APPENDIX

GUIDELINES FOR THE AGRICULTURAL WATER CONSERVATION QUESTIONNAIRE

The goal of the agricultural water conservation questionnaire is to promote improved irrigation efficiencies, quantifiable water savings, educational and awareness programs, and to ensure the implementation of best management practices and water savings alternatives. Additionally, the information provided will substantiate that adequate measures have or will be implemented to mitigate the potential impacts of the new or replacement well as required in lieu of environmental review for individual well permits.

Increased irrigation efficiencies can reduce the total demand for irrigation water. Irrigation efficiency is defined as the ratio of *irrigation water beneficially used* to *the total irrigation water applied*. Any irrigation system design should seek to reduce total water applied.

Increased irrigation efficiency results in a reduced demand for water. Irrigation efficiency is a measure of the proportion of water applied that is actually beneficially used. Irrigation efficiency (IE) is defined as:

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Total Irrigation Water Applied}}$$

where, beneficial uses include water necessary for:

- crop transpiration
- salinity control
- climate control

and beneficial uses do **not** include:

- application losses such as spray drift or uncollected run-off
- evaporation from wet soil surfaces or wet foliage
- deep percolation of water past the root zone (in excess of leaching requirement)

The two major factors affecting irrigation efficiency are the following:

1. Irrigation scheduling
2. Distribution uniformity of water applied

Irrigation scheduling is the practice of determining when and how much to irrigate. This can be accomplished by the use of soil moisture sensors and irrigation planning to determine soil moisture deficits, and installing time clocks at the pump to ensure that an irrigation system shuts off once the proper amount of water is applied.

Distribution uniformity (DU) refers to how uniformly the water is applied to a field. The higher the level of uniformity, the less total water is needed to meet crop water requirements. All of the other irrigation system improvements address the potential for improving the distribution uniformity of water applied. For a net water savings to be achieved by an increase in the distribution uniformity of water applied, the irrigation system needs to be run for less time.

DEFINITIONS OF TERMS

*** Terms are in order of BMPs listed on pages 3 and 4 of the Agricultural Water Conservation Questionnaire*

IRRIGATION MANAGEMENT PRACTICES

WATER FLOWMETER:
Water measurement is essential for irrigation management. Flowmeters are an important tool for water management. Although savings cannot be guaranteed, water use can be quantified (the first step in estimating irrigation efficiency). For flowmeters to read accurately, they must meet manufacturer recommendations for installation.

TIME CLOCK ON PUMP AND/OR PRESSURE SWITCH ON BOOSTER:
An automatic time clock will turn off the pump when irrigation is complete. This can be used primarily for shutting off the water in the middle of the night, or anytime the irrigator will not be able to return to shut off the system precisely when the required irrigation time is reached. A pressure switch can shut off a booster pump when a well pump is shut off by a time clock, or if there is a break in a pipeline. A pressure switch can increase flexibility in the timing of irrigations, as well as stop an irrigation if there is a pipeline break.

SOIL MOISTURE SENSORS AND/OR EVAPOTRANSPIRATION (ET) ESTIMATES:
Irrigation set times and frequency can be estimated by using one or more of the following soil moisture sensors or ET estimating methods: tensiometer, electrical resistance blocks, neutron probe, infrared thermometer, California Irrigation Management Information System (CIMIS) ET information, or on-site evaporation pan data. Knowing the soil water holding capacity, the soil moisture level at a given time, the crop rate of ET, and the distribution uniformity of the irrigation system used, a grower can determine the crop water needs and, therefore, more accurately plan irrigation set times and frequency.

PRE-IRRIGATION REDUCTION:
A reduction in pre-irrigation set time, or a change in pre-irrigation set times to reduce the amount of water applied can reduce water use. Switching from furrow to sprinkler pre-irrigation can also allow for smaller pre-irrigation applications.

AGRICULTURAL MOBILE IRRIGATION LAB:
The technical services of the agricultural mobile irrigation laboratory can provide growers with an analysis of the distribution uniformity of an irrigation system. The report is useful for identifying causes of low uniformity or to evaluate if improvements to an irrigation system increased uniformity. Some Ag Mobile Labs will also perform pump efficiency tests.

