aquaflex
SOIL MOISTURE SENSORS

AQUAFLEX SMART
User Manual

IRRIGATION MANAGEMENT MADE EASY

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Conditions of Use

AQUAFLEX must be installed and operated as specified in the AQUAFLEX User Manuals. In particular, AQUAFLEX user's attention is drawn to the following warnings:

AQUAFLEX, and AQUAFLEX components, only provide data on soil moisture and temperature. Use of this data is entirely at the discretion of the user. The use of data generated by AQUAFLEX should therefore be subject to current best practice principles of soil moisture management and agronomic management. These must include regular checks on the integrity of AQUAFLEX and the data it is producing plus regular visual inspections of crops, plants or other materials being monitored by AQUAFLEX.

The AQUAFLEX system may have other sensors connected to it (e.g. air temperature, rain gauge information etc). Use of the data from these sensors is entirely at the discretion of the user. The use of data generated by AQUAFLEX should therefore be subject to current best practice principles of agronomic management for these sensors. These must include regular checks on the integrity of the sensors and the data it is producing plus regular visual inspections of crops, plants or other materials being monitored by the sensors.

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IRRIGATION MANAGEMENT MADE EASY

Contents

1 Overview of Aquaflex

Soil Moisture and Temperature are the biggest factors that influence plant growth. In Spring and Autumn, soil temperature is the main limiting factor to growth. In the peak of the season, soil moisture becomes the dominant factor.

By measuring both parameters Aquaflex provides the information to ensure both soil moisture and temperature are maintained at the correct levels to maximise plant production.

Aquaflex is an important irrigation tool that helps optimise plant growth and quality. The grower can make informed irrigation decisions by using the data trends provided by Aquaflex.

Aquaflex Smart

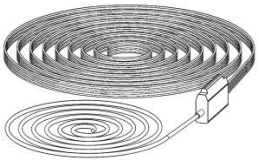
The Aquaflex Smart System and Aquaflex Mobile software are tools to get you started with monitoring the soil environment quickly and easily.

This manual will detail the installation of the various components and provide a brief guide on making use of the data.

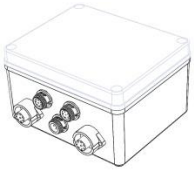
2 Aquaflex Smart kit contents

Aquaflex Smart is supplied as a kit and comes complete with all the parts required for a standard installation. Please check the following list to ensure the kit is complete before attempting to install the Aquaflex Smart system.

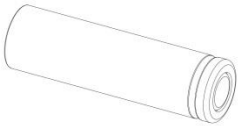
Qty	Name	Description
1	Aquaflex Sensor	Sensor with 3m data cable. A data cable extension can be supplied on request.
1	Aquaflex Smart Hub	Enclosure that sensors connect to.
1	18650 Li-Ion battery	Single Li-Ion 3.7V battery
1	Mounting kit	Screws and cable ties for mounting the Aquaflex Smart Hub
1	Aquaflex Data Manager Software	Allows Aquaflex Sensor Data to be viewed on a PC.



