

April 16, 1935.

O. H. ENGLEHART

1,997,901

WATER SYSTEMS

Filed Dec. 18, 1932

Fig. 1

Fig. 2

Fig. 3

Fig. 4

INVENTOR,
Oscar H. Englehart
BY *Wm. B. Smith* ATTORNEY



IQ4 Advanced ET

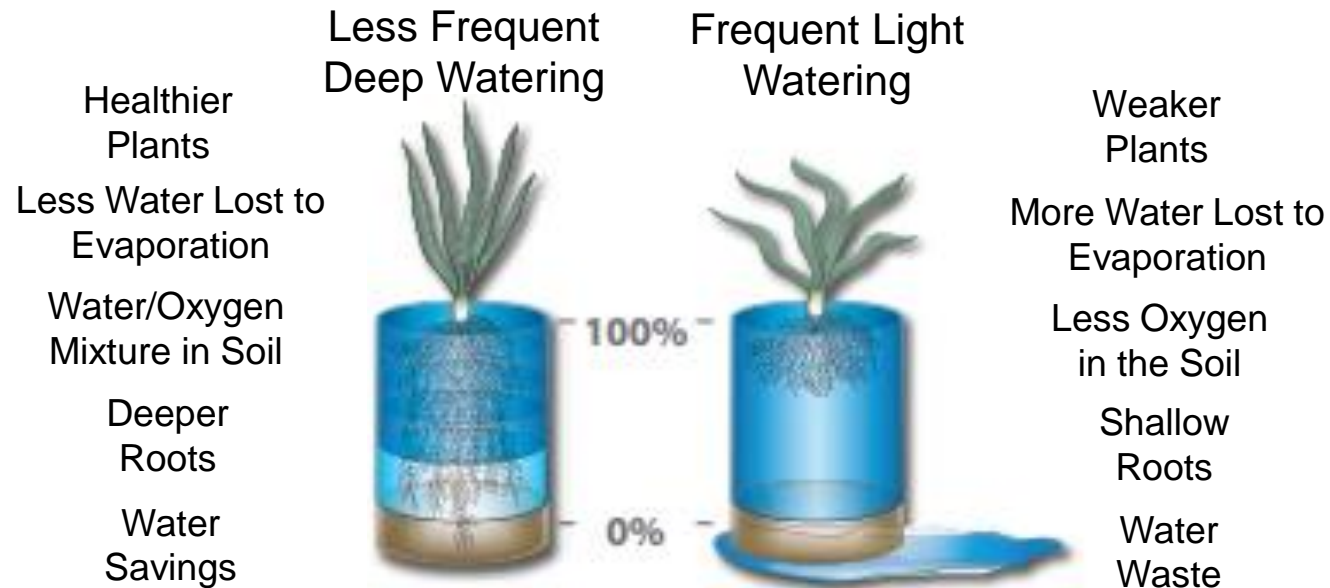
Configuration and Operation

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Advanced ET Adjusted Programming

- IQ4 utilizes Irrigation Association terminology and methodology for Management Allowed Depletion (MAD) Irrigation Scheduling.
- MAD provides deeper, less frequent irrigation cycles that promotes healthier plants with deeper roots.
- Weather Source ET adjusted programs automatically adjust program day cycles and station run times based on the weather.



Advanced ET Adjusted Programming

- Advanced ET is now available in IQ4, enabling Management Allowed Depletion (MAD programming)
- Advanced ET joins other irrigation schedule adjustment options available in IQ4 such as Seasonal Adjust and Simple ET
- Advanced ET gives you the most control and configuration to manage water use and plant health efficiently and effectively

What is ET and How Does it Relate to Irrigation?

- Evapotranspiration (ET) is a calculation of soil moisture lost from the plants root zone due to evaporation and plant transpiration.
- ET is calculated using weather data such as air temperature, relative humidity, solar radiation, and wind run.
- Supplemental irrigation can be dictated by ET values and user-determined target minimum/maximum root zone soil moisture thresholds.
- ET irrigation management is a time proven method to both save water and maintain heathy plant material

MAD Irrigation Terminology

Term	Description
MAD	Management Allowed Depletion – Method of irrigation scheduling where irrigation is run only when soil moisture drops to a per defined level
ET	Evapotranspiration – Measurement of water lost from the soil due to evaporation (from temperature, humidity, wind, solar radiation) and plant transpiration
PAW	Plant Available Water – The amount of water in the soil available to the plant
Refill%	Target soil moisture balance when irrigation is finished
KL	Landscape Coefficient – Water use requirements for specific plant types, planting densities, and microclimates
Max ET	Maximum ET that can be replaced on a single day to keep irrigation operation inside the site water window
Daily ET	Daily ET replacement – Method of Irrigation scheduling where irrigation operates daily to replace the soil moisture lost that day
PR	Precipitation Rate – Average depth of water applied by irrigation zone in 1 hours time (application rate)

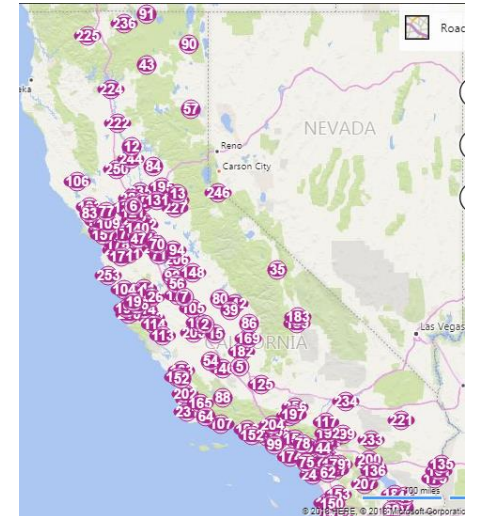
IQ4 Advanced ET - Configuration

- Advanced ET requires configuration in four areas:
 - Weather source
 - Allowable day schedule
 - Landscape Configuration
 - Sprinkler details
- All these settings are **required** for the Advanced ET feature to work correctly
- Note: Advanced ET does not require a flow sensor

