Water Conservation and Quantification of Water Demands in Subdivisions

A Guidance Manual for Public Officials and Developers

Prepared by
Brian C. Wilson, P.E.

New Mexico State Engineer Office
Technical Report 48
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1. PURPOSE

To facilitate the review and approval process of new subdivisions, and to prevent the establishment of subdivisions with inadequate: water supply and fire suppression systems; liquid and solid waste disposal; gas, electric, and telecommunication services; and roads; and to mitigate risks to the public health and welfare and the pollution of water resources, it is imperative that development guidelines which can be consistently applied in every county and locale throughout the state be made available to county planners, county commissions, developers, and state agencies.

The purpose of this document is to provide guidelines for the preparation and review of subdivision water supply proposals and associated water right applications. Criteria upon which an evaluation of such proposals may be made by the reviewing authority are presented for Water Conservation Measures, Water Demand Analysis, Design Requirements for Community Water Distribution Systems, and Water Right Requirements and Limitations.

2. THE NEW MEXICO SUBDIVISION ACT NMSA 1978, AS AMENDED IN 1995

2.1. Classification of Subdivisions

Type One: 500 or more parcels, any one of which is less than 10 acres.
Type Two: 25-499 parcels, any one of which is less than 10 acres.
Type Three: 24 or less parcels, any one of which is less than 10 acres.
Type Four: 25 or more parcels, each of which is greater than 10 acres.
Type Five: 24 or less parcels, each of which is greater than 10 acres.

2.2. Statutory Responsibilities of County Commissions

Section 47-6-9(A) requires that County Commissions adopt regulations setting forth the County's requirements for: (1) water conservation measures; (2) quantifying the maximum annual water requirements of subdivisions, including water for indoor and outdoor uses; (3) assessing water availability to meet the maximum water requirements of subdivisions; and (4) water of an acceptable quality for human consumption and for protecting the water supply from contamination.

Section 47-6-9(C) requires that Bernalillo, Dona Ana and Santa Fe counties adopt regulations pursuant to Section 47-6-9(A) on or before July 1, 1996; and **Section 47-6-9(D)** requires that all other counties adopt regulations by July 1, 1997.

Section 47-6-9(E) states that nothing in the New Mexico Subdivision Act shall be construed to limit the authority of counties to adopt subdivision regulations with requirements that are more stringent than the requirements set forth in the Subdivision Act, provided the County has adopted a comprehensive plan in accordance with Section 3-21-5 NMSA 1978 and those regulations are consistent with such plan.

Section 47-6-11(C) requires the County Commission to: (1) determine whether the subdivider can fulfill the proposals in his disclosure statement required by Section 47-6-17; and (2) determine whether the subdivision will conform with the New Mexico Subdivision Act and the County's subdivision regulations.

2.3. Statutory Responsibilities of the State Engineer Office

Section 47-6-10(A) requires that prior to adopting, amending or repealing any regulation, the County Commission shall consult with representatives of the State Engineer Office to give consideration to the conditions peculiar to the county and submit written guidelines to the County Commission for its consideration in formulating regulations governing subdivision water supply requirements.

Section 47-6-11(F)(1) requires that for preliminary plat approval of Type-One, Type-Two, Type-Three (except for those with 5 or less parcels--these are subject to summary review procedures), and Type-Four subdivisions, County Commissions request an opinion from the State Engineer to determine: (a) whether the subdivider can furnish water sufficient in quantity to fulfill the maximum annual water requirements of the subdivision, including water for indoor and outdoor domestic uses; and (b) whether the subdivider can fulfill the proposals in his disclosure statement concerning water, excepting water quality.

Prior to final plat approval of Type-Three subdivisions with 5 or less parcels, and Type-Five subdivisions, County Commissions may request an opinion from the State Engineer, however, this is not specifically required by the Subdivision Act.

Section 47-6-20(A) states that any public agency receiving a request from the County Commission for an opinion pursuant to Section 47-6-11 shall provide the Commission with the requested opinion within the time period set forth in Section 47-6-22(A). The County Commission shall provide the appropriate public agency with all relevant information that the Commission has received from the subdivider on the subject for which the Commission is seeking an opinion. If the public agency does not have sufficient information upon which to base an opinion, the public agency shall notify the Commission.

Section 47-6-20(B) states that all opinion requests mailed by the County Commissions shall be by certified mail "return receipt requested." County Commissions delivering opinion requests shall obtain receipts showing the day the opinion request was received by the particular public agency.

Section 47-6-11(H) states that if in the opinion of the appropriate public agency, a subdivider cannot fulfill the requirements of Section 47-6-11(F), or if the agency does not have sufficient information upon which to base an opinion: (1) the County Commission shall give the subdivider a copy of the opinion; (2) the subdivider shall be given 30 days from the date of notification, to submit additional information to the public agency through the County Commission; and (3) the public agency shall have 30 days from the date the subdivider submits additional information to change its opinion, or issue an opinion if none was previously offered due to insufficient information. Where the public agency has rendered an adverse opinion, the subdivider has the burden of showing that the adverse opinion is incorrect either as to factual or legal matters.

2.4. Time Limit on Administrative Action

Section 47-6-22(A) states that all opinions required of public agencies shall be submitted to the County Commissions within 30 days after the public agencies receive the written request and accompanying information from the County Commission. If the County Commission does not receive an opinion with the 30 day period, the Commission shall proceed in accordance with its own best judgement concerning the subject of the opinion request. The failure of a public agency to provide an opinion when requested by a County Commission does not indicate that the subdivider's provisions concerning the subject of the opinion request were acceptable or unacceptable or adequate or inadequate.

2.5. Contents of Disclosure Statement

Section 47-6-17(B) requires that the disclosure statement for subdivisions with not fewer than 5 and not more than 100 parcels include: (1) a statement describing the maximum annual water requirements of the subdivision, including water for indoor and outdoor domestic uses, and describing the availability of water to meet the maximum annual water requirements; (2) a statement describing the quality of water in the subdivision available for human consumption; (3) a description of the means of water delivery within the subdivision; and (4) the average depth of water within the subdivision if water is available only from subterranean sources.

Section 47-6-17(C) requires that the disclosure statement for subdivisions with 100 or more parcels shall contain all of the information required in Section 47-6-17(B)

3. PROTOCOL FOR SUBMISSION OF PROPOSALS AND COMMENTS FROM PUBLIC AGENCIES

Subdivision proposals prepared by developers and their consultants are normally submitted to the office of the County Commission where they are date stamped. The Commission then prepares a cover letter and sends proposal packets to the appropriate public agencies for review and comment by certified mail with return receipt requested.

The Subdivision Act specifically requires proposals to be routed through the County Commission to ensure that they have an opportunity to review and comment on all correspondence pertaining to the subdivider's proposal, and to ensure that all correspondence is entered into the public record so that it may be examined by members of the public.

In instances where time is critical, the State Engineer Office may provide its opinion directly to a subdivider if the County Commission is contacted by the State Engineer Office, and the Commission agrees that such action is prudent under the circumstances.

4. REQUIRED CONTENTS OF SUBDIVISION PROPOSALS

Except for those subdivisions which are subject to summary review procedures (See Section 2.3), a subdivision proposal should generally include the following documents:

(1) Executive Summary, including:
  - (a) location by township, range, and sections, or land grant, and proximity to existing communities and transportation routes
  - (b) number of lots; minimum, maximum, and average lot size; total acreage in each phase of development; projected time frame for project completion
  - (c) type of dwellings to be constructed, e.g. single family detached, or multi-family including apartments, condominiums, and townhouses
  - (d) overview of community facilities that will be provided
  - (e) a paragraph summary for each of Items (3)-(11) which follow

(2) Disclosure Statement

(3) Land and Water Use Covenants and Restrictions, including water conservation measures

(4) Water Supply Plan, including, if appropriate:
  (a) water demand analysis
  (b) preliminary engineering plans
  (c) letter from water purveyor
  (d) proof of an existing water right
(5) Water Availability Assessment, including, if appropriate:
  (a) well records, including drilling logs
  (b) history of observed water levels and well yields
  (c) aquifer pump test data, including drawdown and recovery tables
  (d) description and results of computer models
(6) Water Quality Analysis, including results from laboratory analysis of primary and secondary contaminants
(7) Fire Protection Plan, including, if appropriate, letter from the local fire authority having jurisdiction
(8) Liquid Waste Disposal Plan, including, if appropriate, letter from wastewater utility
(9) Solid Waste Disposal Plan, including if appropriate, letter from sanitation utility
(10) Terrain Management Plan, including:
  (a) soil survey and land use limitations
  (b) grading plan
  (c) flood plain management plan
  (d) drainage plan
  (e) erosion control plan
  (f) landscaping and revegetation plan
(11) Transportation Plan, including, if appropriate:
  (a) traffic impact analysis
  (b) specifications for road construction
  (c) specifications for lighting, signage, speed limits, and traffic control signals
  (d) letters from appropriate transportation authorities
(12) Vicinity map showing location and boundaries of the subdivision relative to existing communities, transportation routes, and natural features
(13) Site plan (plat) showing lot envelopes and location of wells if a community water system is proposed

The State Engineer Office is responsible for reviewing Items (1)-(5) and (7). Items (6), (8) and (9) are reviewed by the New Mexico Environment Department. Item (10) is reviewed by the local Soil and Water Conservation District Office; and Item (11) is reviewed by the New Mexico Highway Department.

5. PROTOCOL FOR REVIEW OF PROPOSALS

County Commissions should examine proposal packages received to determine if all required documents have been included before copies are distributed to public agencies for review and comment. This can prevent unnecessary delays in the review process. Upon receiving a proposal from a County Commission, the State Engineer Office date stamps the proposal packet and then examines it to determine if all of the documents required by the county subdivision regulations for the type of subdivision proposed have been included. If there are omissions, the County Commission is contacted to obtain the missing documents. Complete proposals are then routed to the appropriate section in the agency for evaluation.

The first document examined in the proposal package is generally the disclosure statement. The disclosure statement should be comprised of concise factual responses, carefully tailored to provide prospective lot purchasers with information required to make an informed decision. The proposed means of providing water to the subdivision will determine what additional information should be included in the disclosure statement to conform with the state and county subdivision regulations. Omissions or inadequate responses are carefully noted.

To determine if the information presented in the disclosure statement is accurate and reliable, the next documents to be examined are the land and water use covenants and restrictions. Any restrictions that will affect water use will be important in evaluating the water demand analysis, and should also be reflected in the disclosure statement. Contradictions or omissions are carefully noted.

Having gained an overview of the proposed restrictions which may affect water use, the water demand analysis is reviewed to determine if it is technically correct and reasonable. Sources of data and all assumptions should be documented. Deficiencies in documentation, erroneous assumptions, omissions, and all computational errors are noted. In addition, if a letter is required from a water purveyor indicating they are ready, willing, and able to provide water to a proposed subdivision, and if a letter is required from the County Fire Marshall or local fire fighting unit, these documents are examined and any conditional requirements that the subdivider will have to qualify for the service applied for are noted. It is important that the water demand analysis be complete and accurate, because the estimate of the maximum annual water requirement is important in determining the amount of the water right required, where applicable, and, because it will be an essential element in the water availability assessment. Flow rates computed in the water demand analysis for average day, maximum day, and maximum day plus fire flow are important in sizing pumps, pipelines, and storage tanks.

The proposal is then examined for proof of an existing water right sufficient to meet the maximum annual water requirement. The State Engineer may question water right claims to determine if they have been exercised in accordance with state law and court decisions, and this may require the evaluation of a water right to determine if it is still valid after successive years of non-use. If the subdivider does not have a water right, or his water rights are inadequate, this is noted. If change of ownership of a water right, or an application to change the point of diversion, or place or purpose of use is required, this is investigated to determine if the subdivider has filed an application with the

Water Rights Division of the State Engineer Office to do so, and whether or not such application has been approved.

After reviewing the water demand analysis, the water availability assessment is evaluated, to determine if it is complete, accurate, technically sound, and the conclusions reasonable. The primary purpose of this evaluation is to determine whether or not the subdivider can demonstrate that sufficient water is available to meet the demand for the proposed subdivision in the long-term. Where water is extremely scarce, it is of the utmost importance to determine how much water can be practically recovered, and whether or not the yield, which may diminish over time, will be sufficient to meet the projected demand. Data in the water availability assessment is compared with data in the water demand analysis and disclosure statement to make sure they are consistent.

Water quality data is reviewed to determine whether drinking water standards established by the U.S. Environmental Protection Agency (USEPA) are met. If acceptable contaminant levels are exceeded, the water supply may not be suitable for drinking water. Secondary water quality parameters such as iron, sodium, sulfate, hardness (calcium and magnesium), pH, total dissolved solids, and odor, which are not regulated by USEPA, may also need to be analyzed to determine if there is a potential problem and whether or not the more stringent water quality standards adopted by some counties are met. While the New Mexico Environment Department (NMED) is responsible for the water quality review, State Engineer Office staff also review the water quality data to determine if there is a need for water softening or other treatment that may effect the water demand, and to note any details that may be important in the water availability assessment.

Upon completing the review of the proposal, all notes are compiled into a memorandum in which the State Engineer offers an opinion as to whether or not the subdivider can provide water sufficient in quantity to fulfill the maximum annual water requirements of the subdivision and whether the subdivider can fulfill the water supply proposal in his disclosure statement. A cover letter is then prepared, and the completed memorandum is transmitted to the appropriate county officials by certified mail.

Time permitting, State Engineer Office staff may attend County Commission meetings where subdividers present their proposals, to present the State Engineer's opinions on proposals, field questions from the Commission and the public, and to note any specific concerns expressed by those present which may require further investigation by State Engineer Office staff.

6. WATER CONSERVATION MEASURES

Water conservation may be defined as any beneficial reduction in water use or water losses (American Public Works Association, 1981; Prasifka, 1988). Water waste may be defined as the indiscriminate, unreasonable, or excessive running or dissipation of potable water; and non-essential water use may be defined as the indiscriminate, or excessive dissipation of potable water which is unproductive, or does not reasonably sustain economic benefits or life forms, where there is a shortage of potable water (Monterey Peninsula Water Management District, 1988).

Drought is not the only circumstance under which water shortages occur. Population growth or migration can also cause shortages by overburdening water supplies that were once abundant. Thus, water conservation is an important consideration in water supply planning for any new subdivision. Reducing the water demand in subdivisions may add years to the life of aquifers that are being mined, reduce the cost of wastewater treatment, save energy, postpone or eliminate the expansion of water treatment and distribution systems, and decrease the volume of wastewater discharged into rivers and streams.

Indoor water use can be reduced without household members having to make any changes in their daily habits by installing water-saving plumbing fixtures and appliances in new construction. Outdoor water use can be kept to a minimum by installing low-water use landscaping and by careful consideration of any use of hot tubs, swimming pools and water gardens. Controlling excessive water pressure, metering and rate structures (water pricing), and the establishment of a good accounting and auditing system, may be integrated into the design and operation of water systems to reduce water waste.

The purpose of this section is to describe practical water conservation criteria for the design of subdivisions. These criteria can be applied to single-family homes, apartments, condominiums, townhouses, and mobile home parks.

6.1. Indoor Plumbing Fixtures

6.1.1. Toilets. In the United States, most toilets used 7.0 to 8.0 gallons per flush (gpf) until the 1950s, when the 5.5 gpf toilet entered the market; by the early 1980s, the 3.5 gpf toilet became the standard (Vickers, 1989, 1990.). These figures do not include toilet leakage, which is estimated to be as high as 20%. **The National Energy Policy Act of 1992 (NEPA) now requires that toilets manufactured after January 1, 1994 for dwelling units, use no more than 1.6 gpf.** It may be of interest to note that the average family of four flushes 16 to 28 times per day; and 6 flushes per capita per day is a reasonable assumption for estimating water use (Brown and Caldwell, 1984; Karpiscak, 1990).

6.1.2. Showerheads. The maximum flow rate of pre-1980 showerheads in the United States is 5.0 to 8.0 gallons per minute (gpm). However, studies indicate (Brown and Caldwell, 1984), that the average measured flow rate of pre-1980 showerheads is more often about 3.4 gpm because people run these showers at about two-thirds of maximum capacity. In the 1980s, 3.0 gpm showerheads became the industry standard. **NEPA now requires that the maximum flow rate of showerheads shall not exceed 2.5 gpm.**

6.1.3. Faucets. Conventional kitchen and bathroom faucets have a maximum flow rate of 3.0 to 7.0 gpm. **NEPA now requires that the maximum flow rate of kitchen and bathroom faucets shall not exceed 2.5 gpm, and 2.0 gpm faucets are recommended for bathroom sinks.** But, no matter how thrifty a faucet's flow rate, leaving the tap running constantly is really the most wasteful practice. There are faucets available however, which shut-off automatically, including some that use infrared sensors to detect any object that enters the beams' range.

6.1.4. Insulated Hot Water Pipes. Insulation reduces loss of heat from hot water pipes and reduces water wasted while users wait for the flow of hot water at the tap. A 1-4% reduction in water use and energy savings can result (Whipple, 1994, p. 57)

6.2. Appliances

6.2.1. Air Conditioners. An evaporative cooler (swamp cooler) installed in a 1,700 square foot single-family dwelling may consumptively use (evaporate) 10,758 gallons of water during a 1,130 hour cooling season in Albuquerque; and 16,355 gallons in a 1,718 hour cooling season in Las Cruces. (See Appendix B). Bleed-off water that is used to reduce mineral build-up on the pads inside the cooler may increase the total water use by 67% (Watt, 1986, pp. 105, 110) in coolers without pumped bleed-off recirculation. **To conserve water, evaporative coolers that recirculate bleed-off water, or refrigerated air conditioning systems, which require no water, can be installed in new construction; and bleed-off water from evaporative coolers without recirculation can be used for landscape irrigation.**

6.2.2. Dishwashers. To meet U.S. energy-efficiency standards, dishwashers manufactured since mid-1994 save energy by eliminating a hot water wash and rinse cycle, which reduces the total water use. Many of these models use about half the water that dishwashers used 20 years ago. Dishwashers manufactured in the U.S. use 7.5 to 12.5 gallons per wash in the normal cycle; European models which are typically more frugal with water, use 5.5 to 8.5 gallons (Consumer Reports, 1993, 1995a, 1995b). Note that a study conducted by Ohio State University showed that 16 gallons of water are typically used to hand wash 8 place settings and serving pieces (Buzzelli, 1991, p. 57). **To conserve water, low-water use dishwashers which require no more than 13 gallons in the regular cycle, and have a cycle adjustment which reduces the water used for small loads, can be installed in new construction.**

6.2.3. Hot Water Heaters. There are no noteworthy ways to save water in the selection or use of a typical hot water heater. However, installing a point-of-use water heater which produces hot water instantaneously, can reduce water waste (Buzzelli, 1991, p. 39). This can be especially important in homes or apartments where the hot water tank is a long way from the bathroom, and occupants have to run the water a long time before it gets hot enough for a bath or shower.