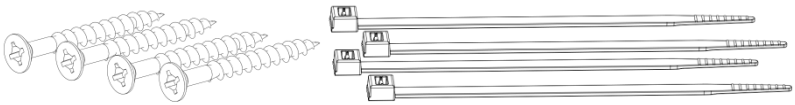
Aquaflex sensor



Aquaflex Smart Hub



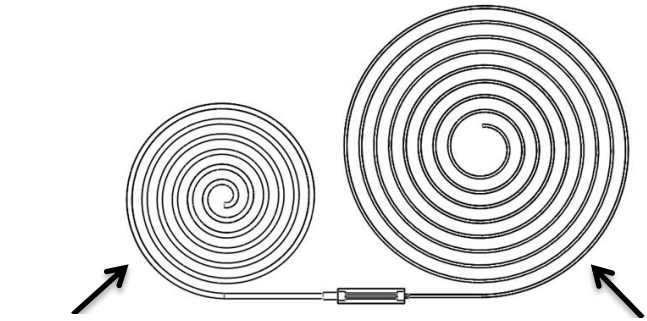
18650 Li Ion battery



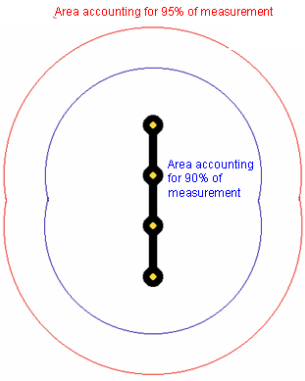
Mounting kit

2.1 Aquaflex Sensor

The sensor uses a process called Time Domain Transmission where an electrical pulse is sent along the 3m (10ft) long sensing tape. The electrical field of the pulse interacts with the surrounding soil which affects the speed and shape of the pulse. The sensor measures the soil moisture in a volume of 6 litres (370 cubic inches) which along with temperature sensing allows the Aquaflex sensor to provide a highly accurate measurement of the soil conditions.

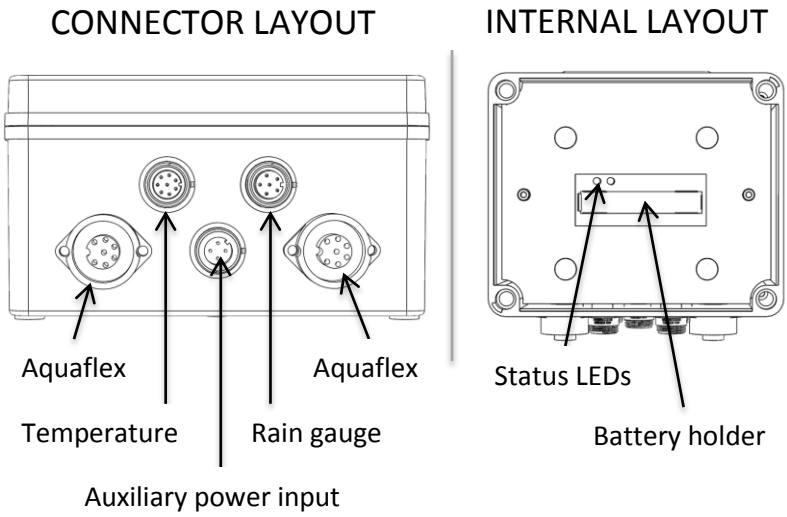


Many factors affect the uniformity of soil moisture, including the uniformity of irrigation, crop root distribution, microclimate and soil properties. By averaging soil moisture measurement across a broader area, Aquaflex provides reliable indications of soil moisture.



2.2 Aquaflex Smart Hub

The Bluetooth LE enabled Aquaflex Smart Hub can be connected to two Aquaflex sensors, a rain gauge and an air temperature sensor.



The Aquaflex Smart Hub recognises when a sensor is connected. Data from the connected sensors will automatically be logged and downloaded to a Smartphone or Tablet running Aquaflex Mobile.

The Aquaflex Smart Hub has a Solar Panel to keep the internal battery charged. The auxiliary power input is used for installations where the solar cell will not receive sufficient sunlight and where it is impractical to replace the battery. Where no solar or external power is available, the battery life is 6 months (when logging once every hour).

2.3 Optional Sensors

The Aquaflex Smart Hub has connections for an optional temperature sensor, rain gauge and a second Aquaflex sensor.

The optional sensors are supplied separately from the Aquaflex Smart kit and can be added at any time simply by plugging them into their respective connectors.

Check the Aquaflex website (www.aquaflex.co.nz) for a full list of accessories.

2.4 Aquaflex Mobile Software

Aquaflex Mobile is an application for Smartphones and Tablets to allow you to configure and retrieve data from your sensors. The application runs on iOS versions 7.1 or higher and on Android 4.3 or higher. The software has the following features.

- Customisable charts allow you to group related data onto one easy to use chart.
- Sensor management for giving your sensors friendly names.
- Wi-Fi and Bluetooth support for configuration of and downloading from your sensors.

The software is available on the Apple Store and the Google Play Store. Just search for **AquaflexMobile**.

3 Installing Aquaflex Mobile

This section details the installation of the Aquaflex Mobile software.