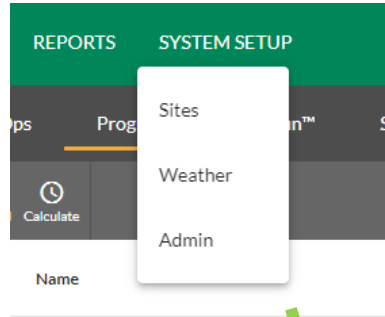
IQ-Cloud Weather Sources

IQ can utilize the following weather sources:

- **IQ Global Weather:** Hourly weather data modeled for a specific location calculated from available weather sources including World Meteorological Organization, NASA weather satellite imagery, NOAA GFS2 model, European Centre for Medium-Range Weather Forecasts and JMA model. There is no charge for using IQ Global Weather.
- **Rain Bird WSPRO2 and WSPROLT Weather Stations:** Physical weather stations with Internet connections monitor real-time weather conditions in your area.
- **California CIMIS Weather Station Network:** A network of 256 physical weather stations located around California. There is no charge for using CIMIS.
- IQ uses the Weather Sources hourly weather data to calculate Evapotranspiration (ET) which is the moisture lost from the soil through evaporation and plant transpiration.



IQ4 Advanced ET – Weather Source Setup



Click here to add a new weather source

The screenshot shows the IQ4 Advanced ET interface. The top navigation bar is green and contains the following items: iQ4, ACTIVITY, SITES, CONTROLLERS, PROGRAMS, REPORTS, and SYSTEM SETUP. The 'SYSTEM SETUP' item is highlighted with a green box. To the right of the navigation bar are several icons: a refresh icon with '124', a triangle icon with '33', a circle with a slash icon with '0', a circle with an 'x' icon with '0', a circle icon with '0', a bell icon with '99+', and a user profile icon. Below the navigation bar is a dark grey header for the 'WEATHER SOURCES' section. On the left of this header are 'Edit' and 'More' icons. On the right is a green box containing an orange circle with a white plus sign, which is highlighted by a green arrow pointing from the text 'Click here to add a new weather source'. Below the header is a table with the following columns: Name, Calendar, Type, Time Zone, and Elevation. The table contains seven rows of data.

Name	Calendar	Type	Time Zone	Elevation
Atlanta 1	View ET Calendar	Global Weather	Eastern Standard Time	--
0000	View ET Calendar	WS-PRO LT	Pacific Standard Time	--
02-Global WS	View ET Calendar	Global Weather	Pacific Standard Time	1 ft
123	View ET Calendar	WS-PRO LT	Pacific Standard Time	--
A-Cimis1	View ET Calendar	CIMIS	Pacific Standard Time	286 ft
AA	View ET Calendar	Global Weather	Pacific Standard Time	--

IQ4 Advanced ET – Weather Source Setup

Enter weather source details and select a weather source type



ADD WEATHER SOURCE

Name *

Weather Source Type *

Elevation *
0.0 ft

Select Site(s) or Controller(s):

- > 4G Canada Test Sites
- > Argentina Controllers
- > Australia Controllers
- > Canada - City of Toronto SIM issues
- > Chris Bauer 4G Controllers
- > David Marion Site
- > Field Test ESP-LXIVM

CANCEL SAVE

Select which controllers will use this weather source ET data – click the Save button



ADD WEATHER SOURCE

(UTC-07:00) Arizona

Elevation *
845.6 ft

Select Site(s) or Controller(s):

