**Computer:** The software shall come preinstalled on a 64-bit, Microsoft Windows 8 computer. The 34.5MM X 182MM X 179MM (1.4” X 7.1” X 7.2”) computer shall be equipped with an external power supply and a solid-state hard drive for file storage. These features limit introduction of dust and other foreign material into the computer because a cooling fan is not required. The solid-state hard drive has no moving parts making it much less prone to failure.

The computer shall include a 22” flat screen monitor with a mounting bracket for attaching the computer to the back of the display if desired.

The system shall include a keyboard, mouse and SD flash card reader/writer. The SD flash card device shall be used to store firmware image files when Pilot field equipment requires new firmware.

The computer shall include a 10M/100M/1000M GIGABIT Ethernet card and 802.11B/G/N WI-FI card for internet connectivity. A 15 month subscription for MacAfee antivirus software shall be preinstalled on the system.

The computer shall come preloaded with Google™ Chrome™ configured as the default web browser.

To obtain regular, online software updates as well as online database backups, a dedicated internet connection (wired or wireless) is strongly recommended.

The computer shall include a 3 year factory warranty.

**Central Control Software:** The central control software shall run as a web application (similar to a web site) within the
Google™ Chrome™ web browser. Although the software is viewed in a web browser, an internet connection is not required.

**General Communications:** The software shall permit both wired and radio two-way communications via a PILOT-FI field interface. The system shall be capable of managing up to 999 addressable conventional field controllers or decoder hubs.

The software shall be a download system and shall not require on-line communications for normal irrigation to take place. This means all diagnostic information provided by the system must be stored in each field controller or decoder hub until such time as the user wishes to retrieve it. However, continuous two way communication must be possible if desired.

The software shall have communications test and diagnostic capabilities with all field devices, and shall log communications attempts and their results for retrieval by the operator.

The software shall have the ability to issue a communications check all field devices on a site and retrieve the status of each. This information shall then be made available for viewing and printing. The report shall include information such as the number of station outputs installed. Firmware version numbers for all modules installed in the field units plus current operational status.

**Field Interface:** The central irrigation computer shall be connected to a PILOT-FI field interface by USB. The field interface shall be completely plug-n-play and shall not require a COM port number. When connected, the display on the field interface shall clearly show that the connection is ok. If there is a problem with the connection the field interface shall clearly display an alarm condition and an alarm button on the screen can be used to determine the cause.

The field interface shall be of modular design with a large faceplate providing access to system troubleshooting tools. Communication modules used in the field interface shall fully enclosed units with options for wired and radio communication. Radio communication shall be available in both UHF and spread-spectrum. All communication modules shall be interchangeable with communication modules used in the field controllers and decoder hubs.

The field interface display shall be available in multiple languages and adding more languages shall require only the insertion of an SD flash card to update the firmware.

**Purpose and Main Functions:** The software shall allow the operator to create, edit, send, and retrieve stand-alone Pilot field controller and decoder hub watering schedules. These watering schedules are known as FCPs.

The software shall also create, edit, and send flow-optimized irrigation schedules using a matrix or grid. The grid shall be organized with management groups in columns and locations in rows. The intersection of each location and management group is referred to as a sub-group. A typical management group is GREENS. A typical location is HOLE 1. The sub-group is HOLE 1 GREENS.

It shall be possible to schedule flow-optimized watering cycles either by a start time – allowing the software to determine when irrigation will stop, or by an end time – allowing the software to determine what time the irrigation will start.

The software shall include a PICK LISTS feature used to customize the programming matrix and tune it to the localized conditions of the golf course.

The software shall enable the customer to manually initiate or stop watering of both individual stations as well as FCPs. The software must also have the ability to stop all irrigation with a single command and provide for the gradual reduction of that demand to limit the possibility of dangerous spikes in pressure.

**Two Modes of Operation:** The software must be capable of simultaneously managing both FCP watering schedules as well as flow-optimized irrigation cycles. The software must be capable of automatically switching between these two modes of operation so that FCP scheduling and flow-optimized irrigation are both possible within the field controller or decoder hub. The system must also be capable of limiting the watering mode to FCP or flow-optimized.

The system shall be capable of managing up to 32 FCPs or stand alone controller schedules per field controller or decoder hub. FCPs or stand-alone controller schedules must be capable of running any combination of up to 100 stations, blocks (groups of up to 10 stations which run simultaneously) and delays. FCPs shall have four day schedule options. These include:

• Water every day

• Select days of the week

• Interval days

• Manual (schedules without start times typically used with field maintenance radio)

FCPs shall have three start time options. These include:

• Up to 10 explicit start times

• Start to end in which the user enters a start time and an end time then the schedule decides how many times it will repeat within that time window. Once set up, the schedule must calculate and display the number of repeats.

