprinkler systems.

End of Uphill Hose | Middle of Uphill Hose | Head of DownHill Hose | Middle of Downhill Hose | End of Downhill Hose
Pressure
(3)
(2)
(1)

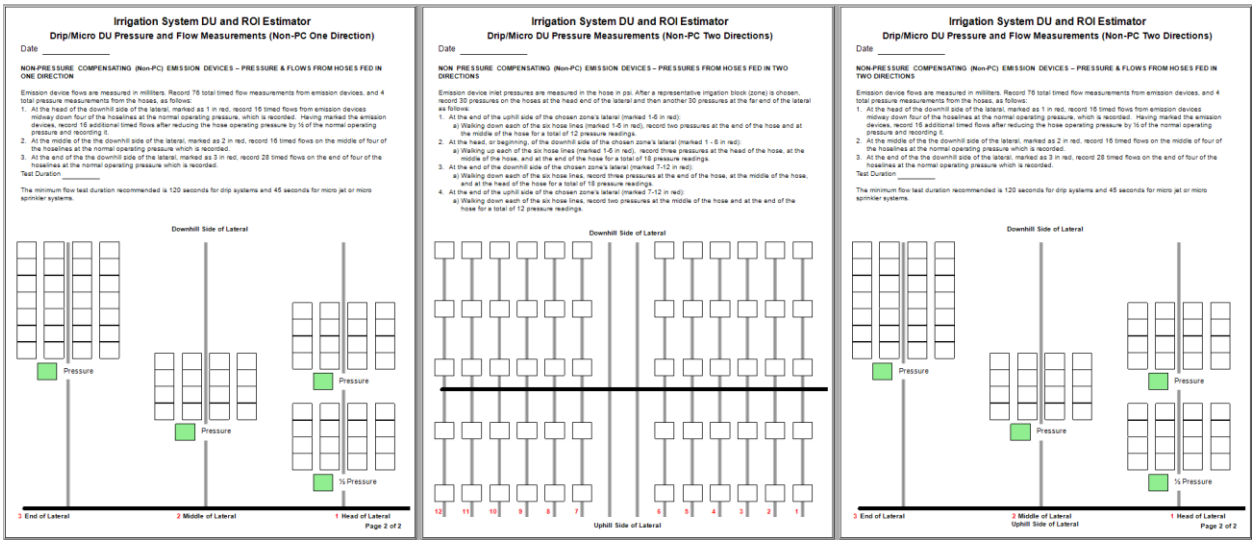
Irrigation System DU and ROI Estimator
Drip/Micro DU Pressure Measurements (Non-PC One Direction)

Date _____

NON PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURES FROM HOSES FED IN ONE DIRECTION

Emission device inlet pressures are measured in the hose in psi. After a representative irrigation block (zone) is chosen, record 18 pressures on the hoses at the head end of the lateral and then another 18 pressures at the far end of the lateral as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1-6 in red):
   a) Walking down each of the six hose lines, record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.
2. At the end of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.

Downhill Side of Lateral
12 11 10 9 8 7 6 5 4 3 2 1
End of Lateral | Uphill Side of Lateral | Head of Lateral
Page 1 of 2



Irrigation System DU and ROI Estimator
Drip/Micro DU Pressure and Flow Measurements (Non-PC One Direction)

Date _____

NON-PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURE & FLOWS FROM HOSES FED IN ONE DIRECTION

Emission device flows are measured in milliliters. Record 76 total timed flow measurements from emission devices, and 4 total pressure measurements from the hoses, as follows:
1. At the head of the downhill side of the lateral, marked as 1 in red, record 16 timed flows from emission devices midway down four of the hoselines at the normal operating pressure, which is recorded. Having marked the emission devices, record 16 additional timed flows after reducing the hose operating pressure by ½ of the normal operating pressure and recording it.
2. At the middle of the the downhill side of the lateral, marked as 2 in red, record 16 timed flows on the middle of four of the hoselines at the normal operating pressure which is recorded.
3. At the end of the the downhill side of the lateral, marked as 3 in red, record 28 timed flows on the end of four of the hoselines at the normal operating pressure which is recorded.

Test Duration _____

The minimum flow test duration recommended is 120 seconds for drip systems and 45 seconds for micro jet or micro sprinkler systems.

Downhill Side of Lateral
Pressure
½ Pressure
3 End of Lateral 2 Middle of Lateral 1 Head of Lateral
Page 2 of 2

Irrigation System DU and ROI Estimator
Drip/Micro DU Pressure Measurements (Non-PC Two Directions)

Date _____

NON PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURES FROM HOSES FED IN TWO DIRECTIONS

Emission device inlet pressures are measured in the hose in psi. After a representative irrigation block (zone) is chosen, record 30 pressures on the hoses at the head end of the lateral and then another 30 pressures at the far end of the lateral as follows:
1. At the end of the uphill side of the chosen zone's lateral (marked 1-6 in red):
   a) Walking down each of the six hose lines (marked 1-6 in red), record two pressures at the end of the hose and at the middle of the hose for a total of 12 pressure readings.
2. At the head, or beginning, of the downhill side of the chosen zone's lateral (marked 1 - 6 in red):
   a) Walking up each of the six hose lines (marked 1-6 in red), record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.
3. At the end of the downhill side of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record three pressures at the end of the hose, at the middle of the hose, and at the head of the hose for a total of 18 pressure readings.
4. At the end of the uphill side of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record two pressures at the middle of the hose and at the end of the hose for a total of 12 pressure readings.

Downhill Side of Lateral
12 11 10 9 8 7 6 5 4 3 2 1
Uphill Side of Lateral

Irrigation System DU and ROI Estimator
Drip/Micro DU Pressure and Flow Measurements (Non-PC Two Directions)

Date _____

NON-PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURE & FLOWS FROM HOSES FED IN TWO DIRECTIONS

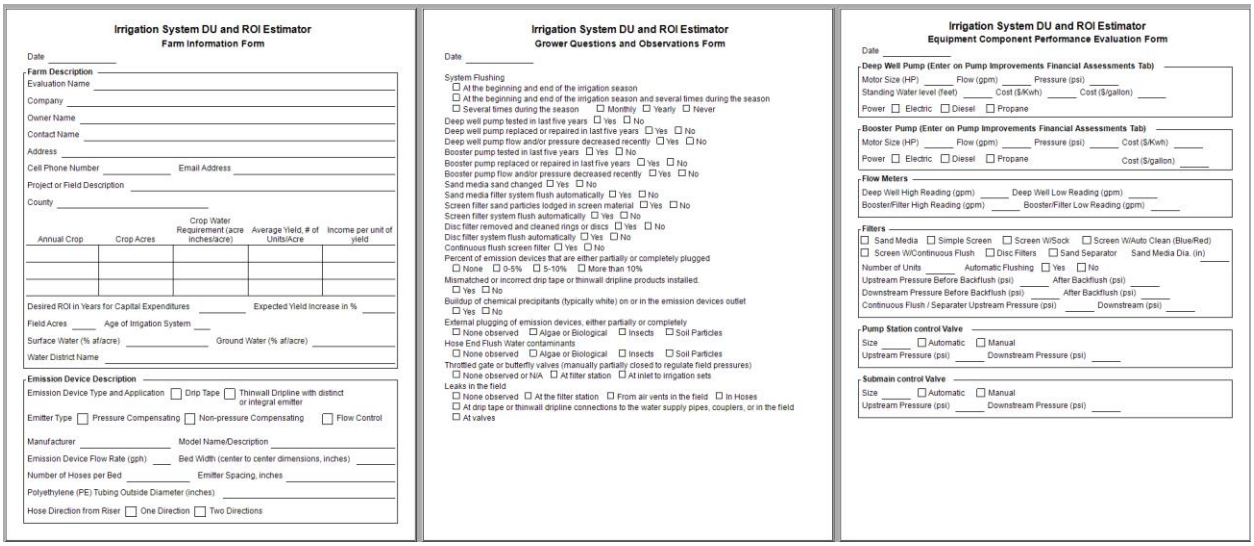
Emission device flows are measured in milliliters. Record 76 total timed flow measurements from emission devices, and 4 total pressure measurements from the hoses, as follows:
1. At the head of the downhill side of the lateral, marked as 1 in red, record 16 timed flows from emission devices midway down four of the hoselines at the normal operating pressure, which is recorded. Having marked the emission devices, record 16 additional timed flows after reducing the hose operating pressure by ½ of the normal operating pressure and recording it.
2. At the middle of the the downhill side of the lateral, marked as 2 in red, record 16 timed flows on the middle of four of the hoselines at the normal operating pressure which is recorded.
3. At the end of the the downhill side of the lateral, marked as 3 in red, record 28 timed flows on the end of four of the hoselines at the normal operating pressure which is recorded.

Test Duration _____

The minimum flow test duration recommended is 120 seconds for drip systems and 45 seconds for micro jet or micro sprinkler systems.

Downhill Side of Lateral
Pressure
½ Pressure
3 End of Lateral 2 Middle of Lateral Uphill Side of Lateral 1 Head of Lateral
Page 2 of 2

Evaluation Forms for Tape: General Forms (3 pages), PC (2 pages); Non-PC (4 pages)



Irrigation System DU and ROI Estimator
Farm Information Form

Date _____

Farm Description

Evaluation Name _____
Company _____
Owner Name _____
Contact Name _____
Address _____
Cell Phone Number _____ Email Address _____
Project or Field Description _____
County _____

Annual Crop	Crop Acres	Crop Water Requirement (acre inches/acre)	Average Yield, # of Units/Acre	Income per unit of yield

Desired ROI in Years for Capital Expenditures _____ Expected Yield Increase in % _____
Field Acres _____ Age of Irrigation System _____
Surface Water (% af/acre) _____ Ground Water (% af/acre) _____
Water District Name _____

Emission Device Description

Emission Device Type and Application ☐ Drip Tape ☐ Thinwall Dripline with distinct or integral emitter
Emitter Type ☐ Pressure Compensating ☐ Non-pressure Compensating ☐ Flow Control
Manufacturer _____ Model Name/Description _____
Emission Device Flow Rate (gph) ___ Bed Width (center to center dimensions, inches) _____
Number of Hoses per Bed _____ Emitter Spacing, inches _____
Polyethylene (PE) Tubing Outside Diameter (inches) _____
Hose Direction from Riser ☐ One Direction ☐ Two Directions

Irrigation System DU and ROI Estimator
Grower Questions and Observations Form

Date _____

System Flushing
☐ At the beginning and end of the irrigation season
☐ At the beginning and end of the irrigation season and several times during the season
☐ Several times during the season ☐ Monthly ☐ Yearly ☐ Never
Deep well pump tested in last five years ☐ Yes ☐ No
Deep well pump replaced or repaired in last five years ☐ Yes ☐ No
Deep well pump flow and/or pressure decreased recently ☐ Yes ☐ No
Booster pump tested in last five years ☐ Yes ☐ No
Booster pump replaced or repaired in last five years ☐ Yes ☐ No
Booster pump flow and/or pressure decreased recently ☐ Yes ☐ No
Sand media sand changed ☐ Yes ☐ No
Sand media filter system flush automatically ☐ Yes ☐ No
Screen filter sand particles lodged in screen material ☐ Yes ☐ No
Screen filter system flush automatically ☐ Yes ☐ No
Disc filter removed and cleaned rings or discs ☐ Yes ☐ No
Disc filter system flush automatically ☐ Yes ☐ No
Continuous flush screen filter ☐ Yes ☐ No
Percent of emission devices that are either partially or completely plugged
☐ None ☐ 0-5% ☐ 5-10% ☐ More than 10%
Mismatched or incorrect drip tape or thinwall dripline products installed.
☐ Yes ☐ No
Buildup of chemical precipitants (typically white) on or in the emission devices outlet
☐ Yes ☐ No
External plugging of emission devices, either partially or completely
☐ None observed ☐ Algae or Biological ☐ Insects ☐ Soil Particles
Hose End Flush Water contaminants
☐ None observed ☐ Algae or Biological ☐ Insects ☐ Soil Particles
Throttled gate or butterfly valves (manually partially closed to regulate field pressures)
☐ None observed or N/A ☐ At filter station ☐ At inlet to irrigation sets
Leaks in the field
☐ None observed ☐ At the filter station ☐ From air vents in the field ☐ In Hoses
☐ At drip tape or thinwall dripline connections to the water supply pipes, couplers, or in the field
☐ At valves

Irrigation System DU and ROI Estimator
Equipment Component Performance Evaluation Form

Date _____

Deep Well Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____
Standing Water level (feet) _____ Cost ($/Kwh) _____ Cost ($/gallon) _____
Power ☐ Electric ☐ Diesel ☐ Propane