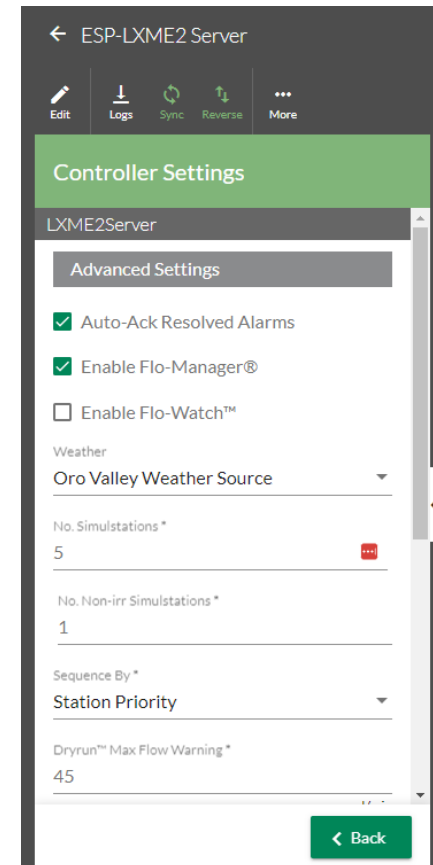
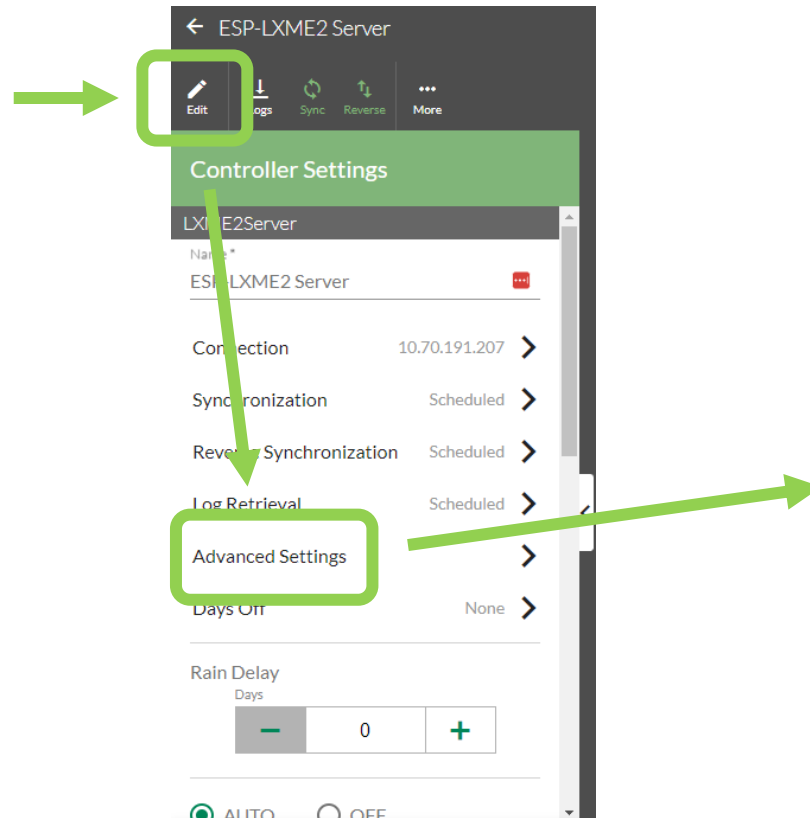
- > 4G Canada Test Sites
- > Argentina Controllers
- > Australia Controllers
- > Canada - City of Toronto SIM issues
- > Chris Bauer 4G Controllers
- > David Marion Site
- > Field Test ESP-LXIVM
- > GSP Test Site
- > IQ4-4G Test Stand Test Controllers

CANCEL SAVE

IQ4 Advanced ET – Weather Source

- Once the weather source is established, it needs to be added to the controller either in the weather source setup or on the controller page

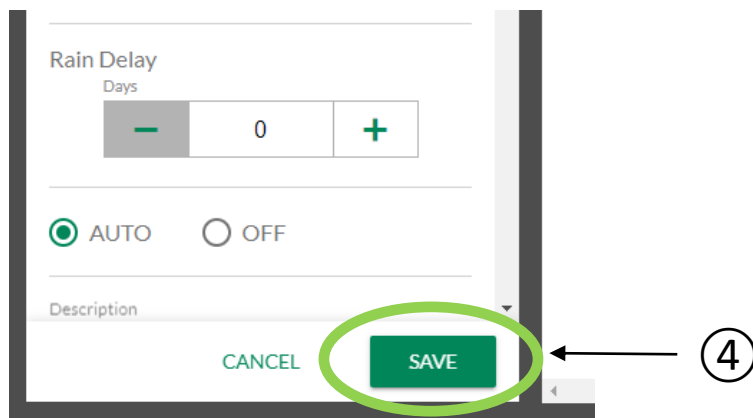
From the Controller page, click the Edit button then the Advanced Settings button



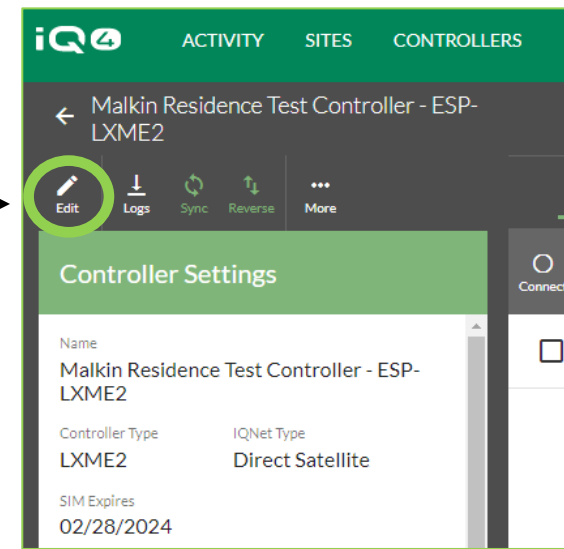
Under the weather setting, select the weather source for this controller
Click Back and then Save

Retrieving Data from a Weather Source

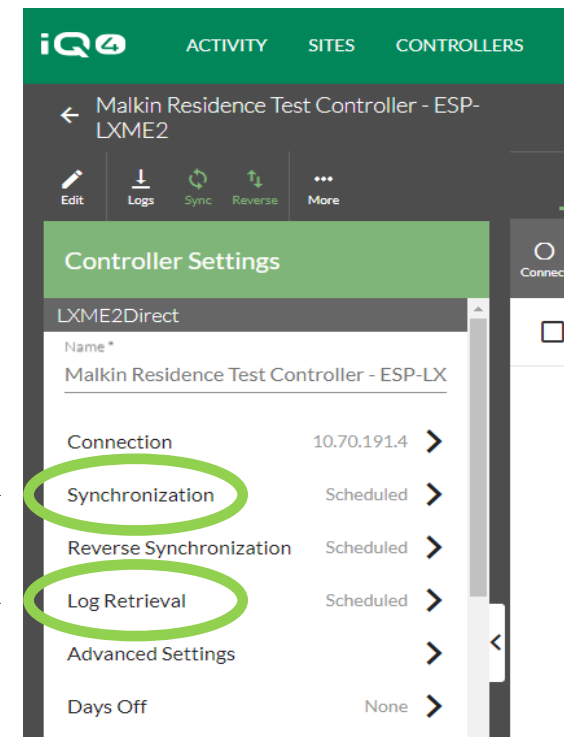
- 1 Click on the Edit button from a controller page.
- 2 Click on the Synchronize option for the controller and configure a time to send updated programming before the first program start time if using Scheduled. If using Automatic, no time is needed (Scheduled Sync is recommended just before the first start time)
- 3 Click on the Log Retrieval option and configure a time to collect logs and reports from the controller after programs are completed if using Scheduled. If using Automatic, no time is needed (Scheduled Sync is recommended just before the first start time)
- 4 The Weather Source Retrieve Data mode is configured for Automatic contact just before the assigned satellites Synchronize time. Click on OK to save and exit.



