No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
1	TE	-	The crediting of rainfall before irrigation puts an unfair burden on the controller's evaluation and can be detrimental to vegetative growth.	Credit irrigation before rainfall or else use some hour-by-hour rainfall records to adjust irrigation/rainfall contributions.	Reject	A summary of the performance of the first 14 controllers tested shows an average adequacy of 100% and average efficiency of 98%. As a practical matter then the Protocol handling of rainfall has had a minor if any effect on performance parameters. Forgiveness in management is provided by the root zone storage and the fact that adequacy values as low as 80% would still provide satisfactory results. At least one manufacturer has indicated that he has patented a look-ahead feature that allows for rainfall probability estimates based on current weather conditions. We are trying to encourage "the intelligent use of rainfall." Research in other systems where rainfall is more prevalent (NJ and FL) appears to demonstrate that the protocol is effective in other environs with essentially the same results in adequacy and average efficiency obtained for controllers tested in these new locations as in the original testing location.
2	GE	4.2	There is no mention of the fact that the testing agency will retain the controller tested.	Add the following wording to paragraph 4.2: "The testing agency will retain the controller tested."	Accept	Statement added.
3	GE		The Testing Protocol is being used to qualify products designed for use in other than the homeowner market. Controllers for these other markets could require other performance capabilities.	Add additional qualifying statements to the Protocol introduction that would more clearly state the capabilities and limitations of the current Protocol.	Accept	In introduction to the protocol it will be made more explicit that the SWAT focuses on improving landscape water use in the residential and light commercial markets and that as such the protocol is appropriate for testing products matched to these markets.
4	GE		The Protocol should include the use of flow sensing capabilities as a required feature.	Modify the Protocol accordingly.	Reject	The system flow rate is not required in any of the Protocol formulas.
5	TE	4.6	Change the wording of the paragraph by adding the word "minimum."	"Valid performance data is then downloaded from a minimum 30-consecutive-day period of testing and . . . ."	Reject	The rainfall of 0.40 in. and ETO of 2.50 in. are not absolute values. They are rates; e.g. 0.4 in./30 days and 2.50 in./30 days. Inserting the word "Minimum" completely subverts the effectiveness of the requirement and makes it meaningless. Literally every testing effort we have attempted in Fresno would be acceptable if the test period was long enough.
6	GE		The process for developing Test Protocols should be more formally organized in a manner similar to professional societies.	Restructure the Protocol drafting and review process. Draft Protocols in a more formal manner.	Reject	There are formalized processes governing the steps of protocol development. The review and comment procedures follow the ISO format except that comments are solicited from a range of stakeholders and not limited to a technical committee.
7	GE		Remove all reference to specific organizations from the Protocol.	Remove reference to CIT, CIMIS, etc.	Accepted	Remove reference to other than the Irrigation Association as the authorizing organization.
8	GE		Develop virtual weather patterns then useful	Conduct tests using virtual weather	Reject	Virtual patterns would require some human definition of