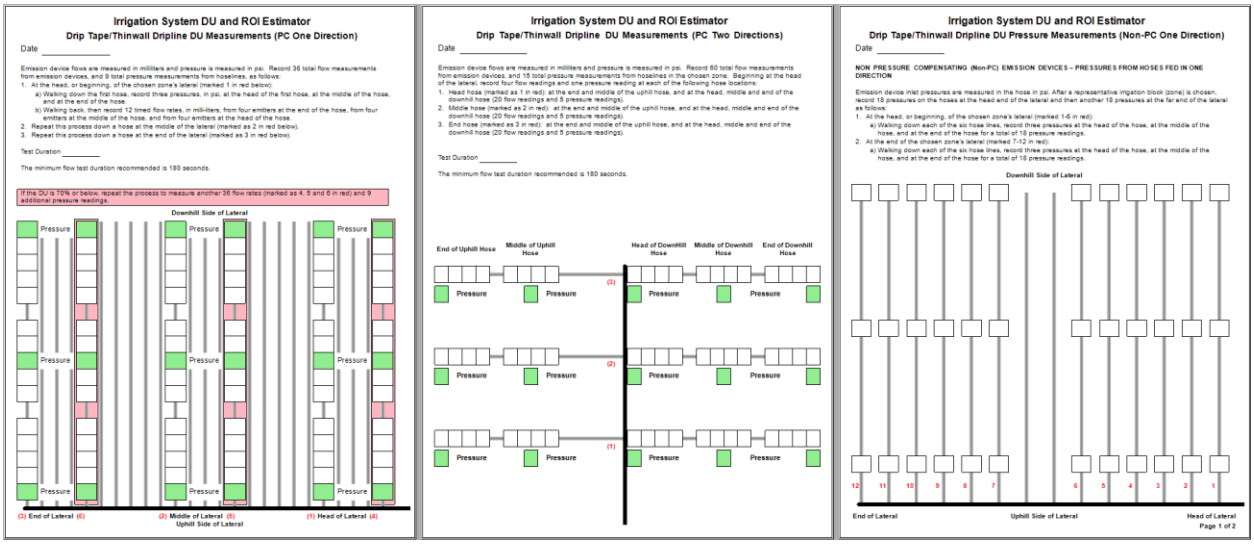
Booster Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____ Cost ($/Kwh) _____
Power ☐ Electric ☐ Diesel ☐ Propane Cost ($/gallon) _____

Flow Meters
Deep Well High Reading (gpm) _____ Deep Well Low Reading (gpm) _____
Booster/Filter High Reading (gpm) _____ Booster/Filter Low Reading (gpm) _____

Filters
☐ Sand Media ☐ Simple Screen ☐ Screen W/Sock ☐ Screen W/Auto Clean (Blue/Red)
☐ Screen W/Continuous Flush ☐ Disc Filters ☐ Sand Separator Sand Media Dia. (in) _____
Number of Units _____ Automatic Flushing ☐ Yes ☐ No
Upstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Downstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Continuous Flush / Separater Upstream Pressure (psi) _____ Downstream (psi) _____

Pump Station control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____

Submain control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____



Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Measurements (PC One Direction)

Date _____

Emission device flows are measured in milliliters and pressure is measured in psi. Record 36 total flow measurements from emission devices, and 9 total pressure measurements from hoselines, as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1 in red below):
   a) Walking down the first hose, record three pressures, in psi, at the head of the first hose, at the middle of the hose, and at the end of the hose.
   b) Walking back, then record 12 timed flow rates, in mill-liters, from four emitters at the end of the hose, from four emitters at the middle of the hose, and from four emitters at the head of the hose.
2. Repeat this process down a hose at the middle of the lateral (marked as 2 in red below).
3. Repeat this process down a hose at the end of the lateral (marked as 3 in red below).

Test Duration _____

The minimum flow test duration recommended is 180 seconds.

If the DU is 70% or below, repeat the process to measure another 36 flow rates (marked as 4, 5 and 6 in red) and 9 additional pressure readings.

Downhill Side of Lateral
Pressure
(3) End of Lateral (6) (2) Middle of Lateral (5) (1) Head of Lateral (4)
Uphill Side of Lateral

Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Measurements (PC Two Directions)

Date _____

Emission device flows are measured in milliliters and pressure is measured in psi. Record 60 total flow measurements from emission devices, and 15 total pressure measurements from hoselines in the chosen zone. Beginning at the head of the lateral, record four flow readings and one pressure reading at each of the following hose locations:
1. Head hose (marked as 1 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).
2. Middle hose (marked as 2 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).
3. End hose (marked as 3 in red): at the end and middle of the uphill hose, and at the head, middle and end of the downhill hose (20 flow readings and 5 pressure readings).

Test Duration _____

The minimum flow test duration recommended is 180 seconds.

End of Uphill Hose | Middle of Uphill Hose | Head of Downhill Hose | Middle of Downhill Hose | End of Downhill Hose
(3)
(2)
(1)
Pressure

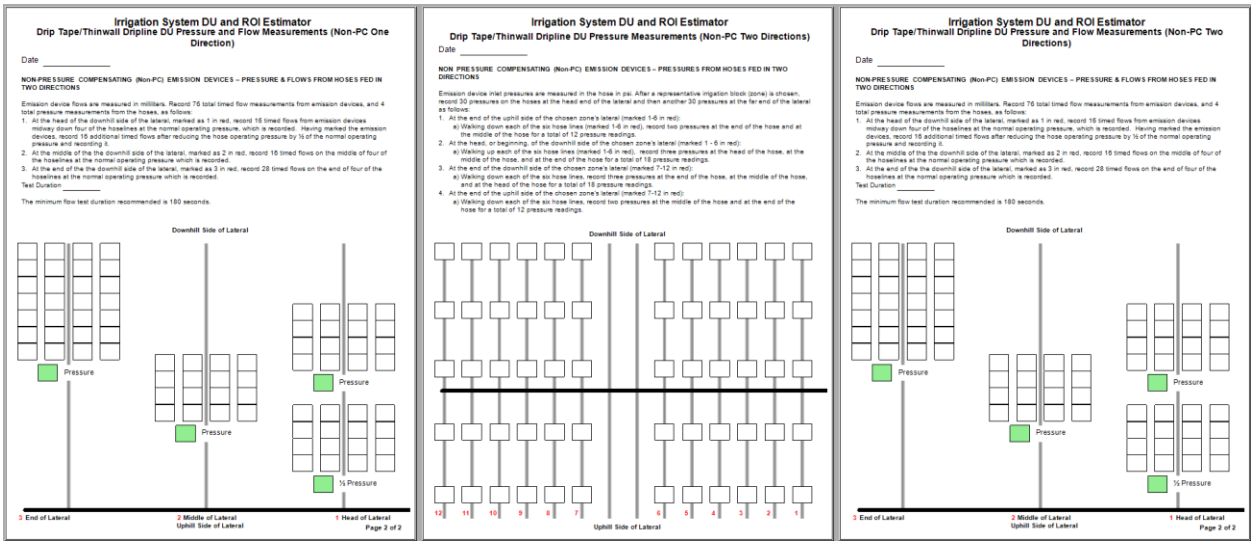
Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Pressure Measurements (Non-PC One Direction)

Date _____

NON PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURES FROM HOSES FED IN ONE DIRECTION

Emission device inlet pressures are measured in the hose in psi. After a representative irrigation block (zone) is chosen, record 18 pressures on the hoses at the head end of the lateral and then another 18 pressures at the far end of the lateral as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1-6 in red):
   a) Walking down each of the six hose lines, record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.
2. At the end of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.

Downhill Side of Lateral
12 11 10 9 8 7 6 5 4 3 2 1
End of Lateral | Uphill Side of Lateral | Head of Lateral
Page 1 of 2



Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Pressure and Flow Measurements (Non-PC One Direction)

Date _____

NON-PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURE & FLOWS FROM HOSES FED IN TWO DIRECTIONS

Emission device flows are measured in milliliters. Record 76 total timed flow measurements from emission devices, and 4 total pressure measurements from the hoses, as follows:
1. At the head of the downhill side of the lateral, marked as 1 in red, record 16 timed flows from emission devices midway down four of the hoselines at the normal operating pressure, which is recorded. Having marked the emission devices, record 16 additional timed flows after reducing the hose operating pressure by ½ of the normal operating pressure and recording it.
2. At the middle of the the downhill side of the lateral, marked as 2 in red, record 16 timed flows on the middle of four of the hoselines at the normal operating pressure which is recorded.
3. At the end of the the downhill side of the lateral, marked as 3 in red, record 28 timed flows on the end of four of the hoselines at the normal operating pressure which is recorded.

Test Duration _____

The minimum flow test duration recommended is 180 seconds.

Downhill Side of Lateral
Pressure
½ Pressure
3 End of Lateral 2 Middle of Lateral 1 Head of Lateral
Uphill Side of Lateral
Page 2 of 2

Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Pressure Measurements (Non-PC Two Directions)

Date _____

NON PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURES FROM HOSES FED IN TWO DIRECTIONS

Emission device inlet pressures are measured in the hose in psi. After a representative irrigation block (zone) is chosen, record 30 pressures on the hoses at the head end of the lateral and then another 30 pressures at the far end of the lateral as follows:
1. At the end of the uphill side of the chosen zone's lateral (marked 1-6 in red):
   a) Walking down each of the six hose lines (marked 1-6 in red), record two pressures at the end of the hose and at the middle of the hose for a total of 12 pressure readings.
2. At the head, or beginning, of the downhill side of the chosen zone's lateral (marked 1 - 6 in red):
   a) Walking up each of the six hose lines (marked 1-6 in red), record three pressures at the head of the hose, at the middle of the hose, and at the end of the hose for a total of 18 pressure readings.
3. At the end of the downhill side of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record three pressures at the end of the hose, at the middle of the hose, and at the head of the hose for a total of 18 pressure readings.
4. At the end of the uphill side of the chosen zone's lateral (marked 7-12 in red):
   a) Walking down each of the six hose lines, record two pressures at the middle of the hose and at the end of the hose for a total of 12 pressure readings.

Downhill Side of Lateral
12 11 10 9 8 7 6 5 4 3 2 1
Uphill Side of Lateral

Irrigation System DU and ROI Estimator
Drip Tape/Thinwall Dripline DU Pressure and Flow Measurements (Non-PC Two Directions)

Date _____

NON-PRESSURE COMPENSATING (Non-PC) EMISSION DEVICES – PRESSURE & FLOWS FROM HOSES FED IN TWO DIRECTIONS

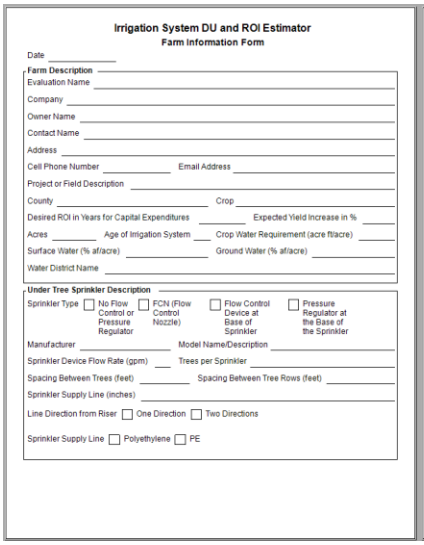
Emission device flows are measured in milliliters. Record 76 total timed flow measurements from emission devices, and 4 total pressure measurements from the hoses, as follows:
1. At the head of the downhill side of the lateral, marked as 1 in red, record 16 timed flows from emission devices midway down four of the hoselines at the normal operating pressure, which is recorded. Having marked the emission devices, record 16 additional timed flows after reducing the hose operating pressure by ½ of the normal operating pressure and recording it.
2. At the middle of the the downhill side of the lateral, marked as 2 in red, record 16 timed flows on the middle of four of the hoselines at the normal operating pressure which is recorded.
3. At the end of the the downhill side of the lateral, marked as 3 in red, record 28 timed flows on the end of four of the hoselines at the normal operating pressure which is recorded.

Test Duration _____

The minimum flow test duration recommended is 180 seconds.

Downhill Side of Lateral
Pressure
½ Pressure
3 End of Lateral 2 Middle of Lateral 1 Head of Lateral
Uphill Side of Lateral
Page 2 of 2

Evaluation Forms for Sprinklers: General Forms (3 pages), PC (2 pages); Non-PC (3 pages)

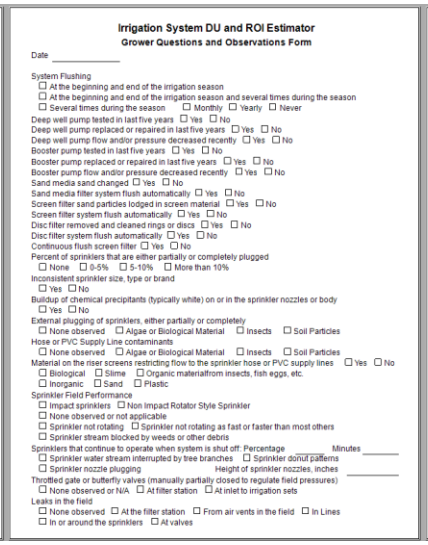


Irrigation System DU and ROI Estimator
Farm Information Form

Date _____

Farm Description
Evaluation Name _____
Company _____
Owner Name _____
Contact Name _____
Address _____
Cell Phone Number _____ Email Address _____
Project or Field Description _____
County _____ Crop _____
Desired ROI in Years for Capital Expenditures _____ Expected Yield Increase in % _____
Acres _____ Age of Irrigation System ___ Crop Water Requirement (acre ft/acre) _____
Surface Water (% af/acre) _____ Ground Water (% af/acre) _____
Water District Name _____

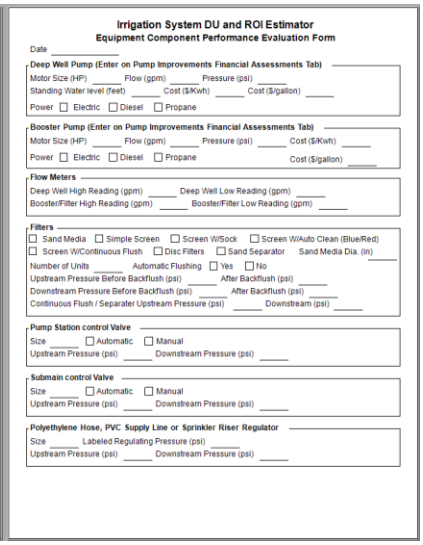
Under Tree Sprinkler Description
Sprinkler Type ☐ No Flow Control or Pressure Regulator ☐ FCN (Flow Control Nozzle) ☐ Flow Control Device at Base of Sprinkler ☐ Pressure Regulator at the Base of the Sprinkler
Manufacturer _____ Model Name/Description _____
Sprinkler Device Flow Rate (gpm) ___ Trees per Sprinkler _____
Spacing Between Trees (feet) _____ Spacing Between Tree Rows (feet) _____
Sprinkler Supply Line (inches) _____
Line Direction from Riser ☐ One Direction ☐ Two Directions
Sprinkler Supply Line ☐ Polyethylene ☐ PE