3.1 Install guide for Apple iOS devices

1. Tap on the **AppStore Store** icon to open the Apple AppStore.
2. When the AppStore has opened tap the **Search** box in the upper right hand corner of the screen. Type in **AquaflexMobile** and tap the **Search** button on the on screen keyboard.
3. When the search is complete there should be a listing called **AquaflexMobile**. Tap on the listing to display the details.
4. From the **AquaflexMobile** details view tap the **Get** button under the application title. The button will change to **Install** and should be tapped again to confirm the installation. You may be prompted to enter your iTunes password after which the installation will begin.
5. **AquaflexMobile** can be started by tapping its icon from the application list screen when it has finished installing.

3.2 Install guide for Android devices

1. Tap on the **Play Store** icon to open the Google Application Store. 
2. When the **Play Store** has opened tap the **Search** icon on the upper right hand corner of the screen. Type in **AquaflexMobile** and tap the **Search** button on the on screen keyboard.
3. When the search is complete there should be a listing called **Aquaflex Mobile**. Tap on the listing  to display the details.
4. From the **Aquaflex Mobile** details view tap the **Install** button under the application title. You will be prompted to agree with the application permissions. When you are ready tap accept to confirm the installation.
5. Aquaflex Mobile can be started by tapping its icon  from the application list screen when it has finished installing.

4 Installation and Aquaflex Sensor Siting

Installation involves locating a suitable site for the sensor(s), burying the sensor(s) correctly, mounting and connecting the Aquaflex Smart Hub and configuring the system using the Aquaflex Mobile application.

The quality of data from the Aquaflex sensor is dependent on the quality of the installation. This guide provides brief instructions for common applications. Detailed guides for specific applications are available on the Aquaflex website (www.aquaflex.co.nz) or by contacting Streat Instruments. Please read the installation method that applies to your application.

4.1 Siting and Installation guide

There are two main methods for installing the sensor(s) depending on the required installation depth for the sensor.

- For shallow installation (e.g. turf applications) the sensor can be simply 'slit' into the turf.
- For deeper installations a trench must be dug for the sensor.

Installation Hints

- Always unroll the data cable. Pulling cables off the side of a roll results in the cable coiling.
- Install the data cable in a metal or plastic conduit if there is risk of damage from spiking etc**. Note: The flat sensor tape must not be similarly protected.**
- Ensure that the sensor tape is at least 150mm away from any foreign objects such as fence posts or water lines.
- Mark the location of the sensor(s) so that it can be located easily. Placing a marker and noting the GPS point is often sufficient.

Siting guide

Your Aquaflex sensor(s) should be buried in a location with soil that is representative of the land you intend to monitor. Here are a few points to consider:

- Avoid old water races, fence lines, tree lines or tracks as they will not give representative soil moisture data.
- Avoid humps or hollows or any areas that will give data that is extreme compared to the irrigation area.
- Install away from fence lines as the soil structure is very different to that of the paddock as it is not grazed, re-sown or compacted.
- Install away from posts as stock tends to congregate near them which causes the soil to become compacted.
- Take note of the prevailing wind and rain patterns, avoid stock camps and fence lines where stock will camp.
- Avoid installing sensors near to access tracks due to possible run-off.
- Avoid installing near gates.
- Record the GPS information for the selected site.

Centre Pivot Irrigators

- Install the sensor(s) 2/3 of the length of the pivot away from the pivot point and not in the first half or last few spans.
- A distance of at least 10m (30ft) from the fence line. A 7m Aquaflex Extension cable will be required.
- Keep a distance of 5m (16ft) from the pivot wheel tracks

Roto Rainer Irrigators

- Install the sensor near to the middle (width and length) of the irrigated area. An Aquaflex Extension cable may be required.

Orchard or Vineyard installation

- Install the sensor within the row of trees/vines and into the space between the plants in the row.

Shallow Installation

Use this technique for depths 150mm (6 inches) or less.