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
8			in continuing testing when natural weather patterns do not cooperate.	patterns.		both the variability and intensity of weather factors. This would be open to endless discussions of what represents the "real world." It seems more practical to let "Mother Nature" define the real world. As a practical matter, the delays caused by Fresno's somewhat unique weather patterns have been tolerable. The EPA has examined this issue as well and determined that virtual weather simulation is too impractical and expensive to implement.
9	GE		Not sure if 0.4 in. of rainfall is sufficient to test the controller's capabilities particularly if it comes as a single storm or is spread over several days.		Reject	A summary of the results of the testing of the first 14 controllers is as follows: ETO, average 3.52 in., range 2.55 to 4.77 in. Gross Rainfall, average 1.12 in., range 0.39 to 3.98 in. Irrigation adequacy, average 100%, range 99.7 to 100% Scheduling efficiency, average 98.0%, range 73.1 to 100% The majority of the vendors then have developed controllers that demonstrate an ability to handle ETO and rainfall amounts significantly in excess of the required minimum values of ETO of 2.50 in. and rainfall of .40 in. The 89-day test in Florida shows an ETO value of 13.95 in. and a gross rainfall value of 10.67 in. During this test period the controller irrigation adequacy averaged 97.9% and the scheduling averaged 98.4%. The comparable values from the controllers' 30-day test are 100% and 98.5% for the irrigation adequacy and scheduling efficiency respectively. Based on the test results to date, at this time the technical committee feels the ETo and rainfall thresholds and 30-day period are adequate.
10	GE		When rainfall events occur during a 24 hour period it can penalize a controller that has already irrigated. Adjustments should be made to insure a fair comparison.		Reject	All controllers were evaluated using the same weather realities. See Explanation No. 1. Rainfall makes a "dumb" contribution to the moisture balance. The controller is expected to make a smart contribution.
11	TE	6.0	Why is 0.8 used for rainfall effectiveness when the IA scheduling manual suggests an average of about 0.55? We should be consistent.	Use 0.55 instead of 0.8.	Reject	The Protocol makes no reference to rainfall effectiveness and the referenced section of the IA BMP is yet to receive supporting scientific validation. The 0.8 multiplier is a first approximation to allow for non-uniformity of rainfall coverage and storm runoff. The calculated net rainfall is added to the root zone storage available on a priority basis over irrigation amounts. The general question of rainfall effectiveness involves rainfall intensity and droplet size, interception by plants and

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
11						plant physiology. The phenomenon is beyond the science of this protocol.
12	GE		A 30-day testing period is too short to determine the water conservation potential for a climate-based controller.	Change the test period to 90 days covering the growth transition from spring to summer or summer to fall.	Reject	The Protocol tests the "mechanical" ability of the controller to control an irrigation system using given input data and real time weather data. It makes no judgement on the quality of these inputs. The Florida 89-day test used a smart controller previously subjected to the 30-day test. In this test the controller experienced 3.56 in. of ETO and 3.98 in. of rainfall. Effective irrigation amounts ranged from 1.54 in. to 1.96 in. The average irrigation adequacy was 100% and the scheduling efficiency average was 98.5%. In a recent 89-day test using a weather feed from Florida the same controller experienced 13.95 in. of ETO and 10.67 in. of rainfall. Effective irrigation amounts ranged from 2.28 in. to 6.71 in. The average irrigation adequacy was 97.9% and the scheduling efficiency average was 98.4%. The 89-day results are virtually the same as the original 30-day results. In addition to the virtually identical results, as a practical matter a 90-day test period will increase the already significant wait for SWAT report generation and review with seemingly little or no benefit.
13	GE	4.6	"Being tied only to CIMIS weather station data obviously limits the applicability of this Protocol to other regions of the USA."	Eliminate reference to CIMIS.	Accept	While the current Protocol makes no reference to CIMIS directly some statement needs to be made on how the reference weather source is to be selected. The following addition to the protocol is suggested: "4.7 Weather Data Source The testing agency and the manufacturer shall mutually agree on an accredited weather data source to be used in the evaluation." Note Tthe SWAT Committee will review the use of "accredited" and may recommend "weather data that the testing lab and Technical Working Group deem credible."
14	TE	3.1 & Table 2	KC values in Table 2 may not be valid for all locations.		Accept	The Protocol tests the controller's ability to "mechanically process" a combination of given input data and weather data. The controller then makes no judgement on the quality of the input data per se. It is important, however, for the Protocol to use reasonable KC values so as to not mislead designers in the next step of setting up controllers to function on site. The following addition to paragraph 3.1 is suggested. "The KC values in Table 2 are meant to be