Irrigation System DU and ROI Estimator
Grower Questions and Observations Form

Date _____

System Flushing
☐ At the beginning and end of the irrigation season
☐ At the beginning and end of the irrigation season and several times during the season
☐ Several times during the season ☐ Monthly ☐ Yearly ☐ Never
Deep well pump tested in last five years ☐ Yes ☐ No
Deep well pump replaced or repaired in last five years ☐ Yes ☐ No
Deep well pump flow and/or pressure decreased recently ☐ Yes ☐ No
Booster pump tested in last five years ☐ Yes ☐ No
Booster pump replaced or repaired in last five years ☐ Yes ☐ No
Booster pump flow and/or pressure decreased recently ☐ Yes ☐ No
Sand media sand changed ☐ Yes ☐ No
Sand media filter system flush automatically ☐ Yes ☐ No
Screen filter sand particles lodged in screen material ☐ Yes ☐ No
Screen filter system flush automatically ☐ Yes ☐ No
Disc filter removed and cleaned rings or discs ☐ Yes ☐ No
Disc filter system flush automatically ☐ Yes ☐ No
Continuous flush screen filter ☐ Yes ☐ No
Percent of sprinklers that are either partially or completely plugged
☐ None ☐ 0-5% ☐ 5-10% ☐ More than 10%
Inconsistent sprinkler size, type or brand
☐ Yes ☐ No
Buildup of chemical precipitants (typically white) on or in the sprinkler nozzles or body
☐ Yes ☐ No
External plugging of sprinklers, either partially or completely
☐ None observed ☐ Algae or Biological Material ☐ Insects ☐ Soil Particles
Hose or PVC Supply Line contaminants
☐ None observed ☐ Algae or Biological Material ☐ Insects ☐ Soil Particles
Material on the riser screens restricting flow to the sprinkler hose or PVC supply lines ☐ Yes ☐ No
☐ Biological ☐ Slime ☐ Organic materialfrom insects, fish eggs, etc.
☐ Inorganic ☐ Sand ☐ Plastic
Sprinkler Field Performance
☐ Impact sprinklers ☐ Non Impact Rotator Style Sprinkler
☐ None observed or not applicable
☐ Sprinkler not rotating ☐ Sprinkler not rotating as fast or faster than most others
☐ Sprinkler stream blocked by weeds or other debris
Sprinklers that continue to operate when system is shut off: Percentage _____ Minutes _____
☐ Sprinkler water stream interrupted by tree branches ☐ Sprinkler donut patterns
☐ Sprinkler nozzle plugging Height of sprinkler nozzles, inches _____
Throttled gate or butterfly valves (manually partially closed to regulate field pressures)
☐ None observed or N/A ☐ At filter station ☐ At inlet to irrigation sets
Leaks in the field
☐ None observed ☐ At the filter station ☐ From air vents in the field ☐ In Lines
☐ In or around the sprinklers ☐ At valves



Irrigation System DU and ROI Estimator
Equipment Component Performance Evaluation Form

Date _____

Deep Well Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____
Standing Water level (feet) _____ Cost ($/Kwh) _____ Cost ($/gallon) _____
Power ☐ Electric ☐ Diesel ☐ Propane

Booster Pump (Enter on Pump Improvements Financial Assessments Tab)
Motor Size (HP) _____ Flow (gpm) _____ Pressure (psi) _____ Cost ($/Kwh) _____
Power ☐ Electric ☐ Diesel ☐ Propane Cost ($/gallon) _____

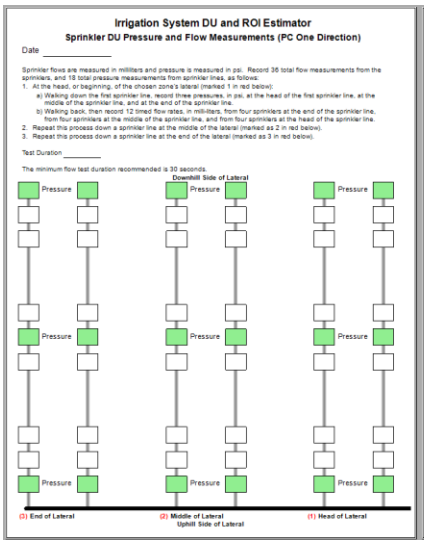
Flow Meters
Deep Well High Reading (gpm) _____ Deep Well Low Reading (gpm) _____
Booster/Filter High Reading (gpm) _____ Booster/Filter Low Reading (gpm) _____

Filters
☐ Sand Media ☐ Simple Screen ☐ Screen W/Sock ☐ Screen W/Auto Clean (Blue/Red)
☐ Screen W/Continuous Flush ☐ Disc Filters ☐ Sand Separator Sand Media Dia. (in) _____
Number of Units _____ Automatic Flushing ☐ Yes ☐ No
Upstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Downstream Pressure Before Backflush (psi) _____ After Backflush (psi) _____
Continuous Flush / Separater Upstream Pressure (psi) _____ Downstream (psi) _____

Pump Station control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____

Submain control Valve
Size _____ ☐ Automatic ☐ Manual
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____

Polyethylene Hose, PVC Supply Line or Sprinkler Riser Regulator
Size _____ Labeled Regulating Pressure (psi) _____
Upstream Pressure (psi) _____ Downstream Pressure (psi) _____



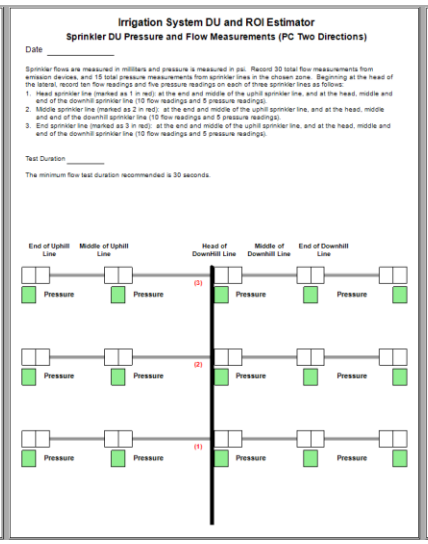
Irrigation System DU and ROI Estimator
Sprinkler DU Pressure and Flow Measurements (PC One Direction)

Date _____

Sprinkler flows are measured in milliliters and pressure is measured in psi. Record 36 total flow measurements from the sprinklers, and 18 total pressure measurements from sprinkler lines, as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1 in red below):
   a) Walking down the first sprinkler line, record three pressures, in psi, at the head of the first sprinkler line, at the middle of the sprinkler line, and at the end of the sprinkler line.
   b) Walking back, then record 12 timed flow rates, in milliliters, from four sprinklers at the end of the sprinkler line, from four sprinklers at the middle of the sprinkler line, and from four sprinklers at the head of the sprinkler line.
2. Repeat this process down a sprinkler line at the middle of the lateral (marked as 2 in red below).
3. Repeat this process down a sprinkler line at the end of the lateral (marked as 3 in red below).

Test Duration _____

The minimum flow test duration recommended is 30 seconds.



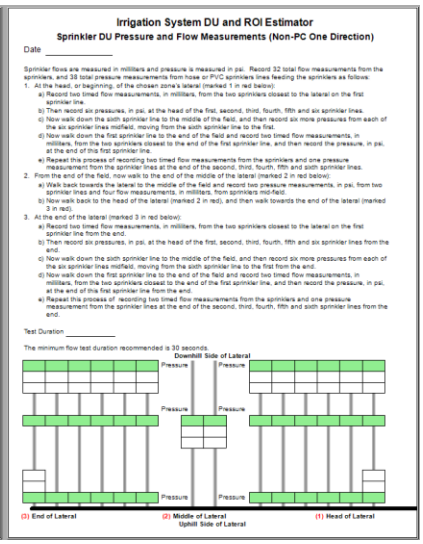
Irrigation System DU and ROI Estimator
Sprinkler DU Pressure and Flow Measurements (PC Two Directions)

Date _____

Sprinkler flows are measured in milliliters and pressure is measured in psi. Record 30 total flow measurements from emission devices, and 15 total pressure measurements from sprinkler lines in the chosen zone. Beginning at the head of the lateral, record ten flow readings and five pressure readings on each of three sprinkler lines as follows:
1. Head sprinkler line (marked as 1 in red): at the end and middle of the uphill sprinkler line, and at the head, middle and end of the downhill sprinkler line (10 flow readings and 5 pressure readings);
2. Middle sprinkler line (marked as 2 in red): at the end and middle of the uphill sprinkler line, and at the head, middle and end of the downhill sprinkler line (10 flow readings and 5 pressure readings);
3. End sprinkler line (marked as 3 in red): at the end and middle of the uphill sprinkler line, and at the head, middle and end of the downhill sprinkler line (10 flow readings and 5 pressure readings);

Test Duration _____

The minimum flow test duration recommended is 30 seconds.



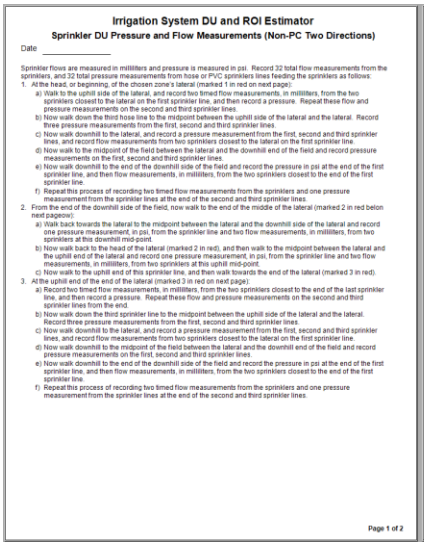
Irrigation System DU and ROI Estimator
Sprinkler DU Pressure and Flow Measurements (Non-PC One Direction)

Date _____

Sprinkler flows are measured in milliliters and pressure is measured in psi. Record 32 total flow measurements from the sprinklers, and 38 total pressure measurements from hose or PVC sprinklers lines feeding the sprinklers as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1 in red below):
   a) Record two timed flow measurements, in milliliters, from the two sprinklers closest to the lateral on the first sprinkler line.
   b) Then record six pressures, in psi, at the head of the first, second, third, fourth, fifth and six sprinkler lines.
   c) Now walk down the sixth sprinkler line to the middle of the field, and then record six more pressures from each of the six sprinkler lines midfield, moving from the sixth sprinkler line to the first.
   d) Now walk down the first sprinkler line to the end of the field and record two timed flow measurements, in milliliters, from the two sprinklers closest to the end of the first sprinkler line, and then record the pressure, in psi, at the end of this first sprinkler line.
   e) Repeat this process of recording two timed flow measurements from the sprinklers and one pressure measurement from the sprinkler lines at the end of the second, third, fourth, fifth and sixth sprinkler lines.
2. From the end of the field, now walk to the end of the middle of the lateral (marked 2 in red below):
   a) Walk back towards the lateral to the middle of the field and record two pressure measurements, in psi, from two sprinkler lines and four flow measurements, in milliliters, from sprinklers mid-field.
   b) Now walk back to the head of the lateral (marked 2 in red), and then walk towards the end of the lateral (marked 3 in red).
3. At the end of the lateral (marked 3 in red below):
   a) Record two timed flow measurements, in milliliters, from the two sprinklers closest to the lateral on the first sprinkler line from the end.
   b) Then record six pressures, in psi, at the head of the first, second, third, fourth, fifth and six sprinkler lines from the end.
   c) Now walk down the sixth sprinkler line to the middle of the field, and then record six more pressures from each of the six sprinkler lines midfield, moving from the sixth sprinkler line to the first from the end.
   d) Now walk down the first sprinkler line to the end of the field and record two timed flow measurements, in milliliters, from the two sprinklers closest to the end of the first sprinkler line, and then record the pressure, in psi, at the end of this first sprinkler line from the end.
   e) Repeat this process of recording two timed flow measurements from the sprinklers and one pressure measurement from the sprinkler lines at the end of the second, third, fourth, fifth and sixth sprinkler lines from the end.

Test Duration _____

The minimum flow test duration recommended is 30 seconds.