1



2



3

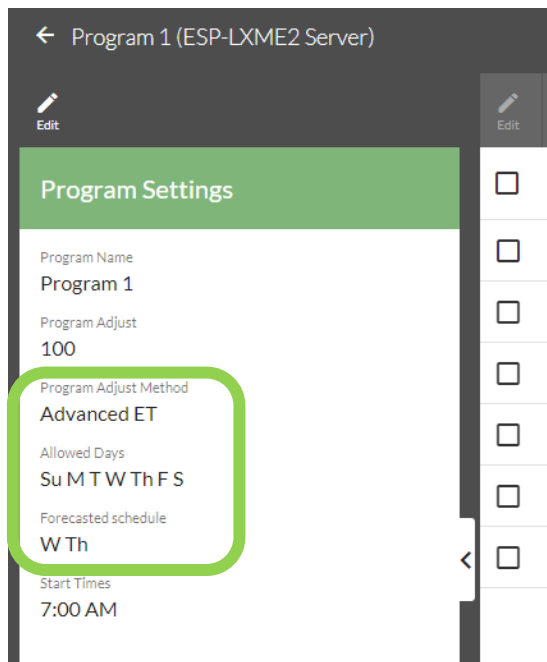
Conduct a Site Audit & Collect Site Data

IQ Satellite Station Data Collection Form

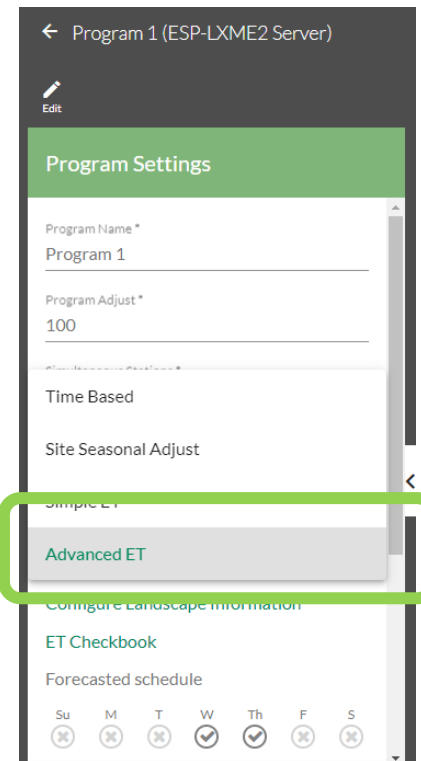
Satellite Name																					
Satellite Type																					
Satellite Address																					
Satellite Communication																					
Satellite IP Address																					
Station Number	Name/Location	Station Decoder Address	Valve Type	Number of Valves	Station Priority	GPM	Plant Type	Root Depth	Micro-Climate	Sprinkler Model	Sprinkler Nozzle	Sprinkler Arc	Operating PSI	Distribution Uniformity %	Slope %	Spacing (SxL)	Station Adjust %	Precip Rate	FloZone	Use Weather Sensor(s)	
Station 1																					
Station 2																					
Station 3																					
Station 4																					
Station 5																					
Station 6																					
Station 7																					
Station 8																					
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IQ4 Advanced ET – Allowable Day Schedule

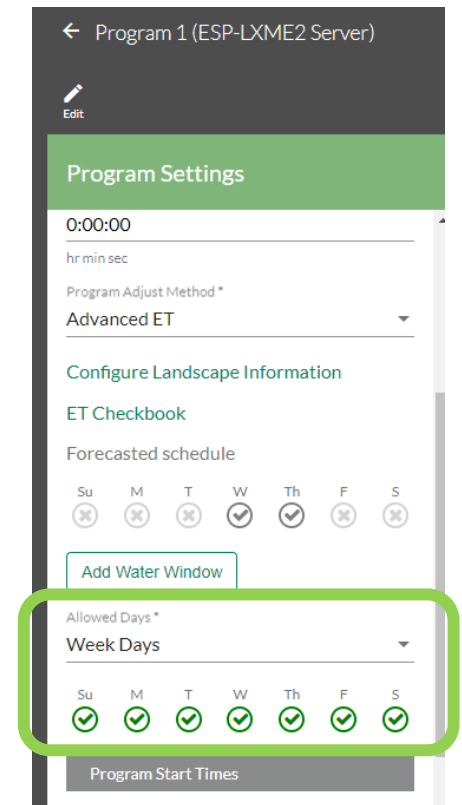
- Advanced ET will determine the frequency that irrigation occurs.
- The Allowed Days setting will configure which days irrigation will be allowed to operate



To set the Program to Advanced ET, click on the Edit button for a Program. Under Program Adjust Method, select Advanced ET