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
14						representative for test purposes only. They should be verified before being accepted in specific locations."
15	TE	Table 1	KS Values should vary by months. [See Footnote (2) in the Protocol.]	Revise KL calculation.	Reject	The science required to develop time-framed KS (and KL) values has not developed to the point that the public has access to the range of values required.
16	TE	Table 1	Root depths in Table 1 are too shallow. Increase Zone # 2 to 7 in. and Zone #4 to 18 in.	Change the root zone depths to 7 in. in Zone 2	Reject	There are no root zone depths shown in Table 1. Table 1-A in the "Sensor" testing protocol does show root zone working depths. Zone 2 shows 5.0 in. This was based on personal communications with MWD staff relative to their actual field measurements. Zone 4 is already at 18 in.
17	TE	Table 1	Application rates for fixed spray head can be as high as 2 to 2.5 in./hr.	Increase the precipitation rates in Table 1 for pop-up spray heads to over 2.0 in./hr	Reject	As long as the application rate exceeds the soil intake rate, the system must be cycled in order to avoid a runoff penalty. This requires the manufacturer to deal with the situation. An increase to 2.0 in./hr will further test the cycling capabilities of the controller. It should be noted that while 2.0 in/hr is possible; most spray systems apply water at a lesser rate.
18	TE	Table 1	Consider using ground cover in Zone 6 (clay on a 20% slope) as a more practical answer to a potentially difficult field situation.	In Table 1, Item #5, change the vegetation from Bermuda grass to ground cover or shrubs.	Reject	While this is probably a good suggestion, the protocol was meant to challenge the controller to deal with difficult situations particularly as relates to minimizing runoff potential. We recognize there are an infinite number of important site characteristics that ideally we would like to test for, but as a practical matter only a limited number of stratifications in sample design are possible.
19	TE	4.4	Consider giving a hard water window and a 5-day watering allowance.		Reject	The protocol must reflect generally accepted scientific concepts and management principles. We were not aware of any generally accepted restrictions on watering times.
20	GE	1.0	Do not believe you can accurately or fairly quantify "Accumulated Stress" experienced by landscape plants or irrigation adequacy based on this Protocol.		Reject	The term "accumulated stress" in section 1.0 scope will be changed to "accumulated deficit." The protocol should make no reference to stress. The deficit is as defined by the formulas. The setting of the root zone working water storage (RZWWS), Table 1, Item 4, relates indirectly to stress. The larger the assumed value in a given situation, the higher will be the dry end stress that the plants will experience. With these higher stress levels the quality of the vegetation will be compromised. The controller programmer then indirectly impacts vegetative quality when he sets the RZWWS value.
21	GE	Table 1	Why does the Protocol use pop-up sprinklers with an application rate higher than the soil		Reject	Pop-up sprinklers are probably the most commonly used sprinklers for homeowner irrigation systems. Also

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
21			intake rate? This requires cycling that is seldom practiced in the real world.			commonly observable in sub-divisions is surface runoff in street gutters. Recognizing these realities, the Protocol requires cycling in order to extend the soak time and reduce or eliminate runoff.
22	GE		The weather station at the site should be used by the testing agency to grade the controller performance and not used as a weather source for the controller under test.		Reject	The Test Protocol is silent on the question of where or how the controller under test acquires the required weather data. The best source of weather data is left up to the manufacturer. The question of how best to provide the required weather information to individual homeowners may become a SWAT R&D effort in the future. At this time the Protocol makes the assumption that the weather station is in the same environment as the controller.
23	GE		I am concerned that controllers with onsite sensors may require multiple test units since there is inherent variation in sensors themselves which could cause variation in performance.		Reject	The Protocol tests the controller as an assembly offered by the manufacturer. Variability in temperature or rainfall sensors, for example, then becomes folded into the "assembly" efficiency results. As a practical matter this Protocol characterizes the performance of the controller assembly only.
24	GE		Not enough attention is paid to the irrigation of zones that do not require complete coverage of the surface area; for example, drip irrigation of woody ground cover.		Reject	Zone #5 with trees and ground cover irrigated by surface drip systems was meant to provide this irrigation scenario.
25	GE		Suggest that the smart controller must be originally set up and programmed by someone familiar with the technology and not left to the homeowner if the water saving potential is to be realized.	Add the following to the 1.0 scope: In order to utilize the full water saving potential of smart controllers, they must be set up and programmed by individuals familiar with the technology. They offer a new level of automated control beyond the historic "set and forget" time clocks.	Accept	All smart controllers must be properly setup to operate at their potential. A language change will reflect this in the Protocol.
26	TE	4.3 Table 1	I feel the definition of "irrigation adequacy" should consider managed allowed depletion (MAD).	Show a managed allowed depletion in the calculation.	Reject	The RZWWS values given are thought to be representative for the soil texture. As the controller functions in a given situation the value can be adjusted in relation to vegetative quality observations. Ultimately if the grass quality is better than needed a larger RZWWS value can be tried. This has the effect of extending intervals and increasing root zone stress. If the vegetation begins to show stress, a smaller RZWWS value can be used which has the effect of shortening the intervals thereby reducing root zone stress levels. This provides a way of adjusting the system operation to meet vegetative quality objectives. If it can be shown that encouraging deeper root zone development is desirable this can be accomplished by inputting a larger RZWWS