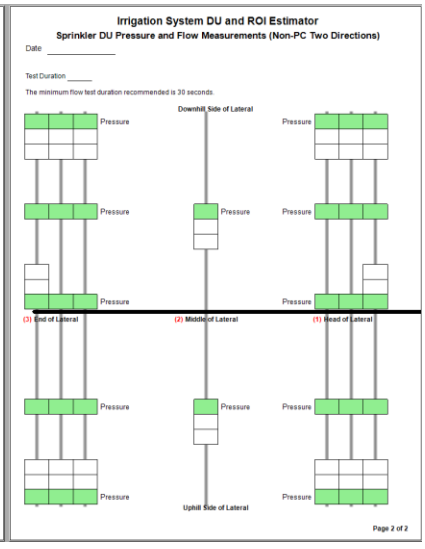


Irrigation System DU and ROI Estimator
Sprinkler DU Pressure and Flow Measurements (Non-PC Two Directions)

Date _____

Sprinkler flows are measured in milliliters and pressure is measured in psi. Record 32 total flow measurements from the sprinklers, and 32 total pressure measurements from hose or PVC sprinklers lines feeding the sprinklers as follows:
1. At the head, or beginning, of the chosen zone's lateral (marked 1 in red on next page):
   a) Walk to the uphill side of the lateral, and record two timed flow measurements, in milliliters, from the two sprinklers closest to the lateral on the first sprinkler line, and then record a pressure. Repeat these flow and pressure measurements on the second and third sprinkler lines.
   b) Now walk down the third hose line to the midpoint between the uphill side of the lateral and the lateral. Record three pressure measurements from the first, second and third sprinkler lines.
   c) Now walk downhill to the lateral, and record a pressure measurement from the first, second and third sprinkler lines, and record flow measurements from two sprinklers closest to the lateral on the first sprinkler line.
   d) Now walk to the midpoint of the field between the lateral and the downhill end of the field and record pressure measurements on the first, second and third sprinkler lines.
   e) Now walk downhill to the end of the downhill side of the field and record the pressure in psi at the end of the first sprinkler line, and then flow measurements, in milliliters, from the two sprinklers closest to the end of the first sprinkler line.
   f) Repeat this process of recording two timed flow measurements from the sprinklers and one pressure measurement from the sprinkler lines at the end of the second and third sprinkler lines.
2. From the end of the downhill side of the field, now walk to the end of the middle of the lateral (marked 2 in red belon next pageow):
   a) Walk back towards the lateral to the midpoint between the lateral and the downhill side of the lateral and record one pressure measurement, in psi, from the sprinkler line and two flow measurements, in milliliters, from two sprinklers at this downhill mid-point.
   b) Now walk back to the head of the lateral (marked 2 in red), and then walk to the midpoint between the lateral and the uphill end of the lateral and record one pressure measurement, in psi, from the sprinkler line and two flow measurements, in milliliters, from two sprinklers at this uphill mid-point.
   c) Now walk to the uphill end of this sprinkler line, and then walk towards the end of the lateral (marked 3 in red).
3. At the uphill end of the end of the lateral (marked 3 in red on next page):
   a) Record two timed flow measurements, in milliliters, from the two sprinklers closest to the end of the last sprinkler line, and then record a pressure. Repeat these flow and pressure measurements on the second and third sprinkler lines from the end.
   b) Now walk down the third sprinkler line to the midpoint between the uphill side of the lateral and the lateral. Record three pressure measurements from the first, second and third sprinkler lines.
   c) Now walk downhill to the lateral, and record a pressure measurement from the first, second and third sprinkler lines, and record flow measurements from two sprinklers closest to the lateral on the first sprinkler line.
   d) Now walk downhill to the midpoint of the field between the lateral and the downhill end of the field and record pressure measurements on the first, second and third sprinkler lines.
   e) Now walk downhill to the end of the downhill side of the field and record the pressure in psi at the end of the first sprinkler line, and then flow measurements, in milliliters, from the two sprinklers closest to the end of the first sprinkler line.
   f) Repeat this process of recording two timed flow measurements from the sprinklers and one pressure measurement from the sprinkler lines at the end of the second and third sprinkler lines.

Page 1 of 2



Irrigation System DU and ROI Estimator
Sprinkler DU Pressure and Flow Measurements (Non-PC Two Directions)

Date _____

Test Duration _____

The minimum flow test duration recommended is 30 seconds.

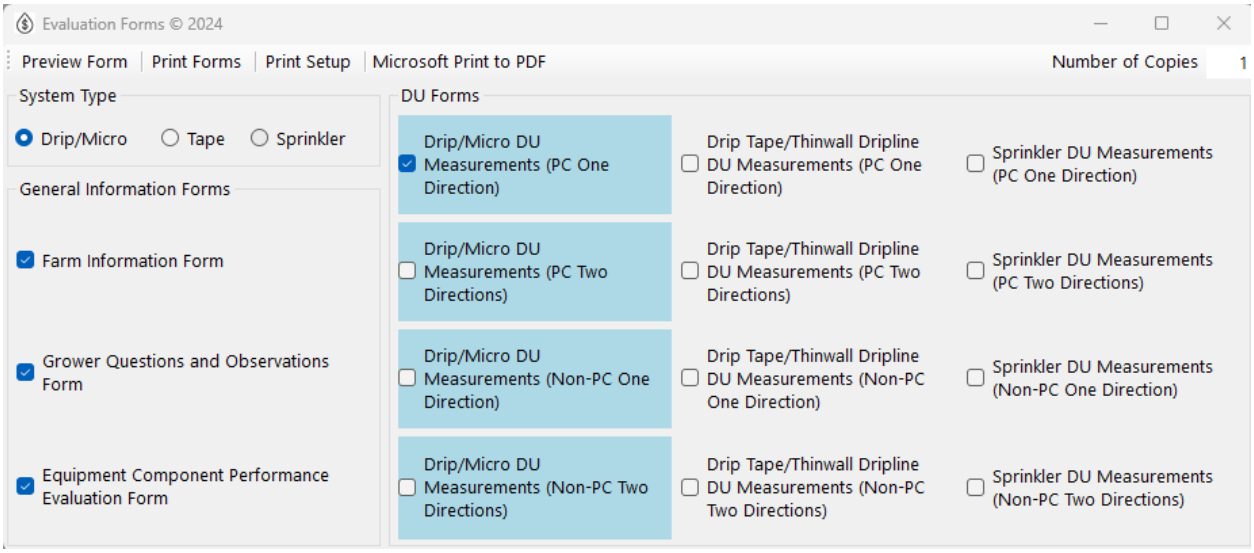
Page 2 of 2

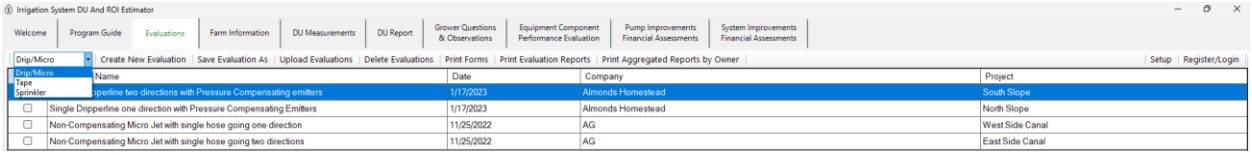
PC evaluations primarily collect flow data to detect potential emission device plugging issues since, in theory, pressure variation should not affect flow if the system operates within the PC emission device's specified operating range (typically ~10-50 psi depending on the make and model). In contrast, Non-PC evaluations collect both flow and more extensive pressure data since poor DU could be caused by plugging and/or system pressure variation since non-PC devices emit more flow as hose pressure increases. The following provides more detail on each of the four choices for the three system types:

1. **PC One Direction**: To conduct an evaluation on **Drip/Micro and Tape** systems that use PC emission devices and where hoses are fed in one direction, 36 flow and 9 pressure measurements must be taken at specified locations to calculate a system DU. If the resulting DU is less than 0.70, then an additional 36 flow and 9 pressure measurements must be taken. On **Sprinkler** systems with FCN, Flow Control Device at Base of Sprinkler or Pressure Regulator at Base of Sprinkler, 36 flow and 18 pressure measurements must be taken, but no additional measurements are needed even if the DU is below 0.70.
2. **PC Two Directions**: To conduct an evaluation on **Drip/Micro and Tape** systems that use PC emission devices and where hoses are fed in two directions, 60 flow and 15 pressure measurements must be taken at specified locations to calculate a system DU. No additional measurements are needed even if the overall System DU is below .70. On **Sprinkler systems** with FCN, Flow Control Device at Base of Sprinkler or Pressure Regulator at Base of Sprinkler, 30 flow and 15 pressure measurements must be taken, and no additional measurements are needed even if the DU is below 0.70.
3. **Non-PC and Tape with Flow Control One Direction**: To conduct an evaluation on **Drip/Micro and Tape** systems that use Non-PC or Tape with Flow Control emission devices and are fed in one direction, 36 pressure measurements must be taken at specified locations and recorded on the Non-PC **Pressure** Measurement data collection form, and 76 flow measurements and 4 pressure measurements must be taken at specified locations and recorded on the Non-PC **Pressure and Flow** Measurement data collection form. As detailed in the instructions, 16 of the flow measurements are first taken at the normal operating pressure at a location close to the head of the lateral from emission devices that have been marked since afterwards, a second flow measurement is taken from the same emission devices at half the normal operating pressure (by crimping the hose inlet to achieve this desired pressure). Collecting flow data at normal pressure, and then at half of normal pressure, allows the program to develop a "clean water" emission device flow vs. pressure curve. After the data is collected in-field on the paper forms, it is entered into the DU Estimator program, which calculates both a "pressure DU" and "flow DU", which are then multiplied by one another to compute the overall System DU. No additional measurements are needed even if the overall System DU is below .70. On **Sprinkler systems**, 32 flow and 38 pressure measurements must be taken and no additional measurements are needed even if the DU is below 0.70.
4. **Non-PC and Tape with Flow Control Two Directions**: To conduct an evaluation on **Drip/Micro and Tape** systems that use Non-PC or Tape with Flow Control emission devices and are fed in two directions, 60 pressure measurements must be taken at specified locations and recorded on the Non-PC **Pressure** Measurement data collection form, and 76 flow measurements and 4 pressure measurements must be taken at specified locations and recorded on the Non-PC **Pressure and Flow** Measurement data collection form. As detailed in the instructions, 16 of the flow measurements are first taken at the normal operating pressure at a location close to the head of the lateral from emission devices that have been marked since afterwards, a second flow measurement is taken from the same emission devices at half the normal operating pressure (by crimping the hose inlet to

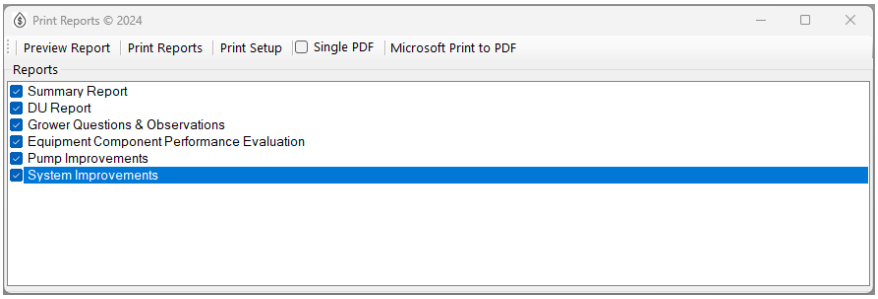
achieve this desired pressure). Collecting flow data at normal pressure, and then at half of normal pressure, allows the program to develop a "clean water" emission device flow vs. pressure curve. After the field data is collected on the paper forms, it is entered into the computer program, which calculates both a "pressure DU" and "flow DU", which are then multiplied by one another to compute the overall System DU. No additional measurements are needed even if the DU is below .70. On **Sprinkler systems**, 32 flow and 32 pressure measurements must be taken and no additional measurements are needed even if the DU is below 0.70.

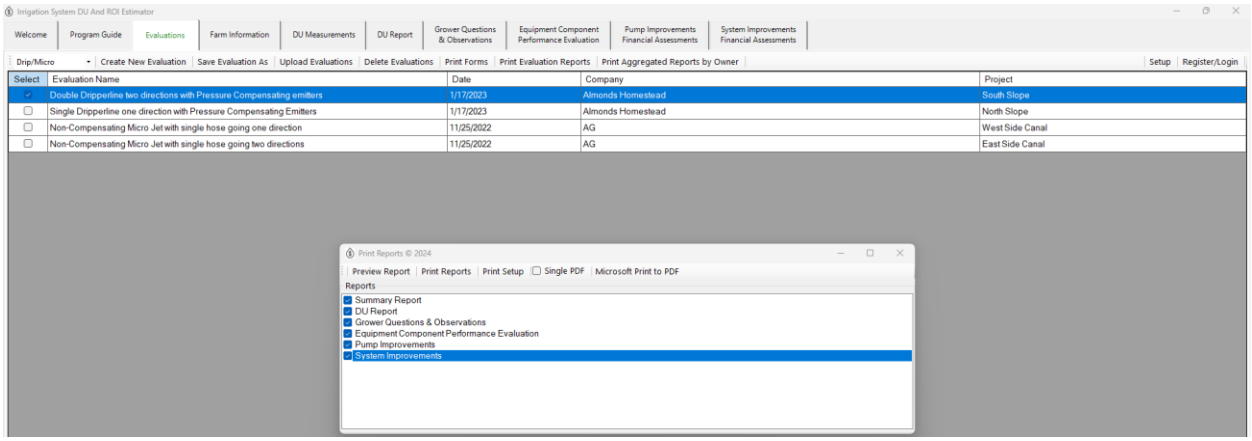
Note that the "Preview Form" subtab at the top of the image below allows the selected forms for a Drip/Micro PC One-Direction evaluation to be previewed prior to selecting "Print Forms", and that "Print Setup" allows selection of a hard copy printer or Print to PDF, which is then displayed adjacent.



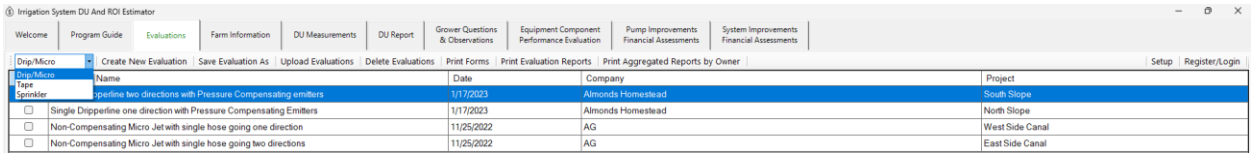


Adjacent to the "Print Forms" sub-tab shown above is the "Print Evaluation Reports" sub-tab which provides, when selected, menu options as shown in the following two images for print preview or printing, either individually or in a Single PDF when selected, all thirteen pages of evaluation reports. These reports are shown in more detail in the User Manual.