TRANSPLANTS:
Transplant any crop other than celery, cauliflower, and fresh market tomatoes. *Only transplanting crops that are not normally transplanted can conserve additional water.* Adjusting practices from direct-seeding a crop to transplanting a crop allows the number of initial irrigations to be reduced and may allow late season irrigations to be reduced if fewer harvest passes are completed because of better crop uniformity.

EDUCATIONAL SESSIONS:
Register farm representative(s) in any irrigation-related education courses, seminars or workshops offered in the Central California area by the University of California Cooperative Extension, equipment manufactures, Resource Conservation Districts, or others. Many of the conservation practices in this list must be accompanied by improved management practices. Attendance of educational meetings should help improve management.

CONSERVATION PROGRAM:
Development of a water conservation program could include, but not be limited to, bilingual training of irrigators and implementing recommendations from technical experts in the field. Contact the University of California Cooperative Extension, the Resource Conservation District, the Central Coast Agricultural Water Quality Coalition, Pajaro Valley Water Management Agency or others for information on the availability of assistance for development of a water conservation plan.

RE-USE OF TAILWATER OR RUN-OFF:
Tailwater or run-off can be collected in a sump and re-used either for irrigation or dust control purposes. In certain cases, it may be necessary to use such sumps to avoid uncollected run-off.

RECYCLED WATER:
In April 2009, the Pajaro Valley Water Management Agency began delivering tertiary treated, disinfected recycled water into the Coastal Distribution System from the Watsonville Area Water Recycling Project. The recycled water facility will produce 4,000 acre-feet of recycled water (new to the basin) to be blended with approximately 2,000 acre-feet of "blend" water, for a total of 6,000 acre-feet per year. That water, delivered through the coastal distribution system, will be able to irrigate a portion of more than 6,000 acres during spring, summer and fall months. It is considered "new" water since it otherwise would be discharged into Monterey Bay National Marine Sanctuary.

IRRIGATION EFFICIENCY AUDITS
Irrigation audits consist of three main activities: site inspection, performance testing and irrigation scheduling. Each activity in itself can result in significant water and cost savings. Distribution uniformity (DU) and Irrigation Efficiency (IE) are very important parameters in the use of water budget irrigation scheduling. DU figures represent how evenly the irrigation water is spread over the field. During an irrigation some areas obviously receive more water than others. An adequate irrigation must apply sufficient water to all areas of the field. In order to adequately irrigate the driest areas, excess water must be applied over the entire field. The extra amount of irrigation required is calculated directly from the DU. An IE audit will assist in achieving a higher level of uniformity and fine tuning the irrigation scheduling.

SUMMER FALLOW OR OTHER FALLOW:
For Summer Fallow, no irrigation water applied for 90 consecutive days during any period between April 1 and September 30 (the period of highest water demand). For Other Fallow, no irrigation water applied for any 210 consecutive days during the season. Maps indicating fields to be left fallow must be provided. This can be quantified, shows a strong financial commitment, and can be checked for compliance.

12-MONTH SET-ASIDE:
No irrigation water applied for 12 consecutive months beginning anytime between January 1 and December 31. Maps indicating set-aside fields must be provided. This reduces water use on the set-aside acreage to almost zero. This can be quantified, shows a strong financial commitment, and can be checked for compliance.

LIST OTHER BMPs …:
There are other practices with water conservation potential that are not listed. Some practices improve the water infiltration characteristics of soils to absorb rainfall; some increase the organic matter content and water holding capacity of soils, etc. Such practices include, but are not limited to:

Minimum Tillage
Seed Variety Selection

Replacement of Concrete Pipelines with High Pressure PVC Lines
Soil Fumigation
Soil Amendments
Polyacrylimide (PAM)
Drip Germination
Furrow Dikes

SPRINKLER IRRIGATION SYSTEM IMPROVEMENTS

REDUCED SPRINKLER SPACING:
A reduction in the spacing between sprinkler lines, including the use of alternate-set irrigation ("split sets"), will improve the uniformity of water applied by portable sprinkler irrigation systems. An increase in uniformity is achieved by a reduction in the spacing between sprinklers. For example, a sprinkler spacing or move distance of ten 40-inch beds (33 feet) can result in a five to ten percent increase in distribution uniformity compared to a spacing of twelve 40-inch beds (40 feet), over the course of a single irrigation.