6.2.4. Washing Machines. To meet U.S. energy-efficiency standards, washing machines manufactured since mid-1994 save energy by eliminating hot water rinses, which reduces the total water use. In the regular cycle, top-loaders use 40 to 45 gallons per load; the front loaders 25 to 30 gallons. In the permanent-press cycle, water use increases by 5 to 10 gallons for top loaders, but is about the same for the front loaders (Consumer Reports, 1995a, 1995c). Some washers use as much as 68 gallons in the heavy duty cycle. Suds-saver washing machines which spew wash water into a tub or sink next to the machine, and then suck it up again to be reused for one or more additional wash-water fills can save laundry detergent and up to 17 gallons of water for each reuse (Consumer Reports, 1993). **To conserve water, low-water use washing machines which require no more than 43 gallons in the regular cycle and 53 gallons in the permanent-press cycle, and have a**

cycle or water-level adjustment which reduces the water used for small loads, can be installed in new construction.

6.2.5. Water Softeners. A softener is designed to remove hardness, i.e., calcium and magnesium, the minerals that lead to soap-curd deposits in the bathtub and sinks, dull-looking laundry, spots on dishes, scaly deposits on faucets and showerheads, and scale inside the water heater and pipes. A softener is not intended to make water any safer to drink. Water requirements for regeneration vary from 15 to 120 gallons per 1,000 gallons of water softened (Consumer Reports, 1990). The Environmental Protection Agency (1980) has reported that water softener regeneration typically occurs once or twice a week, discharging 30 to 88 gallons per regeneration; and that water requirements for this purpose range from 2.3 to 15.7 gallons per capita per day (gpcd), but average about 5 gallons per capita per day (gpcd). A softener controlled only by a timer regenerates at regular intervals and may use more salt and water than necessary because they regenerate whether or not the resin needs it. On the other hand, demand-control softeners monitor water flow or changes in hardness to adjust regeneration more precisely to the actual demand for water. There are also softeners which have electronic controls, that can calculate the average number of gallons of water used in the previous 7 days or track abnormal variations in average water use, and call for regeneration accordingly. **To conserve water, product specifications can be compared and a softener selected that regenerates automatically with a low regeneration water requirement per 1,000 gallons of water softened.**

6.3. Landscaping

6.3.1. Xeriscape. In 1980, the Denver Water Department coined the term **xeriscape** as a systematic approach to landscaping to conserve water (Knox, 1989). Xeriscape, from the Greek word "xeri" for dry, is a style of landscaping based on seven common-sense steps to create a beautiful, yet low-water use landscape. A well-designed xeriscape minimizes the area in irrigated turf; only trees, shrubs, flowers and groundcovers with low water requirements are planted; and plants are zoned in the landscape according to their different water needs so they can be irrigated separately, and efficiently. The goal in developing a water wise landscape is to reduce the need for irrigation, irregardless of whether it is in turf or ornamental areas of the landscape. As the irrigated area is reduced, water savings increase. Xeriscape can reduce outdoor water use by 50% or more without sacrificing the quality and beauty of a home environment. It is environmentally sound, requiring less fertilizer and chemicals, and it is low-maintenance. The seven steps to xeriscaping are:

Step 1: Planning and Design. A landscape design is developed to suit homeowner's needs, life style, and climate. A well-planned xeriscape can increase the value of property and reduce water use. Prepare a site plan drawn to scale showing the location of the house, its orientation to the sun, other structures, utilities, and existing vegetation. Delineate those areas that will be developed for specific uses. Limit the disturbance of native vegetation on slopes and the perimeter of lots to eliminate the need for planting vegetation that must be watered. Divide the landscape into water use zones. High water-use zones are small, highly-visible areas, that receive the most care and require frequent watering. The high water-use zone is normally the area nearest to the house and is typically where most family activity occurs; plants in this zone are functional, i.e., attractive and durable, such as turfgrass. The moderate water-use zone blends verdant areas with the more arid parts of the landscape; plants in this zone are watered only occasionally. The low water-use zone requires the least care; plants are only irrigated during establishment (typically 12-18 months); and thereafter, they survive on rainfall only. It is important to avoid abrupt changes from low to high water-use zones because this results in overwatering along the edge of the low water-use zone.

Step 2: Soil Analysis. Evaluate the soil, including its structure, texture, water-holding capacity and drainage. The physical and chemical characteristics of the existing soil will determine the type of soil improvement needed. When most homes are built, the soil around them is usually altered. The area against the foundation of the house is especially likely to be filled with poor soil and debris and may be far from ideal for growing turf, perennials and other plants.

Step 3: Appropriate Plant Selection. Select plants that are well-suited to the site and local environment. Soil type and exposure to direct sunlight are important considerations. Match the water use zones with the condition of the planting site. Place high water-use plants in areas of the landscape that stay moist, and low water-use plants in areas that stay drier naturally. In order to avoid waste, plants with similar light and water requirements should be grouped together. The irrigation system should then be designed to deliver the amount of water that each grouping needs to be healthy.

Step 4: Practical Turf Areas. Use turf for a specific function or aesthetic benefit. A small "oasis" of turf near the entrance to the home or a playing surface of durable turf in recreational areas, are all examples of practical turf areas. Avoid planting a steep slope with turf because it will be difficult to water and maintain sufficient soil moisture to keep the turf green (Christopher, 1994, p. 63). Design turf areas in practical shapes that can be efficiently irrigated and maintained. Avoid sharp angles and long narrow strips that are difficult to mow and water (Christopher, 1994, p. 63; University of Georgia, 1992, p. 10). Minimize the area of irrigated turf where possible; restrict turfgrass to low-water use varieties that are well adapted to the climate, soil, exposure, intended use, and expected level of care they will receive. Acclimation to sunny or shady exposures, heat, frost and drought tolerance, resiliency under wear, aesthetic appeal, and maintenance requirements--cutting, watering, fertilizing, and weeding, are all important considerations in selecting a turfgrass.

Step 5: Efficient Irrigation. A water-wise landscape requires a minimal amount of irrigation water, and water should be applied efficiently and effectively to make every drop count. Just as plants are zoned in the landscape according to their different water needs, zone the irrigation system so that plants with different water needs are irrigated separately. Water turfgrass, for instance, separately from shrubs and flowers. Using irrigation water efficiently also requires the selection of an appropriate type of irrigation system for the plants and for each area of the landscape. Trees and shrubs in the low water-use zone would need supplemental water only during establishment, while plants in moderate water-use zones require water only during periods of limited rainfall. For these plants, a temporary system such as a soaker hose or hand watering may be all that is required. On the other hand, high water-use zones require frequent watering and may warrant a permanent system with automatic controls. Whenever possible, use highly efficient watering techniques, such as drip irrigation. Soil moisture sensors such as gypsum blocks and tensiometers may be used to determine when to irrigate. Irrigation controllers may be used to water plants on time and in sequence, day by week by month, but they must be properly programmed to reflect seasonal changes in plant water requirements, otherwise water may be wasted. Bermadon valves are generally preferable to clock-type controllers; the Bermadon valve must be turned on manually but it turns itself off after a set amount of water passes through it (Christopher, 1994, p. 38). Sensors which automatically turn the irrigation system off if rain falls or if the soil is too wet to need watering, can improve irrigation efficiency and reduce waste. Considerable water savings can be realized by studying the water needs of plants, breaking bad watering habits, and learning how to water, when to water, and the most efficient ways to water. Use the following guidelines for lawn watering: (1) Water only when the grass really needs it; (2) deep-soak the roots and water less frequently--daily sprinkling may result in a shallow root system and weakens the grass, making it more susceptible to disease and more fragile in dry conditions and during winter; (3) water during the cool, early morning hours to minimize evaporation; (4) avoid watering on windy days to minimize wind drift and evaporation; (5) aim sprinklers--don't waste water on open dirt, sidewalks or driveways; (6) adjust sprinklers to throw a low pattern of water to minimize evaporation; and (7) monitor the amount of water applied (Buzzelli, 1991, p. 89).

Research conducted by the Rodale Institute indicates that for uniformity, efficiency, and range (distance) of coverage, the impulse- or impact-type sprinklers are the best (Ellefson, 1992, p. 107). Inexpensive revolving sprinklers (with revolving arms that move by water pressure), as well as fixed sprinklers that shoot water through a pattern of holes in their tops, give the least uniform coverage, often leaking and/or distributing most of the water near the sprinkler. Oscillating sprinklers cover a square area, but often deposit too much water at the ends of their oscillations, where they pause to reverse direction. In addition, though oscillating sprinklers may be great for children to play in, throwing water high in the air increases evaporation and wind drift losses. Traveling sprinklers (the ones that look like little tractors) have revolving arms and move across the lawn for better distribution and efficiency.

Step 6: Use of Mulches. Mulching is a very beneficial landscape practice. Mulches conserve moisture by preventing evaporative water loss from the soil surface and reducing the need for irrigation during periods of limited rainfall. By maintaining an even moisture supply in the soil, mulches prevent fluctuations in soil moisture that can damage roots. Mulches also prevent crusting of the soil surface and allow water to penetrate readily to plant roots. They insulate the roots of plants from summer heat and winter cold and help control weeds that compete with plants for moisture. By serving as a barrier between the plant and soil, mulches help discourage soil-borne diseases that stress plants and cause them to use more water. A 3-4 inch depth of mulch is normally optimum. Depending on the mulch and growing conditions, a depth greater than 5 inches will discourage plants from growing and retard the percolation of water down to the soil. Use fine-textured, organic non-matting mulches when possible. Fall leaves, pine straw pine bark nuggets, and shredded hardwood bark are excellent choices. Mulch as large an area as possible under trees and shrubs. Islands of unplanted mulch require no water and little routine maintenance.

Step 7: Appropriate Maintenance. Keep plants healthy, but do not encourage water-demanding new growth. Once plants are established, reduce the amount of nitrogen applied as well as the application rate and frequency of application. Avoid plant stress by mowing properly, by thinning shrubs instead of shearing, and by controlling weeds and pests before they affect plant health.

6.3.2. Landscape Design Requirements

In the text which follows, a procedure to implement a program for landscape requirements in new developments is presented. Model landscape ordinances which have been effectively implemented by water utilities and districts in the U.S. are included in Appendix A.

Procedure for Enacting an Ordinance
Governing Landscape Design Guidelines
(Center for the Study of Law and Politics, 1990, p. 61)

Step 1: Prepare an ordinance for adoption and use it as a part of city or county building permit approval process. The ordinance may include:

(1) Limits on turf area size by percentage of landscapable area (typically 20-50%). The landscapable area is the total lot or project area less the footprint of all buildings, driveways, non-irrigated portions of parking lots, hardscape such as decks, patios, walkways, and other non-porous paved areas, and utility easements. Water features are included in the calculation of landscapable area, but areas dedicated to the production of food crops such as vegetable gardens and orchards are not (California Department of Water Resources, 1992, p. 8).

(2) The prohibition of turf and high water-using plants in areas next to buildings, along narrow pathways or median islands, in the drip line area of native trees, or in sloping locations.

Step 2: Prepare landscaping design guidelines, which are a detailed explanation of how landscapers can comply with the ordinance. Include:

(1) A list of plants with low water requirements

(2) Descriptions of the recommended types of irrigation control systems, methods of irrigation, soil preparation methods, lower water-use varieties of turf, a maintenance and watering schedule, and proper placement of plants in the landscape. Remember that plants with similar light and water needs should be grouped together.

Step 3: Present the ordinance and guidelines to city and county governments for review and comment. Solicit comments from landscape architects, planners, developers, and water purveyors and incorporate comments received into the proposed ordinance and guidelines.

Step 4: Adopt the ordinance and guidelines. Incorporate them into the building permit approval process and apply them to all new construction.

Step 5: Enforce the ordinance and guidelines. Landscape design requirements are most effective when accompanied by a design review service offered through the city or county planning office, or local water utility. Such services can help subdividers and homeowners develop landscaping plans that are consistent with community water conservation goals. Some communities designate review boards, usually consisting of landscape architects or planners, to evaluate and approve landscape designs for certain types of new development. For example, a city or county may use a review board to ensure that new landscaping and irrigation systems comply with its xeriscape requirements. After the landscape project has been completed, the site is visited and a certificate of compliance is issued if all landscape design requirements are met. To provide an incentive for low water use landscaping, a credit or rebate may be offered toward the connection fee if homeowners comply with landscaping guidelines.

A prototype for landscaping guidelines which must be met to qualify for a rebate is presented in the text which follows.

Prototype for Landscape Rebate Program Requirements
(Center for the Study of Law and Politics, 1990, p. 69)

(1) There is 20% less turf area than traditional landscapes and not more than:
- 800 square feet of irrigated turf per single-family detached dwelling
- 500 square feet of irrigated turf per condominium or townhouse
- 300 square feet of irrigated area per apartment or mobile home dwelling

(2) Not more than 40% of the total irrigated landscaped area is turf.

(3) In planned unit developments, turf areas are consolidated into large, relatively flat areas creating "oases of green" surrounded by dwelling unit clusters, thereby producing the greatest visual impact and optimizing irrigation efficiency. Turf is not used adjacent to building foundations, along narrow paths or median strips, or within the drip line of native trees.

(4) Low water-use shrubs and ground covers are used in landscaped areas where turf is not used.

(5) Water-loving plants generally are confined to drainage areas and patios or other intensively used or highly lighted areas.

(6) Rock plants and other colorful low water-use plants are used to add seasonal color highlight, visual interest, and balance.

(7) Prior to landscaping, soil tests are conducted, and the ground is carefully prepared. At a minimum, ground beneath planting is scarified and covered with a mixture of not less than 4-6 inches of topsoil amended with at least 4 cubic yards of organic material per 1,000

square feet and other soil amendments in a quantity and type approved by a landscape architect.

(8) Well-designed underground sprinkler systems are installed in landscaped areas. Turf heads are on a system that is separately controlled from shrub and other nonturf areas. Design of the turf-area system provides uniform application. Low-discharge heads are used in nonturf areas or where slopes present a runoff problem. Automatic water timers and rain sensing shut-offs are used at all stations.

(9) In nonturf areas, a 3-inch surface layer of organic mulch is installed around all plants except for low ground covers.

6.3.3. Training Landscape Maintenance Personnel. A training program for landscape maintenance personnel will make them much more effective water conservers. A training program should include:

Irrigation scheduling. This should include an overview of the water requirements of different species of plants, signs of plant stress, use of soil probes and soil cores to check soil moisture, installation and use of soil moisture sensors such as gypsum blocks and tensiometers, determination of how much water to apply, best time of day to irrigate, duration of irrigation, and use of automatic controllers to turn water on and off.

Irrigation system maintenance. How to spot problems in irrigation equipment and make, contract for, or recommend to site managers the needed repairs.

Landscape maintenance practices that reduce the need for irrigation water. These practices include:

(1) Proper height for turf mowing
(2) Proper frequency of turf aeration and thatching to increase water retention
(3) Proper fertilization schedule to maintain plant health and drought tolerance
(4) Soil preparation and mulching practices to increase water retention

6.3.4. Irrigation with Reclaimed Wastewater

A complete evaluation of all the factors involved in the reuse of reclaimed wastewater must be performed to determine if it is feasible to use such waters for landscape irrigation in a proposed subdivision, and the results of the feasibility study should be thoroughly documented in the subdivision proposal. A general overview of this subject is provided in the text which follows. More detailed information may be obtained from federal guidelines, state regulations, municipal ordinances, engineering texts, and journal articles.

Regulation. There are no federal standards governing water reuse in the U.S., however, the U.S. Environmental Protection Agency has published guidelines for water reuse (USEPA, 1992) that address all important aspects of water reuse, including recommended wastewater treatment processes, treatment reliability provisions, reclaimed water quality limits, monitoring frequencies, setback distances, and other controls for various water reuse applications. Regulations that do exist have been developed at the state level, and these normally include acceptable levels of constituents of reclaimed water and prescribe means for assurance of reliability in the production of reclaimed water to ensure that the use of reclaimed water for the specified purposes does not impose undue risks to health (Crook, 1994, p. 67). Higher treatment standards are usually specified for the irrigation of food crops, golf courses, parks, and playgrounds, than for forage produced for non-milk-producing cattle, and roadway landscaping. Where the risk of human exposure is high, regulations may specify treatment and water quality requirements that will produce an effluent that is essentially free of measurable levels of pathogens, including viruses. General guidelines for the reuse of domestic wastewater in New Mexico have been prepared by the New Mexico Environment Department, and these may be obtained by contacting that agency.

Water Quality. The presence of toxic chemicals and pathogenic microorganisms in untreated wastewater creates the potential for adverse health effects where there is contact, inhalation, or ingestion of chemical or microbiological constituents of health concern. Thus, acceptability of reclaimed water for landscape irrigation depends on its physical, chemical and microbiological quality. The quality of reclaimed water depends on the source water quality, wastewater treatment processes and treatment effectiveness, treatment reliability, and distribution system design and operation. Factors that affect the source water quality include use of water softeners (increases sodium) and detergents (increases boron) in dwelling units, presence of industrial waste, infiltration into the sewage collection system, and seasonal variations in flows caused by stormwater.

Treatment Reliability. The need for reclamation facilities to reliably and consistently produce and distribute reclaimed water of adequate quality and quantity is essential and dictates that careful attention be given to reliability features during the design, construction, and operation of the facilities. Reliability requirements include standby power supplies; alarm systems; multiple or standby treatment process units and equipment to prevent treatment upsets during power and equipment failures, flooding, peak loads, and maintenance shutdowns; emergency storage or disposal of inadequately treated wastewater; elimination of treatment process bypassing; design flexibility of piping and pumping to permit rerouting of flows under emergency conditions; monitoring devices and automatic controllers; and provisions for uninterrupted chlorine feed. Non-design reliability features include provisions for qualified personnel, an effective monitoring program, a quality assurance program, and an effective maintenance and process control program (Crook, 1994, pp. 60-61, 70). An industrial pretreatment program and enforcement of sewer use ordinances to prevent illicit dumping of hazardous materials into the collection system, are generally required to ensure treatment reliability.