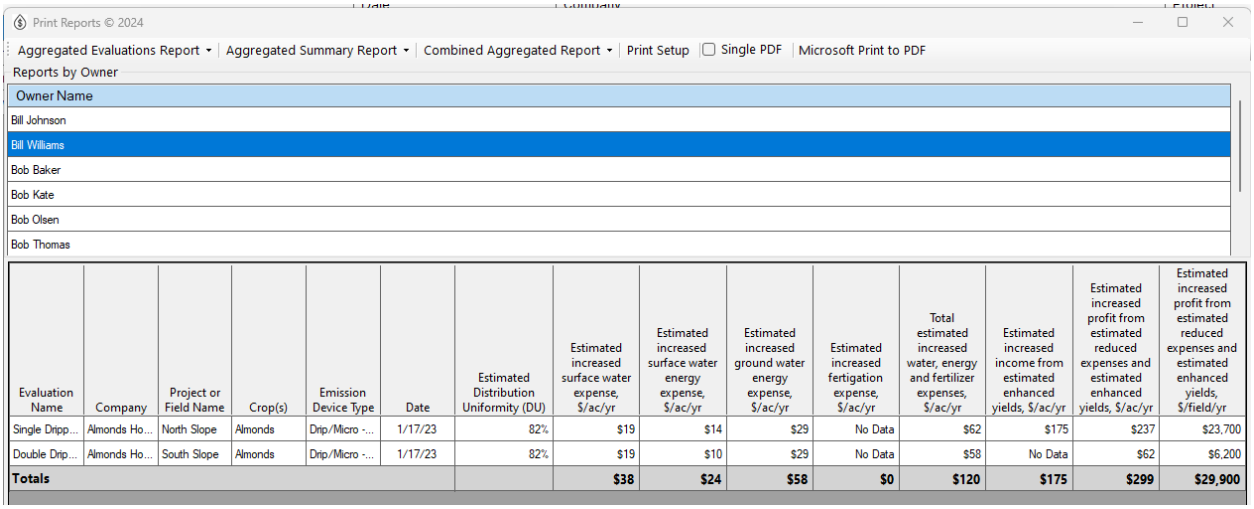


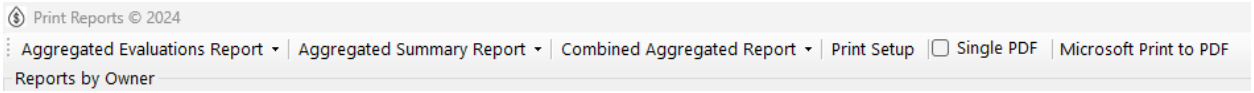


After selecting the Preview Report sub-tab, viewing choices appear on the left as shown below for each report including magnification level and number of on-screen pages, and/or page numbers may be selected with arrows on the right:

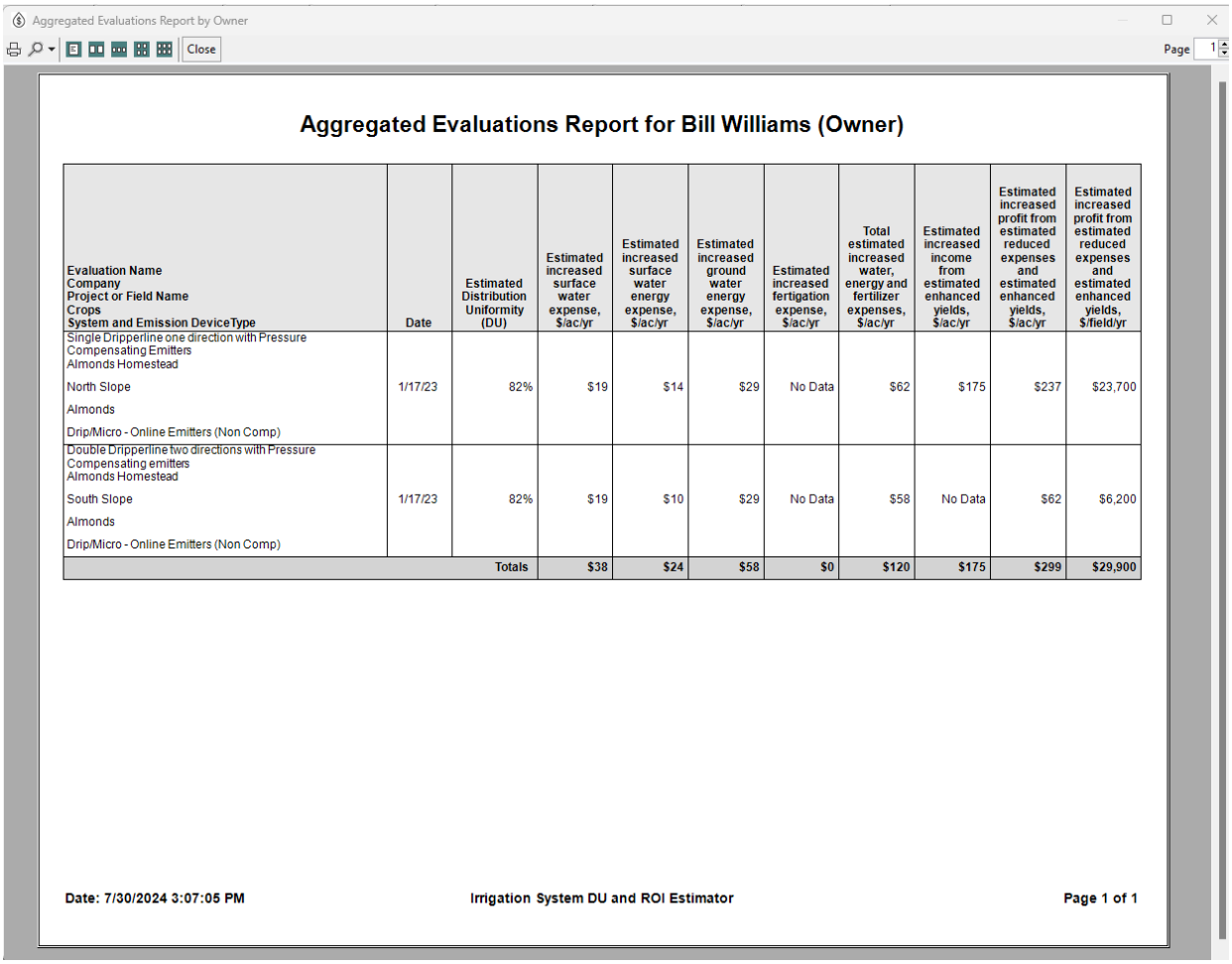


Adjacent is the “Print Aggregated Reports by Owner” sub-tab as shown above, where the aggregated financial results of one owner’s multiple field evaluations may be viewed on screen as shown below after owner Bill Williams is selected:





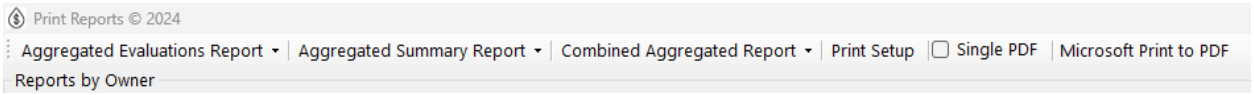
The top left sub-tab “Aggregated Evaluations Report” as shown above may then be selected to preview or print the aggregated evaluations report for owner Bill Williams, as shown below:



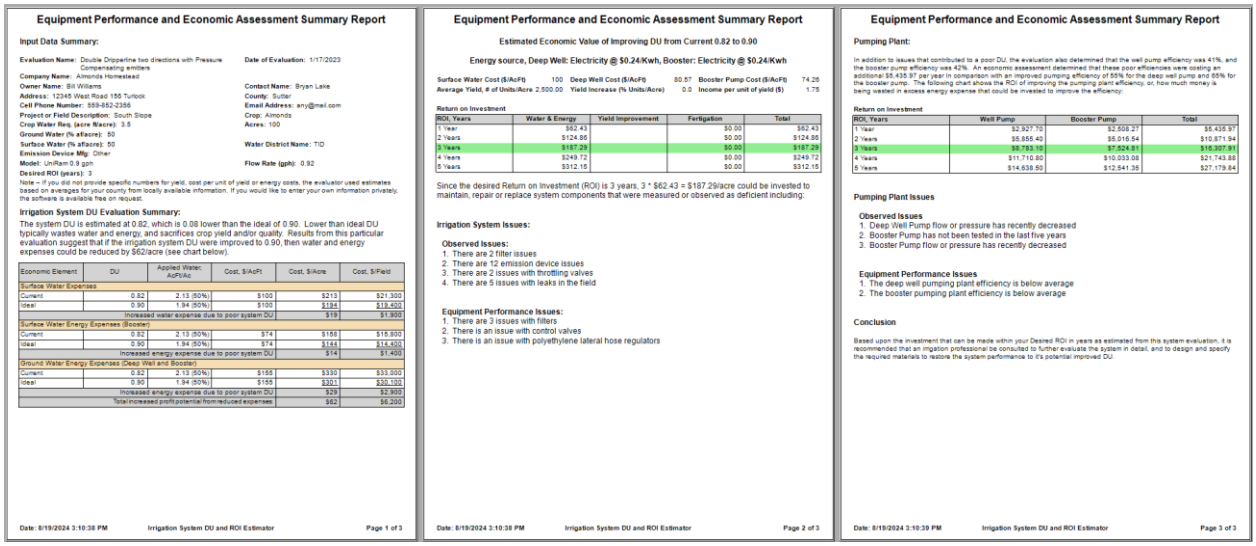
Aggregated Evaluations Report for Bill Williams (Owner)

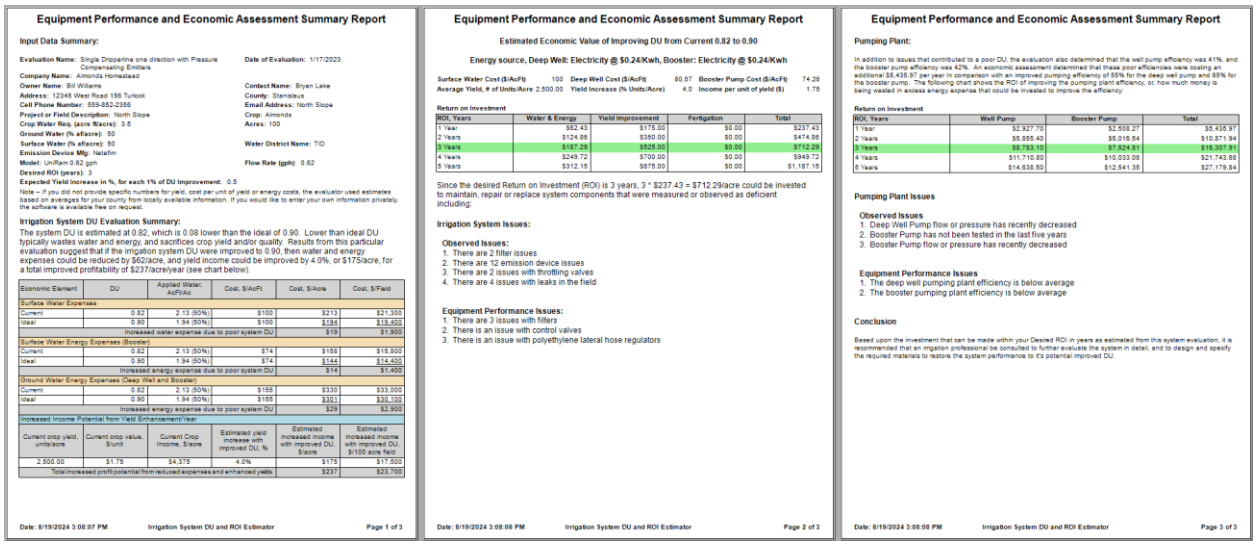
Evaluation Name Company Project or Field Name Crops System and Emission DeviceType	Date	Estimated Distribution Uniformity (DU)	Estimated increased surface water expense, $/ac/yr	Estimated increased surface water energy expense, $/ac/yr	Estimated increased ground water energy expense, $/ac/yr	Estimated increased fertigation expense, $/ac/yr	Total estimated increased water, energy and fertilizer expenses, $/ac/yr	Estimated increased income from estimated enhanced yields, $/ac/yr	Estimated increased profit from estimated reduced expenses and estimated enhanced yields, $/ac/yr	Estimated increased profit from estimated reduced expenses and estimated enhanced yields, $/field/yr
Single Dripperline one direction with Pressure Compensating Emitters Almonds Homestead North Slope Almonds Drip/Micro - Online Emitters (Non Comp)	1/17/23	82%	$19	$14	$29	No Data	$62	$175	$237	$23,700
Double Dripperline two directions with Pressure Compensating emitters Almonds Homestead South Slope Almonds Drip/Micro - Online Emitters (Non Comp)	1/17/23	82%	$19	$10	$29	No Data	$58	No Data	$62	$6,200
		Totals	$38	$24	$58	$0	$120	$175	$299	$29,900

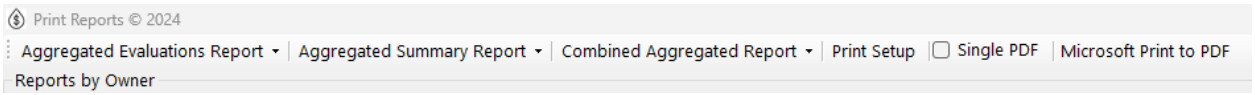
Date: 7/30/2024 3:07:05 PM Irrigation System DU and ROI Estimator Page 1 of 1



As a convenience, the adjacent sub-tab “Aggregated Summary Report” as shown above provides the summary report for each of the evaluations listed in the aggregated evaluations report as shown below for Bill Williams’ two evaluations:





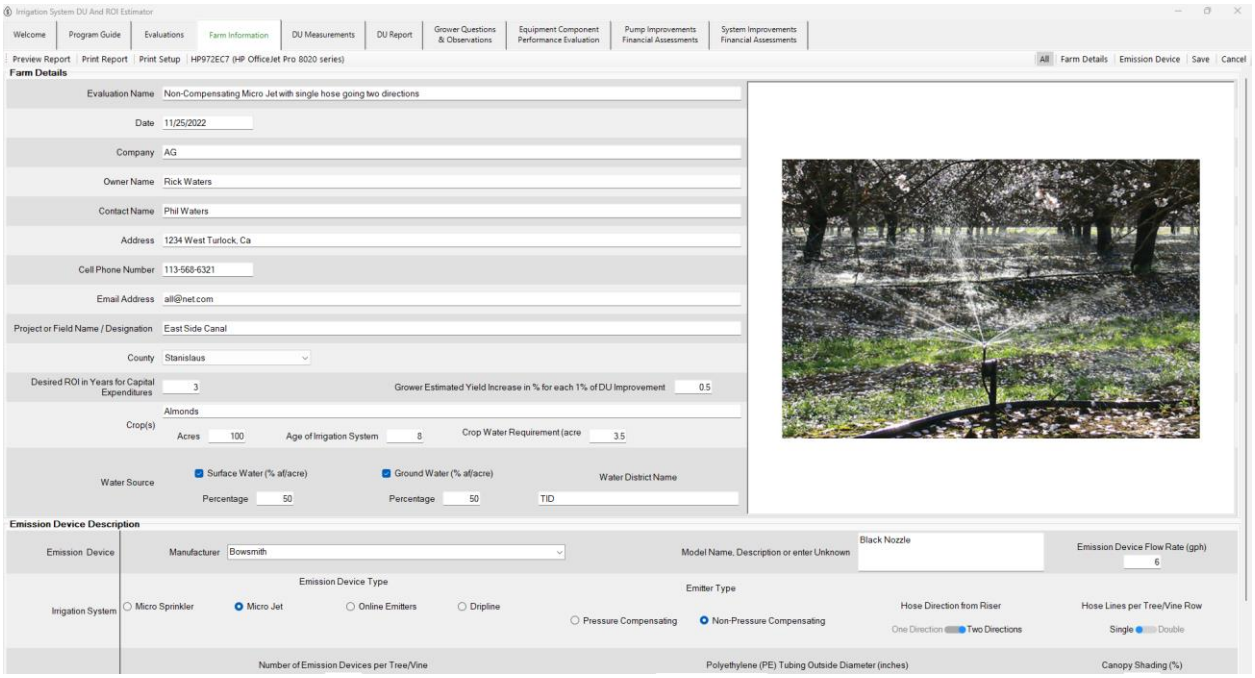


As a further convenience, the adjacent “Combined Aggregated Report” tab as shown above may be selected to preview and/or print both the aggregated evaluations report and the corresponding aggregated summary reports (as shown previously) to a printer or to a single PDF.

In summary, the aggregated reports feature allows owners to view the financial impact of multiple evaluations in a single glance as a further aid to investment decision making, i.e. the field evaluations estimating the most financial impact may receive investment priority. In this case, the first field’s estimated financial impact was $237/acre while the second field’s impact was only $62/acre. As a convenience, the corresponding field summary reports may be accessed here as well to provide a review of the evaluations’ key findings.

4. **Farm Information Tab**:

The Farm Information Tab highlighted in green above is what opens when a user chooses to create a new evaluation in the Evaluation tab. It includes a Farm Details and Emission Device panel which are accessed on the far right of the screen as shown below:



The Farm Details panel is used to collect basic information about the field and system to be evaluated as well as the owner's return on investment (ROI) preferences (in years), and the grower's yield improvement expectations (Grower Estimated Yield Increase in % for each 1% of DU Improvement). A typical ROI value is 3 years (which means the owner would like investments to pay for themselves within 3 years), and a typical estimated yield increase value is 0.5% for each 1.0% DU increase (which means the grower expects yields to increase 0.5% for each percentage point DU is improved as a result of investments to correct system deficiencies). For example, if the evaluation DU is 0.75 and, through investment, an ideal DU of 0.90 is achieved, then an estimated yield increase could be as much as 7.5% (0.9 - 0.75 = 0.15 DU improvement; 0.15 * 0.5 = 7.5% potential yield increase). If a typical yield increase value of zero is entered, then the ROI analysis reflects water, energy and fertigation cost savings only and ignores the financial opportunity from yield improvement.

The Emission Device panel collects information about the emission device, the irrigation system, and the system layout. This data dictates which Forms, and data collection procedures, are used for the evaluation since Pressure Compensating (PC) differs from Non-Pressure Compensating (Non-PC), and One Direction Hose from the Riser differs from Two Directions Hose from the Riser.

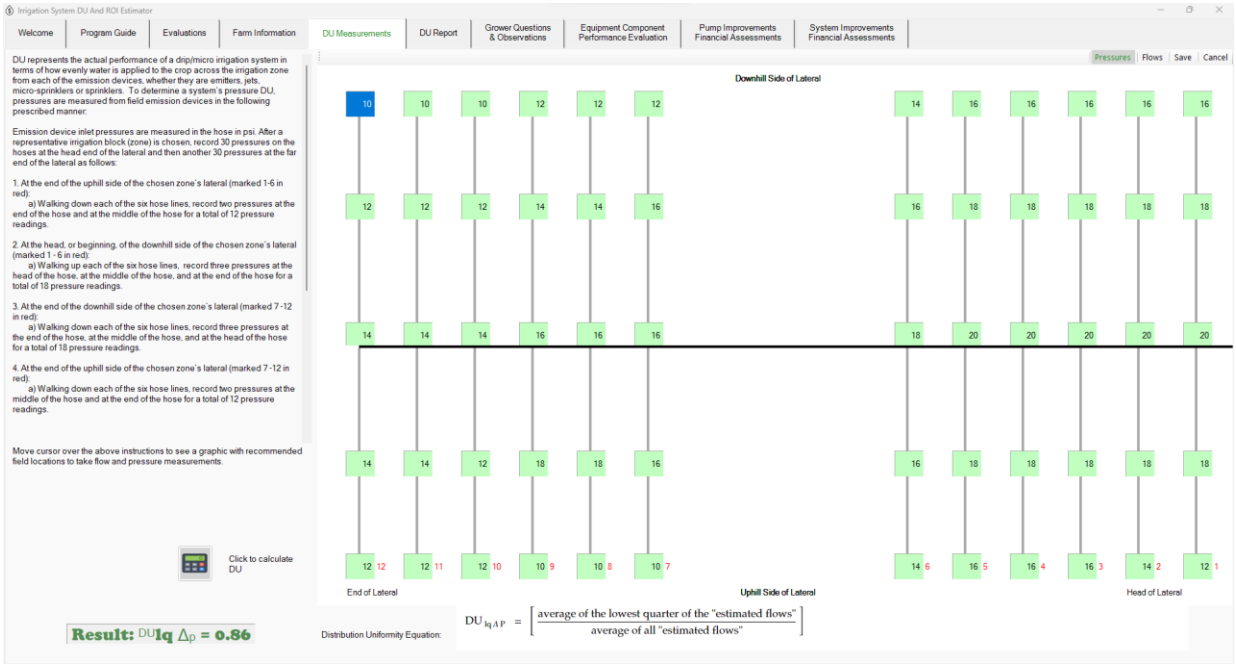
Once data is entered, click on the Save sub-tab on the far right to proceed, or Cancel to start over.

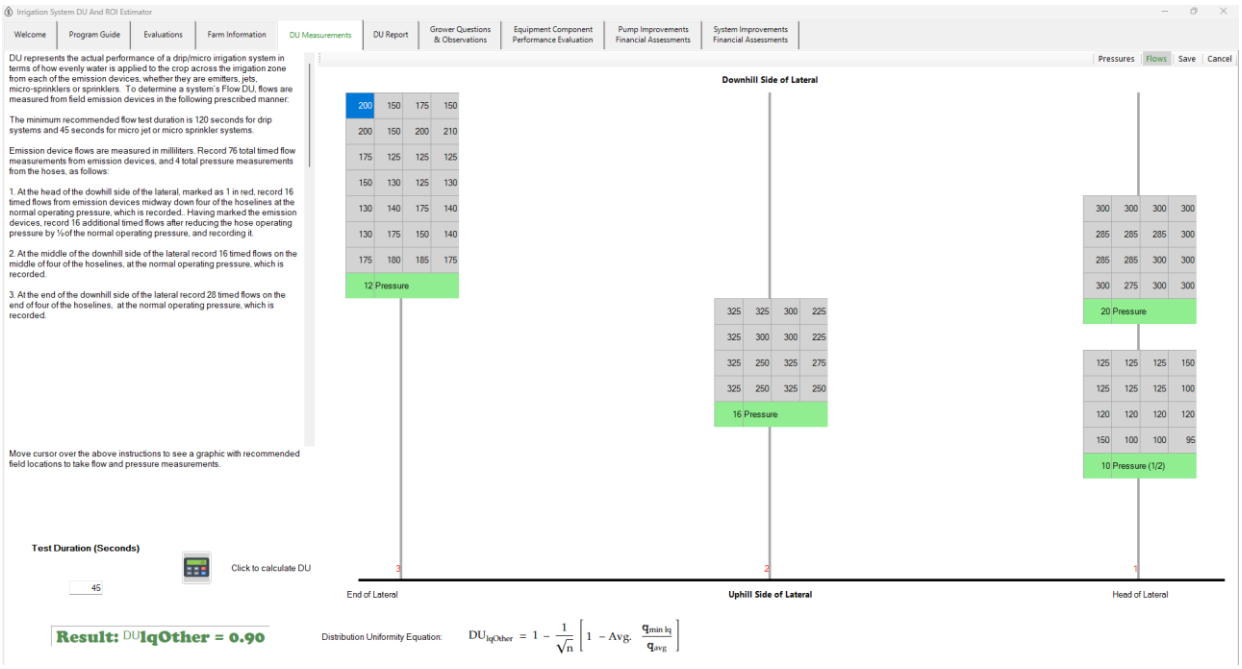
The Preview Report sub-tab on the far left may be used to view the data as it would appear in the collection form format, and then it may be printed to hard copy for PDF.

5. **DU Measurements Tab**:

The DU Measurements Tab as shown in green above is where pressure and flow information collected from an evaluation is entered.

On evaluations for systems that use Non-PC emission devices (as shown below), a Pressures and Flows sub-tab appears on the far right to access either the Pressure or Flow panels for data collection instructions and data input screens.





On evaluations for systems that use PC emission devices (as shown below), a single panel appears showing where pressure and flow readings should be taken depending on whether the system is fed in one direction or two directions (the image below is fed in one direction).

On the upper left of these two panels, DU is defined and instructions provided on where to collect the flow and pressure data. When the cursor hovers over the instructions, an image appears to assist in locating appropriate data collection sites.

Once the data is entered, the Save sub-tab may be chosen, or Cancel to start over.

Then the Calculate icon on the bottom left of the panel may be selected to automatically compute the system DU. The formula used for the computation is provided at the bottom of the panel.

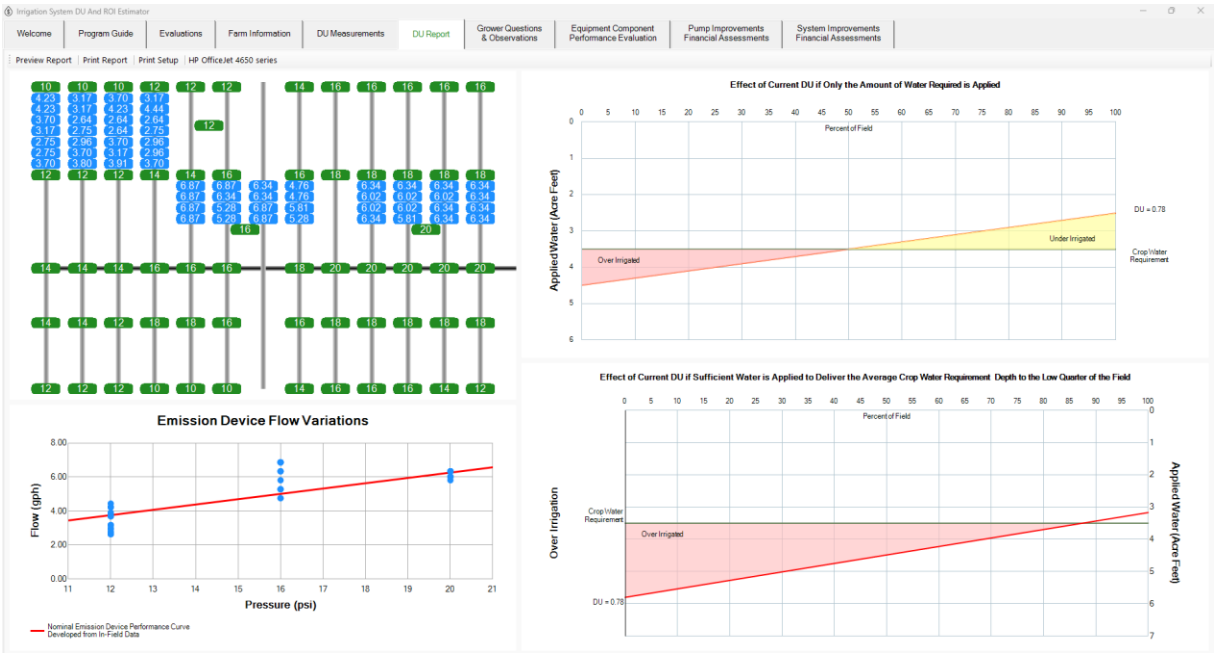
If the calculated DU is less than an ideal of 0.90, the program translates the less than ideal DU into economic terms including the cost of wasted water and energy, and the forgone crop yield and quality income. A return on investment (ROI) analysis is provided, which estimates how much money that is being wasted and foregone could rather be invested in repairs and/or upgrades.

If the calculated DU is 0.90 or above, a message on the System Improvements Report will provide a congratulations message since the DU is adequate and does not warrant investment or remediation efforts at this time.