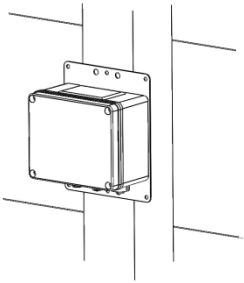
1. Select and mark the position of the sensor with a string line. Position the sensor where it can be easily located in future – e.g. on a marker line on a sports field or in a position on a golf green marked by sight markers (e.g. between two known points).
2. With a turf cutter or sharp, flat blade, carefully cut a slit in the turf. The slit should be deep enough so the sensing tape sits in the plant roots, usually 100mm (4 inches) for turf.
3. Carefully insert the sensor cable into the slit to the desired depth. **Note: The sensor must be installed on its edge to prevent water lying on top. The arrow on the Sensor Block should point up.**
4. For the Sensor Block at the end of the sensor, carefully peel back sufficient turf to create a slightly larger and deeper cavity in which to bury the Sensor block. The sensor block contains the temperature sensor and this is normally installed at a depth of 100 to 150mm (4 to 6 inches).
5. Place the Sensor block into the cavity and fold the turf back.
6. Add finely crumbled soil or sand into the slit so to fill in air gaps around the sensing tape then gently push from behind each side of the slit to close it. Pack from the sides to recreate original density and remove air pockets.
7. Repair and smooth as necessary.
8. Run the data cable in a slit or trench to the location for the Aquaflex Smart Hub. **Note: Ensure that the cable is buried deep enough to avoid damage during maintenance.**
   The Aquaflex Smart Hub can be mounted above ground on a post, or buried underground in a valve box.
9. Apply a liberal amount of water to allow the sensor to bed in and remove air pockets. **Note: Rolling the soil with a heavy roller will help compact the soil around the sensing tape.**

Deep Installation

For deeper installations (over 150mm (6 inches) deep, a trench will be dug to the desired depth for the sensor. The depth of the sensor is determined by the application and usually allows the sensor to measure the soil in the root zone of the plant. **Note: for most plants 70% of the roots are in the top 50% of the root depth and hence this is where the plant draws most of the water from.**

1. Dig a trench that is 3m (10ft) long and to the required depth. **Note: the sensor tape is often installed on a slope to measure through the root profile, the Sensor Block is always at the shallow end (100 to 150mm) as this is where the temperature measurement is made.** Ensure there is a layer of loose soil in the bottom of the trench. This is to prevent air pockets beneath the flat sensor tape.
2. Install the sensor tape on its edge at the bottom of its trench. The arrow on the Sensor Block should point up. **Note: It is essential that the flat sensor tape be installed on its edge to prevent water lying on top of the tape, resulting in false readings.**
3. Firmly pack loose soil around the sensor tape ensuring that there are no air pockets around or beneath the sensor tape. In some soils (e.g. clay) watering may help.
4. Carefully refill the trench taking care to keep the soil profile and density as close to its original state as possible. It is important to try to replace stones in the same density and layer as removed.
5. Run the data cable in a slit or trench to the location for the Aquaflex Smart Hub. **Note: Ensure that the cable is buried deep enough to avoid damage during maintenance.**
6. Mark the location of the sensor so that it can be identified in the future. Noting the GPS point and placing a paving stone into the ground above each end of the sensing tape is often sufficient.

4.2 Mounting the Aquaflex Smart Hub



The Aquaflex Smart Hub should be mounted within reach of the Aquaflex Sensor data cable (and cables from Auxiliary sensors if fitted) and in a position where it won't be damaged by stock, or submerged in water etc. The Solar Panel on the top of the Aquaflex Smart Battery Hub should be exposed to as much sunlight as possible.

An existing fence post is often ideal, if there isn't an existing fencepost available a new post could be installed.

The aluminium backing plate has several pre-drilled holes to aid the mounting of the Aquaflex Smart Hub.