Conveyance and Distribution Facilities. The distribution network includes pipelines and appurtenances, pumping stations, and storage facilities. The major concern which guides design, construction, and operation of a reclaimed water distribution system is the prevention of cross-connections. A cross-connection is a physical connection between a potable water system and any source containing nonpotable water through which potable water could be contaminated. Another major concern of regulatory agencies is improper use or inadvertent use of reclaimed water. Typical regulatory controls to prevent cross-connections and intentional or unintentional misuse of reclaimed water include the following: color-coding of pipes and appurtenances (pumps, outlets, and valve boxes); horizontal and vertical separation of potable and reclaimed water lines; prevention of ability to tie into reclaimed water lines; backflow protection devices on potable water lines; and pipeline design and construction criteria (Crook, 1994, p. 61-62). The color purple is generally used to identify reclaimed water lines and appurtenances. Other design, operation, and safety requirements include: certified operator on duty at reclamation plant 24-hours per day; adequate storage or rerouting of excess flows during rainy periods and winter months; lining of detention ponds; key operated valves and outlets; use area controls including groundwater monitoring, surface runoff control, and prohibition of irrigation when the ground is saturated or frozen; fencing; signs; setback distances (from dwellings, public roads, wells, and reservoirs); control of windblown spray; and provisions for worker protection (Crook, 1994, p. 70-71). It is important to emphasize that in locales where groundwater is the source of potable water for residents, the installation of groundwater monitoring wells will be necessary to determine the impact, if any, of the application of reclaimed water on water quality and water levels.

Water Rights to Reclaimed Water. It is important to establish who has the legal right to the water--the supplier of the water entering the wastewater treatment plant, the treatment plant owner, or the public. The reuse of wastewater is subject to the administrative requirements which normally apply to changes in freshwater diversions, and the impact on return flow and downstream users must be taken into consideration. Depending upon the situation, it may be necessary to file an application with the State Engineer Office for a new appropriation of water, or to change the place and purpose of use.

Feasibility Studies. Before a plan for the reuse of reclaimed water is adopted as a part of a new subdivision development, a feasibility study should be prepared that would include an evaluation of environmental regulations; ownership, appropriation of water rights, and impact on return flow; legal liability; quality of water required for the proposed use; contractual provisions which set forth the responsibilities and liabilities of the provider and users; public acceptance; past reuse experience; environmental conditions (climate, soil, topography, groundwater levels and quality) at the point of use; economics; and technical feasibility. Conditions that must be met before reclaimed water is a viable option generally require that the reclaimed water is of adequate quality for the use, considering all relevant factors; that it is provided at a reasonable cost to the user, which is comparable to, or less than the cost of potable domestic water; that the use will not be detrimental to public health; and that the use will not adversely affect downstream water rights, will not degrade water quality, and is determined not to be injurious to plantlife, fish and wildlife (Thomas, 1994, p. 94-95).

6.3.5. Water Harvesting

Downspout Collection. A 1,000 square foot roof will yield 150 gallons of water during a 0.25-inch rain. By extending downspouts from gutters into the ground and adding on a section of solid pipe followed by a perforated pipe, water can be directed into planting beds.

Grading. Design paved surfaces to slope into turfgrass areas, planting beds, holding ponds, or cisterns; on steeply sloping sites, use terraces to slow down and collect the runoff; create small depressions or swales at the bottom of slopes to catch runoff (Ellefson, 1992, p. 104).

Collection Basins, Ponds, and Cisterns: These may be used to store runoff and should be lined with either hard-packed clay, concrete, or nonporous vinyl liners to prevent the water from percolating into the soil. A pump with a filtration system or gravity flow siphons can be used to withdraw water for landscape irrigation. Small cisterns, adequately elevated, work well with drip irrigated planting beds. Ponds and cisterns may also be a source of water for fire fighting provided that sufficient storage can be maintained. However, in regions that experience cold winters, ice cover may preclude the use of ponds and cisterns for this purpose.

Swales. These are long, level excavations, which can vary greatly in width and form from small ridges in gardens, rock piles placed across slope, or deliberately excavated hollows at the base of slopes or in flatlands (Mollison, 1992, p. 167). The purpose of a swale is to intercept overland flow, to hold it for a few hours or days, so that it can be absorbed by the soil and recharge the ground water. Swales are built on contour or on dead level survey lines, and it is important to emphasize that they are not designed to be a watercourse. The base is ripped, graveled, sanded, loosened, or dressed with gypsum to increase infiltration. Runoff from slopes, roofs, roads, and other paved areas, and flows in diversion drains, may be directed into the swale. The interswale may be left bare, however, it is generally seeded with cereal grasses and covered with a mulch to increase infiltration, reduce evaporation, and prevent soil erosion. Trees are normally planted on the outer banks, and will shed about 25% of their root system each year, and this, together with leaf litter and soil micro-organisms, becomes organic matter (humus), which increases water retention in the soil (Morrow, 1993, p. 42).

6.4. Recreational Water Facilities and other Water Features

It is recommended that the water use estimate for hot tubs, swimming pools, ponds, and water gardens be consistent with the procedure in Step 4 on page 23 of this manual, and be carefully considered in the water conservation measures for new subdivisions. From the perspective of water conservation, such facilities may be more appropriate where they will serve an aesthetic or recreational purpose which benefits all inhabitants of a community. Fountains or other types of decorative water bodies where water is sprayed into the air are discouraged.

6.5. Design and Operation of Water System

6.5.1. Pressure Reduction. Over-pressurized water systems can result in inefficient water use. Pressure-reducing valves (PRV) should be installed when static pressures exceed 100 pounds per square inch (psi) in the transmission lines and distribution mains, and where pressure exceeds 80 psi at customer meters. (Center for the Study of Law and Politics, 1990, p. 43; Great Lakes Upper Mississippi Board, 1987, p. 108; Rocky Mountain Institute, 1991, p. 26). The static pressure at a residential service connection where a PRV is installed will generally be maintained at 45-55 psi. Note that in some areas particularly where dwellings are built on slopes, differences in elevation and friction losses in the piping system may require working pressures at the street of up to 80 psi to ensure that automatic indoor fire sprinkler systems and landscape irrigation sprinklers function properly (American Water Works Association, 1989, p. 41). Pressure reduction at a service connection can reduce water use by 5% or more (Whipple, 1994, p. 57)

6.5.2. Metering. Metering is an essential element of any residential water-conservation initiative. Without water meters, individual users cannot tell how much water they are using or how much they are saving. By installing water meters and basing billings on water use, local utilities create a strong incentive for consumers to use less water. Metering is a more equitable means of billing for water use, and water-conserving customers will benefit directly. The cost of installing a water meter in new construction is generally much less than retrofitting a service connection with a meter later. Labor costs are the biggest factor in meter retrofit programs, and account for the cost variation. The cost of installing meters will generally be recovered in savings in the water purveyor's supply and delivery costs in 3 to 4 years.

6.5.3. Rate Structures (Water Pricing). It is important that water is priced to reflect the true cost of producing it. Water rates should be designed to recover all costs including construction of water supply facilities, heavy equipment, management, training, operation and maintenance, water quality laboratory tests, depreciation, interest on debt or capital, and taxes; and must provide for the establishment of a reserve fund for future improvements, extensions, and enlargements, and the replacement of system components that wearout with age. **The ability to recover all costs is extremely important in determining the viability of proposed new systems, or of old systems needing assistance (Whipple, 1995, p. 77)**. The rate structure should generate revenues sufficient to allow the utility to operate on a self-sustaining basis; provide assurance that there will be a stable and predictable stream of revenue over time and as circumstances change; and provide incentives for conservation (Mitchell, 1994, p. 13-14). Water subsidies and other price breaks lead to profligate water use. Flat rate billing systems do not promote water conservation, and metering without a use-based water rate will not reduce demand. To conserve water, customers should be billed on the basis of a fixed monthly charge plus a charge per unit of water used. An increasing block-rate structure may be effective in preventing waste. Water and sewer rates should not be lumped together so that water use can be monitored.

6.5.4. Recordkeeping and Water Audits. It is imperative that a recordkeeping system be established to monitor operation and maintenance costs, revenues, and the use of water. A water audit is a detailed examination of where and how much water enters the system, and where and how much leaves it. Water system audits facilitate the assessment of current water uses and provide data needed to reduce water losses, revenue losses, and forecast future demand. With this information, the water utility is better equipped to target conservation efforts and system improvements where they are most needed. Estimating and reducing unaccounted-for water is a major objective of a water system audit. Unaccounted-for water includes distribution-system losses through leaks, unmetered water delivered through fire hydrants, water taken illegally from the distribution system, inoperative system controls (for example, blowoff valves and altitude-control valves), and water used in flushing water mains or sewers (Center for the Study of Law and Politics, 1990, p. 35). Unauthorized use of hydrants includes theft by chemical lawn service companies, building contractors, and water haulers who have the tools needed to open hydrants without permission.

7. WATER DEMAND ANALYSIS

7.1. Classification of Water Systems

7.1.1. Individual Domestic Well. Groundwater is diverted from one Section 72-12-1 NMSA 1978 domestic well to serve one residential connection, which may be a single-family dwelling, or a multi-family dwelling. Each lot purchaser is usually responsible for drilling their own well, installing a pump, pressure tank, and water line, and maintaining the system. The annual diversion from the well is limited to 3 acre-feet in any year.

7.1.2. Shared Well. Groundwater is diverted from one Section 72-12-1 NMSA 1978 domestic well to serve at least 2 residential connections. The subdivider may drill the well that will serve each cluster of homes, install the pump and pressure tank, and water distribution line to the perimeter of each lot. Lot purchasers are generally responsible for installing a water service line from the distribution line to the home they build. Land and water use covenants and restrictions prepared by the subdivider will stipulate that lot purchasers in each cluster of homes will be entitled to use an equitable portion of the permitted water right associated with each well; and lot purchasers will be responsible for the assessment and collection of fees, and the operation and maintenance of the water system. A water meter is required at the wellhead, and the annual diversion from each well is limited to 3 acre-feet or less in any year.

7.1.3. Community Water System. Includes any existing or proposed water supply system which relies upon surface and/or groundwater diversions other than wells permitted by the State Engineer Office under Section 72-12-1 NMSA 1978, and which consists of common storage and/or distribution facilities operated for the delivery of water to multiple service connections. All diversions must be metered at the source, and it is recommended that each service connection be metered. The annual diversion must not exceed the water right.

7.2. Community Water System

To evaluate the ability of a subdivider to provide water sufficient in quantity to satisfy all water uses in a subdivision from a community water system, it is first necessary to quantify the maximum annual water requirements for indoor domestic uses including water for evaporative cooling and water softening, landscape irrigation, fire fighting, and other uses including distribution system losses. For subdivisions that will be developed in phases, it is important that the water production and delivery capacity be adequate to meet the water demand at full development. Inadequate design capacity may result in shortages in water deliveries. The maximum annual water requirement for the subdivision is computed using the following procedure.

Step 1: Determine a reasonable occupancy rate for the proposed dwelling units. Review housing and population data published by the U.S. Department of Commerce, Bureau of the Census, for the county and locale under study; also contact local water utilities to obtain data for similar residential customers. Data obtained from these sources may be used as general guide. The occupancy rate used for the design of a new subdivision should reflect a margin of safety to avoid underestimating the water demand. U.S. Census Bureau data indicate that the average occupancy rate per dwelling unit is 2.7 capita (Vickers, 1990). For design purposes, a minimum occupancy rate of 3.0 capita may be assumed; however, a higher rate (3.1-5.0), may be more appropriate for some residential developments. A lower occupancy rate may be appropriate for developments such as retirement communities provided that there is a reasonable assurance that the lower occupancy rate will continue in the future.

Step 2: Compute total indoor water requirements for each dwelling unit. For dwelling units with water conserving plumbing fixtures and appliances, assume a water requirement of 60 gallons per capita per day (gpcd) for normal household purposes such as drinking, food preparation, bathing, flushing toilets, washing clothes and dishes, and cleaning (See Table 1 which follows for a breakdown of this figure). Water requirements for evaporative cooling may be computed using the procedure presented in Appendix B which takes into consideration the volume of indoor living space, air flow requirements, design dry and wet bulb temperatures, and the annual number of cooling hours. In lieu of using this procedure, water requirements for evaporative cooling in New Mexico may be estimated at 20 gpcd. Water requirements for water softener backwash and regeneration will depend on the total hardness of the water, daily water use, and the frequency of regenerations, but may be estimated at 5 gpcd (See Section 6.2.5). **On the basis of this criteria, the total indoor water use for a dwelling unit equipped with an evaporative cooler and water softener would be 85 gpcd.** The total indoor water requirement (W_1), expressed in gallons per year for each dwelling unit, is computed using Equation (1).

$$W_1 = (CPU)(GPCD)(365 \text{ days/yr}) \qquad \text{(Eq. 1)}$$

CPU is the number of capita per dwelling unit; and GPCD is gallons per capita per day.

Table 1. Indoor water use in single and multi-family dwelling units with water conserving plumbing fixtures and appliances, in gallons per capita per day (gpcd). The prototype for this table is based on data published in a report prepared by Brown and Caldwell (1984) for the U.S. Department of Housing and Urban Development, Washington, DC.

Item and Assumptions	GPCD
Toilets (1.6 gal/flush x 6 flush/capita day)	9.6
Toilet leakage (0.17 x 24 gal/capita day)	4.1
Showers (2.5 gpm x 4.8 minute)	12.0
Baths (50 gal/bath x .14 bath/capita day)	7.0
Faucets (Estimated)	9.0
Dishwasher (13 gal/load x .17 load/capita day)	2.2
Washing machine (50 gal/load x .30 load/capita day	15.0
Subtotal	58.9
Evaporative cooling	20.0
Water softening	5.0
Total	83.9

Step 3: Compute landscape irrigation water requirements for each dwelling unit. The maximum irrigated area on each lot and restrictions on the type of turfgrass should be stipulated in the land and water use covenants and restrictions. Irrigation water requirements expressed in gallons per square foot per year for Kentucky bluegrass, Bermuda grass, Buffalo grass, ornamental trees and shrubs, and herb and vegetable gardens for selected locations in New Mexico counties are provided in Appendix C. Consumptive irrigation water requirements were computed by staff in the New Mexico State Engineer Office using the Original Blaney-Criddle Method and 30-year temperature and precipitation normals for the 1951-80 period of record. Dividing the consumptive irrigation requirements by an application efficiency of 50% for flood and sprinkler irrigation, and 85% for drip, yielded the water requirements shown in the table in Appendix C. The sprinkler irrigation efficiency reflects a worst-case condition where the application rate, frequency of irrigation, and overthrow of sprinkler spray onto sidewalks, driveways, other paved surfaces, and structures, is poorly controlled.

The total irrigation water requirement (W_2), in gallons per year, for each dwelling unit, is computed using Equation (2).

$$W_2=A_1I_1+A_2I_2+A_3I_3+A_4I_4+A_5I_5 \qquad \text{(Eq. 2)}$$

where A_1, A_2, and A_3, are the areas in square feet of (1) turfgrass, (2) trees and shrubs, and (3) herb and vegetable gardens, that are irrigated by flood or sprinklers on one lot; and I_1, I_2, and I_3 are the corresponding flood or sprinkler application requirements in gallons per square foot per year which are obtained from the table in Appendix C; A_4 and A_5 are the areas in square feet of (4) trees and shrubs, and (5) herb and vegetable gardens, that are irrigated by drip; and I_4 and I_5 are the corresponding drip application requirements in gallons per square foot per year.

Step 4: Compute water requirements for ornamental ponds, water gardens, and swimming pools, for each dwelling unit. The calculation of these water requirements includes: volume of pool, number of times pool is completely drained and refilled in one calendar year, surface area, net evaporation rate, and makeup water for evaporation losses. Each dwelling unit will not necessarily have any recreational water facilities; and in regions that experience cold winters, small water bodies may be iced over for several months. These factors should be taken into consideration in the calculation. The total water requirement for these recreational water facilities (W_3), in gallons per year, for each dwelling unit, is computed using Equation (3).

$$W_3=(NPU)/(NDU)[(NR)(V)+(SA)(ENR)(7.48\ gal/ft^3)] \qquad \text{(Eq. 3)}$$

where NPU is the number of pool units; NDU is the number of dwelling units; SA is the average surface area of the pool in square feet; ENR is the net evaporation rate in feet per year; NR is the number of complete refills in one calendar year; and V is the volume of the pool in gallons.

If pan evaporation data is available for the area under study, the gross evaporation for a small water body may be computed by multiplying the pan evaporation by a coefficient of 0.85. The annual gross evaporation may also be estimated by reading values from isopleths drawn on maps prepared by the U.S. Natural Resources Conservation Service (formerly the U.S. Soil Conservation Service) and other agencies. The isopleths normally represent annual evaporation from a large water body such as a lake or reservoir. Since small water bodies have a higher evaporation rate, the value taken from the isopleth should be divided by 0.70 to yield the pan evaporation; multiplying the pan evaporation by 0.85 will yield the gross evaporation for a small water body. The normal annual rainfall may be obtained from long-term weather data (e.g. 30-year normals) published by the National Oceanic and Atmospheric Administration or by reading values from isopleths on precipitation maps. Subtracting the rainfall (R) from the gross evaporation rate (EGR) yields the net evaporation rate (ENR=EGR-R).

Step 5: Compute the total maximum allowable water use for each dwelling unit.

$$W_4 = (W_1+W_2+W_3) \quad \text{(Eq. 4)}$$

Step 6: Compute the total maximum allowable water use for all dwelling units.

$$W_5 = (NDU)(W_4) \quad \text{(Eq. 5).}$$

Step 7: Compute fire fighting water requirements. Water requirements for fire suppression have a significant impact on sizing the distribution system components, including water lines, appurtenances, and storage facilities. The ideal way to develop a fire suppression system is to construct a distribution system that will serve the short and long-range development of the service area so that fire protection will be adequate at full development. Needed fire flow (NFF) is defined as the rate of water flow at a residual pressure of 20 pounds per square inch (psi) and for a specified duration, that is necessary to control a major fire in a specific structure (American Water Works Association, 1989, pp. 1-2). Assuming one structural fire in the subdivision per year, the total water requirement for fire suppression (W_6), in gallons per year, is computed using Equation (6):

$$W_6=(NFF)(T) \quad \text{(Eq. 6)}$$

where NFF is the needed fire flow in gpm; and T is the duration in minutes.

Needed fire flows can be easily calculated using the Insurance Services Office (ISO) methodology which is widely accepted throughout the United States. The ISO is a nonprofit association of insurance companies which provides statistical, actuarial, and survey information for numerous affiliated insurance companies; it compiles data that are used to establish rates for fire protection policies for both residential and commercial properties; and it sets standards for public fire protection systems to minimize the loss of life and property.

For one- and two-family dwellings not exceeding two stories in height, the NFF shown in Table 2 should be used assuming a minimum duration of two hours (120 minutes). For other habitable buildings such as apartments, condominiums, and townhouses, the procedure in Appendix D should be used.

Table 2. Needed fire flow (NFF) for one- and two-family dwellings based on Insurance Services Office standards.