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
26						value.
27	TE		The Test does not verify the accuracy of ETO and rainfall data used by the controller.		Reject	The only output data detected from the controller under test is the valve opening and closing times. How the controller obtains ETO and rainfall data is not a subject of the evaluation. An error in runtime calculations could be compensated for by increasing or decreasing the number of cycles. Errors in the ETO and rainfall amounts by the controller will not carry over to the Protocol's moisture balance calculation. If, for example, the controller is understating the ETO value and consequently understating the runtimes, the Protocol's store moisture will be depleted and the controller's record will show a deficit.
28	GE	1.0 Scope	"Excess water" is defined in the Protocol as "water applied beyond the soil's ability to absorb it." It is determined by moisture balance calculation when the applied water amount exceeds the RZWWS. The literature suggests that the soil holds water available for plants for "one to three days after soil saturation" before the soil "dries" to field capacity. The Protocol should account for this water.	Redefine "Excess water."	Reject	In general the Protocol can only deal with phenomenon that can be characterized by an algorithm, in this case surface water storage is a function of soil type and surface detention. We are not aware of such an algorithm. This effect has been accounted for at least partially by the RZWWS value. This value is not defined on the wet end by a field capacity determination. It is also not defined on the dry end by MAD or WP. It is defined in the field by observing the effect of specific RZWWS values on vegetative quality.
29	GE	1.0 Scope	"Irrigation Adequacy" is defined in the Protocol as not allowing soil moisture levels to deplete to less than the RZWWS value. This is not entirely accurate because of 50% of plant-available water has been depleted.	Modify the "irrigation adequacy" definition.	Reject	The MAD value of 50% depleted is part of an incompletely understood concept. At the dry end it is meant to characterize the limit of root zone depletion. This value is primarily a function of soil type and the impact of root zone stress on vegetative quality. While it is possible to quantify soil type, the impact of root zone stress on vegetative quality can only be established objectively by observing the vegetation after it has been subjected to a specific water management regime which includes the assumed RZWWS value. Adjustments in the RZWWS value can be made to move the require quality closer to the desired goal.
30			To evaluate irrigation adequacy each irrigation event should be given a score based on the following factors: 1. Did it water too much? 2. Was too little water applied? 3. Was there run0ff? 4. Did it wait too long to water? 5. Did it water too soon 6. Was water applied in multiple cycles		Reject	The Protocol properly defines irrigation adequacy. The concerns raised will be commented on individually. 1. A controller that waters too much will be penalized with the surplus shown on the second page of the detailed summary report. 2. A controller that applies too little water will be penalized with a deficit shown on the second page of the detailed summary report. 3. Run-off is noted on the daily moisture balance