Tips for mounting the Aquaflex Smart Hub:

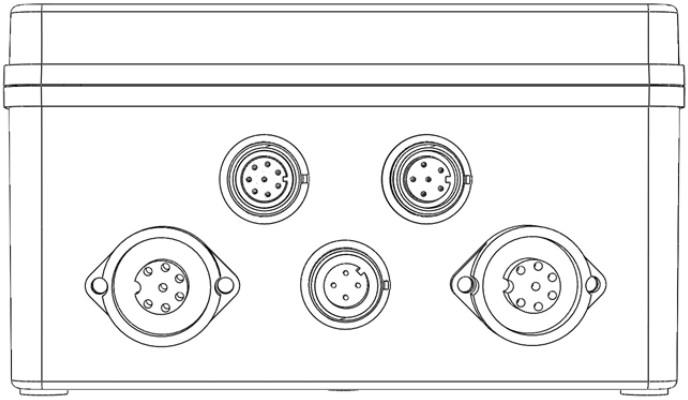
- Check that the Aquaflex sensor data cable is long enough. Optional extension cable lengths are available if required.
- The battery will not charge unless the Aquaflex Smart Hub is located to get sunlight or external power is supplied.
- If mounting to a post use the supplied cable ties to secure the cable(s) to the post.

Mounting steps:

1. Hold the Aquaflex Smart Hub in position. If the material is a hard wood or metal then mark the hole positions and drill to an appropriate size for the screws being used.
2. Insert the screw through the mounting plate and tighten. Ensure at least two screws are securing the Aquaflex Smart Hub.

4.3 Connecting sensors

Sensors are connected via the 5 connectors at the bottom of the Aquaflex Smart Hub. Each sensor type will only fit into its corresponding connector. Use the following diagram to determine where the connectors are located.



Connector (from left)	Pins	Position in image
Aquaflex sensor	7	Bottom left
Temperature sensor	8	Top Left
External power	4	Bottom middle
Rain gauge sensor	6	Top right
Aquaflex sensor	7	Bottom right

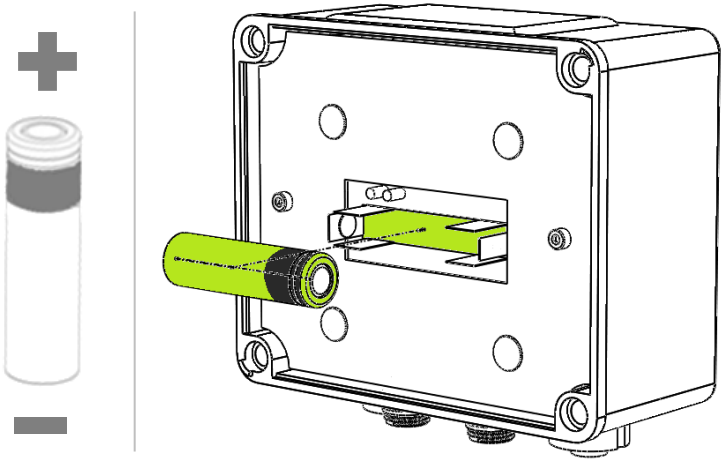
To connect a sensor:

1. Remove the waterproof dust cap from the connector.
2. Insert the sensor plug into the connector socket taking care that the plug and socket locating tabs are lined up.
3. Tighten the locking thread on the plug until it is secure.

4.4 Installing the Battery

The Aquaflex Smart Hub has a single Li-Ion 18650 battery which must be fitted after the system is installed.

1. Loosen the four corner screws on the front cover of the Aquaflex Smart Hub.
2. Carefully pull the front cover forward and remove it.
3. Insert the battery making sure that the polarity is correct.
   The positive end of the battery is marked by a black band and it should point towards the right hand side.



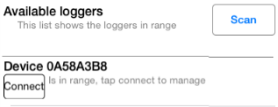
4. Check the seal on the front cover is intact and free from debris and then replace the front cover onto the Aquaflex Smart Hub. The cover has locating keys and will fit only one way.
5. Tighten the four corner screws to secure the faceplate.

4.5 Initial configuration

The Aquaflex Smart Hub will need to be configured when it is installed or if its battery has been removed.

Use the following steps to establish a connection.

1. Tap the blue **Connect** icon either at the bottom of the screen for Smart Phones or the top of the screen for Tablets.
2. The **Connect** screen shows a list of Aquaflex Smart Hubs that are in range. If you do not see your unit then you may be out of range. Tap **Scan** to attempt to discover the unit.



3. If your unit is listed then tap its **Connect** button to open a connection.
4. When the screen changes you are connected. The display will now show the configuration options and current measurements for the unit.