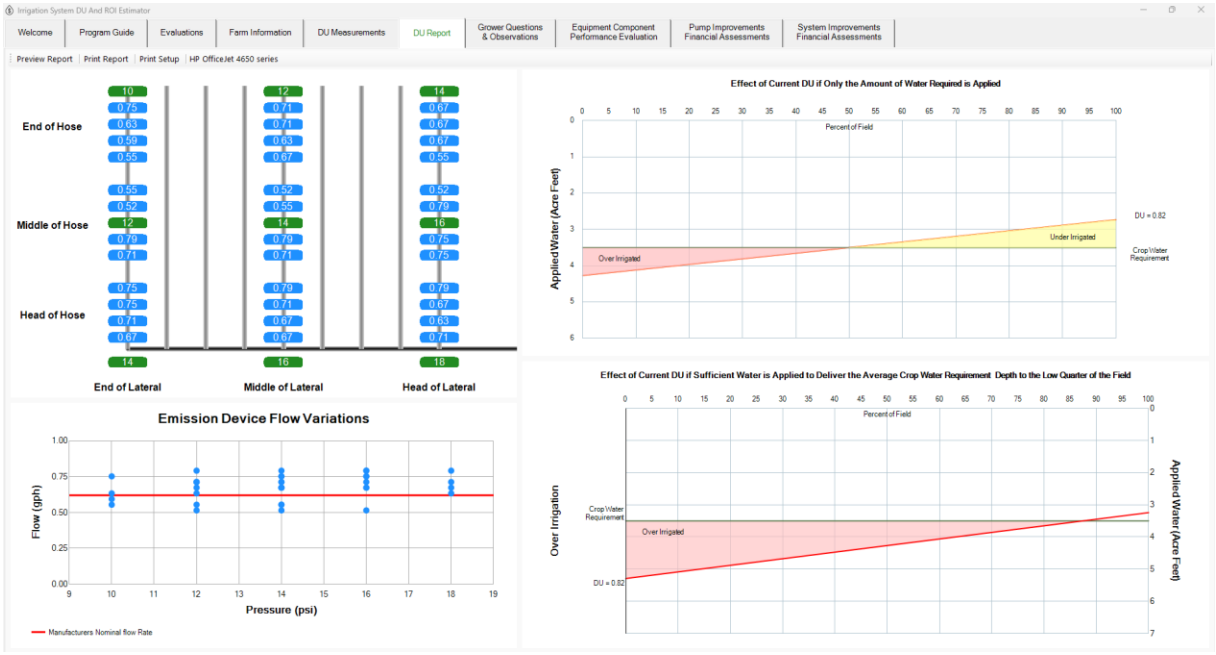
In both cases, however, it is recommended that the observed items identified as part of this report be addressed to optimize overall system operation and avoid possible future system DU degradation.

6. DU Report Tab:

The DU Report Tab is where data collected in the previous DU Measurements Tab is presented and interpreted. It includes, as shown below, the flow and pressure measurements collected, a flow vs. pressure curve, a graph of how much under and over irrigation occurs when just crop water requirement is applied, and a graph of the over irrigation that occurs when the underirrigated water requirement is applied.



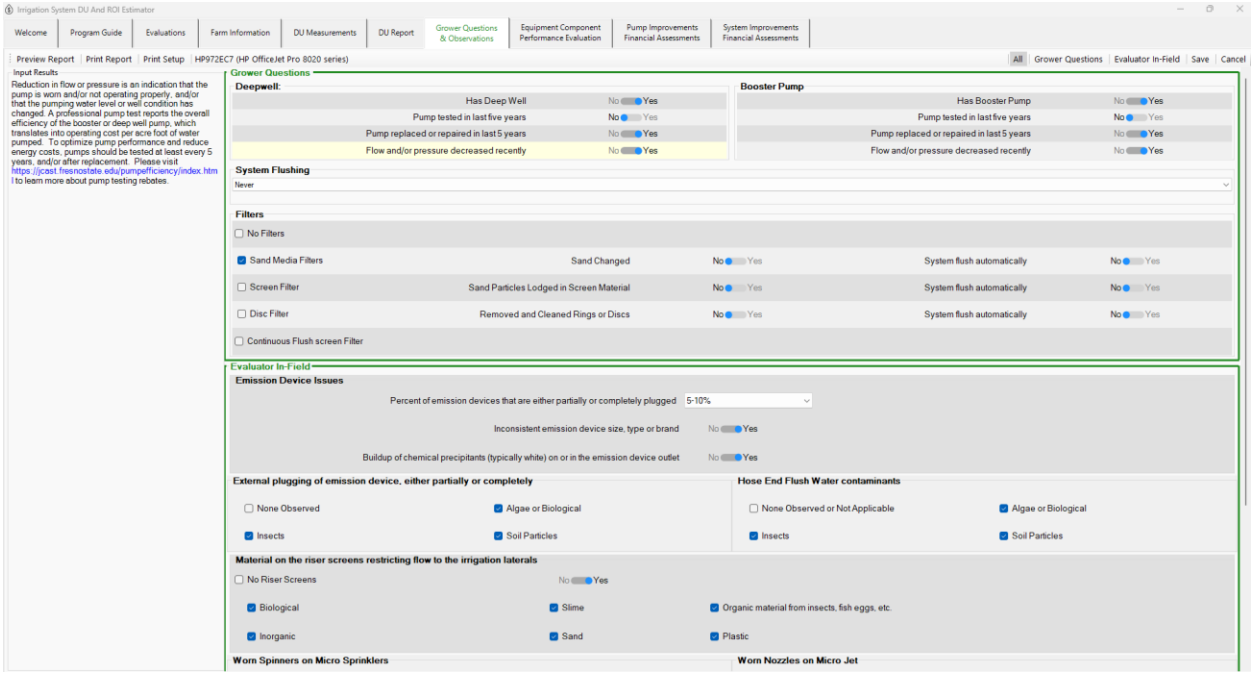
Note that the flow vs pressure curve in the Non-PC report (as shown above) is generated from additional field data that is collected for Non-PC evaluations. In PC reports (as shown below), the flow vs pressure curve is generated from data obtained from the manufacturer of the emission device.



When the Print Preview sub-tab on the upper far left of the DU Report tab is selected, the DU Report may be previewed on screen, and then printed to hard copy or PDF.

7. **Grower Questions & Evaluator Observations Tab**:

The Grower Questions & Evaluator Observations Tab as shown in green above is where information gathered during the grower interview and from the evaluator's own in-field observations is collected via two panels located on the upper right: Grower Questions, and Evaluator In-Field. When the All sub-tab is selected, as shown below, the user may use the scroll bar on the far right to view both panels (Grower Questions and Evaluator In-Field) sequentially.

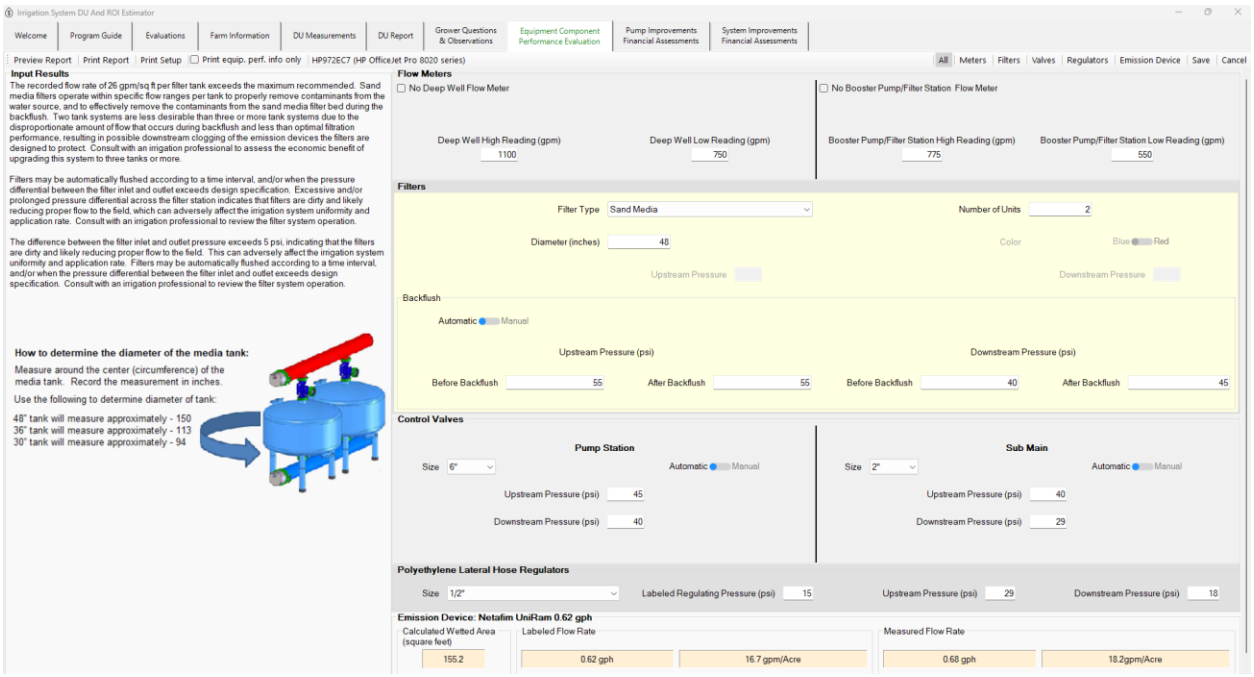


The Grower Questions panel collects operational information, as applicable, concerning the deep well, booster pump, filtration system and filter flushing. The Evaluator Observations panel collects information, as applicable, concerning observed issues with emission device and internal plugging, hose-end flush water and screen riser contaminants, sprinkler, micro-sprinkler/micro-jet functionality, gate and butterfly valve status, and leaks. Once the information is entered, select Save, or Cancel to start over.

Input Results are located in the upper left of this panel where additional interpretive information appears when the cursor hovers over any of the topics listed above as highlighted in yellow above. The Print Preview sub-tab on the upper left may be used to view a report of this tab on-screen, and then printed to hard copy or PDF.

8. **Equipment Performance Evaluation Tab**:

The Equipment Performance Evaluation Tab as shown in green above consists of multiple sub-tabs on the far right to launch the Meters, Filters, Valves, Regulators and Emission Devices panels. If the All sub-tab is selected, as shown below, then the user may use the scroll bar on the far right to view all panels sequentially. The information collected helps evaluate the equipment component performance and functionality, and then interprets the data.



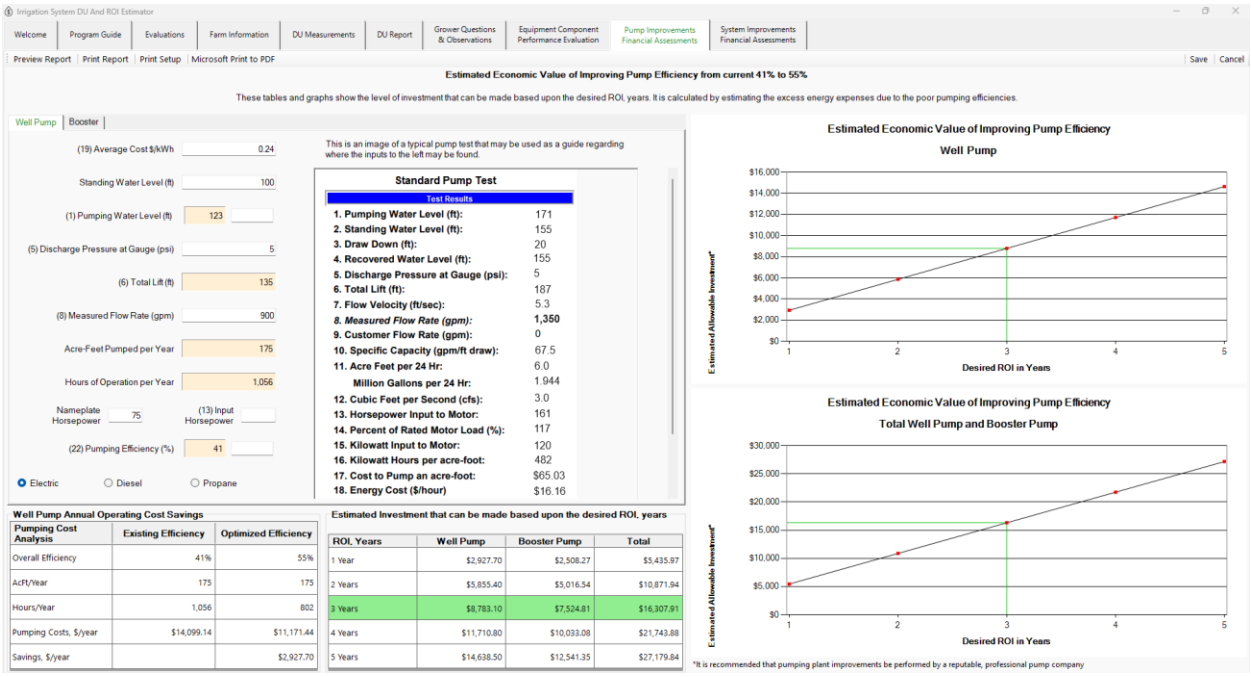
Input Results are located in the upper left of this panel where additional interpretive information appears when the cursor hovers over any of the topics listed above as shown highlighted in yellow above. The Print Preview sub-tab on the upper left may be used to view a report of this tab on-screen, and then printed to hard copy or PDF.