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
30			to avoid run-off?			calculation for each irrigation cycle. It can result from either too long a run time (D Run), or insufficient soak time between cycles (S Run). 4. If the controller waited too long to irrigate, the ending daily moisture balance calculation will show a deficit that will be logged in the deficit column. 5. Not sure how watering too soon is quantified. It could be related to rainfall. For example, the longer the irrigation is delayed the more likely a rainfall event will occur. This will be reflected in the rainfall efficiency calculation that is shown in the evaluation summary of the detailed moisture balance calculation. It seems prudent to schedule an irrigation event before the RZWWS is completely exhausted. This allows a margin of safety in the event that the system experiences a failure. 6. Multiple cycles are logged on the Daily Moisture Balance. The log shows, for all cycles individually, the start time and the run time. If the run and soak times were incorrectly calculated the log will show an efficiency penalty. For the topics raised, the Protocol logs performance information that in total will quantify their effects on the performance summarizing parameters.
31	3.0	3.8	"This evaluation concept requires the use of accepted formulas for calculating crop evapotranspiration (ETC)." What is an accepted formula and how does the protocol verify it was used? As pointed out earlier, ET can be off 20% and still get a "passing" score under the proposed specifications.		Reject	Section 2.0 references the use of the ASCE-EWRI formula by the Protocol only. It sets no condition on the controller manufacturer. He is free to estimate ETC by what ever means he deems suitable as long as the performance results are satisfactory. The Protocol makes no judgement as to what score is "passing."
32	3.0	3.8	"When a controller uses non-accepted methods (for calculating ET) there needs to be a way to verify that ET is calculated correctly."		Reject	The controller is responsible for a result only. The Protocol measures the quality of that result. It is impossible for the Protocol to critique and set standards on the individual judgements made by the manufacturer.
33	TE	4.6	"If a controller being tested uses another method to calculate ET, testing should be conducted for a longer period of time and in many locations across the country."	Modify the Protocol to show the test period as 3 months and at three locations, California, Florida and New Jersey.	Reject	SWAT Research in other systems for 90-day intervals where rainfall is more prevalent (NJ and FL) appears to demonstrate that the protocol is effective in other environs with essentially the same results in adequacy

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
33						and average efficiency obtained for controllers tested in these new locations as in the original testing location. Based on this outcome, testing of every individual controller in multiple locations is deemed unnecessary. The purpose of the Protocol is not to evaluate the myriad of methods for computing ET but rather to evaluate a controllers ability to provide practical weather-based control of irrigation.
34	TE	Formulas	My concern is the arbitrary 80% that allows for a loss of 20% of the rainfall to non-uniformity and runoff. Suggest an approach that considers rainfall intensity and its effect on potential runoff.		Reject	In general rainfall intensity data is not commonly available from publicly accessible weather feeds. The Test Protocol then would have no basis for judging the controller's capabilities. Further, if it was, the runoff phenomenon on individual valve micro watersheds would be complex beyond our reasonable ability to characterize. Until the impact of micro climate on rainfall uniformity and the runoff potential from individual zones is better understood, the 20% arbitrary loss is suggested. Further, there is also a lack of understanding on the definition of "effective rainfall." The Protocol defines it as "rainfall that was effectively stored in (the) root zone working storage for use by crop." The Protocol makes no distinction related to rainfall intensity or droplet size. There is a need for research to better define the "effectiveness" of rainfall.
35	TE	Table 2	Question the accuracy and applicability of the KC values for turf.	Add the following explanation to section 3.1 and 3.6: "The crop coefficients incorporated into the Protocol are required for evaluation purposes only. They may not be applicable in other locations."	Accept/ Reject	The use of crop coefficients as a function of age is meant to be an improvement over fixed values. For purposes of the Protocol a high degree of scientific accuracy is not required. A caution about their accuracy will be added to sections 3.1 and 3.6.
36	TE	Table 2	My recommendation is to eliminate the seasonal KC Table from the Protocol and use a fixed KC value for each zone per the IA BMPs.		Reject	Periodic research on turf grass as California State University-Fresno over the last 20 years suggests that a fixed value would result in either grossly unacceptable quality or wasted water. Seasonal KC values add a level of sophistication that will better index water applications to plant needs at a time when water conservation is becoming more important. The existing IA BMPs reflect authors' perspectives and are not necessarily backed by scientific testing. Research to date suggests that KC values do change depending on season.
37	GE		After initial programming and calibration the controller is expected to perform without further intervention during the test period. There is nothing in the Protocol that states	Add the following definition to Section 3.0: 3.11 Smart Controllers Smart controllers estimate or measure depletion of available plant soil moisture in	Accept	The IA official definition of a Smart Controller will be added to section 3.0. It stipulates operation throughout the irrigation season without human intervention.