If the battery has just been replaced then the software will prompt you with **Logger not setup**. Tap **Clear logs** which will set the time and set to logging to once every hour.

Otherwise scroll to the bottom of the screen, select the desired **Log Interval** and then tap the **Set Time** button to set the time in the Aquaflex Smart Hub. **Note: Setting the time or changing the Log Interval will clear the data in the Aquaflex Smart Hub.**

Tap the **Disconnect** button at the top of the screen after setting the time.

5 Using Aquaflex Mobile

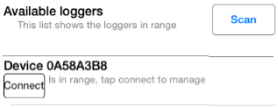
Aquaflex Mobile software allows connection of Smartphones or Tablets to an Aquaflex Smart Hub for configuration and downloading of data.

Using Aquaflex Mobile to regularly download the data from the Aquaflex Smart Hub will prevent data from being lost due to its memory becoming full. The data will be most useful to you if it is kept up to date.

5.1 Connecting to an Aquaflex Smart Hub

Aquaflex Mobile can configure and download the data from an Aquaflex Smart Hub when it is connected to it.

1. Tap the blue **Connect** icon either at the bottom of the screen for Smart Phones or the top of the screen for Tablets.
2. The **Connect** screen shows a list of Aquaflex Smart Hubs that are in range. If you do not see your unit then you may be out of range. Tap **Scan** to attempt to discover the unit.



3. If your unit is listed then tap its **Connect** button to open a connection.
4. When the screen changes you are connected. The display will now show the configuration options and current measurements for the unit.
5. To return to the **Connect** screen tap the **Disconnect** button at the top of the screen.

5.2 Downloading data

1. Use the steps in **Connecting to an Aquaflex Smart Hub** to establish a connection and display the unit details.
2. Tap the **Download** button at the top of the screen. The text in the button will show the progress of the download.
3. When the download is complete you will be prompted to disconnect. The data can be viewed from the **Chart** screen.

5.3 Using charts

Charts are used to view the sensor data from an Aquaflex Smart Hub. Charts can be customised to display any combination of sensors.

Scaling axis

The chart can be scaled by pinch zooming anywhere on the chart area. It can also be scrolled by swiping left or right on the chart area. Alternatively the axes can be scaled or scrolled individually by pinching zooming or swiping on its axis near the side of the screen.

Changing the time range

Aquaflex Mobile has several buttons on the chart display for quickly navigating the data. Tapping the green **Latest** button scrolls the chart to the most recent data point. The blue buttons will scale the time axis to the range they indicate.

Changing to a different chart

From the **Charts** screen tap either the Charts icon or the chart list icon which will open the **Chart List** screen. Then tap on the chart of interest and the **Charts** screen will appear with the selected chart.

5.4 Creating and editing charts

Charts can have any combination and number of sensors. Beware that too many sensors on one chart may slow down the device.

To create a chart you first must open the **Charts** screen. Tap the Create icon ✚ to show the **Create** screen. Enter in a name for the chart at the top of the screen. Tap the Add button for each sensor you want to display on the chart. Tap the back arrow to save the new chart.

To edit a chart you must first have the chart you want to edit selected in the **Charts** screen. Tap the Edit icon ✎ to show the **Edit** screen. Tap the back arrow to save the changes.

Add or remove sensors

Open either the **Create** or **Edit** screen. To add a sensor tap the Add button for the sensor that is in the **Available sensors to add** section. The sensor will be moved to the **Sensors on this chart** section. Tap the back button to save the changes.

To remove a sensor tap the Remove button for the sensor that is in the **Sensors on this chart** section. The sensor will be moved to the **Available sensors to add** section. Tap the back button to save the changes.

Setting Field Capacity and Refill Point

The Field Capacity, Refill Point or any other limit lines you wish to add can be added as a Static line in the Create or Edit Chart screen.

Open either the **Create** or **Edit** screen. Under the section called **Static lines on this chart** tap in the name field and type a name for the line, enter a moisture value and tap the **Add** button. **Note: Static lines are always shown on the moisture axis.**

Removing charts

Open the chart you want to remove. Tap **Remove** icon and you will be prompted to confirm deleting the chart. The sensor data does not get deleted.