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
Over 100	500
31-100	750
11-30	1000
Less than 11	1500

Step 8. Compute the maximum annual water requirement for the subdivision. Distribution system losses in small water systems typically range from 5-10% of the total withdrawal (American Water Works Association, 1993, p. 2-4; Prasifka, 1988, p. 50). For design purposes, 5% losses may be assumed for subdivisions with less than 50 homes; and 10% losses for subdivisions with more than 50 homes. Distribution system losses do not apply to water requirements for fire fighting because of the short duration (typically 2 hours) of this water demand. The maximum annual water requirement (W_7) in gallons per year, for all purposes in a subdivision, is computed using Equation (7).

$$W_7=[(W_5)/E_c]+W_6 \qquad \text{(Eq. 7)}$$

where E_c is the conveyance efficiency of the distribution system expressed as a decimal. For subdivisions with less than 50 homes, E_c is 0.95; and for more than 50 homes E_c is 0.90.

Water requirements for other uses such as guest houses, day care centers, dormitories, cafeterias, health spas, parks, greenbelts, playing fields, golf courses, and other community facilities; and livestock watering, should be estimated separately using the same concepts presented in the procedure in this section. These water requirements are subject to the application of the conveyance efficiency factor, E_c, and should be included in the estimate of the maximum annual water requirement, (W_7).

7.2.1. Example Calculation of Maximum Allowable Subdivision Water Use

The application of the method to estimate water demands and maximum allowable subdivision water use is illustrated for hypothetical subdivisions in Taos and Las Cruces as follows:

(1) Indoor water use, normal household purposes

(a) Taos (3 occupants, no evaporative cooler or water softener)
60 gpcd
65,700 gallons per year
(0.20 acre-feet per year)

(b) Las Cruces (3 occupants, with evaporative cooler and water softener)
85 gpcd
93,075 gallons per year
(0.29 acre-feet per year)

(2) Landscape water use, per dwelling unit. Landscape water use for 1,600 square feet of sprinkler irrigated Kentucky bluegrass (Appendix C) will vary from:

(a) Taos — 48,200 gallons per year (0.15 acre-feet per year)

(b) Las Cruces — 89,400 gallons per year (0.27 acre-feet per year)

(3) Other outdoor water use, per dwelling unit — None

(4) Total maximum water use per dwelling unit, exclusive of fire flow requirements.

(a) Taos — 113,900 gallons per year (0.35 acre-feet per year)

(b) Las Cruces — 182,475 gallons per year (0.56 acre-feet per year)

(5) Total maximum allowable water use for all dwelling units, assuming 20 homes.

(a) Taos — 2,278,000 gallons per year (6.99 acre-feet per year)

(b) Las Cruces — 3,649,500 gallons per year (11.20 acre-feet per year)

(6) Water demands for other water uses, such as guest houses, day care centers, dormitories, cafeterias, health spas; parks, greenbelts, playing fields and golf courses; and livestock watering, shall be estimated separately. For this example, these are assumed to equal — 0 gallons

(7) Water demands for fire fighting, assuming NFF is 500 gallons per minute for 120 minutes — 60,000 gallons

(8) Total maximum allowable subdivision water use for the 20 dwelling units assumed in this example is the sum of Items (5) and (6) divided by an assumed conveyance efficiency of 0.95 plus Item (7).

(a) Taos — 2,397,895 gallons per year (7.36 acre-feet per year)

(b) Las Cruces — 3,841,579 gallons per year (11.79 acre-feet per year)

7.3. Shared Well

Water requirements for small clusters of homes (generally 6 or less) which are served by a shared well may be computed using the same procedure outlined for Community Water Systems. For small subdivisions, water requirements for fire suppression may not be necessary if a fire department located within close proximity will provide emergency service and can do so in a timely manner. In addition, distribution system losses may be considered negligible for design purposes. Because the total diversion from a Section 72-12-1 domestic well that serves a cluster of homes cannot exceed 3 acre-feet in any calendar year, the question which may need to be answered is how much water will be available to each lot owner for landscape irrigation and other outdoor water uses. To make this determination, the following procedure is used.

Step 1: Determine a reasonable occupancy rate for the proposed dwelling units.

Step 2: Compute total indoor water requirements (W_8), in gallons per year, for the dwelling units using Equation (8).

$$W_8=(NDU)(CPU)(GPCD)(365\ days/yr) \qquad (Eq.\ 8)$$

Step 3: Compute the amount of water (W_9), in gallons per year, that could be used for landscape irrigation on each lot using Equation (9). The diversion from each well which serves a cluster of homes cannot exceed 3 acre-feet per year, or 977,553 gallons per year.

$$W_9=(977{,}553\ gal/yr-W_8)/(NDU) \qquad (Eq.\ 9)$$

Step 4: Compute the maximum area, in square feet, that can be used by a lot owner for landscape irrigation using Equation (10).

$$A_s=(W_9/I) \qquad (Eq.\ 10)$$

where A_s is the area in square feet that is irrigated by flood or sprinklers on one lot; and (I) is the flood or sprinkler application requirement in gallons per square foot per year for a specific type of vegetation and locale shown in the table in Appendix C. The higher the value of (I), the smaller the area which can be irrigated; and conversely, the lower the value of (I), the greater the area which can be irrigated. Using the (I) for Kentucky bluegrass, which has the highest water requirement, will result in the smallest area that can be irrigated with the amount of water available.

Step 5: Compute the maximum area, in square feet, that can be used for landscape irrigation using the procedures presented earlier computing limitations on maximum allowable subdivision water use.

Step 6: The maximum allowable area, in square feet, that can be used for landscape irrigation is the lesser of the areas computed using Steps 4 or 5 above.

7.4. Methods for Limiting Maximum Allowable Subdivision Water Use

Water use in the proposed subdivision should be limited to the maximum allowable subdivision water use, either by regulating metered water deliveries or by limiting outdoor water use. Enforcement would be by county regulation, if applicable, or by land and water use covenants. In cases where subdivision water supplies will be provided from new appropriations of groundwater or individual domestic wells within declared underground water basins, and provided that statutory criteria are met, the water right permit may be issued by the State Engineer in an amount not to exceed the maximum allowable subdivision water use approved for the subdivision. SEO recommended guidelines permit the subdivider and County to specify methods of ensuring compliance with the maximum allowable subdivision water use. There are three options for limiting the maximum annual water use of a subdivision which may be considered by the County and the subdivider.

Method A: Water supplies to the subdivision and to each dwelling unit limited only by metered water deliveries. Under Method A, the total amount of water provided to each lot in the subdivision in any year would be limited to the total maximum water use, as computed in Section 7.2.1. Each lot purchaser would be allowed to use water for whatever purpose he chooses within the permitted amount, including any distribution of outdoor landscaping and, possibly, pools or ornamental water bodies. Other than the limitation on water use, covenants would not be required.

Method B: Water supplies to the subdivision and to each dwelling unit limited by the adoption of a standard water conservative landscape covenant for the subdivision, or as may be adopted by the County. The maximum irrigated area on each lot (e.g., 1,600 square feet for single family detached dwellings) and restrictions on the type of turfgrass and other types of vegetation must be included in the water demand analysis, and stipulated in the disclosure statement and in the land and water use covenants and restrictions. Examples of such criteria and ordinances are included in Appendix A.

Method C: Recommended allowable subdivision water use based on an allocation meeting water conservation criteria with detailed design provisions regarding landscape water use and detailed restrictive covenants. Under Method C, the subdivider would submit a detailed landscape plan (generally from a landscape architect) including area designations for plant groups with similar light and water requirements, layout of irrigation system, and calculation of irrigation water requirements. Components of such use would be calculated by the subdivider based on the SEO tables of irrigation water requirements. The maximum irrigated area on each lot and restrictions on the type of turfgrass and other types of vegetation must be included in the water demand analysis, and stipulated in the disclosure statement and in the land and water use covenants and restrictions. Such designs may result in a lower demand for water than the SEO recommended maximum allowable, and are generally intended to make the maximum possible beneficial use of a limited supply.

8. DESIGN REQUIREMENTS FOR COMMUNITY WATER DISTRIBUTION SYSTEMS

The water distribution system internal to the development shall be sized to meet both the initial and future demands for the proposed development. Oversizing for future extensions may be required. In constructing the internal water distribution system, the following design provisions are recommended.

8.1. Design Flow

A water utility must continue to serve its customers during a fire. The Insurance Services Office recommends that the fire suppression system be able to operate with the remainder of the potable water system operating at the maximum daily rate (Lindeburg, 1986, p. 7-16). Therefore, the distribution system shall be sized for maximum daily demand plus the fire flow requirement, or, maximum hourly demand, whichever is greater (American Water Works Association, 1989, p. 16).

8.1.1. Average Day Demand. The average of the total amount of water used each day during a 1-year period. The average daily demand (Q_{AD}) in gallons per day (gpd) and in gallons per minute (gpm) is computed using Equation (11a) and Equation (11b) respectively.

$$Q_{AD} \text{ in gpd} = (W_5)/(365 \text{ days/yr}) \qquad \text{(Eq. 11a)}$$

$$Q_{AD} \text{ in gpm} = (W_5)/(525{,}600 \text{ min/yr}) \qquad \text{(Eq. 11b)}$$

8.1.2. Maximum Day Demand. The maximum total amount of water used during any 24 hour period in a 3-year period. Maximum daily demand (Q_{MD}) is typically 1.5-2.0 times average daily demand (Lindeburg, 1986, p. 7-17); and for design purposes, shall not be less than 1.5 times the average daily demand. It is important that the multiplier used is justified by the registered professional engineer designing the water supply system. The maximum daily demand (Q_{MD}) in gpd and gpm is computed using Equation (12a) and Equation (12b) respectively.

$$Q_{MD} \text{ in gpd} = (F_{MD})(Q_{AD} \text{ in gpd}) \qquad \text{(Eq. 12a)}$$

$$Q_{MD} \text{ in gpm} = (F_{MD})(Q_{AD} \text{ in gpm}) \qquad \text{(Eq. 12b)}$$

where F_{MD} is the demand multiplier for the maximum daily demand.

8.1.3. Maximum Hour Demand. The maximum amount of water used in any single hour, of any day, in a 3-year period. Maximum hourly demand (Q_{MH}) is typically 2.0-6.0 times average daily demand; and for design purposes, shall not be less than 2.0 times the average daily demand. It is important that the multiplier used is justified by the registered professional engineer designing the water supply system. The maximum hourly demand (Q_{MH}) in gpm is computed using Equation (13).

$$Q_{MH} \text{ in gpm} = (F_{MH})(Q_{AD} \text{ in gpm}) \qquad \text{(Eq. 13)}$$

where F_{MH} is the demand multiplier for the maximum hourly demand.

8.1.4. Maximum Day Plus Fire Flow. The aggregated demand for maximum daily demand plus fire flow (Q_{MDF}) in gpm is computed using Equation (14).

$$Q_{MDF} \text{ in gpm} = Q_{MD} + NFF \qquad \text{(Eq. 14)}$$

8.2. Pipe Flow Velocity

Velocities in water distribution lines typically range from 5-10 feet per second (fps) at the design flow rate (Gagliardi, 1992, p. C.21; Tullis, 1989, p. 22). Pipe flow velocities are limited by design to avoid a number of potential operating problems. If the velocity is less than 3.0 fps, problems may occur due to suspended solids settling out or trapped air that cannot be removed. However, velocities in pump suction lines must be kept low enough to maintain the pump's required net positive suction head (NPSH). On the other hand, high velocities may cause cavitation and erosion of the pipe wall or liner, water hammer which may damage pumps and valves, and increase pumping costs. **Design criteria published by the Crane Company (1988, p. 3-6) suggest that pipe flow velocities of up to 7 fps are reasonable for municipal water distribution lines.** The pipe flow velocity in the service line from the distribution water main to the customer water meter should not exceed 15 fps (American Water Works Association, 1975, p. 48)

8.3. Pressure

The pressure in the distribution system is affected by the water demand in the area; size of mains and design of the distribution grid system; elevation of the main and the customer's piping; distance from the utility's pumps; and pressure zones (American Water Works Association, 1975, p. 38). The system should be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow. If future connection to a different supply system is anticipated, critical pressure in that system may be used as initial design pressure. See also Section 6.5.1 on **Pressure Reduction** for more on this subject.

8.4. Sizing Pipelines

The purpose of the design flow analysis is to determine the minimum acceptable inside diameter of each segment of the piping system that will accommodate the design flow rate while maintaining the pressure drop and flow velocity within reasonable limits (Casiglia, 1992, p. B.63). Except for short cul-de-sacs, the minimum size of water mains that must provide required fire flows at fire hydrants, is 6 inches in diameter (American Water Works Association, 1989, p. 19; Great Lakes Upper Mississippi River Board, 1987, p. 111). Where the external supply or pressure is not adequate to meet requirements, larger pipe diameter, parallel or looping lines, or additional storage or pumping shall be provided to meet requirements (Boulder County Land Use Department, 1995, p. 7-4.). If friction head losses are ignored, an initial estimate of the required inside pipe diameter (D) in inches, is computed using Equation (15).

$$D=(0.6393)(Q/V)^{0.5} \qquad \text{(Eq. 15)}$$

where Q is the maximum daily demand plus the fire flow requirement in gpm, or, the maximum hourly demand in gpm, whichever is greater; and V is the flow velocity in the pipe in feet per second.

8.5. Hydrant Flow Rate and Location

The minimum flow rate for each fire hydrant shall be 500 gpm. A higher flow rate may be required to suppress fires at multiple-family dwellings such as apartments and condominiums. The maximum distance between hydrants, as measured along the roadway, should not exceed 300 ft in high density residential areas and 600 ft in areas of moderate density (American Water Works Association, 1989, p. 20). In low density areas where homes are built on large lots spacing criteria adopted by the authority having jurisdiction may permit up to 1,000 ft between hydrants along the roadway. However, no lot should be more than 500 ft from the nearest hydrant, in any area. Hydrants should be installed at each street intersection; in the middle of long blocks, particularly when required flow exceeds 1,300 gpm; and near the end of long dead-end streets. The planning of hydrant locations should be a cooperative effort between the water utility and the fire department.

8.6. Storage

New water systems should be designed with sufficient treatment and storage capacity to meet the maximum daily demand plus the required fire flow for the specified duration. Distribution storage equalizes demands on supply sources, production works, and transmission and distribution mains. As a result, the sizes or capacities of these components need not be so large. In addition, system flow and pressures are improved and stabilized to better serve customers throughout the service area; and reserve supplies are provided in the distribution system for emergencies, such as fire fighting and power outages. In normal system operations, some water from storage should be used each day not only to maintain uniformity in production and pumping, but also to ensure circulation of the stored water (American Water Works Association, 1989, p. 24). Storage in the distribution system is normally brought to full capacity each night and is increased during low-demand periods of the day. By pumping at night, water utilities can take advantage of reduced electrical rates for off-peak power.

8.7. Adequacy and Reliability of System

A water supply system is considered to be fully adequate if it can deliver the required fire flows to all points in the distribution system with usage at the maximum daily rate. When the delivery is also possible with the most critical limiting component out of service for a specified length of time, depending on the type of component, the system is considered to be reliable (American Water Works Association, 1989, p. 32).

Distribution system components are often taken out of service for maintenance. In addition, system components fail on occasion. For this reason, utilities should construct their distribution systems with loops, backup pumps, backup power supplies, and storage tanks so that if any component fails or is out of service the effect on the availability of water is minimized.

9. WATER RIGHT REQUIREMENTS AND LIMITATIONS

9.1. Doctrine of Prior Appropriation

In New Mexico, water resources are administered under the Doctrine of Prior Appropriation. A person who takes water and applies it to beneficial use is an appropriator; and the taking of the water constitutes the appropriation, which includes a priority date. This priority entitles the appropriator to receive a full appropriation before those with junior, or more recent water rights receive their appropriations.

9.2. Owning a Water Right

All natural waters in streams and watercourses, or underground, belong to the public and are subject to appropriation. An appropriation water right, like equipment or furniture, is considered property and can be separated from the land and transferred to another location subject to statutory requirements. The appropriator "owns" only the right to use the water and not the "corpus," or body of water itself. Beneficial use is the basis, the measure and the limit of the right and priority in time gives the better right. All beneficial uses are considered equal regardless of the value resulting from the use. Municipalities, county governments, and certain other political subdivisions of the state may condemn water rights for public purposes provided that this action is approved by the court and original owners are reasonably compensated.

9.3. Obtaining a Water Right

To obtain a right, an application must be filed with the State Engineer for a permit to appropriate water. The applicant must specify the source of water, purpose and place of use, point of diversion, and amount of water to be used. After the application is filed, the applicant presents all essential facts in a legal notice which is published in a newspaper circulated in the area where the water will be appropriated, once a week for 3 consecutive weeks. Protests to the application must be filed with the State Engineer within 10 days of the last date of the published notice. If a protest is filed, a hearing may be required before the State Engineer before the application is acted upon. An application will be denied if unappropriated water is not available, if the new use will impair existing water rights, or would be contrary to the conservation of water in the state, or detrimental to the public welfare of the state. If the State Engineer concludes that unappropriated water is available and that other criteria are met, the application is approved and it becomes a permit to appropriate water. The permit states when construction should be completed and when the water will be applied to beneficial use. The completion deadline depends on the size and complexity of the project; and an additional period of time may be allowed for the application of water to beneficial use. When construction is completed, or at the construction deadline, the site is inspected, and a certificate of completion is issued provided that all requirements are met.

This procedure applies to all surface waters, but only to ground water in declared underground basins. When the State Engineer finds that the water of an underground source has reasonably ascertainable boundaries, he can assume jurisdiction over the appropriation and use of such water by declaring the basin. Within a declared underground water basin, no well may be drilled without a permit and drilling may be done only by a well driller licensed by the State Engineer Office. The State Engineer declares and extends basins to protect prior appropriations, to guarantee the water's beneficial use and to ensure the orderly development of the resource. A basin may be declared without prior notice, however, after declaring the basin, a public hearing is required on the declaration within a specified time. The State Engineer has no jurisdiction outside declared underground basins, except to prevent waste. Declaring a basin has no effect on water rights initiated before the declaration date. After that date, however, those wanting a water right or wanting to drill additional wells to fulfill an existing right must apply to the State Engineer for a permit. If the water in a basin has been fully appropriated, no new water rights can be issued. The important effect of declaring an underground basin is that applicants bear the burden of proof to show that unappropriated water is available and that the appropriation will not impair existing surface or groundwater rights, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state. Water right owners outside the underground basin boundaries are protected by the appropriation doctrine. If they believe their water right may be impaired, they have recourse to the courts, not the State Engineer.

Applications to appropriate small amounts of underground water for individual domestic use, livestock watering, public works projects such as the construction of highways, and mineral exploration, are exempt from normal administrative procedures which require the advertisement of the application and public hearings, except where there are judicial constraints imposed by state or federal courts. The diversion from a well permitted for any of these purposes is limited to a maximum of 3 acre-feet in any year.