Alternate-set irrigation, the practice of placing every other line of sprinkler pipe at an intermediate location between mainline valves, can generally result in a 10 to 15 percent increase in uniformity over the course of two irrigations. Although the potential increase in distribution uniformity can be significant, these practices must be accompanied by a reduction in irrigation set times to achieve a reduction in water use.

SPRINKLER IMPROVEMENTS:
General sprinkler improvements may include sprinkler maintenance and repair, replacing worn sprinkler nozzles, replacing nozzles of non-uniform size, using low-pressure nozzles, using flow control nozzles, or changing the height of sprinkler risers.

The flow of water from a sprinkler is dependent upon the water pressure and the size of the nozzle. A uniform nozzle size is necessary for uniform water application throughout a field.

Low-pressure nozzles have a non-circular orifice that results in an increased break-up of the water stream leaving the sprinkler nozzle. Such increased break-up of the water stream can be beneficial to the resulting water application pattern between sprinklers and increase uniformity at lower operating pressures (below 50 psi).

Flow control nozzles have rubber orifices which change diameter depending on the operating pressure. This results in pressure-compensating characteristics. The use of such nozzles can result in an increased uniformity of flow rates throughout a field where pressures vary significantly.

An unrestricted water stream is necessary to achieve a uniform sprinkler pattern. Where the height of a crop interferes with the water stream, taller sprinkler risers can improve the uniformity of water applied. These practices must be accompanied by a reduction in irrigation set times to achieve a reduction in water use.

OFF-WIND IRRIGATION:
Wind conditions can be a major obstacle to efficient sprinkler irrigation. Pre-infiltration spray losses and wind distortion of sprinkler application patterns are two important factors that can limit the irrigation efficiency of water applied by sprinklers. Wind speeds greater than 5 mph significantly reduce the amount and the distribution uniformity of water applied. Sprinkler irrigation conducted at times when

the wind speed is five miles per hour or less will result in better crop uniformity and more efficient water use.

LEAKAGE REDUCTION:
Water savings from leakage reduction is obvious, and can be significant.

LINEAR-MOVE (overhead):
Traveling irrigation systems have the potential to apply water at high levels of uniformity and are less affected by wind. Their use is limited to relatively level ground because of their high application rates.

MICRO IRRIGATION SYSTEMS

DRIP TAPE / HOSE AND MICRO-SPRAYS AND MICRO-SPRINKLERS:
Water savings have been shown resulting from conservation of water, higher distribution uniformity, reduced surface evaporation, ability to micro-manage irrigation programs, and capability to "spoon-feed" crops with fertigation.

PRESSURE COMPENSATING EMITTERS / TAPE:
Uniform pressure is required to obtain high distribution uniformity in drip systems. Pressure compensating drip emitters minimize fluctuations in discharge rate with changes in pressure in the tape or hose. Pressure compensating tape is frequently used for situations where changes in elevation affect pressure or to improve uniformity in fields with long rows.

SURFACE IRRIGATION SYSTEM IMPROVEMENTS

SURGE FLOW IRRIGATION:
Using surge flow valves and irrigation techniques to increase advance ratios can improve the water distribution uniformity.

SHORTEN FIELD RUN:
The length of the field rows may affect distribution uniformity. For drip and sprinkler systems, the length of the row affects the flow rate in the lateral pipe or drip line. A high flow rate in a pipe or drip line may cause frictional losses of pressure and lead to lower discharge rates near the tail-end of the field. For furrow systems, long row lengths may lead to an over application of water at the head of the field and an under application of water at the tail-end.

TAILWATER RETURN SYSTEM:
Recovery and re-use of tailwater that otherwise would have been lost, is a clear and measurable water savings. A tailwater return system is different from a runoff collection sump, in that it can directly return water to the irrigated areas.

LASER LEVELING / MAJOR LAND GRADING:
Smooth, gradually-sloped to level fields can improve water distribution uniformity when surface irrigation is used. Grading and leveling of previously unleveled ground is also included.