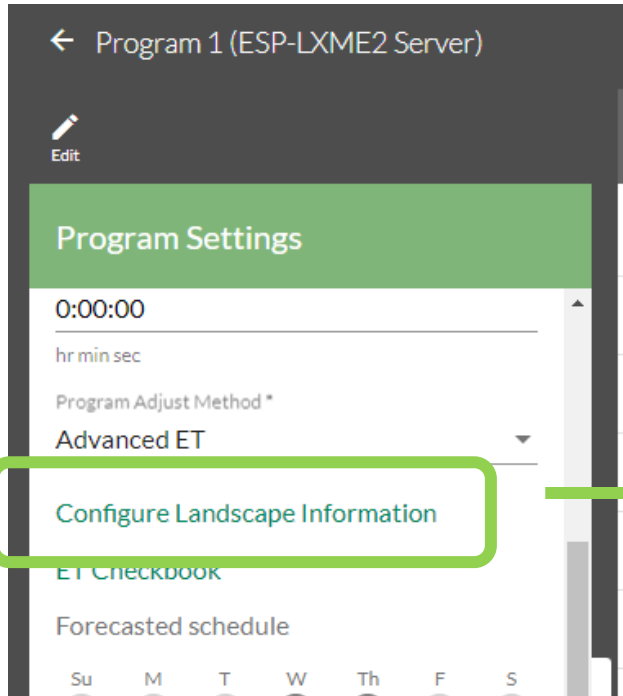
To set the Allowed Days, scroll to the Allowed Days field and select the day irrigation is allowed to operate



IQ4 Advanced ET – Landscape Configuration

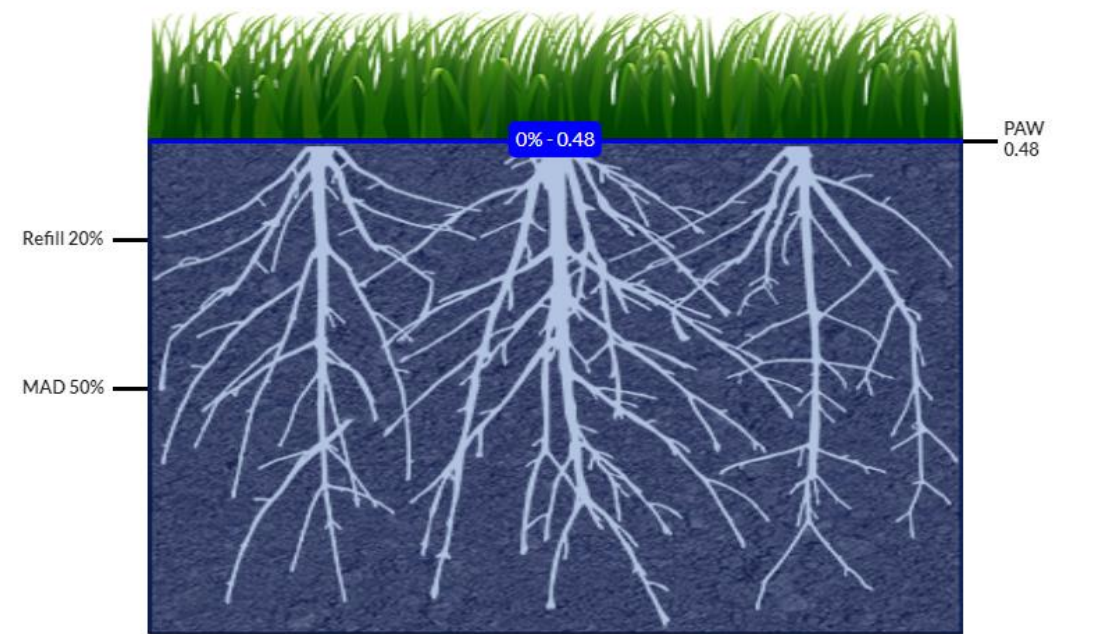
- Advanced ET requires information about the plant material and environment it is planted in
 - Plant material
 - Soil type
 - Root depth
 - MAD - % the root zone is allowed to deplete before watering
 - Refill % - % of the root zone that can deplete without scheduling irrigation
 - Max Watering ET – the maximum amount of water that can be applied in one irrigation
 - Landscape Coefficient – adjustment made to irrigation runtimes based on species, density and sun/shade environment
 - Forecasting Method
 - MAD – Uses landscape and sprinkler data to determine frequency and duration of irrigation
 - Daily ET – determines station runtimes for a user-defined day schedule using daily ET values

IQ4 Advanced ET – Landscape Configuration



Product Manager Test Controllers - ESP-LXME2 Server - Landscape Information

Plant Material*	Cool Season Turfgrass
Soil Type*	Sandy Loam
Root Depth*	4 in
Management Allowed Depletion (MAD)*	50%
Refill Percentage*	20%
Max Watering ET*	0.8 in
Landscape Coefficient*	0.7
Forecasting Method*	MAD



Best Practices:

- Set the MAD to 50% no matter what the Soil Type
- Set the Refill to 0% to prevent shallow rooted plants

CLOSE SAVE

IQ4 Advanced ET – Sprinkler Details

- Advanced ET requires detailed sprinkler information for each station
- There are two methods to enter the required details
 - User entered precipitation rate (Custom PR)
 - Sprinkler selection from Rain Bird database (Calculated PR)
- Navigation:
 - Click on the Stations tab for the controller
 - Select a station checkbox
 - Click the Edit button
 - Select Sprinkler Details
 - Enter the required data