9.4. Quantifying a Water Right

The amount allocated to a new right depends on reasonable need and water availability. For community water systems that will be supplied by groundwater, consideration should be given to economic constraints, maintenance requirements, and limitations of aquifer performance, that may effect the feasibility of pumping a well continuously for extended periods of time. It may also be prudent to provide a margin of safety in the determination of the sustainable yield which allows for some diminishment in well yield over time. Therefore, as a matter of practicality, the diversion right for some community water systems may be taken as a percentage of the production capacity of the existing well, provided that this value does not exceed the amount of water specified in the water right application.

9.5. Changing Ownership

If the seller of a parcel of land has water rights that the buyer expects to obtain with the property, the buyer should require that the water right be conveyed in the property deed and that all documents related to the water right be conveyed to the buyer. Under a 1996 state law, the buyer must file a change of ownership form in the State Engineer Office and then at the county clerk's office in the county where the water right is located. Those who inherit or purchase water rights must also complete and file a change of ownership form.

9.6. Separating a Right from the Land

Although the right to water is conveyed with the sale of irrigated land, unless reserved in the deed, a water right can be sold separately from the land and applied to a new use in another area provided that the transfer will not impair other rights in the move-to location, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state.

9.7. Changing the Place or Purpose of Use

A water right transfer does not always mean a new owner. A transfer can mean that the owner wants to change the use of the water, the amount of the allocation, or the location of a well under a recognized right. Changes in place and purpose of use or changing the location of a well require filing an application with the State Engineer and proof that the change will not impair existing rights, would not be contrary to the conservation of water in the state, or detrimental to the public welfare of the state.

9.8. Specification of Water Right and Water Use Limitations in Disclosure Statements

County subdivision regulations usually require that the subdivider's disclosure statement include any limitation, physical or legal, anticipated for each water use. The content of these statements will depend upon the classification of the proposed water supply system.

9.8.1. Individual Domestic Well. For subdivisions where each lot purchaser will be responsible for drilling their own well the following text should be included in the disclosure statement: *The State Engineer will grant a domestic permit under Section 72-12-1 NMSA 1978 only to the person, who in good faith, intends to use the well for household or other domestic purpose. The permit is limited to the maximum allowable water use stated herein. If the total withdrawal is to exceed 3 acre-feet per annum from any well or group of wells that supply a common system, it will be necessary for the subdivider or users to obtain water rights.*

9.8.2. Shared Well. For subdivisions where the subdivider or homeowners will drill one or more wells each which will serve a cluster of homes (generally 2-6), it is important that all parties understand that the State Engineer does not grant domestic well permits to supply clusters of lots in any subdivision in the name of the subdivider or developer. The following text should be included in the disclosure statement: *A "conditional Section 72-12-1 NMSA 1978 well" may be drilled in the name of the developer (Article 1-15.5, Groundwater Rules and Regulations) after State Engineer approval of an application. This will allow the well to be drilled and tested but no water may be diverted for any use. Upon the sale of the lot on which the well is located, the owner may file application under Section 72-12-1 (Article 1-15.5, Groundwater Rules and Regulations), specifying the lots to be served from the well. The State Engineer will grant the application previously described, with a requirement that the well be metered and reports of use will be required to be submitted to the State Engineer on at least a quarterly if not monthly basis. The diversion from the well will be limited to a maximum of 3 acre-feet in any year.*

To ensure that the total amount of water diverted in any calendar year from a well which provides water to more than one lot does not exceed 3 acre-feet, the subdivider's disclosure statement should also include a restriction on the total area, expressed in square feet, that a lot owner can plant in lawn grasses, ornamental shrubbery and trees, and gardens, which would require irrigation; and prohibit hot tubs, swimming pools, and ponds or water gardens, where the area irrigated (square feet) is the maximum permitted under the criteria adopted. And finally, the total amount of water each lot owner will be entitled to should be specified. The entitlement is determined by dividing the domestic water right by the number of residential connections served by each individual well. However, in counties where more stringent restrictions have been placed on the amount of water each lot owner can use in any calendar year, if the entitlement allowed by the county is less than the result of the previous calculation, the lower figure should be specified in the disclosure statement.

9.8.3. Community Water System. For subdivisions where groundwater will be diverted from one or more wells exclusive of those permitted under Section 72-12-1 NMSA 1978, or where surface water will be diverted to supply the subdivision, proof of an existing water right sufficient in quantity to meet the water demand in the subdivision shall be provided in the development plan and the maximum annual water requirement and limitation of the right shall be included in the disclosure statement. This statement may be written as follows: *Proof that (name of subdivider) is owner of (number of acre-feet) of water rights that will meet the requirements of the proposed subdivision is included in (identify section) of the development plan.*

9.8.4. Extended Community Water System. For subdivisions where water is diverted from the distribution mains of an established water purveyor, a letter of intention indicating that the water purveyor is ready, willing, and able to provide water, and proof of a valid water right sufficient in quantity to meet the water demand of its current customers as well as the new subdivision shall be provided in the development plan; and the highest annual water use recorded by the water purveyor during the most recent 3 years, the maximum annual water requirement for the new subdivision, and the limitation of the right, shall be included in the disclosure statement. This statement may be written as follows: *Data provided by (name of water purveyor) indicate that the maximum annual water requirement for current customers is (number of acre-feet) per year and the maximum annual water requirement for (name of new subdivision) is estimated at (number of acre-feet) per year, which brings the total demand to (acre-feet) per year. Proof that (name of water purveyor) is owner of (number of acre-feet) of water rights that will meet both existing commitments and the requirements of the proposed subdivision is included (identify section) of the development plan.*

9.8.5. Metering Requirements. The following text should also be included in the disclosure statement where applicable. *In declared underground water basins, for any well which serves two or more connections, a totalizing meter must be installed before the first branch of the discharge line from the well and the installation shall be acceptable to the State Engineer. A written document shall be submitted to the State Engineer with the name of the manufacturer, model, serial number, date of installation, and initial reading of the meter prior to appropriation of water; and records of the amount of water diverted shall be submitted quarterly to the State Engineer Office on or before the 10th of January, April, July and October of each year.*

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Appendix A

Model Ordinances Governing Landscape Design Requirements

Marin Municipal Water District, California
City of Palo Alto, California

ORDINANCE NO. 326

MANUAL

FALL 1991

marin municipal water district

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MARIN MUNICIPAL WATER DISTRICT

ORDINANCE NO. 326

AN ORDINANCE REVISING WATER CONSERVATION REQUIREMENTS

BE IT ORDAINED BY THE BOARD OF DIRECTORS OF THE MARIN MUNICIPAL WATER DISTRICT AS FOLLOWS:

Section 1. Section 11.04.080 of the Marin Municipal Water District (MMWD) Code is repealed and Chapter 11.60 is added to Title 11 of the District's code to read as follows:

11.60.010 Purpose. All applicants for new, increased, or modified service shall comply with the requirements set forth in this chapter in addition to those set forth in Chapter 11.04 of this Code as a condition of receiving service.

11.60.020 Definitions. Definitions used in this chapter are as follows:

(1) **Developed landscape area:** All outdoor areas under irrigation, surrounding hardscape areas, swimming pools, and decorative pools and fountains.

(2) **Hardscape:** Patios, decks and paths. Does not include driveways and sidewalks.

(3) **High-water-use plants:** Annuals, plants in containers, and plants not on MMWD's list of low-water-use plants.

(4) **Landscape Plans:** This includes a planting plan, an irrigation plan, and a grading plan. All plans must be drawn at a scale that clearly and accurately identifies plants, irrigation layout, equipment, and finish grades. Landscape plans shall include the following:

(A) **Planting Plan:** Planting plans must accurately identify and locate, but are not limited to the following:

(i) New and existing trees, shrubs, groundcovers and turf areas within the developed landscape area;

(ii) Plants by botanical name, common name, container size, spacing and quantities;

(iii) Property lines, streets and street names;

(iv) Driveway(s), sidewalk(s) and other hardscape features as necessary;

(v) Pool(s), fountain(s), fence(s) and retaining wall(s);

(vi) Existing and proposed buildings;

(vii) The square footage(s) of the various landscape hydrozones on the plan. Hydrozones are separate portions of the landscape area having plants with similar water needs that are served by a valve or set of valves with the same setting. These hydrozones include, but are not limited to turf, high-water-use plants with overhead irrigation, low-water-use plants with overhead irrigation, drip irrigation and fountain and pool areas. If more than one water meter serves the site, the individual hydrozones must be identified with the meter providing water service.

(B) Irrigation Plan: The irrigation plan shall be drawn at the same scale as the planting plan. The irrigation plan will be separate from but in the same format as the planting plan. The irrigation plan shall show but not be limited to the following:

(i) Irrigation system point of connection;

(ii) Water service pressure at point of irrigation system connection;

(iii) Water meter size;

(iv) Backflow prevention devices;

(v) Major components of the irrigation system;

(vi) Total precipitation rate in inches per hour for each overhead irrigation circuit;

(vii) Total flow rate (gph) and operating pressure (psi) for each irrigation circuit;

(viii) Irrigation legend will have the following elements: Symbols for various irrigation equipment, general description of equipment, manufacture name and model number, operating pressure, manufacturer's irrigation nozzle rating in gallons per minute (gpm) or gallons per hour (gph) as necessary, minimum and maximum spray radius, manufacturer's rated precipitation rate per nozzle;

(ix) Reclaimed water piping and guidelines as required.

(C) Grading Plan: The grading plan shall be drawn at the same scale as the planting and irrigation plan. The grading plan must show all finish grades, spot elevations as necessary and existing, and new contours within the developed landscape area.

(5) **Landscape Architect:** A person who holds a certificate to practice landscape architecture in the state of California under the authority of the California State Board of Landscape Architects.

(6) **Low-water-use plants:** Plants on MMWD low-water-use plant list, or any other plant approved by MMWD. (Generally, a plant that once established, can survive on two irrigations per month during the summer months.)

(7) **Overhead Irrigation:** An irrigation method that delivers water to the landscape in a spray or stream-like manner from above-ground spray heads (includes micro-misters, does not include bubblers).

(8) **Overspray:** Water that is delivered beyond the targeted landscape area during windless hours onto adjacent pavements, walks, structures, or other non-landscaped areas during an irrigation cycle.

(9) **Runoff:** Irrigation water that is not absorbed by the soil or landscape area to which it is applied and which flows onto other areas.

11.60.030 **Requirements For All Services**

(1) **Pressure Regulation.** A pressure-regulating valve shall be installed and maintained by the consumer if static service pressure exceeds 80 pounds per square inch. The pressure-regulating valve shall be located between the meter and the first point of water use, or first point of division in the pipe, and set at not more than 50 pounds per square inch when measured at the most elevated fixture in the structure served. This requirement may be waived if the consumer presents evidence satisfactory to the District that excessive pressure has been considered in the design of water-using devices and that no water will be wasted as a result of high pressure operation.

(2) **Interior Plumbing Fixtures.** All plumbing installed, replaced or moved in any new or existing service must meet the following requirements:

(A) Toilets shall use 1.6 gallons, or less, of water per flush;

(B) Shower heads shall use 3 gallons, or less, of water per minute;

(C) Kitchen and lavatory faucets shall use 2.5 gallons, or less, of water per minute;

(D) Non-residential services with more than one showerhead or one sink (lavatory) per bathroom facility shall equip these fixtures with self-closing valves.

(3) Pool Covers. Pool covers are required for all new outdoor swimming pools.

11.60.040 Landscape Requirements For Single-Family Residences (New and Modified Landscapes).

The combined size of turf areas and swimming pools for new single family residences shall be limited to not more than 25% of the total developed landscape area. When existing landscape areas are modified by the addition of turf and/or a pool, the total combined area of the turf and pool shall be no more than 25% of the total developed landscape area.

11.60.050 Landscape Requirements For All Services Other Than Single-Family Residences (New and Modified Landscapes).

(1) Turf and Swimming Pools. The combined size of turf areas and swimming pools shall be limited to not more than 25% of the total developed landscape area in services irrigated with potable water. In landscapes irrigated with reclaimed water, the combined size of turf areas and swimming pools shall be limited to not more than 40% of the total developed landscape area. In areas designated for future reclaimed water service, the 40% turf/pool limit will be allowed only if the service will have reclaimed water available within one year of the service agreement date.

(2) High-Water-Use Plants and Features. High-water-use plants, decorative pools (non-swimming), fountains, and water features shall be limited to not more than 10% of the total developed landscape area.

(3) Other Plants. All other plantings shall be composed of low-water-use plant materials. The District may waive this requirement if sufficient evidence is presented that the site is not suitable for such plants.

(4) Irrigation Systems. All irrigated landscaped areas will be irrigated by an automatic irrigation system which meets these requirements:

(A) Electric controller with repeat start time and multiple program potential, set for irrigation between the hours of 6 pm and 11 am for potable water and 10 pm and 7 am for reclaimed water;

(B) Automatic rain shut-off unit for each controller;

(C) In areas with slopes exceeding 15%, the precipitation rate shall not exceed .85 inches per hour;

(D) Under-the-head check valves, built-in spray head check valves, or in-line check valves must be installed as needed to prevent low head drainage and puddling;

(E) Separate irrigation circuit(s) must be provided for each of the following: turf, high-water-use plants, low-water-use plants, plants on drip irrigation, planting areas with different exposures, slopes and soils with different infiltration rates;

(F) Use a point application (drip, bubbler, etc.) or subsurface irrigation system where overspray, angle of slope, soil texture, or widely spaced plants make overhead irrigation impractical due to overspray, runoff, or inefficiency. (Overhead irrigation is inefficient when less than 50% of spray pattern of any head will hit mature plants.)

(G) Overhead irrigation must meet the following additional requirements:

(i) Distance between spray heads on turf shall not exceed 55% of the spray diameter;

(ii) Distance between spray heads elsewhere shall not exceed 70% of the spray diameter;

(iii) Spray heads must be adjusted so spray radius or special pattern is within 25% of the manufacturer's rating;

(iv) Spray heads must be located so that overspray will not accumulate and flow off adjacent pavements, walkways, structures, and other non-landscaped areas during an irrigation cycle.

(v) Overhead irrigation is prohibited in median strips and parking islands less than eight feet wide;

(vi) Planted areas which are acutely angled or irregularly shaped and which are adjacent to hardscape surfaces shall not be irrigated by an overhead system unless they are at least 120% of the spray diameter of the irrigation heads being used.

(vii) Precipitation rates for all heads within each valve circuit must be matched to within 20% of one another;

(5) <u>Soil Preparation</u>. For overhead irrigation, soil preparation must meet the recommendations of a soils laboratory report or otherwise meet the following minimum requirements:

(A) Areas with slope ratios greater than 3:1 must be amended as recommended by a landscape architect;

(B) Areas with slope ratios of 3:1 or less must meet the following soil preparation requirements:

(i) Rip or rotary cultivate existing soil to a depth of six (6) inches;

(ii) Incorporate an organic amendment at the rate of 5 cubic yards per 1000 square feet into the top six (6) inches of soil.

(6) Mulching. All exposed soil surfaces of non-turf areas within the developed landscape area must be mulched with a minimum two (2) inch deep layer of organic material.

(7) Plan Review, Certification and Site Inspections.

(A) Plan Review and Certification.

(i) For all services other than single family residences, applicants shall obtain approval for landscape plans for new or modified landscapes from MMWD before construction begins.

(ii) All landscape plans submitted must be certified by a landscape architect that they are in compliance. The landscape architect must also sign and return a District checklist indicating compliance with District requirements. Each page of plans must also be stamped to certify compliance.

(B) It shall be the responsibility of the owner or the owner's agent to:

(i) Schedule a site inspection with a landscape architect prior to installation of the irrigation system. The inspection is to verify that the installing contractor is using District approved plans for the site and that the soil preparation requirements of this section have been met. The landscape architect must complete and submit to the District a District verification form within 10 days of this inspection;

(ii) Schedule an inspection with a landscape architect within 10 days of completion of work to verify compliance with the approved landscape plans. The landscape architect must complete and submit to the District a District verification form within 10 day of this inspection.

(C) District reserves the right to perform site inspections at any time before, during, or after irrigation system and landscape installation and to require corrective measures if requirements of this ordinance are not satisfied.

11.60.060 Other Provisions.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the forgoing requirements of this chapter.

Section 2. The severability provisions of sections 1.10.110 of the Marin Municipal Water District Code are applicable to this Ordinance.

PASSED AND ADOPTED THIS 28th DAY OF August 1991, by the following vote of the Board:

AYES: Boessenecker, Cronin, Miller, Morrison, Wray

NOES: None

ABSENT: None

Charles H. Wray

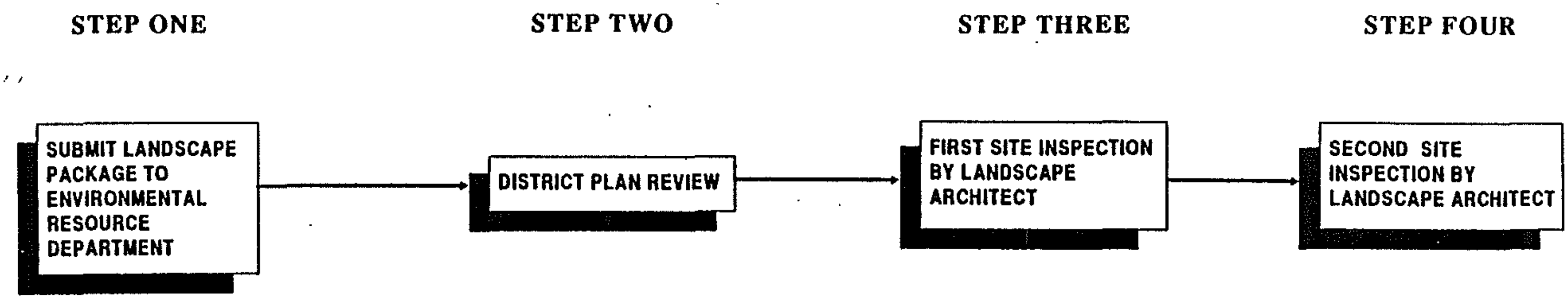
President, Board of Directors

ATTEST:

Julie Thm

Secretary, Board of Directors

LANDSCAPE CERTIFICATION PATHWAY
FOR
ORDINANCE 326



LANDSCAPE
CERTIFICATE
PATHWAY

APPENDIX C
FIGURE 1
(EFFECTIVE 10/91)

MARIN MUNICIPAL WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CHECKLIST & CERTIFICATION FOR ORDINANCE No. 326

LANDSCAPE PLAN REVIEW

GENERAL PROJECT INFORMATION

Please complete the following information:

DISTRICT PLAN REVIEW NUMBER: ______________________________

PROJECT NAME: ______________________________

PROJECT ADDRESS: ______________________________

____

LANDSCAPE PLAN REVIEW INSTRUCTIONS

All landscape plans submitted to the District must be certified by a landscape architect that they are in compliance with Ordinance 326. All plans must pass this review process and receive District approval before beginning construction. This checklist is for the landscape architect's review.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before construction begins.

