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Figure 7. Inline water meter to measure water flow.

on this meter should not be assessed a sewer charge as incurred when using potable water supplies.

Types of Irrigation Systems

The type of irrigation method for delivering water to plants plays a large role in the amount of water used and the effectiveness of the irrigation system. The primary types of irrigation systems are overhead sprinkler, microirrigation or drip, and subirrigation systems that may be used in greenhouse production or interior plantings.

Overhead Sprinkler Systems

Overhead sprinkler systems spray water into the air above and around plant foliage in a broadcast pattern. Water droplets from these systems are large enough to fall through the canopy to the soil or growing substrate. Sprinkler nozzles are designed to function at a certain pressure and discharge rate, which determines the diameter of water throw.

Overhead irrigation is efficient for larger turfgrass areas. It is also commonly used for watering smaller, one to three-gallon container plants placed close together in nursery production, even though water is lost from falling on the ground between containers. Overhead sprinklers are only 70% to 75% efficient in water delivery because evaporation occurs in the air, from the plant foliage, and from the ground surface. The circular pattern of application also makes it difficult to achieve a high degree of uniformity in delivering water to all plants. This is especially true when sprinkler heads are placed in rectangular spacing patterns necessary for irrigating most landscaped and nursery production areas.

Uniform coverage of irrigation water is important to prevent areas from being over-watered or under-watered. Sprinkler heads do not distribute water evenly throughout the radius of coverage. As the distance from a sprinkler head increases, the amount of water reaching the ground decreases due primarily to evaporation and wind action. The best way of providing uniform water distribution over an area is to plan the spacing of sprinkler heads so that water from one head overlaps the water sprayed from the heads next to it. This overlapping in coverage from one head to another achieves the most uniform water coverage and water conservation.

Figure 8. Overhead irrigation system in nursery production.

The most common reason for overirrigation is lack of uniform coverage. Sprinklers should be placed ***head-to-head*** to achieve maximum uniformity. This means that the distance between sprinkler heads is equal to the ***spray radius*** of the heads. For example, if the spray radius of sprinkler heads in a zone is 15 feet, the heads should be spaced 15 feet apart. This also means that sprinklers are required in all corners to achieve uniform coverage.

Microirrigation Systems

One of the most efficient and effective watering methods currently available for landscape purposes and large container plant production is microirrigation, which includes both ***drip*** and ***microspray*** irrigation. Low-pressure emitters (that is, nozzles that drip, spray, or sprinkle) are attached to small plastic tubing and are designed for slow release of water to smaller areas, frequently to the soil around individual plants.

Since microirrigation applies water to individual containers or plants near the growing substrate surface, it infiltrates quickly. Thus, less water is used than in overhead watering systems. The pumping station and pipe size requirements are also smaller for a drip system than for overhead, resulting in relative cost savings. Both water and nutrients can be delivered efficiently. Evaporation is greatly reduced with low-volume irrigation so the application efficiency may be as great as 90% to 95%. Therefore, water conservation and energy conservation are accomplished by using microirrigation.

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Figure 9. Microirrigation system in greenhouse production.

Micro-irrigation systems (also known as low-volume irrigation) can have many benefits, including

- Decreased water loss from evaporation, wind and runoff.
- Minimized pest problems, such as weeds and diseases, by applying water to the root area of the plant.
- Increased water application efficiency when retrofitting in-ground sprinkler systems.
- Flexibility in meeting variable water needs of new, maturing and established plants.
- Minimized erosion when watering plants on steep slopes.
- Compliance with local water conservation codes and ordinances.

A risk with microirrigation is poor water quality that may clog emitters, regardless of the style. Clogging can be reduced if filters are installed in the system. Filtering well water and surface water is strongly recommended. Another very common risk with microirrigation is the use of inaccurate numbers of emitters or the improper placement of emitters required to support the plant's water needs. This problem is compensated for by running the drip zone longer, which makes the system inefficient.