IQ4 Advanced ET – Sprinkler Details

Manual Ops Programs Dryrun™ Stations Master Valves Sensors Clients

Edit Table Edit Start Stop All Advance

#	Station Name	Status	Run Time	Programs	Landsc
<input checked="" type="checkbox"/>	1 Football Fields	-	00:19:03	1	Grass
<input type="checkbox"/>	2 Soccer Fields	-	00:45:52	1	Grass
<input type="checkbox"/>	3 Baseball Fields	-	00:45:52	1	Grass
<input type="checkbox"/>	4 Lacrosse Fields	-	00:45:52	1	Grass

Football Fields

Name *
Football Fields

Priority
Medium

Flow Rate *
22.00 gal/min

Landscape Type
Grass

Sprinkler Type
Rotors/Impacts

Sprinkler Details Spray Heads >

Cycle Soak
0:06:00 0:25:00
hr min sec hr min sec

Sensors
Local Sensor

CANCEL SAVE

Football Fields

Sprinkler Details

Sprinkler Type *
Spray Heads

Precipitation Rate
 Custom Rate
 Calculated Rate 2.31 in/hr

Sprinkler *
VAN_Series_Nozzle

Nozzle *
VAN-15-360

Pressure * Arc ° *
20.00 360
psi

Spacing

CANCEL SAVE

IQ4 Advanced ET – ET Checkbook



ET Checkbook

Program: Trees - low water use
Controller: Malkin Residence Test Controller - ESP-LXME2
Weather Source: Oro Valley - GW-Pro

[View Landscape Information](#)

[Add Record](#)

[Export to PDF](#)

[Export to CSV](#)

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 0:00 AM	Irrigation:02/06/2023 07:00:00 AM	0.02		0.712
02/07/2023 3:00 AM	Daily ET using historic ET values 21 hrs: 02/06/2023 06:00:00 AM to 02/07/2023 03:00:00 AM - Oro Valley - GW-Pro		0.088	0.657
02/07/2023 3:01 AM	Sync with Satellite			
02/07/2023 3:01 AM	Irrigation:02/06/2023 07:00:00 AM	0.01		0.667
02/07/2023 3:56 AM	Sync with Satellite			
02/07/2023 6:09 AM	Daily ET using historic ET values 3 hrs: 02/07/2023 03:00:00 AM to 02/07/2023 06:00:00 AM - Oro Valley - GW-Pro		0.012	0.655

Forecasted Irrigation

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 7:00 AM	Daily ET 11 hrs: 02/06/2023 08:00:00 PM to 02/07/2023 07:00:00 AM - Oro Valley - GW-Pro	0	0.023	0.644
02/07/2023 7:00 AM	Irrigation:02/07/2023 07:00:00 AM	0.01	0	0.654
02/08/2023 7:00 AM	Daily ET 24 hrs: 02/07/2023 07:00:00 AM to 02/08/2023 07:00:00 AM - Oro Valley - GW-Pro	0	0.05	0.604
02/08/2023 7:00 AM	Daily ET 24 hrs: 02/07/2023 07:00:00 AM to 02/08/2023 07:00:00 AM - Oro Valley - GW-Pro	0	0.05	0.554

ET Checkbook and 7-Day Look Ahead Forecasting

- ① The ET Checkbook 7-Day Look Ahead Forecast is used to calculate the following:
- ② • Forecasted Program Watering Day Cycle.
- ③ • Forecasted Program Station Run Times which includes Manual Program Adjust%. Future ET data not yet available from the weather source is calculated using the average of the last 7- days ET.

Forecasted Irrigation

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 4:00 AM	Daily ET 8 hrs: 02/06/2023 08:00:00 PM to 02/07/2023 04:00:00 AM - Oro Valley - GW-Pro	0	0.023	0.265
02/07/2023 4:00 AM	Irrigation:02/07/2023 04:00:00 AM	0.195	0	0.46
02/08/2023 4:00 AM	Daily ET 24 hrs: 02/07/2023 04:00:00 AM to 02/08/2023 04:00:00 AM - Oro Valley - GW-Pro	0	0.07	0.39
02/09/2023 4:00 AM	Daily ET 24 hrs: 02/08/2023 04:00:00 AM to 02/09/2023 04:00:00 AM - Oro Valley - GW-Pro	0	0.07	0.32

Forecasted schedule

Su M T W Th F S

(X) (✓) (X) (X) (X) (✓) (X)

Add Water Window

Allowed Days *

Week Days

Su M T W Th F S

(✓) (✓) (✓) (✓) (✓) (✓) (X)

Forecast Landscape Sprinkler

02:42:37

Low Water Use Shrubs - Point Source Emitters Rain Bird RD1800 - U-Series

02:42:37

ACTIVE ADJUSTMENTS

Base Run Time 01:37:34

Advanced ET 166%

Forecasted schedule T

Adjusted Run Time 02:42:37

Tip: If the current soil moisture has not depleted to MAD%, the program will not operate tonight unless the 7-Day Look Ahead calculates that the soil moisture balance will drop below the MAD% before the next allowed program start day. In this case, the program will operate and refill the soil moisture balance to the Refill%.

Advanced ET Program Operation

ET Checkbook

- ① Prior to the configured Auto Contacts / Synchronize time, IQ does the following:
Automatically collects data from the assigned weather source and updates the ET Checkbook.
- ② Checks the updated balance and if it is at or below MAD%, or the 7-Day Look Ahead estimates it will drop below MAD% before the next program start day, a program start is scheduled, and the station run times are adjusted to operate to the Refill%.