Please submit the following information to the District's Environmental Resources Division for their review:

1. **Completed Project Data Sheet (PDS).**
2. **Completed Landscape Plan Review (LPR).**
3. **One complete set of landscape plans.**

The District will notify applicant if the plans pass or fail the review. All plans that pass the review will receive a District stamp of approval on all sepia reproducible drawings before beginning construction. The plans not passing review will be resubmitted to the District until those plans do pass review.

GENERAL PLAN REQUIREMENTS

Please show plan page number(s) and drawing date of plans.

1. [ ] Planting plan(s) ______________________________

2. [ ] Irrigation plan(s) ______________________________

3. [ ] Grading plan(s) ______________________________

IRRIGATION REQUIREMENTS:

1. [ ] The irrigation plan is drawn at the same scale as the planting plan. The irrigation plan is separate from but in the same format as the planting plan.

2. The irrigation plan has the following information:
   - a. [ ] Irrigation system point of connection;
   - b. [ ] Water service pressure at point of irrigation system connection;
   - c. [ ] Water meter size;
   - d. [ ] Backflow prevention device(s);
   - e. [ ] Major components of the irrigation system;
   - f. [ ] Total precipitation rate shown in inches per hour for each valve circuit using over-head irrigation.
   - g. [ ] Total flow rate (GPM) and operating pressure (PSI) for each irrigation circuit.

3. Pressure regulation valve(s) are shown.
   - a. [ ] A pressure regulation valve(s) is indicated where water pressure exceeds 80 psi. The water service pressure is ___ psi.
   - b. [ ] A pressure regulation valve was not needed because water service pressure less than 80 psi. The irrigation design pressure is ___ psi.

4. [ ] Automatic controller with repeat start times and multiple program potential are shown on plan.

5. [ ] Automatic rain shut-off unit(s) are shown on plan for each controller.

6. [ ] Precipitation rates do not exceed .85 inches per hour on slopes exceeding 15%.

7. [ ] Check valves are shown on plan.

8. Separate irrigation circuit(s) are provided for the following:
   a. [ ] Turf;
   b. [ ] High-water use plants;
   c. [ ] Low-water use plants;
   d. [ ] Plants on drip;
   e. [ ] Exposure variations;
   f. [ ] Slope variations;
   g. [ ] Soils with different infiltration rates;
   h. [ ] Different precipitation rates.

9. [ ] Point application or subsurface irrigation systems are used where overspray, angle or slope, soil texture, or widely spaced plants make overhead irrigation impractical due to overspray, runoff, or inefficiency.

10. Irrigation legend has the following information:
    a. [ ] Symbols for all irrigation equipment;
    b. [ ] General description of equipment;
    c. [ ] Manufacturer name and model number;
    d. [ ] Operating pressure;
    e. [ ] Manufacturer's rated gpm per nozzle;
    f. [ ] Minimum and maximum spray radius;
    g. [ ] Manufacturer's rated precipitation rate per nozzle.

11. Overhead irrigation satisfies the following criteria:
    a. [ ] Distance between spray heads on turf does not exceed 55% of the spray diameter;
    b. [ ] Distance between spray heads elsewhere does not exceed 70% of spray diameter;
    c. [ ] Spray heads are adjusted so spray radius or special pattern is within 25% of the manufacturer's rating;
    d. [ ] Spray heads are located so overspray will not accumulate and flow off adjacent pavements, walkways, structures and other non-landscaped areas during an irrigation cycle;

e. [ ] Median strips and parking islands less than eight feet wide have no overhead irrigation;
f. [ ] Planted areas which are acutely angled or irregularly shaped and which are adjacent to hardscape surfaces are not irrigated by an overhead system unless they are at least 120% ofthe spray diameter of the irrigation heads being used;
g. [ ] Precipitation rates within each overhead circuit are matched to within 20% of one another.

12. [ ] All reclaimed water piping and guidelines have been met.

GRADING REQUIREMENTS:

1. [ ] The grading plan is drawn at the same scale as the planting and irrigation plans.

2. The grading plan shows the following information:

a. [ ] Finish grades;
b. [ ] Spot elevations as necessary;
c. [ ] Existing and new contours within the developed landscape area.

PLANTING REQUIREMENTS:

1. [ ] The planting plan is drawn at the same scale as the irrigation and grading plan.

2. The planting plan shows the following information:
a. [ ] New and existing trees, shrubs, groundcovers and turf areas within the developed landscape area;
b. [ ] Plant botanical name(s), common name(s), container size(s),spacing and quantities;
c. [ ] Property lines, streets and street names;
d. [ ] Driveway(s), sidewalk(s) and other hardscape features as necessary;
e. [ ] Pool(s), fountain(s), fence(s) and retaining wall(s);
f. [ ] Existing and proposed buildings;
g. [ ] Square footages for the various landscape hydrozones.

3. [ ] The combined area of turf and swimming pools does not exceed 25% of the total developed landscape area.
Note: This requirement applies only to services using **potable water** for irrigation.

4. [ ] The combined area of turf and swimming pools does not exceed 40% of the total developed landscape area.
Note: This requirement applies only to services using **reclaimed water** for irrigation.

5. [ ] This landscape is in an area designated as a **future reclaimed water service area** and will have reclaimed water available within one year of the service agreement date.

A reclaimed water service connection date has been confirmed by the District's Reclaimed Water Section. The planting plan meets the requirements for services using reclaimed water for irrigation. Refer to Planting requirements, Item 4.

6. [ ] High-water use plants, decorative pools, fountains and water features do not exceed 10% of the total developed landscape area.

7. [ ] All other plantings are composed of low-water use plant material.

8. Planting areas with overhead irrigation with slope ratios greater than 3:1 conform to one of the following:

   a. [ ] The recommendations of a soils laboratory report and the report submitted to District for review.
   b. [ ] The recommendations of the landscape architect. Also, these recommendations can be found in either the written specifications or on the planting plan.

9. Planting areas with overhead irrigation with slope ratios less than 3:1 conform to one of the following:

   a. [ ] The recommendations of a soils laboratory report and the report submitted to District for review.
   b. [ ] Planter soils will be ripped or rotary cultivated to a depth of 6 inches and have an organic amendment incorporated into the soil at a rate of 5 cubic yards per 1000 square feet.

10. [ ] All exposed soil surfaces of non-turf areas within the developed landscape are mulched with a minimum 2 inch layer of organic material.

CERTIFICATION STATEMENT:

I hereby certify that the planting, irrigation and grading plans are accurate and follow the Marin Municipal Water District's Water Conservation Ordinance No.326.

LANDSCAPE ARCHITECT: ______________________________

(Print Name)

ADDRESS: ______________________________

PHONE: ______________________ FAX: ______________________

____

State license stamp with signature

(Effective 10/91)

MARIN MUNICIPAL
WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CERTIFICATION STATEMENT

ORDINANCE NO. 326

FIRST SITE INSPECTION

Please complete the following information:

DISTRICT PLAN REVIEW NUMBER: ____________________

PROJECT NAME: ____

PROJECT ADDRESS: ____

____

ACCESSORS'S PARCEL NUMBER: ____________________

LANDSCAPE SITE INSPECTION INSTRUCTIONS

It is the responsibility of the owner or the owner's agent to schedule a site inspection with a landscape architect prior to installation of the irrigation system. This checklist is for the landscape architect's first site inspection.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before making changes in the field.

The landscape architect must complete and return this certification statement form to the District's Environmental Resources Division within 10 days of inspection.

FIRST SITE INSPECTION:

1. [ ] The installing contractor has District approved planting and irrigation plans on site.

2. [ ] Soil preparation requirements have been satisfied.

CERTIFICATION STATEMENT:

I hereby certify that the above information is accurate and that this project follows the Marin Municipal Water District's Water Conservation Ordinance No.326:

INSPECTION DATE: ____________________

LANDSCAPE ARCHITECT: ____
(Print Name)

ADDRESS: ____

____

PHONE: ___________________________ FAX: ___________________________

____
State license stamp with signature

(Effective 10/91)

MARIN MUNICIPAL
WATER DISTRICT

220 Nellen Avenue
Corte Madera, CA 94925-1169
415.924.4600
FAX 415.927.4953

LANDSCAPE ARCHITECT'S CERTIFICATION STATEMENT FOR ORDINANCE NO. 326

SECOND SITE INSPECTION

GENERAL PROJECT INFORMATION

Please complete the following information:

DISTRICT PLAN REVIEW NUMBER: ____________________

PROJECT NAME: ____________________

PROJECT ADDRESS: ____________________

____

ACCESSORS'S PARCEL NUMBER: ____________________

LANDSCAPE SITE INSPECTION INSTRUCTIONS

It is the responsibility of the owner or the owner's agent to schedule a site inspection with a landscape architect within ten days of completion of work to verify compliance with the approved landscape plans. This checklist is for the landscape architect's second site inspection.

Please check all the boxes and fill in the appropriate blanks below. Unchecked boxes and blanks require the landscape architect to submit a written explanation why the District should consider a variance and why that requirement cannot be met.

The District will consider and may allow the substitution of well-designed conservation alternatives or innovations which may equally reduce water consumption for any of the Ordinance 326 requirements. However, all written explanations, variances, substitutions, alternatives or innovations must be reviewed and approved by the District before making changes in the field.

The landscape architect must complete and submit this certification statement form to the Districts Environmental Resources Division within 10 days of inspection.

SECOND SITE INSPECTION

1. [ ] The installed landscape meets all District planting requirements. (Refer to project's Landscape Plan Review form pages 4 and 5.)

2. [ ] The installed landscape meets all District irrigation requirements. (Refer to project's Landscape Plan Review form pages 2 and 3.)

CERTIFICATION STATEMENT:

I hereby certify that the above information is accurate and that this project follows the Marin Municipal Water District's Water Conservation Ordinance No.326:

INSPECTION DATE: ______________________

LANDSCAPE ARCHITECT: ______________________
(Print name)

ADDRESS: ______________________

____

PHONE:______________________ FAX:______________________

____
State license stamp with signature

(Effective 10/91)

LANDSCAPE WATER EFFICIENCY STANDARDS for the CITY OF PALO ALTO

in compliance with the STATE OF CALIFORNIA WATER CONSERVATION IN LANDSCAPING ACT AB 325

Developed by the City of Palo Alto
Department of Utilities, Energy Services Section,
in cooperation with the
Department of Planning and Community Environment

March 15, 1993

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CITY OF PALO ALTO
LANDSCAPE STANDARDS

I. Purpose

The purpose of these standards is to promote efficient water use through landscape design and irrigation management appropriate to Palo Alto's climate zone.

II. Applicability

A. The standards apply to new and rehabilitated industrial, commercial and institutional landscaping and all new or rehabilitated multi-family common areas.

B. Single-family residences and multi-family private areas are exempt from these standards. However, all residents are encouraged to follow them.

C. The standards do not apply to cemeteries or registered historical sites. However, landscape managers at these sites are encouraged to follow efficient irrigation system management practices as indicated in Section V.C.2.

D. The standards do not apply to any landscaping which is irrigated solely by reclaimed water and to which there is no pipeline installed to deliver potable City water.

E. School yards, parks, playgrounds, sports fields, and golf courses are exempt from a maximum water allowance. Every other requirement of these standards is applicable, including estimation of irrigation water requirements. In addition, turf areas of these sites shall have a landscape irrigation audit performed after the installation or renovation of the irrigation system.

III. Definitions

The terms used in this document have the meaning set forth below:

Common areas:
: Those areas in a residential development maintained by either the developer or a homeowner's association.

Conversion factor (0.00083):
: A number that converts the maximum water allowance from inches per square foot per year to units of one hundred cubic feet (CCF) per square foot per year. Water is metered and sold in Palo Alto in CCF units.

The conversion is calculated as follows:

(435.6 CCF/43,560 sq.ft.)/12 inches = 0.00083

Where 435.6 CCF = water per acre foot
43,560 sq. ft. = one acre
12 inches = one foot

Effective Precipitation:

The portion of total precipitation that is used by plants in the landscape. Precipitation is not a reliable source of water but can contribute in some degree toward the water needs of the landscape.

Estimated Applied Water

That portion of total water used in a landscape to be supplied by the City metered water supply. The estimated applied water may not exceed the maximum water allowance specified in Section IV. The Water Use Calculations form in Appendix 3 indicates one methodology acceptable for the purposes of conforming to these standards.

ET Adjustment Factor:

A factor of .8, that when applied to reference evapotranspiration, adjusts plant water requirements based on an average of plant water requirements and irrigation system efficiency.

ET_o: See, Reference Evapotranspiration

Hydrozone:

A portion of the landscaped area having plants with similar water needs in a similar microclimate. It may be served by one or more valves. A hydrozone may be irrigated or non-irrigated. For example, a naturalized area planted with native vegetation that will not need supplemental irrigation once established is a non-irrigated hydrozone.

Irrigation Efficiency:

A measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from estimates of irrigation system design and management practices.

Irrigation Zone:

Same as irrigation circuit. An irrigation distribution line and associated application devices controlled by one valve.

Irrigation Zone Water Requirement:

The plant water requirement of an irrigation zone or circuit divided by the estimated design efficiency of the type and configuration of application devices in that zone. The result is expressed in CCF. Table 2 in Appendix 3 lists design efficiencies acceptable for conforming to the Landscape Standards.

Landscaped Area:

The parcel minus building pad(s), driveways, parking areas, impervious hardscapes such as decks and patios, and other non-porous surfaces. Examples of landscaped areas could include: plant areas, water bodies, porous walkways and natural areas. A natural area is one occupied by mature plants, native or acclimated plants growing on undisturbed grades, and which is not irrigated.

Landscape Coefficient:

A factor derived from analysis of plant species, planting density, and microclimate which, when compared to ET_O, results in an estimate of the amount of water required to maintain a planted area.

Table 1 in Appendix 3 lists numeric values developed through research done by Cooperative Extension, University of California, and others which are acceptable for the purposes of the Landscape Standards.

Local Annual Mean Precipitation:

The average amount of rain per year based on an average of annual rainfall over a 30-year period, in inches. The 30-year average for Palo Alto may be obtained from:

Department of Utilities, Resource Conservation
250 Hamilton Avenue
Palo Alto, CA 94301.

Maximum water allowance:

For design purposes, the upper limit of annual water use for the established landscaped area which may be supplied through City water meters as specified by the formula in Section IV.

Plant Water Requirement:

An estimate of the amount of water required to maintain an acceptable degree of health and vigor in the planting or group of plants irrigated by one valve.

Reference Evapotranspiration (ET_O):

A standard measurement of environmental parameters which affect the water use of plants. ET_O is measured in inches per day, month, or year and is derived from measurements of evapotranspiration from a test plot of four to seven-inch tall turf in an open field that is well watered.

Total Water Use:

The sum of water from the City metered water supply and also from effective precipitation estimated to be used for a landscape.

IV. Calculation of Maximum Water Allowance

A. Maximum Water Allowance

A Maximum Water Allowance (MWA) will be established for each site submitted for review:

$$MWA = (ET_O) \times .8 \times (LA) \times 0.00083$$

Where:
MWA = Maximum Water Allowance in CCF
ET_O = Annual Reference Evapotranspiration in inches for Palo Alto
0.8= Local ET adjustment factor
LA = Landscaped area in square feet
0.00083 = Conversion factor into CCF per square foot

Example for a one acre site:

MWA = 43.1 x .8 x 43560 x 0.00083

MWA = 1246.6 CCF annual water allowance

The MWA will be itemized on a Landscape Water Use Statement form provided by the City. See Appendix 1 for a sample form.

Note: For the purposes of these standards, the annual ET_O for Palo Alto may be considered to be 43.1 inches/square foot/year. Using **real-time ET_o** data for irrigation management after plant installation, e.g.,from the California Irrigation Management Information System (CIMIS), or other site-specific, electronically monitored, ET_O calculation system is encouraged.

B. Effective Precipitation

It is understood that rainfall may provide some or all of a landscape's water requirements during some winter months in Palo Alto's climate zone. At the option of the landscape architect or irrigation designer, landscape water use calculations may include up to 25% of the local annual mean precipitation. This percentage shall be referred to as "effective precipitation."

All provisions of Section VII, Water Use Monitoring, shall apply to the metered water use of landscape water accounts whether effective precipitation is included in the landscape water use calculations or not.

V. Requirements for Landscape Plans

A. Planting Design Plan

1. Landscape Design Requirements

a. Plant Selection and Grouping

i. Any plants may be used in the landscape, provided the total metered water use does not exceed the maximum landscape water allowance plus allowable effective precipitation and that the plants meet the specifications set forth in Sections ii. and iii. below.

Table 1 in Appendix 3 provides values which may be used to derive estimated water use for various types of landscaped areas.

ii. Plants having similar water use shall be grouped together in distinct hydrozones.

iii. Plants shall be selected appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the site. Protection and preservation of native species and natural areas is encouraged.

iv. The plant establishment period is considered to be 18 months for the purposes of these standards. Landscapes may require more irrigation than the maximum water allowance during the first 18 months after planting.

b. <u>Water Features</u>

i. Water needed to fill and maintain levels in water features shall be calculated in CCF and included as part of the maximum landscape water allowance.

ii. Fountains or other types of decorative water bodies where water is sprayed into the air are discouraged. "Misting" will not be allowed. Any water feature submitted for review shall be designed to minimize evaporation.

iii. Recirculating water shall be used for any water feature.

iv. Use of reclaimed water for fountains and water features is encouraged. **Reclaimed water used in this way need not be included in calculation of the maximum landscape water allowance.**

v. Refilling of all fountains and/or other types of decorative water bodies with potable water may be prohibited during a City-Council-declared water emergency.

c. <u>Horticultural Soils Analysis</u>

i. For projects with a landscaped area greater than 44,000 square feet, a basic soil chemistry analysis or horticultural suitability analysis from a laboratory specializing in landscape soils is required. The soil analysis shall be made for approved projects after rough grading is completed. If soil is imported for use in the landscaped area, an analysis shall be submitted from each different source of origin of that fill material. Samples will be selected for analysis from each different soil type area of the project.

Final inspections of the project will not be completed without receipt of the soils test report.

ii. Soil will be amended according to the soils test report recommendations.

2. Documents to be submitted for Planting Plan review

a. Statement of Design Intent

Each landscape plan submitted for review shall be accompanied by a Statement of Design Intent. This statement shall consist of 1) a brief statement of the design concept and description of the project at maturity, 2) a description of the irrigation of the proposed project describing how the system conforms to Palo Alto's irrigation design requirements, and 3) a summary of the projected long range maintenance of the project until maturity.