• Start plus repeats in which the user enters a start time and the number of times the schedule will repeat. Once set up the schedule must calculate approximately what time the schedule will finish.

FCP runtimes shall be from 1 minute up to 6 hours. It shall be possible to associate any and all of these runtimes with any combination of stations, blocks of stations or delays. Once the runtimes are entered the schedule must calculate and display the total irrigation time for that schedule. The calculated total schedule runtime shall take into account any seasonal adjustment factor applied to it.

The software shall be capable of retrieving FCPs from the field controllers or decoder hubs where they can be reviewed and compared side by side with the FCPs currently in the software. The user shall have the option of overwriting the FCPs stored in the central irrigation software or making changes to the FCPs stored in the software and writing them back to the field controllers or decoder hubs.

**Flow-optimized Watering Cycles:** Flow-optimized irrigation shall be a complete set of watering instructions for all field controllers or decoder hubs on the site. It shall contain all the start times, run times, cycles and soaks for all field controllers or decoder hubs.

To prevent destabilizing the carefully balanced sequence of events which must be loaded in each decoder hub or field controller when flow-optimized watering is used, it shall not be possible to edit the event list at the controller or hub. The complete list of events shall be viewable through the face pack of each field controller or decoder hub.

Decoders: The software shall be capable of operating up to 998,001 decoders segregated into groups of 999 decoders in up to 999 decoder hubs.

Decoder irrigation scheduling shall be identical in all regards to conventional controller watering.

Decoder addresses shall be included on the irrigation plan exactly the way station numbers are with a typical field controller. Decoder addresses shall not be randomly assigned. Decoders shall be addressable from 1 to 999 allowing each decoder to represent a specific station number on each pedestal-mounted decoder hub so the addresses may be known in advance to place them on the irrigation plan.

**Backup watering:** As a backup, should the central irrigation computer be unable to send a new list of flow-optimized watering events, the system shall be capable of calculating 1, 2 or 3 days of completely unique flow-optimized watering cycles. These unique watering cycles shall allow for different runtimes on each day. If the central irrigation computer fails to replace the flow-optimized events stored in the field controllers or decoder hubs, the field units will automatically water according to those stored events. If there is only one day’s worth of events stored in the field units, that one day will repeat continuously until new instructions are delivered by the central software. If two days are stored, the units will cycle days 1 then 2 repeatedly. If three days are stored, the cycle will be days 1-2-3.

The central software shall be capable of replacing any of the three days and shall not have to change all three days. The central software shall have a way to delete all flow-optimized events from the field controllers or decoder hubs.

**Flow-optimization:** The central irrigation software must flow-optimize each individual station. The system must not attempt to create flow-optimized FCPs or stand-alone controller schedules.

The flow-optimization process must take into consideration the following constraints:

• Station flow rate. This could be a single valve-in-head sprinkler or the total flow requirement for a block of sprinklers.

• Maximum simultaneous stations supported by the electrical characteristics of the field device in use. For example, if a field controller is capable of running a maximum of 20 stations simultaneously, flow-optimization must take this into consideration and ensure it never tries to turn on more than 20 stations at a time with that controller.

• Pump/water source limitations. The total flow rate demand of all simultaneously running sprinklers must not exceed the available capacity of the pump station.

• It shall be possible to configure each water source to gradually ramp up the pump station’s supply limit. The flow-optimization process must take the temporarily limited pump station capacity into consideration when it calculates the sequence of events for that watering cycle.

• Any priorities assigned to individual stations, locations or management groups must be considered during the flow-optimization process. To guarantee best possible use of the pump station, the flow-optimization process shall not limit the choice of stations to run solely by their priorities. Higher priorities must only be given extra weight as the flow-optimization process determines which station to run next.

• The process must account for any station overrides in the system database. For example, if a station has been defined as a master valve so that it can energize a pump start relay and keep the pump running throughout the duration of the watering cycle, the process should consider that station to be outside of the process and treated like a station with a flow rate demand of zero.

• The flow-optimization process must consider any delayed starts assigned to individual stations, locations or management groups. For example, if watering for most of the course is scheduled to occur between 11:00 pm and 2:00 am but the user has entered a delayed start time of 4:00 am for the GREENS management group, stations in that management group must not run until 4:00 am.

• The flow-optimization process must consider the maximum allowable flow rate through each segment of the hydraulic network. The combined flow rate demand of all stations “downstream” of a particular segment must not exceed the maximum allowable capacity of that segment.

**Irrigation Scheduling:** The software must be capable of scheduling irrigation given the runtime, a 24-hour ET value or a depth of water the user would like to apply.

The software shall include a Pick List feature used to apply percent adjustments to the entire system, locations, management groups and field controllers or decoder hubs and individual stations. The runtime adjustments shall include a timer such that a change to the adjustment can be set to remain in effect for a number of days before reverting to its previous value.