Program: Trees - low water use
 Controller: Malkin Residence Test Controller - ESP-LXME2
 Weather Source: Oro Valley - GW-Pro

[View Landscape Information](#)

[Add Record](#)

[Export to PDF](#)

[Export to CSV](#)

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 3:00 AM	Daily ET using historic ET values 21 hrs: 02/06/2023 06:00:00 AM to 02/07/2023 03:00:00 AM - Oro Valley - GW-Pro		0.088	0.657
02/07/2023 3:01 AM	Sync with Satellite			
02/07/2023 3:01 AM	Irrigation:02/06/2023 07:00:00 AM	0.01		0.667
02/07/2023 3:56 AM	Sync with Satellite			
02/07/2023 6:09 AM	Daily ET using historic ET values 3 hrs: 02/07/2023 03:00:00 AM to 02/07/2023 06:00:00 AM - Oro Valley - GW-Pro		0.012	0.655

Forecasted Irrigation

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 7:00 AM	Daily ET 11 hrs: 02/06/2023 08:00:00 PM to 02/07/2023 07:00:00 AM - Oro Valley - GW-Pro	0	0.023	0.644
02/07/2023 7:00 AM	Irrigation:02/07/2023 07:00:00 AM	0.01	0	0.654
02/08/2023 7:00 AM	Daily ET 24 hrs: 02/07/2023 07:00:00 AM to 02/08/2023 07:00:00 AM - Oro Valley - GW-Pro	0	0.05	0.604
02/08/2023 7:00 AM	Daily ET	0	0.05	0.554

- If the program is configured to prevent the program from starting tonight, a program start is not scheduled
- Program and Station adjustments are compound adjustments

ET Checkbook Adjustments

- ① The current Soil Moisture Balance can be adjusted by clicking the Add Record button on the ET Checkbook dialog box.
- ② Select the desired balance, enter a description, and click OK. Selecting MAD Level will cause the program to operate tonight.

ET Checkbook

Program: Trees - low water use
Controller: Malkin Residence Test Controller - ESP-LXME2
Weather Source: Oro Valley - GW-Pro

[View Landscape Information](#) **Add Record** [Export to PDF](#) [Export to CSV](#)

Date	Description	Deposit	Withdrawal	Balance
02/07/2023 3:00 AM	Daily ET using historic ET values 21 hrs: 02/06/2023 06:00:00 AM to 02/07/2023 03:00:00 AM - Oro Valley - GW-Pro		0.088	0.657
02/07/2023 3:01 AM	Sync with Satellite			
02/07/2023 3:01 AM	Irrigation:02/06/2023 07:00:00 AM	0.01		0.667

Add Record

Adjustment Type
Withdrawal

Amount *
0.01

Description *
User entered withdrawal

CLOSE SUBMIT

Add Record

Adjustment Type
Deposit
Withdrawal
Set to Field Capacity (0%)
Set to Refill (0%)
Set to MAD (50%)

CLOSE SUBMIT

Program MAD Adjustments

If programs are operating too frequently, adjust the Root Depth ① deeper or if programs are not operating frequently enough, adjust the Root Depth shallower.

Tip: Changes in Landscape Information configuration will reset the ET Checkbook to Field Capacity (0% depleted). Use ET Checkbook/Add Entry to adjust the soil moisture balance to match the actual site conditions.

Malkin Residence - Test Controller - Malkin Residence Test Controller - ESP-LXME2 - Landscape Information

Plant Material *	Trees
Soil Type *	Sandy Loam
Root Depth *	12
Management Allowed Depletion (MAD) *	50 in
Refill Percentage *	20 %
Max. Watering ET *	1 %
Landscape Coefficient *	0.5
Forecasting Method *	MAD

① →

0% - 1.44

PAW 1.44

Refill 20%

MAD 50%

CLOSE SAVE

Program MAD Adjustments

If you want to apply more water to all stations in a program each time the program starts, adjust the Refill% ^② to a lower number (0% in the example). This is helpful when you have high daily ET's and you cannot irrigate the site for 1 or more consecutive days

Malkin Residence - Test Controller - Malkin Residence Test Controller - ESP-LXME2 - Landscape Information

Plant Material *	Trees
Soil Type *	Sandy Loam
Root Depth *	12
Management Allowed Depletion (MAD) *	50
Refill Percentage *	0
Max Watering ET *	1
Landscape Coefficient *	0.5
Forecasting Method *	MAD