A sample Statement of Design Intent appears in Appendix 2.

b. Landscape Planting Plan

The planting plan shall be drawn on project base sheets at a scale that accurately and clearly identifies:

i. All hydrozones.

ii. Landscape materials, trees, shrubs, groundcover, turf, and other vegetation. Planting symbols shall be clearly drawn and plants labeled by botanical name, common name, container size, spacing, and quantities of each group of plants indicated.

iii. Property lines and street names.

iv. Streets, driveways, walkways, and other paved areas.

v. Pools, ponds, water features, fences and retaining walls.

vi. Existing and proposed buildings and structures including elevation, if applicable.

vii. Natural features including, but not limited to, rock outcroppings, existing trees, and shrubs that will remain.

viii. Location, size, and species of existing street trees.

ix. Spot elevations used in making the grading plan.

x. A calculation of the total landscaped area in square feet.

c. Planting Specifications and details

Planting specifications shall include details of tree staking and plant installation, soil preparation details, and any other applicable planting and installation details. These specifications must include the following:

A minimum of 2 inches of mulch shall be added in non-turf areas to soil surface after planting except for areas planted with a non-turf groundcover which shall have a minimum of 1 inch of mulch added to the soil surface. Visqueen, sheet plastic, and other non-porous material shall not be placed under the mulch. Porous weed-barrier fabrics are acceptable.

B. Grading Design Plan

Grading design plans satisfying the following conditions shall be submitted with the documents for landscape review:

1. A grading design plan shall be drawn on project base sheets on the same scale as the landscape planting plan. It should be separate from, but use the same format as, the landscape planting plan.

2. The grading design plan shall indicate finished configurations and elevations of the landscaped area, including the height of graded slopes, drainage patterns, pad elevations, and finish grade.

C. Irrigation Design Plan

1. Irrigation Design Plan Requirements

a. Maximum Water Allowance

A maximum water allowance shall be established for new projects.

See the Landscape Water Use Statement in Appendix 1.

b. Unified Plumbing Code

Specifications for irrigation systems shall ensure that all requirements of the adopted unified plumbing code are met.

c. Water Meters

A separate water meter shall be installed to irrigate each approved landscape. This meter shall be designated as an irrigation account and no other utilities will be billed on such accounts.

d. Backflow Prevention

The irrigation system shall be separated from the City of Palo Alto water supply by a backflow prevention device or devices approved by the City Utilities Department. For a list of approved devices contact:

Cross Connection Officer
Department of Utilities
Field Operations (415)496-6972

Written requests may be made to:

Cross Connection Officer
Department of Utilities/Field Operations
City of Palo Alto
P.O. Box 10250
Palo Alto, CA 94303.

e. Soil-Water Relationships

Soil types and infiltration rates shall be considered when designing irrigation systems. All irrigation systems shall be designed to avoid runoff, low head drainage, overspray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, or structures. Proper irrigation equipment shall be used to closely match application rates to infiltration rates thereby minimizing runoff and overspray.

f. Irrigation Zones

Irrigation zones shall have the following characteristics:

i. All plants shall have approximately similar water requirements.

ii. Irrigation zones shall encompass only one microclimate.

iii. All application devices shall have matched precipitation and distribution uniformity.

g. Irrigation Equipment

Irrigation system components shall be selected on the basis that they are appropriate for the task. Criteria shall include performance, ease of maintenance, and public safety.

h. Sprinklers

All sprinklers for turf (microsprays, sprayheads, rotors,etc.) shall have spring retracted pop-up operation with flexible connections to piping. Sprinklers shall be selected and spaced for maximum distribution uniformity. **No overhead sprinkler irrigation systems shall be installed in areas less than eight (8) feet wide.**

i. Bubblers

All bubblers shall be pressure compensating. Bubblers exceeding .33 gpm shall be used only in planting basins with permanent basin walls to prevent runoff (i.e., tree wells in hardscape areas, planters, containers, etc.)

j. Drip Systems

Drip systems shall be designed to provide water uniformly to the area of a mature rootzone. Drip systems shall use PVC lateral piping below grade for primary distribution of water to emitters or groups of emitters. Secondary distribution lines may be of other materials.

k. Electric Control Valves (ECVs)

At each ECV, there shall be a pressure gauge valve (Schrader Valve) for measuring zone pressure during operation. This valve may be an integral part of the ECV or it may be "tapped" into a PVC fitting downstream of the ECV outlet.

l. Irrigation Controllers

Electronic controllers shall be required for all projects. They shall be capable of managing all aspects of the irrigation system design. Minimum controller requirements are as follows:

i. Precise individual station timing.

ii. Runtime capabilities for extremes in precipitation rates.

iii. At least one program for each hydrozone and microclimate.

iv. Sufficient multiple cycles to avoid runoff.

v. Extended day calendar for deep-rooted plants.

vi. Power failure backup for all programs.

m. Anti-Drain Valves

The irrigation system shall be designed to prevent gravity drainage of water through application devices. Two anti-drain valves which are available are in-line check valves for lateral piping, or in-head check valves to prevent low head drainage.

n. Rain Sensing Devices

Irrigation systems shall be equipped with rain sensing devices to prevent irrigation during rainy weather. Soil moisture sensors shall not be used as rain sensing devices.

o. Tree Irrigation

Trees in mixed planting areas of shrubs and/or ground covers shall have an additional means of irrigation for deep watering (i.e. drip or bubblers) which shall be separate from all other circuits and served by separate valves.

Trees may not be planted in turf unless surrounded by a mulched area of a diameter equal to the diameter of the projected median-life crown drip line.

2. Irrigation System Management

Irrigation management practices shall consist of efficient scheduling, system inspections, and maintenance.

a. Irrigation Operation

Irrigation shall be scheduled according to any emergency water use ordinance in effect.

b. Establishment Period

The plant establishment period shall be considered to be **18 months.**

c. Real-Time ET_o Data

Whenever possible, irrigation management shall incorporate the use of real-time ET_o data from the California Irrigation Management Information System (CIMIS), or other site-specific, electronically monitored, ET_o calculating system.

d. Irrigation System Inspections

The irrigation system should be inspected after each mowing for turf areas and bi-monthly in other areas for the life of the system. This 'wet-check' inspection consists of operating the valves and observing the performance of each irrigation zone.

f. Irrigation System Maintenance

The irrigation system should be kept clean and properly adjusted. Damaged equipment should be repaired promptly with identical equipment to maintain the original design integrity.

3. Irrigation Efficiency

Irrigation systems shall be designed, constructed, managed, and maintained to achieve as high an overall efficiency as possible. Irrigation efficiency (IE) is calculated as follows:

IE = Design Efficiency (DE) x Management Efficiency (ME)

a. Design Efficiency

DE is based on equipment performance and design factors. Table 2 in Appendix 3 lists efficiencies which are acceptable for the purpose of conforming with these standards.

b. Management Efficiency

ME is based on scheduling procedures and maintenance practices. The management efficiency shall be assumed to be 70% with the use of monthly irrigation schedules, inspection of turf areas after mowing, bi-monthly non-turf irrigation system inspections, controllors turned off during rainy periods, and appropriate system maintenance. The management efficiency may be increased by adding automated scheduling equipment and flow sensing control systems as described below to the above requirements.

The City will not consider a lower management efficiency percentage in the calculation of maximum water requirements. If inspection and maintenance are neglected, the overall efficiency of the system will decrease over time. The result is likely to be increased costs, either in replacing plant materials or in excess water use, or both.

c. Automated Scheduling Equipment

With the **additional** installation of automatic scheduling equipment, management efficiency shall be assumed to be increased by 10%. Automated scheduling equipment includes Central Computer Control utilizing an ET_0 weather station (CIMIS) or soil moisture sensors. Use of soil moisture sensors must meet the following conditions:

i. The irrigation base schedule shall be used as a reference for moisture sensor settings.

ii. There shall be a minimum of one sensor for each hydrozone and/or microclimate. One sensor per irrigation zone is encouraged.

iii. The soil moisture sensing system shall be designed so that adjustments can be made from a central control unit at the controller. Field adjustments shall not be required.

iv. Sensors shall be monitored on a weekly basis.

d. Flow Sensing Control System

With the installation of a flow sensing control system **in addition to the basic practices itemized in Section b. above,** management efficiency shall be assumed to be increased by 10% when the following conditions are met:

i. A master electric control valve shall be installed just downstream of the backflow device.

ii. The flow sensing control system shall include a flow sensor and an integral irrigation controller that can monitor station GPM for overflows, underflows and main line breaks.

iii. The controller shall be capable of shutting off 1) malfunctioning individual stations without disrupting the remaining program and 2) the master valve in the event of a mainline or valve failure downstream.

4. Documents to be submitted for Irrigation Plan Review

a. Water Use Statement

A landscape water use statement in the form which appears in Appendix 1 shall be submitted with the plans for every project. **This landscape water use statement defines the maximum landscape water allowance for each site. Therefore it should be completed before final planting or irrigation designs are developed.**

Copies of this form are available from the City:
Dept. of Planning and Community Environment
250 Hamilton Ave.
Palo Alto, CA 94301

b. Irrigation Drawings and Details

Drawings shall be the same scale as the landscape planting plan and shall accurately and clearly identify:

i. Location and size of the landscape water meter.

ii. Minimum static pressure at the point of connection. The nominal system static pressure for each of the Palo Alto water service areas is available from the Palo Alto Water Transmission Supervisor at:

Department of Utilities
Water-Gas-Wastewater/Municipal Services Center
3201 E. Bayshore Blvd.
Palo Alto, CA 94303

iii. Location, type, and size of all components of the irrigation system, including electronic controllers, main and lateral lines, valves, application devices, rain shutoff sensors, flow sensors, soil moisture sensors, booster pumps and backflow prevention devices.

iv. Station/Zone number, valve size, flow rate (GPM), and operating pressure for each irrigation zone.

v. Spot elevations used in making the grading plan.

vi. Details of assembly and installation.

c. Irrigation Specifications and Details

Specifications shall prescribe quality of materials, standards of workmanship, expected results, and guarantees and include details as required.

d. Calculation Worksheets

A summary of the information used to determine landscape water requirements and irrigation efficiency shall be submitted in a form similar to the Water Use Calculations sheet in Appendix 3. The City requires documentation of the values used to determine the total estimated irrigation requirement. Documentation in other formats which provide substantially the same information and which are clearly itemized and concise may be submitted for review.

VI. Alternative Equipment or Design

The City realizes that more and more research is being conducted on plant water needs, in mixed plantings as well as for individual species. As this data becomes available and is accepted by landscape professionals, more detailed data may be available than that itemized in Table 1, Appendix 3. The City will accept alternative methodologies for calculat ing plant water needs as long as the methodology has been endorsed and accepted by appropriate academic and professional organizations.

Also, new and increasingly efficient irrigation equipment is being designed and manufactured. Irrigation designers may submit test data to support different efficiencies for irrigation application devices other than those listed in Table 2, Appendix 3. Acceptable test data will include, at a minimum, results based on **field** testing, not bench testing, endorsed and accepted by appropriate professionals.

VII. Water Use Monitoring

A.. Landscape water use will be monitored on an annual basis for comparison to the MWA. All irrigation accounts which have been established as a result of an approved landscape plan will be subject to annual review by the Department of Utilities.

1. Water use will be based on utility records of the water meter installed as the irrigation meter for each landscape.

2. The first 18 months after planting will be considered as the establishment period for the landscape plant materials.

3. Irrigation water use will not be compared to the MWA for that landscape until 12 months after the 18-month establishment period.

B. The Department of Utilities will determine whether the irrigation account water usage is lower than or equal to the MWA, or greater than the MWA established for that landscape.

1. If the irrigation account water use is lower than or equal to the MWA, the landscape shall be designated as a water-efficient landscape.

a. The property owner, or party responsible for utilities payment, as appropriate, will be presented with a Water-Efficient Landscape award. The landscape will then be eligible for display of a notice or sign from the Department of Utilities regarding its status.

b. A copy of the Water-Efficient Landscape award will also be sent or presented to the Landscape Architect and/or Irrigation Designer responsible for the plant selection and irrigation design.

c. TheWater-Efficient Landscape status will remain in effect as long as the irrigation water use remains lower than or equal to the MWA.

2. If the irrigation account water use is greater than the MWA, the landscape shall have a landscape irrigation audit.

   a. At a minimum, the audit shall be in accordance with the California Landscape Water Management Program as described in the Landscape Irrigation Auditor Handbook, the entire document which is hereby incorporated by reference. See: Landscape Irrigation Auditor Handbook, Dept. of Water Resources, Water Conservation Office, June 1990, version 5.5.

   b. The audit report shall be delivered to the Department of Utilities within 90 days of notification of excess water use.

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Appendix B

Procedure for the Quantification of Evaporative Cooling Water Requirements

Procedure for the Quantification of Evaporative Cooling Water Requirements

Prepared by
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November 1995

OPERATING CHARACTERISTICS OF DRIP EVAPORATIVE COOLERS

Drip-type direct evaporative coolers, also known as "desert coolers," "swamp coolers," and "water coolers," are only satisfactory in arid climates, and for applications having a high sensible heat gain and a low latent heat gain. Thus, crowded areas, such as department stores and theaters, are better served by other types of air conditioning equipment.

A typical evaporative cooler is a cubical metal or plastic box with large flat vertical air filters, called pads, that are fitted into separate pad-holders in the cooler frame for easy removal and replacement. The pads consist of very wettable porous material such as spun glass fibers, aspen excelsior pads, or a tinsel made of copper or aluminum. A pump lifts water from the sump in the bottom of the unit and delivers it to perforated troughs at the top of the unit. The pads are kept moist by water dripped continuously into their upper edges. Unevaporated water trickles down through the pads and collects in the bottom pan for discharge or recirculation. A fan, which is generally a centrifugal or "squirrel cage" type of blower, draws outside air through the pads, and this cools and humidifies the air. Most coolers discharge the washed air through side outlets, but there are also coolers that deliver air directly downward. Down-flow type coolers generally have more pad area and gain greater output capacity or better economy and pad life than side-outlet coolers. Evaporative coolers are designed for 100% outside air intake, and therefore provision must be made for exhausting this same quantity of air from the conditioned spaces (Trane Company, 1974, p. 222). Many coolers have two or three fan speeds, so users can modulate outputs as needed. Thermostats are seldom cooler components; most serve only ducted and engineered systems (Watt, 1986, p. 125).

Every gallon of water evaporated from a cooler leaves behind its entire content of dissolved minerals. The accumulation of scale on the pads reduces the quantity of air flowing through them and the performance of the cooler decreases. In areas where water is very hard (high calcium and magnesium), and/or where dusty conditions prevail, pads may become clogged very quickly and must be replaced frequently. Water used to flush the pads is called "bleed-off" or "blowdown" water. Bleed-off water reduces the build-up of lime scale and dirt on the pads; dilutes the mineral concentration of the pan water; and prevents pump malfunctions due to blockages (Watt, 1986, p. 108-109). There are two types of bleed-off systems. The once-through or pumpless type, and the recirculating or pump type. The pumpless type is simpler and cheaper but consumes more water and needs constant drainage. The recirculating pump type cools better, saves water, and can operate with intermittent draining but, for pad life, should be flushed periodically or have a small constant drain flow. The necessary bleed-off rate varies with the entering water mineral content and its scaling tendency. Logic suggests that bleed-off should equal the amount evaporated, however, where entering water is only moderately hard, bleed-offs 25-50% less may be adequate; and one authority suggests bleeding off 1gallon per hour for each 1,000 cubic feet per minute (cfm) of air flow (Watt, 1986, p. 105, 110).

PROCEDURE FOR QUANTIFYING EVAPORATIVE COOLING WATER REQUIREMENTS

The following procedure may be used to compute the water requirements for evaporative cooling units installed in single and multi-family dwelling units.

Step 1: Compute the volume of interior space which will be cooled in each dwelling unit. The total volume (V), in cubic feet, is computed using Equation (1) for buildings with flat, nonvaulted ceilings.

$$V=(A_f)(H) \qquad \text{(Eq. 1)}$$

where A_f is the total floor area and H is the average ceiling height, which is typically 8 ft. For dwelling units which have some rooms with vaulted ceilings, or other buildings with very high ceilings (not necessarily vaulted), the calculation of interior space must be modified accordingly.

Step 2: Compute the required capacity of the cooling unit for each dwelling unit. This is the rate at which air must be moved through the building. Manufacturers generally recommend that there should be a complete change of air in the building every 4 minutes. The volumetric rate of air flow, in cubic feet per minute (CFM), is computed using Equation (2).

$$CFM=V/T_1 \qquad \text{(Eq. 2)}$$

where T_1 is the time in minutes required for a 100% air change.

Step 3: Determine the design dry bulb (DB) and mean coincident wet bulb (WB) temperatures which are appropriate for the climate and locale by reviewing data published by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE, 1989) or Ecodyne (1980). Data for selected locations in New Mexico are shown in the table included in this paper.

Step 4: Compute the maximum hourly make-up water requirement for each dwelling unit. Approximately 1 gallon per hour (gph) is evaporated by a cooling unit operating at 80% efficiency for each 1,000 cfm of unit capacity, for each 10 degrees Fahrenheit of wet bulb depression (Arvin, 19??). The maximum make-up water requirement, or consumptive use (CU_1), in gallons per hour, is computed using Equation (3).

$$CU_1=(CFM/1{,}000)(DB-WB/10) \qquad \text{(Eq. 3)}$$

where DB is the design dry bulb temperature, and WB is the mean coincident wet bulb temperature, for the area under study.

Step 5: Compute the annual make-up water requirement for each dwelling unit. Except under extreme temperature conditions, evaporative coolers will only operate at maximum capacity for a limited number of hours in each 24-hour period. Cooling units typically have two fan speeds--high and low. At low fan speeds, the air flow rate is usually 67% of the high rate. The number of hours a cooling unit operates at maximum capacity will be dependent upon the climatic conditions and the design and construction of the buildings, and will generally be some fraction of the total number of cooling season hours. As a matter of practicality, the average annual make-up water requirement may be estimated to be 80% of the maximum requirement. The annual make-up water requirement (CU_2) for each building, in gallons per year, is computed using Equation (4).

$$CU_2=(K)(CU_1)(T_2) \qquad \text{(Eq. 4)}$$

where K is the coefficient applied to reflect average operating conditions, and T_2 is the total number of design cooling hours in a calendar year, for the area under study. Note that K will be higher in areas where the evaporative cooling unit operates at maximum capacity for a greater number of hours each day than in areas where cooling requirements are more moderate, and the unit operates at maximum capacity for fewer hours each day.