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
37			there shall be no intervention.	order to operate an irrigation system, replenishing water as needed while minimizing excess water use. A properly programmed smart controller requires initial site specific set-up and will make irrigation schedule adjustments, including run times and required cycles, throughout the irrigation season without human intervention.		
38	TE	4.6	During the test period nothing is done to assure no remote intervention has occurred.	Add the following to section 4.0: 4.7 Testing Affidavit The manufacturer may be required to sign an affidavit attesting to the fact that during the test period the controller operated as required by the IA definition of a smart controller.	Reject	The testing is closely monitored. It should be remembered that the Protocol stipulates the use of data logging and the development of daily moisture balances. These are based on the actual valve run times recorded not any record kept by the controller memory Such logging makes any remote intervention to alter test results improbable and unlikely to avoid detection.
39	TE		It is important for the controller's on site weather collection devices to be in the same environment as the weather station that is used to judge the results.	Add the following qualifying comment to Section 3.8: The Definition of Evapotranspiration (ETO) "When controllers use on site weather collection devices, the Protocol ETO data is obtained from CIMIS Station 80, located approximately ½ mile Northwest of the test site."	Reject	CIMIS Station 80 is located approximately ½ mile Northwest of the test lab. The controllers' on site weather collection devices are located at the Lab with mountings and exposures as specified by the company's technician. Judging the general quality of weather data inputs remote from certified weather stations is important but beyond the scope of this Test Protocol.
40	TE	4.6	Test duration (30 days) and rainfall minimum (0.40 in.) appear to be far too limited in order to sample climate variability particularly in humid regions. Suggest three months as a reasonable period to capture changing seasonal demands.	Change the test duration to 3 months and add a temperate and humid site to the Fresno "Dry" site.	Reject	SWAT research in other systems for 90-day intervals where rainfall is more prevalent (NJ and FL) appears to demonstrate that the protocol is effective in other environs with essentially the same results in adequacy and average efficiency obtained for controllers tested in these new locations as in the original testing location. Based on this outcome, testing of every individual controller in multiple locations is deemed unnecessary.
41	TE	4.6	Continue to argue for the insertion of the word "minimum" before the words "30 consecutive day period."		Reject	See Footnote No. 1 on page 2. This proposed change was "Not Approved" in October, 2007. No one else commented on the point during this current review.
42	GE		Argue for the incorporation of flow meters into the system as an assist in recognizing and reacting to default conditions.		Reject	Recognizing and reacting to default conditions is not a part of this current Protocol. A separate study would be required to identify common default conditions and specify appropriate reactions. Not sure how flow sensing impacts the moisture balance calculations when system components are operating as designed.
43	GE		Allowing a portion of the RZWWS value as available for rainfall storage is a flawed concept because the lower part of the root		Reject	Controllers experiencing 0.39 in. of rain during the 30-day test period gave irrigation adequacy and scheduling efficiency results of 100%. Another controller that

Type of comment: GE = general TE = technical ED = editorial

No.	Com Type	Page/ Para	Comment	Proposed Change	Accept/ Reject	Explanation
43			zone would not receive water causing deeper roots to atrophy threatening plant health.			received 3.56 in. of rain during the test period gave an irrigation adequacy of 100% and a scheduling efficiency average of 98.5%. Further, the average scheduling efficiency for the first 14 controllers tested was 98.2 %. If the rainfall priority judgement is “unfairly” penalizing controllers, the penalty appears to be of no practical significance.
44	GE		Some field tests indicate that controllers which did well in the SWAT test showed no water savings when installed in the field and operated over 2 years.	Modify section 1.0 Scope to include the requirement that input data must be independently verified and the controller programmed by a qualified technician.	Accept	The Protocol should emphasize that the test input data was selected to stress the adaptive capability of the controller. The input data for specific locations must be verified and the controller programmed by a qualified technician.

Type of comment: GE = general TE = technical ED = editorial