Subirrigation Systems

Subirrigation systems are an environmentally responsible alternative used to conserve water and reduce fertilizer use. They are used by greenhouse growers and in the interior plantscape. In subirrigation systems, water and nutrient solutions provided at the base of a container rises by capillary action through holes in the bottom, which is then absorbed by the growing media. After adequate absorption, the solution is returned to a storage tank to be recycled. These systems are adaptable to crops grown in pots or flats. Several basic types of subirrigation systems are used for potted plants in greenhouses.

A ***capillary mat system*** places pots on a thick mat that is kept constantly wet with a nutrient solution. The mat is placed on a level bench over a layer of plastic. Water is supplied from drip tubes laid on top of the fabric. Water is absorbed into containers as needed by capillary action. Other systems incorporate watertight benches, troughs or floor systems through which water and nutrient solutions can be circulated for bottom watering.

Sub-irrigated planters are specially adapted containers used in the interior landscape. Water is introduced from a bottom reservoir that is subsequently soaked into the media through capillary action, usually with the aid of a wick and sometimes regulated by a sensor tip. This creates the opportunity to automate watering, and makes sub-irrigated planters popular for indoor plantings. One disadvantage of the closed system in these containers is that soluble salts cannot be flushed into the lower soil profile causing build up over time.

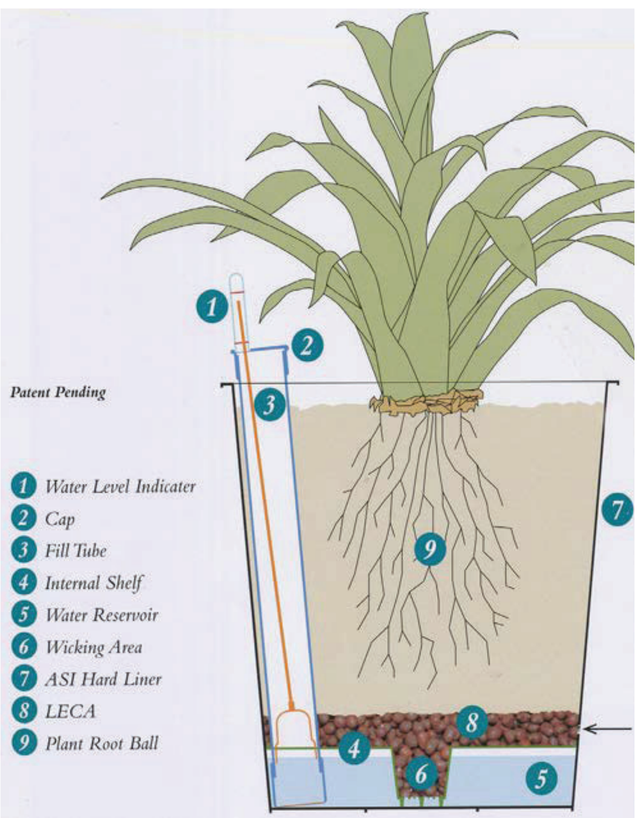

photo courtesy of architectural supplements

Figure 10. Concept of subirrigation in interior planters. When indicated by a float gauge, water is added to a hidden reservoir beneath the planter. Water is drawn into the growing media through wicking material submerged in the water reservoir as needed by capillary action.

Advantages of subirrigation systems are water and nutrient conservation because solutions are contained and recycled, uniform water application is provided to all containers, foliage remains dry reducing potential disease problems, and labor input is possible. A few disadvantages include high cost of initial system installation and the possibility of increased presence of disease in recycled water.

Consequences of Improper Design

There are many possible consequences of the improper design of irrigation systems including factors relating to

1) Public health if backflow prevention systems are not properly designed or installed.
2) Waste of natural resources including water, chemicals, and the energy required for pumping if systems are not properly designed and thus water cannot be applied uniformly.
3) Pollution of water supplies if poor system design results in nonuniform water or chemical applications and leaching of chemicals to the water supplies.
4) Operator safety if components are not properly selected and installed.
5) Cost of irrigation if total annual fixed and operating costs are not considered.

Figure 11. Poorly-designed irrigation systems waste resources.