Step 6: Compute the total annual evaporative cooling water requirement for each dwelling unit. The annual water requirement (W) for each building, in gallons per year, is computed using Equation (5).

$$W=(F)(CU_2) \qquad \text{(Eq. 5)}$$

where F is the bleed-off water multiplier. As a general rule of thumb, it may be assumed that F is 1.15 for residential cooling units with recirculating bleed-off systems, and 1.67 for coolers without bleed-off recirculation (See Watt, 1986, p. 105 and 110 for discussion on this subject).

Step 7: Compute the total annual evaporative cooling water requirement in gallons per capita per day (GPCD) using Equation (6).

$$GPCD=W/[(CPU)(365\ \text{days/yr})] \qquad \text{(Eq. 6)}$$

where CPU is the number of capita per dwelling unit.

EXAMPLE CALCULATION NO. 1

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Santa Fe**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) $V=(1{,}700\ ft^2)(8\ ft)=13{,}600\ ft^3$

(2) $CFM=(13{,}600\ ft^3)/(4\ min)=3{,}400$

(3) DB=90.0 and WB=61.0 (from table)

(4) $CU_1=(3{,}400\ cfm/1{,}000)(90.0\text{-}61.0/10)=9.86$ gallons per hour (gph)

(5) $CU_2=(0.80)(9.86\ gph)(686\ hours)=5{,}411$ gallons per year (gpy)

(6) W=(1.15)(5,411 gpy)=6,223 gpy

(7) GPCD=6,223/[(3 capita)(365 days/yr)]=5.68

EXAMPLE CALCULATION NO. 2

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Albuquerque**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) $V=(1{,}700\ ft^2)(8\ ft)=13{,}600\ ft^3$

(2) $CFM=(13{,}600\ ft^3)/(4\ min)=3{,}400$

(3) DB=96.0 and WB=61.0 (from table)

(4) $CU_1=(3{,}400\ cfm/1{,}000)(96.0\text{-}61.0/10)=11.90$ gallons per hour (gph)

(5) $CU_2=(0.80)(11.90\ gph)(1130\ hours)=10{,}758$ gallons per year

(6) W=(1.15)(10,758 gpy)=12,372 gpy

(7) GPCD=12,372/[(3 capita)(365 days/yr)]=11.30

EXAMPLE CALCULATION NO. 3

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Carlsbad**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) $V=(1{,}700\ ft^2)(8\ ft)=13{,}600\ ft^3$

(2) $CFM=(13{,}600\ ft^3)/(4\ min)=3{,}400$

(3) DB=103.0 and WB=67.0 (from table)

(4) $CU_1=(3{,}400\ cfm/1{,}000)(103.0-67.0/10)=12.24$ gallons per hour (gph)

(5) $CU_2=(0.80)(12.24\ gph)(1779\ hours)=17{,}420$ gallons per year

(6) W=(1.15)(17,420 gpy)=20,033 gpy

(7) GPCD=20,033/[(3 capita)(365 days/yr)]=18.29

EXAMPLE CALCULATION NO. 4

Evaporative cooling water requirements for a 1,700 square foot home with 8 foot high ceilings and 3 occupants, in **Las Cruces**, New Mexico. Assume that a cooling unit with a recirculating bleed-off system will be installed to conserve water.

(1) $V=(1{,}700\ ft^2)(8\ ft)=13{,}600\ ft^3$

(2) $CFM=(13{,}600\ ft^3)/(4\ min)=3{,}400$

(3) DB=99.0 and WB=64.0 (from table)

(4) $CU_1=(3{,}400\ cfm/1{,}000)(99.0-64.0/10)=11.90$ gallons per hour (gph)

(5) $CU_2=(0.80)(11.90\ gph)(1718\ hours)=16{,}355$ gallons per year

(6) W=(1.15)(16,355 gpy)=18,808 gpy

(7) GPCD=18,808[(3 capita)(365 days/yr)]=17.18

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Recommended design dry bulb and mean coincident wet bulb temperatures for selected locations in New Mexico. (Source: Ecodyne, 1980; Watt, 1986).			
		Design Temperatures in Degrees Fahrenheit for 99% Confidence Level	
Locale	Cooling Hours	Dry Bulb	Wet Bulb
Alamogordo	1718	98.0	64.0
Albuquerque	1130	96.0	61.0
Artesia	1779	103.0	67.0
Carlsbad	1779	103.0	67.0
Clayton	See Distrib.	91.0	61.0
Clovis	1199	95.0	65.0
Deming	1718	99.0	64.0
Farmington	See Distrib.	95.0	63.0
Gallup	See Distrib.	90.0	59.0
Grants	See Distrib.	89.0	59.0
Hobbs	See Distrib.	101.0	66.0
Las Cruces	1718	99.0	64.0
Las Vegas	See Distrib.	91.0	64.0
Los Alamos	See Distrib.	89.0	60.0
Raton	See Distrib.	91.0	60.0
Roswell	1617	100.0	66.0
Santa Fe	686	90.0	61.0
Silver City	See Distrib.	95.0	61.0
Socorro	See Distrib.	97.0	62. 0
Truth or Consequences	1718	99.0	64.0
Tucumcari	See Distrib.	99.0	66.0

Appendix C

Landscape Irrigation Requirements in New Mexico

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Bernalillo	Albuquerque	50.13	37.45	26.42	28.17	26.59	16.57	15.64
Bernalillo	Corrales and Rio Rancho	45.42	34.53	24.30	25.68	22.30	15.11	13.12
Bernalillo	Los Ranchos	44.21	33.56	23.79	25.16	22.40	14.80	13.18
Catron	Reserve	45.63	36.05	24.47	26.39	16.92	15.52	9.95
Chaves	Roswell	54.17	40.79	28.36	29.94	25.74	17.61	15.14
Cibola	Grants and Milan	32.38	24.46	16.43	17.00	13.86	10.00	8.15
Colfax	Cimarron	29.10	20.11	11.76	12.95	11.99	7.62	7.05
Colfax	Raton	28.82	19.60	11.24	12.55	11.94	7.38	7.03
Colfax	Springer	30.59	21.51	12.83	13.98	12.63	8.22	7.43
Curry	Clovis	40.63	28.32	17.32	19.00	17.30	11.18	10.18
De Baca	Fort Sumner	45.38	33.04	21.74	23.20	20.63	13.65	12.14
Dona Ana	Hatch	51.44	38.88	27.14	28.54	24.56	16.79	14.45
Dona Ana	Las Cruces and Mesilla Park	55.98	42.52	30.12	31.63	27.88	18.60	16.40
Eddy	Artesia	52.19	38.81	26.60	28.31	25.00	16.65	14.70
Eddy	Carlsbad	55.74	41.05	27.70	29.55	26.18	17.38	15.40

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Eddy	Loving	56.39	42.10	29.01	30.24	26.95	17.79	15.85
Grant	Bayard and Central	37.95	27.39	17.64	18.84	16.16	11.08	9.50
Grant	Silver City	38.42	27.70	17.84	19.49	17.07	11.46	10.04
Guadalupe	Santa Rosa	44.61	32.51	21.26	22.65	19.77	13.32	11.63
Harding	Mosquero	33.45	22.86	13.38	14.86	13.64	8.74	8.02
Hidalgo	Lordsburg	53.68	40.53	28.31	29.93	26.27	17.61	15.45
Lea	Hobbs	48.93	34.92	22.48	24.06	22.10	14.15	13.00
Lincoln	Carrizozo	41.45	30.46	20.22	21.68	18.86	12.75	11.10
Lincoln	Ruidoso	17.95	12.27	5.65	5.82	3.94	3.42	2.32
Los Alamos	Los Alamos	28.76	19.37	11.12	12.44	12.06	7.32	7.09
Luna	Deming	53.42	40.59	28.60	30.06	26.22	17.68	15.42
McKinley	Gallup	33.40	25.47	17.59	18.23	15.72	10.72	9.25
Mora	Wagon Mound	26.62	17.80	9.72	11.06	10.66	6.50	6.27
Otero	Alamogordo	55.07	40.93	28.14	29.96	27.14	17.62	15.96

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Otero	Cloudcroft	16.71	9.84	4.19	4.08	3.55	2.40	2.09
Otero	Tularosa	56.03	42.14	29.46	31.05	28.09	18.27	16.52
Quay	Tucumcari	45.72	32.92	21.27	22.89	20.53	13.46	12.08
Rio Arriba	Chama	20.50	14.70	8.81	9.37	8.35	5.51	4.91
Rio Arriba	Espanola	37.99	28.60	19.70	20.74	18.28	12.20	10.75
Roosevelt	Portales	42.29	30.31	19.12	20.56	17.64	12.09	10.38
Sandoval	Bernalillo	43.32	32.71	22.81	24.17	21.38	14.22	12.58
San Juan	Aztec	39.00	29.93	21.16	22.14	19.68	13.02	11.58
San Juan	Bloomfield	44.48	33.49	23.69	25.11	23.65	14.77	13.91
San Juan	Farmington	39.92	30.68	21.82	22.75	20.13	13.38	11.84
San Miguel	Las Vegas	28.12	19.30	11.17	12.22	11.23	7.19	6.61
Santa Fe	Santa Fe	32.70	23.36	14.91	16.13	15.11	9.49	8.89
Sierra	Truth or Consequences	55.48	41.38	29.01	30.58	28.44	17.99	16.73
Socorro	Socorro	48.36	36.39	25.48	26.80	24.05	15.77	14.15

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Landscape irrigation water requirements in a normal weather year (1951-80), in gallons per square foot per year, for flood and sprinkler irrigation assuming an application efficiency of 50%, and drip irrigation assuming an efficiency of 85%, in selected locations in New Mexico. (Prepared by Brian C. Wilson, P.E., and Anthony Lucero, 1995)

		Flood or Sprinkler Irrigation					Drip Irrigation	
County	Locale	KYBL	BERM	BUFF	TREE	HORT	TREE	HORT
Taos	Questa	27.02	19.86	12.95	13.66	12.27	8.04	7.22
Taos	Red River	11.57	8.07	3.73	4.24	3.18	2.49	1.87
Taos	Taos	30.09	22.22	14.64	15.58	14.03	9.17	8.25
Torrance	Estancia	32.46	24.24	16.01	16.68	14.12	9.81	8.31
Union	Clayton	32.85	23.49	14.45	15.78	13.76	9.28	8.10
Union	Des Moines	27.34	18.49	10.21	11.51	10.71	6.77	6.30
Valencia	Belen	48.17	36.50	25.84	27.30	24.46	16.06	14.39
Valencia	Los Lunas	44.63	33.87	23.84	25.02	22.07	14.72	12.98

Key: KYBL=Kentucky bluegrass; BERM=Bermuda grass; BUFF=Buffalo grass; TREE=Trees and shrubs; HORT=Horticultural plants, e.g., herb and vegetable gardens.

Appendix D

Insurance Services Office Procedure for Calculating Needed Fire Flow

FIRE SUPPRESSION RATING SCHEDULE

INSURANCE SERVICES OFFICE

Edition 6-80

ISO COMMERCIAL RISK SERVICES, INC.

TWO SYLVAN WAY PARSIPPANY, N.J. 07054 (201) 267-0359

August 1, 1990

TO: ALL HOLDERS OF THE FIRE SUPPRESSION RATING SCHEDULE (FSRS)

The FSRS produces ten different public protection classifications defining differing levels of public fire suppression capabilities. These classifications are reflected in many individual property insurance cost relativities. The FSRS objectively reviews those features of available public fire protection that have a significant influence on minimizing damage once a fire has occurred (Fire Alarm, Water Supply System and Fire Department).

The Fire Suppression Rating Schedule (FSRS) does not include a review of prevention features that would require a subjective evaluation of enforcement on an overall community basis. Rather, the Specific Commercial Property Evaluation Schedule used by CRS recognizes those fire prevention and building code activities that impact on those conditions evaluated in individual properties.

It is recognized that most communities have adopted one of the available model codes; and, that most have implemented some program for enforcing codes, educating the public regarding fire safety matters and investigating fires to seek prosecution where arson is the cause. It is important that such programs be continued where they exist, and be implemented where they do not exist, so as to impact positively on identified fire problems within a community. These programs are an important component of a community's total fire defense system.

An Addendum to the FSRS is effective August 1, 1990, in the state of LOUISIANA. If you are operating in the state of LOUISIANA, you may wish to contact the Property Insurance Association of Louisiana for a copy of that addendum at 433 Metairie Road - Suite 400, Metairie, LA 70005.

300. GENERAL:

This item develops Needed Fire Flows for selected locations throughout the city which are used in the review of subsequent items of this Schedule. The calculation of a Needed Fire Flow (NFF_i) for a subject building in gallons per minute (gpm) considers the Construction (C_i), Occupancy (O_i), Exposure (X_i) and Communication (P_i) of each selected building, or fire division, as outlined below.

310. CONSTRUCTION FACTOR (C_i):

That portion of the Needed Fire Flow attributed to the construction and area of the selected building is determined by the following formula:

$C_i = 18F(A_i)^{0.5}$

F = Coefficient related to the class of construction:

F = 1.5 for Construction Class 1* (Frame)
= 1.0 for Construction Class 2* (Joisted Masonry)
= 0.8 for Construction Class 3* (Non-Combustible) and Construction Class 4* (Masonry Non-Combustible)
= 0.6 for Construction Class 5* (Modified Fire Resistive) and Construction Class 6* (Fire Resistive)

A_i = Effective* area

In buildings with mixed construction a value, C_{im}, shall be calculated for each class of construction using the effective area of the building. These C_{im} values are multiplied by their individual percentage of the total area. The C_i applicable to the entire building is the sum of these values. However, the value of the C_i shall not be less than the value for any part of the building based upon its own construction and area.

The maximum value of C_i is limited by the following:

8,000 gpm for Construction Classes 1 and 2
6,000 gpm for Construction Classes 3, 4, 5 and 6
6,000 gpm for a 1-story building of any class of construction.

The minimum value of C_i is 500 gpm. The calculated value of C_i shall be rounded to the nearest 250 gpm.

320. OCCUPANCY FACTOR (O_i):

The factors below reflect the influence of the occupancy in the selected building on the Needed Fire Flow.

Occupancy Combustibility Class*	Occupancy Factor (O_i)
C-1*(Non-Combustible)	0.75
C-2*(Limited Combustible)	0.85
C-3*(Combustible)	1.00
C-4*(Free Burning)	1.15
C-5*(Rapid Burning)	1.25

330. EXPOSURES (X_i) AND COMMUNICATION (P_i) FACTORS:

The factors developed in this item reflect the influence of exposed and communicating buildings on the Needed Fire Flow. A value for ($X_i + P_i$) shall be developed for each side of the subject building:

$(X+P)_i = 1.0 + \sum_{i=1}^{n} (X_i + P_i)$, maximum 1.75, where n = number of sides of subject building.

A. Factor for Exposure (X_i):

The factor for X_i depends upon the construction and length-height value* (length of wall in feet, times height in stories) of the exposed building and the distance between facing walls of the subject building and the exposed building, and shall be selected from Table 330.A.

*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

TABLE 330.A
FACTOR FOR EXPOSURE (X_i)

Construction of Facing Wall of Subject Bldg.	Distance Feet to the Exposed Building	Length - Height of Facing Wall of Exposed Building	Construction of Facing Wall of Exposed Building Classes: 1,3	2, 4, 5, & 6: Unprotected Openings	2, 4, 5, & 6: Semi-Protected Openings (wired glass or outside open sprinklers)	2, 4, 5, & 6: Blank Wall
Frame, Metal or Masonry with Openings	0-10	1-100	0.22	0.21	0.16	0
		101-200	0.23	0.22	0.17	0
		201-300	0.24	0.23	0.18	0
		301-400	0.25	0.24	0.19	0
		Over 400	0.25	0.25	0.20	0
	11-30	1-100	0.17	0.15	0.11	0
		101-200	0.18	0.16	0.12	0
		201-300	0.19	0.18	0.14	0
		301-400	0.20	0.19	0.15	0
		Over 400	0.20	0.19	0.15	.0
	31-60	1-100	0.12	0.10	0.07	0
		101-200	0.13	0.11	0.08	0
		201-300	0.14	0.13	0.10	0
		301-400	0.15	0.14	0.11	0
		Over 400	0.15	0.15	0.12	0
	61-100	1-100	0.08	0.06	0.04	0
		101-200	0.08	0.07	0.05	0
		201-300	0.09	0.08	0.06	0
		301-400	0.10	0.09	0.07	0
		Over 400	0.10	0.10	0.08	0
Blank Masonry Wall	Facing Wall of the Exposed Building Is Higher Than Subject Building: Use the above table EXCEPT use only the Length-Height of Facing Wall of the Exposed Building ABOVE the height of the Facing Wall of the Subject Building. Buildings five stories or over in height, consider as five stories.					
	When the Height of the Facing Wall of the Exposed Building is the Same or Lower than the Height of the Facing Wall of the Subject Building, $X_i = 0$.					

330. EXPOSURE (X_i) AND COMMUNICATION (P_i) FACTORS: (Continued)

B. Factor for Communications (P_i):

The factor for P_i depends upon the protection for communicating party wall* openings and the length and construction of communications between fire divisions* and shall be selected from Table 330.B. When more than one communication type exists in any one side wall, apply only the largest factor P_i for that side. When there is no communication on a side, $P_i = 0$

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*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

TABLE 330.B
FACTOR FOR COMMUNICATIONS (P_i)

Description of Protection of Passageway Openings	Fire Resistive, Non-Combustible or Slow-Burning Communications				Communications With Combustible Construction					
	Open	Enclosed			Open			Enclosed		
	Any Length	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +	10 Ft. or Less	11 Ft. to 20 Ft.	21 Ft. to 50 Ft. +
Unprotected	0	+ +	0.30	0.20	0.30	0.20	0.10	+ +	+ +	0.30
Single Class A Fire Door at One End of Passageway	0	0.20	0.10	0	0.20	0.15	0	0.30	0.20	0.10
Single Class B Fire Door at One End of Passageway	0	0.30	0.20	0.10	0.25	0.20	0.10	0.35	0.25	0.15
Single Class A Fire Door at Each End or Double Class A Fire Doors at One End of Passageway	0	0	0	0	0	0	0	0	0	0
Single Class B Fire Door at Each End or Double Class B Fire Doors at One End of Passageway	0	0.10	0.05	0	0	0	0	0.15	0.10	0

\+ For over 50 feet, $P_i = 0$.

\+ + For unprotected passageways of this length, consider the 2 buildings as a single Fire Division.

Note: When a party wall has communicating openings protected by a single automatic or self-closing Class B fire door, it qualifies as a division wall* for reduction of area.

Note: Where communications are protected by a recognized water curtain, the value of P_i is O.

*When an asterisk is shown next to a term in this item, the term is defined in greater detail in the Commercial Fire Rating Schedule.