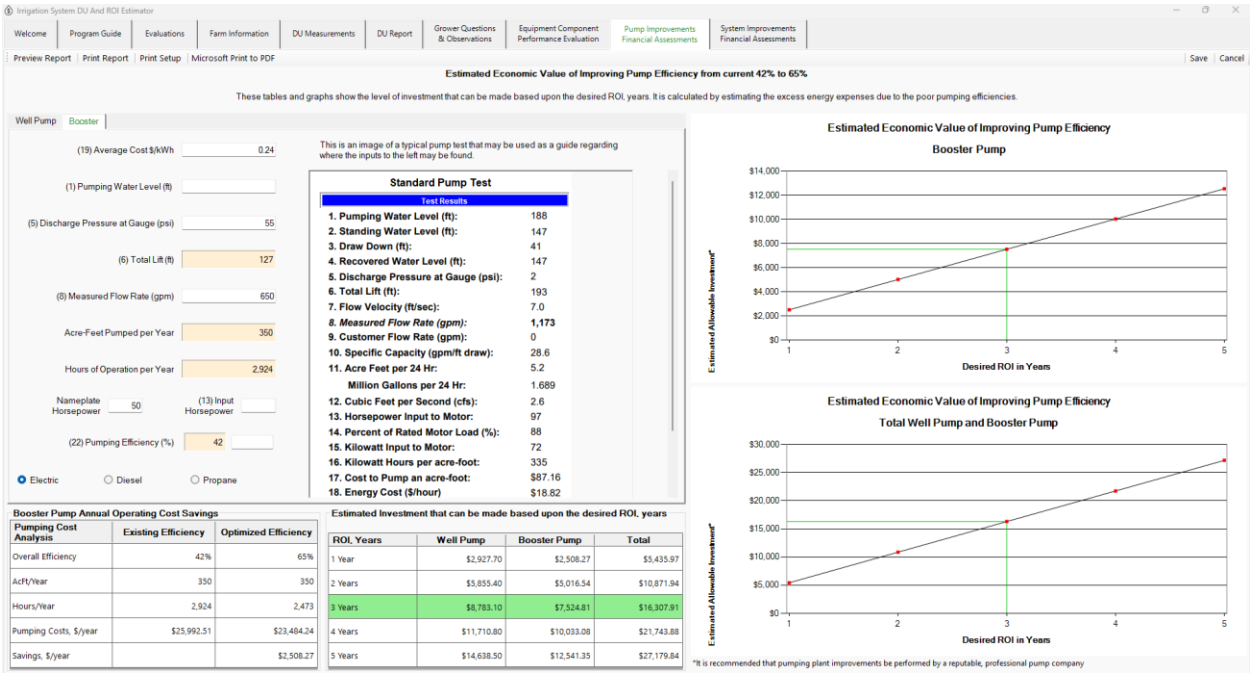
Print Equipment Performance Info Only is an additional option to view and print the data as it would appear in the collection form for the evaluator's records.

9. **Pump Improvements Financial Assessments Tab**:

The Pump Improvements Financial Assessments Tab is where pumping plant efficiency and its value in terms of energy costs is estimated, and translates the value via charts and graphs into Return on Investment (ROI) scenarios, in years, to correct detected deficiencies from existing to ideal. If the existing pump efficiency is 65% or above for booster pumps and/or 55% or above for well pumps, no investment recommendation is made since those levels are satisfactory. The sub-tabs in green, as shown below, on the far left of the screen may be selected to view either the Well Pump panel or the Booster Pump panel. The gold cells in each panel are calculated, while the other values are provided by the evaluator and/or a pump test report. Once the data is entered, select the Save sub-tab on the far right, or Cancel to start over.

The table on the bottom left provides a pumping cost analysis comparing the existing efficiency with an optimized efficiency. The savings, $/year, are then presented in the bottom middle table to determine the estimated dollar investment that could be made to correct the pump inefficiencies depending on the grower's stated preferred ROI time frame, in years.



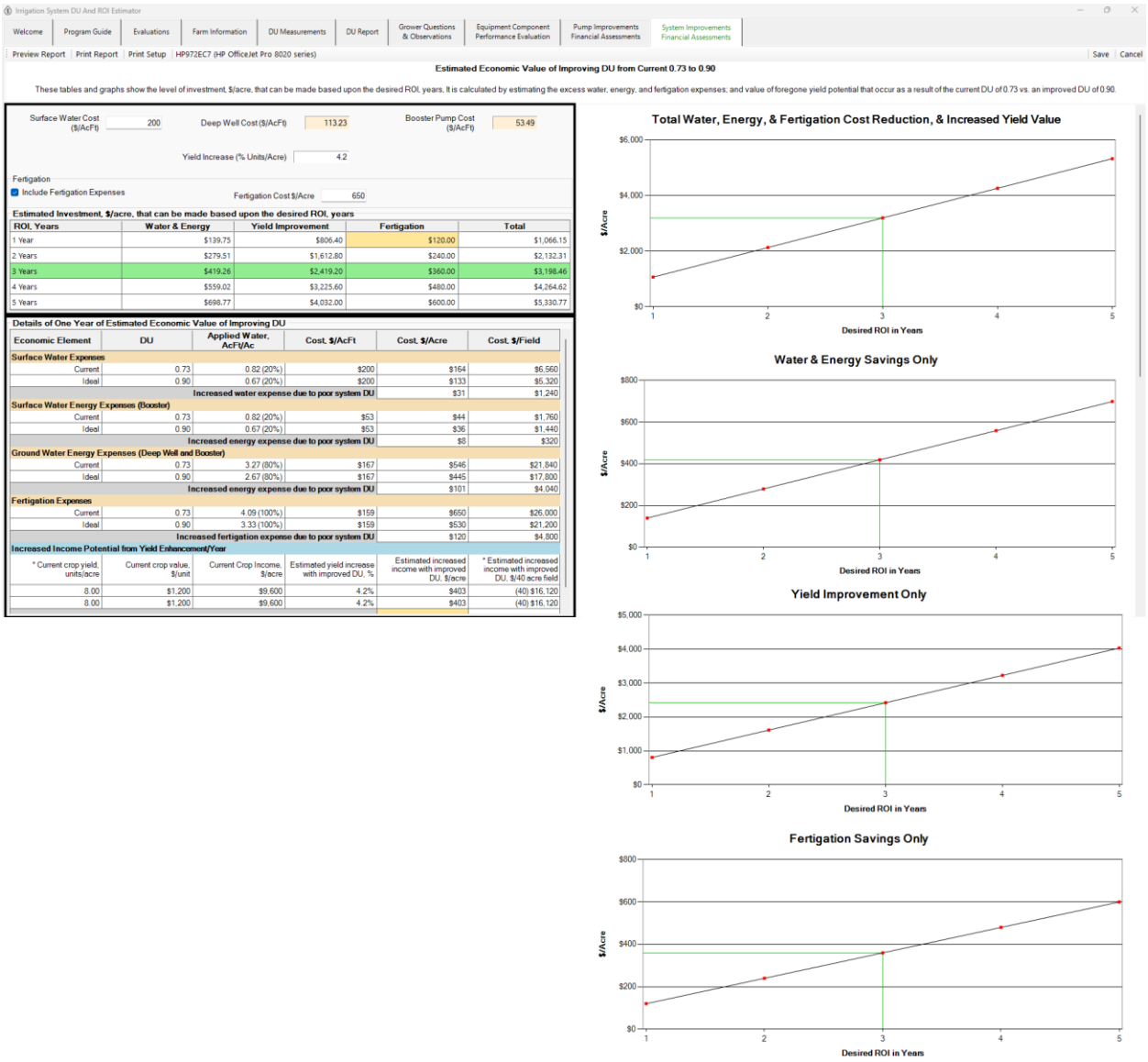


The graphs on the right reflect these values for the well pump (when the well pump sub-tab is selected), the booster pump (when the booster pump sub-tab is selected), and both the well pump and booster pump. If, for example, a three year ROI is selected then that value will correspondingly be indicated on the graphs in green lines. To view other ROI scenarios, simply click on the desired number of years, in which case the lines on the graph will change as well.

The Print Preview sub-tab on the upper left may be used to view this report on-screen and then it may be printed to hard copy or PDF.

10. **System Improvements Financial Assessment Tab**:

The System Improvements Financial Assessment Tab as shown in green above is where the value of poor DU in terms of unnecessary water, energy and fertigation costs, and potential forgone yield, is estimated, and translates the value via charts and graphs into Return on Investment (ROI) scenarios, in years, to correct the deficiencies. If the resulting DU is less than 0.90, it compares the current economics at a poor DU with projected economics with a higher, ideal DU of .90.



The table on the upper left estimates the investment, $/Acre, which can be made based upon the desired return on investment (ROI), in years, to correct the deficiencies. The cells shaded gold at the top

of the table are calculated; the yield increase % is carried over from the Farm Information Tab, but may be adjusted here is desired, and the remaining cells require user input including water and fertigation costs. Once the data is entered, select the Save sub-tab on the far right, or Cancel to start over.

The graphs on the right reflect these values for total water, energy and fertigation cost reductions and increased yield value, water and energy savings only, yield improvement only, and fertigation savings only. If a three year ROI is selected in the top left table, as shown highlighted with a green bar above, then that value will correspondingly be indicated on the graphs to the right with green lines. To view other ROI scenarios, simply click on the desired number of years, in which case the lines on the graph will change as well.

The table on the bottom left provides details of one year of estimated economic values of improving DU including reduced water, energy and fertigation costs, and the value of the estimated crop yield increase, per acre and per "field" (total acres of the project). In this particular case, the tape field had two vegetable crops per year.

The Print Preview sub-tab on the upper left may be used to view this report on-screen, and then Print may be selected.

Summary

The Irrigation System DU and ROI Estimator may be used to guide field technicians on how to conduct a simplified irrigation system distribution uniformity analysis, which includes collecting flow and pressure data, information about the system operation, and observing the status of equipment components. It then uniquely translates resulting DU information and system deficiencies into economic terms (estimated excessive water, energy and fertigation costs, and forgone yield potential) that are intended to help the grower make meaningful investment decisions. It is hoped that this program and its reports will assist the technician in communicating the identified deficiencies to growers in such a way that growers are compelled to engage with irrigation professionals to correct the deficiencies, and that ultimately farm profitability and resource use efficiency will be improved.

List of materials needed to conduct an evaluation:

1. Clip board
2. Water proof writing instrument
3. Printed program forms to fill out during the field evaluation
4. Access to a computer to run the program, create reports and email results to client
5. 0-30 psi oil filled pressure gauge fitted with a pitot tube
6. 0-60 psi oil filled pressure gauge
7. 0-100 psi oil filled pressure gauge
8. Various sizes of polyethylene hose end couplers with fittings to connect to pressure gauge
9. 2 - ¼" Schrader valves
10. Tap and drill bit (to measure upstream and downstream pressure on control valves that don't have gauges or Schrader valves installed).
11. 0-100 milliliter graduated cylinder, plastic
12. 0-500 milliliter graduated cylinder, plastic
13. 0-1000 milliliter graduated cylinder, plastic
14. 60 plastic catchment basins
15. Vice grips to reduce hose flow and pressure for ½ pressure reading
16. Stopwatch
17. Emitter punch
18. Goof plugs
19. 5 gallon bucket
20. Loose cloth to capture debris from hose end flush water

Preparing for an Irrigation System Evaluation

The following information should be reviewed and acted upon prior to conducting an irrigation system evaluation:

1. Gather as much of the information to populate the Farm Information tab as possible from the client prior to the day of the evaluation. Request a copy of the irrigation system design and/or layout if available. If it is not available item #2 is then critical. See Items #8, #9 & #10 for a critical need of the client prior to doing the evaluation.
2. Request that the irrigator be present at the beginning of the evaluation to assist in explaining the operation and layout of the irrigation system. In addition, the irrigator should assist you in choosing a representative lateral to collect the pressure and flow data from. The representative lateral should be in the average area of the irrigation zone, not the "best" or "worst" area. The irrigation zone being evaluated should be equivalent to "one normal irrigation set".
3. Some of the information required to complete the Farm Information Tab may need to be obtained when you are onsite the day of the evaluation. All system data is necessary to perform the calculations and to complete the reports.
4. Have all of the necessary tools listed above with you and understand how each is used. In particular, you should be familiar with how to field install a Schrader valve on the upstream side of the submain valves if there are no functioning gauges or Schrader valves. This should be done prior to the irrigator turning on the pumping system.
5. Have printed copies of all Program Forms with you since additional or corrected data may be collected on site the day of the evaluation.
6. It is important to have your computer with you, especially when performing an evaluation on a drip/micro or tape Pressure Compensating system with the hose running one direction. In this case, you must input the pressure and flow data required in the DU Measurements tab to calculate the existing DU, and if the DU is less than 0.70 you will be instructed to **collect 36 additional flow readings and 9 additional pressure readings** in order to obtain a statistically correct DU result. To facilitate this additional data collection, 36 additional flow and 9 additional pressure input cells will appear on the DU Measurement screen if the initial DU measures below 0.70. These cells must be populated with the additional data in order to compute the statistically correct DU for a PC one direction evaluation.
7. If there are no flow meters on the pumping plants, then the field flow must be estimated. One method is to use the Measured Flow Rate (gpm/acre) value found at the bottom right of the Equipment Component Performance Evaluation Tab and multiply it times the acreage of the "one normal irrigation set". You can then manually input this value in the Measured Flow Rate (gpm) cell within the Pump Improvements Financial Assessment Tab.
8. If there are no pressure gauges on the pump(s) discharge piping, request that the grower have them installed prior to the evaluation. These pressures are required to estimate the pumping costs in the Pump and Irrigation System Improvements Financial Assessments Tabs.
9. If there are no pressure gauges on the upstream side of the filter, the pump discharge pressure that is supplying the system pressure may be used instead. This could be a well pump or a booster pump

depending upon the pumping plant configuration. If there are no pressure gauges on the downstream side of the filter, request the client to install one because both upstream and downstream pressure readings are required to assess filter performance.

10. If there are existing gauges, as required and detailed in #8 & #9 above, request that the client or the irrigator verify that they are functioning properly prior to the evaluation. This may be accomplished by comparing their readings with the readings from a known functional gauge.