② →

CLOSE SAVE

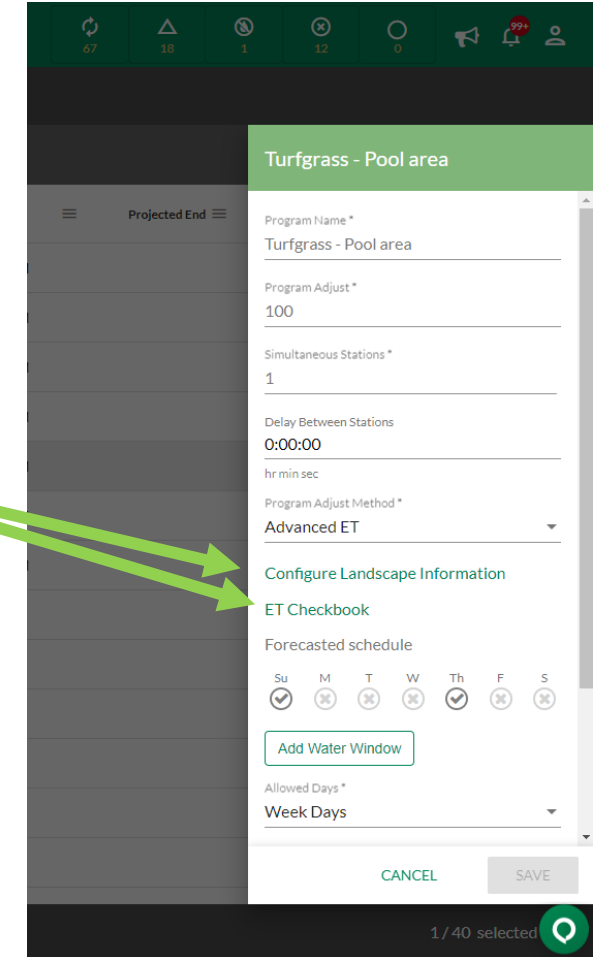
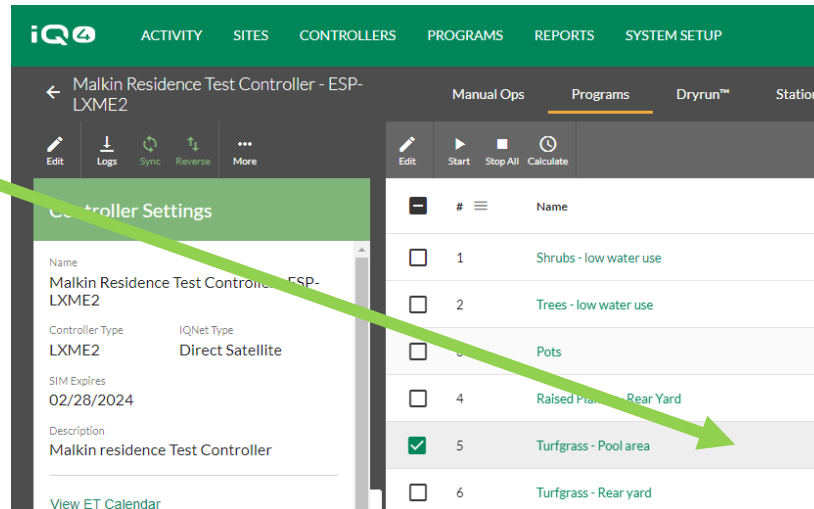
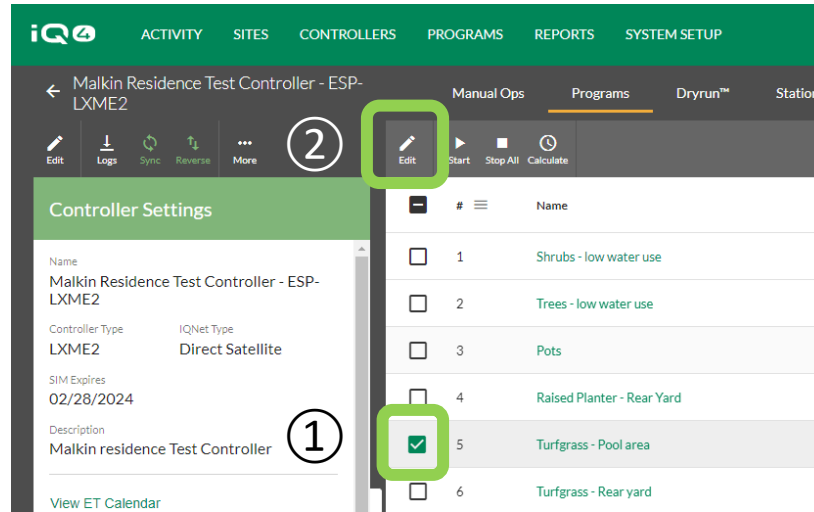
Navigation to Landscape Information and ET Checkbook

To easily navigate to the Advanced ET information, go to the Program page for the desired program.

Steps:

- ① Select the desired program
 - ② Click on the Edit button
- Or
- ③ Click on the Program row away from the Program name text

The Program Edit box will appear with links to the Landscape Information and ET Checkbook displays



Appendix



IQ4 Advanced ET – Overview

ET Programming Overview

IQ requires specific information about the sites' landscape and irrigation system along with the Evapotranspiration (ET) data to understand how often and how long to irrigate to satisfy the landscape water requirement. This information is collected in a site audit. The Irrigation Association (www.irrigation.org) offers seminars on Landscape Irrigation Auditing, Irrigation Scheduling, SMART Technologies for Irrigation Management, and other topics that will help you maximize the water savings potential of the IQ Software. The IQ Advanced ET Software Feature Pack uses Irrigation Association terminology and calculations so what you learn from this training can be directly applied to the use of this software. Check the Irrigation Association website for seminar descriptions, locations, and dates.

Calculating a base schedule is a function of:

1. Plant Water Requirement
2. Irrigation Water Requirement
3. Schedule Requirements

There is a set of landscape information that needs to be set at the program level. These settings include plant material, soil type, root depth, management allowed depletion (MAD), refill percentage, maximum watering ET, landscape coefficient, and forecasting method.

Plant Water Requirement - ET_L

Plant water requirement settings include the following: Plant Material, Reference ET, and Landscape Coefficient

The ET equation that is used is the following:

$$ET_L = K_L \times ET_0$$

where:

ET_L = Evapotranspiration of the landscape

K_L = Landscape coefficient

ET_0 = Reference evapotranspiration

$$K_L = K_s \times K_d \times K_{mc}$$

K_s = Species factor

K_d = Density factor


K_{mc} = Microclimate factor

Irrigation Water Requirement

Irrigation water requirement settings include the following: Precipitation Rate (PR), and Distribution Uniformity (DU)

Schedule Requirements

Schedule requirement settings include the following: Soil Type, Plant Available Water (PAW), Root Depth, and Management Allowed Depletion.

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