5.5 Renaming sensors

Open the **Settings** screen by tapping the Settings icon and tap the **Edit** button for the sensor you want to rename. The sensor label will become editable. Tap the **Done** button when finished.

5.6 Removing sensors

Removing a sensor will clear all its data from your device and cannot be undone.

Open the **Settings** screen by tapping the Settings icon and tap the **Delete** button for the sensor you want to remove. You will be prompted to confirm.

5.7 Clearing all data

Clearing the data from your device will remove all sensor data, charts and other settings. This cannot be undone.

Open the **Settings** screen by tapping the Settings icon and tap the **Clear** button. You will be prompted to confirm.

6 Making the best use of your Aquaflex data

The soil moisture and temperature data trends can help you make decisions around when to irrigate and for how long. For example, if the soil moisture is trending downwards and no rain is forecast then you can use the trends to measure rate of moisture loss and then irrigate to compensate.

Optimal irrigation is achieved when applying enough water to keep the plant in maximum growth mode and by not applying too much water that it drains through the soil before it is retained. There are three key parameters to monitor when irrigating, Field Capacity, Refill Point and soil temperature.

Field Capacity (FC) is defined as the maximum amount of water the soil can hold against the forces of gravity.

Refill Point (RP), sometimes called **Stress Point**, is the minimum amount of water in the soil before a plant becomes stressed.

Soil temperature is the temperature of the soil at the depth of the plant roots. Plants have an optimal growth temperature range.

The area between the Field Capacity and Refill Point is referred to as **Readily Available Water** (RAW). RAW is the water that is easy for the plants to extract from the soil and where you will get maximum production. Set a **Field Capacity** and **Refill Point** on your Aquaflex sensor chart and use your irrigation system to keep the moisture trace within the RAW area.

Look up the application note **Setting Field Capacity and Refill Point** on www.aquaflex.co.nz for details.

7 Maintenance and Troubleshooting

The following points should be considered for maintenance.

- Prevent foliage from covering the solar cell and wipe clean if dirty
- Check rain gauges at each download and clear any blockages

Forcing a reset

Reset the Aquaflex Smart Hub by removing all its power. This is done by covering the solar cell and removing the battery. Watch the Green LED for a quick flash when the battery is inserted which indicates it has started up.

Troubleshooting

Symptom	Resolution
Aquaflex Mobile does not appear after searching the Store	The operating system of your device may not be compatible. To install Aquaflex mobile your device version must be Android 4.3 or iOS 7 or higher.
The Aquaflex Mobile scan does not find the Aquaflex Smart Hub	The Aquaflex Smart Hub communicates using Bluetooth Low Energy. The Bluetooth must be enabled on your device and it must be compatible with Bluetooth LE. If you use an Android device the minimum supported version is 4.3. If you use an Apple device the minimum support version is iOS 7. Disable and then enable the Bluetooth on your device or restart it. Reset the Aquaflex Smart Hub using the above **Forcing a reset** procedure.
Aquaflex Mobile connects but sensors readings are not shown	Check that the sensors are connected to the Aquaflex Smart Hub correctly. Check the battery is over 4.0 volts. Reset the Aquaflex Smart Hub using the above **Forcing a reset** procedure.

Aquaflex Smart Hub Specifications

Power	Lithium Ion 18650 battery 3.7V 3.1aH. Battery has life of 6 months at 1 hour log interval when no solar or external power available. Battery life will decrease with more frequent log interval
External Power input	
Voltage limits	5 to 12 VDC
Current	Up to 250mA. 5mA typical
Memory capacity	8160 records (340 days when logging once per hour)
Operating Temperature	-10 to 40°C (14 to 104°F)
Digital input	
Voltage limits	0 to 36 VDC
Max Frequency	14Hz Square Wave
Analog input	
Voltage limits	0 to 36 VDC and 12VAC
Bluetooth radio	
Signal Range	Up to 10 metres (30ft) line of sight
Frequency	2.4 Ghz
Advertising interval	200ms

8 Sensor Locations

Please record the location and serial number of each sensor in the table below for future reference.

Sensors:

Location	Serial Number	Installed By	Date