FCP or stand-alone controller scheduling shall be configured through a dedicated worksheet supporting all functions offered by the field unit.

Flow-optimized scheduling shall be configured through a grid or matrix displaying every station on the golf course organized in columns based on management group and rows based on location. The user must be able to see at a glance exactly what is scheduled to water, down to the individual stations, without opening any additional windows.

Flow-optimized scheduling shall not require any “program” creation. All information required to schedule irrigation shall be already displayed in the matrix of sprinklers on the golf course. The only additional piece of information required shall be irrigation start time or optionally an irrigation end time. When the end time is used, the flow-optimization process will ensure all irrigation is complete at the desired end time and shall automatically calculate the irrigation start time.

Once scheduling is complete, the software shall take those stations and pass them through the flow-optimization process. The results of that procedure shall be presented in a list showing each scheduled station along with its start time and runtime. In addition, the results of the flow-optimization process shall be presented in a color-coded graph depicting the pump station flow rate versus time with colors identifying times during which each management group is watering. Stations in the flow graph will be represented as blocks of water. The size of each station’s water block will depend on the flow rate for that particular station.

The list of events shall be sorted by controller or decoder hub, then written to the appropriate field device. The process shall indicate the total number of sprinklers (repeats of a single station are accounted for individually) in the flow-optimized event list. It shall be possible to walk to the field controller or decoder hub, check the display and verify that all watering events were properly stored in the field unit. It shall also be possible to use the central control software to retrieve these events to verify they were properly stored in the field unit.

**Runtime Calculation:** All inputs and settings which impact the number of minutes a given station runs shall be applied to the station and the resulting runtime displayed in the same matrix of stations used for scheduling irrigation. The same number shall be calculated and stored along with the station in the station list for each field controller or decoder hub.

Inputs which effect station runtimes shall include:

• Directly entered minutes of runtime from 1 minute up to 6 hours.

• 24 hour ET. To determine runtime given ET, a precipitation rate is required.

• Desired application depth. To determine runtime given a desired application depth a precipitation rate is required.

Settings which impact runtimes shall include:

• System or global seasonal adjust which must apply the same percent adjustment to all stations.

• Management group or location seasonal adjustment which must apply the same percent adjustment to all stations in a given location, management group or field device.

• Percent adjustments to individual stations.

• The above listed station adjustments must be cumulative such that stations with individual adjustment will be affected by adjustments applied to any location, management group or field device which in turn must be affected by any global or system seasonal adjustment.

• Any stations assigned an environmental adjustment factor to account for localized wind, humidity, temperature, etc.

Maps: The software will operate with or without an interactive map. When used, the map shall provide for placement of stations, sprinklers, controllers and hubs on the map. When used, stations depicted on the map shall include a visual indication of their activity. It shall also be possible to click on one or more sprinklers and issue a RUN or STOP command directly from the map.

The software will include drawing tools which the customer can use, or associate with actual devices. The software shall also allow import of vector drawings from AutoCAD files.

**Database:** it shall be possible to begin watering the golf course by entering nothing more than the list of controllers or decoder hubs on the site and the total number of stations available to each device.

The system must include a manual backup option as well as a method for backing up to a server on the internet. The software must remember where it placed the backup so restoring it is only a single click.

The system shall save regular snapshots or copies of the database on a predefined interval. These snapshots shall be organized by date and time then presented in a calendar so the user can select one and return the database to its condition at the time the snapshot was made.

The software shall check once per day for updates to the central control software. When updates are found, either through the automated check or when manually checked, the update shall be copied to the customer’s irrigation computer. The update shall not be automatically installed. These updates shall be provided for things such as issue fixes, new features and the addition of new languages.

Each update file shall be unique from all previous updates. All updates will be stored in the system and made available through a library of past updates allowing the user to return to a previous version if desired.

To make it easier to determine which version you have, each update shall be given a unique name such as White Tees as well as a version number.

Each update will be supplied with a set of release notes listing any changes made since the previous version. Those release notes must be available for viewing from within the software.

**Flow-optimization Setup:** Full flow-optimization shall include hydraulic details for pipes, pumps, and other devices as well. Hydraulic details include:

• Individual station flow rates where a station may be a single VIH rotor or several rotors in a block. When the station operates a block of sprinklers, the sum of all individual flow rates must be used for that station.

• Maximum allowable flow rate through a given segment of the hydraulic network. A built-in database of commonly used pipe types and dimensions in both imperial and metric units shall be provided. Flow rates determined for the pipes in the database shall be based on a water velocity limit of 5 feet per second. A flow rate calculator based on the same water velocity limit of 5 feet per second shall be provided.