

Report: Summary of Building Codes Division Process,  
Residential Fire Sprinklers  
December 2008

**Introduction:**

The division received two code change proposals regarding Appendix P, residential fire sprinklers, as a part of the 2008 Oregon Residential Specialty Code (ORSC) change process. The code change committee and the Residential Structures Board were unable to resolve the technical and policy issues raised by the Appendix P document. The Residential Structures Board asked the division to try to resolve these issues. The division attempted, over several months, to work through the Appendix P document to gain consensus on the policy issues surrounding residential fire sprinklers. Because the division was unable to gain consensus on the issues, it ended the process without adopting a statewide residential fire sprinkler requirement. Municipalities wishing to include mandatory residential fire sprinklers as part of an overall community fire protection plan may do so through the local amendment process. As part of the local amendment application, municipalities will need to address particular policy considerations.

This report summarizes the discussions surrounding residential fire sprinklers. It is intended to provide municipalities the benefit of the information provided to the division. Part I contains a brief background and overview of the process. It highlights the issues that were raised and the comments received. Part II is a more in depth discussion of the key issues that resurfaced throughout the process. Part III summarizes what the division's position would have been had fire sprinklers been adopted as a statewide requirement. Because the division could not reach consensus, and therefore did not adopt residential fire sprinkler provisions, this section is provided as information for industry and government interested in fire sprinklers as part of an overall community fire protection plan. Part IV discusses the local amendment process and issues that municipalities submitting a local amendment request for residential fire sprinklers must address.

**I. Process**

**A. Background and Local Amendment Process**

A number of municipalities in Oregon are experiencing a challenge in providing community fire protection services to high growth areas. Because Oregon's statewide code

preempts local government action, these municipalities requested that the Building Codes Division (division) adopt fire-sprinkling provisions enabling them to utilize mandatory residential sprinkler systems as a community fire protection tool. Because the division was unable to reach consensus, residential fire sprinklers will not be adopted as a statewide requirement, at this time. However, municipalities wanting to include residential fire sprinklers as part of their community fire protection strategy may apply for a local amendment. Oregon Revised Statute (ORS) 455.040 allows the division to approve a local amendment to the statewide code. Any local amendment will need to follow the procedures adopted by the division. A local amendment request for fire sprinklers should address:

1. The scope of the provisions;
2. The secondary costs;
3. Trade-offs;
4. Fees and provisions for inspection and plan review; and
5. The technical installation standards that will apply.

During the public process, the division heard from approximately 30 individuals and associations and received 34 pieces of written testimony over 13 months of public comment. The division met with representatives of the Home Builders and Fire Marshal's Associations as well as building officials from municipalities, representatives of the Land Conservation Development Commission, and representatives of water providers. The division hopes this overview of the process will be useful to local jurisdictions applying for a fire sprinkler local amendment in assessing the issues and appropriate standards.

## **B. Brief Overview of Board and Committee Hearings**

### 1. Committee Hearings

Oregon adopts the International Residential Code (IRC) model code, as the ORSC. The 2006 IRC included sprinkling provisions in Appendix P, an optional appendix for local jurisdictions to adopt. The language adopted at the national level did not address any of the issues raised by the Residential Structures Board (Board) or Oregon stakeholders; it provided in whole, that "an approved automatic fire sprinkler system shall be installed in new one- and two-family dwellings and townhouses in accordance with Section 903.3.1 of the International

Building Code.” The provision leaves the technical and policy issues surrounding fire sprinklers unresolved.

Oregon began accepting code change proposals as part of its adoption of the 2006 IRC in March of 2007. The Oregon Residential Code Change Committee (Committee) received competing proposals regarding Oregon’s adoption of Appendix P. Code Change Proposal 52, sponsored by the Oregon Home Builders Association (Home Builders), proposed not adopting the appendix. Code Change Proposal 53, sponsored by the Oregon Fire Chiefs and the Oregon Fire Marshal Associations (Fire Service), proposed adopting Appendix P and mandating fire sprinklers.<sup>1</sup>

The Committee heard testimony that adoption of Appendix P, as an optional requirement, would fragment the state’s uniform code, as municipalities chose whether or not to require fire sprinklers in new dwellings. Many Oregon communities expressed interest in pursuing fire sprinkling as a means of protecting lives and property.<sup>2</sup> Because of the number of unresolved, complex technical and policy issues involved in the adoption of residential fire sprinklers, on June 28, 2007, the Committee voted against recommending to the Board that Appendix P be adopted into the 2008 ORSC.<sup>3</sup>

## 2. August 29<sup>th</sup> Board Meeting

On August 29, 2007, the Board heard testimony regarding the inclusion of Appendix P in the 2008 ORSC from representatives of organizations including the League of Oregon Cities, Oregon Fire Chiefs Association, Oregon Fire Marshal Association, Oregon Home Builders Association, Oregon Building Official Association, various municipalities, the Committee, and private citizens. The chairman of the Board requested that interested parties work together to come to an agreement on the provisions of Appendix P by the September or October board meeting.<sup>4</sup>

## 3. September 25<sup>th</sup> and October 3<sup>rd</sup> Board Meeting

On September 25, 2007, Home Builders and Fire Services reported to the Board that the two groups had met and thoroughly discussed fire sprinkling. The parties testified that they were working hard toward a consensus document addressing technical and policy provisions for fire sprinkling, but they needed more time to resolve all of the outstanding issues. The chairman of

the Board asked the parties to continue working toward an agreement and report their progress at the next board meeting on October 3, 2007. The division advised the Board that if the parties could not come to an agreement by October, the Board could defer the fire sprinkler issue to December. Deferring the issue past the October meeting would likely require the fire sprinkler issue to be separated from the general ORSC adoption process. The division was concerned that the fire sprinkler issue would delay the proposed new energy efficiency and seismic provisions of the ORSC. The public hearings for these provisions needed to be timed to meet the target effective date of April 1, 2008.<sup>5</sup>

At the October 3, 2007 board meeting, the parties reported that they were still unable to reach a consensus with regard to the fire sprinkler provisions of Appendix P. The Board voted unanimously to defer the Appendix P discussion to December in the hopes that the parties could reach an agreement.<sup>6</sup>

#### 4. December 11<sup>th</sup> Board Meeting

On December 11, 2007, the Home Builders and Fire Services presented a document to the Board representing approximately 90% agreement between the two associations. The parties had developed technical and installation standards based off the NFPA 13D fire sprinkler standards they had modified to address advancements in “multi-purpose,” or “integrated,” sprinkler systems.

While the associations had been able to agree upon the technical installation requirements, they disagreed on the policy aspects. The document presented to the Board contained competing provisions: those drafted by the Home Builders, and alternate proposals from the Fire Services. Both parties requested that the Board choose whose language to move forward, testifying it would be too confusing to advance the competing provisions to a public process.<sup>7</sup> General areas of disagreement between the associations were: (1) when fire sprinklers can be required, on what types of construction and as of what date; (2) what locations would be exempt from fire sprinkler coverage; (3) how to approach indirect costs associated with the installation of fire sprinklers; and (4) how to capture the urban-wildland interface requirements.

The Board, after testimony and discussion, voted to deny both code change proposals 52 (Home Builder’s proposal) and 53 (Fire Service proposal). The Board then unanimously voted to forward the fire sprinkler issue to the division. The Board recommended the division proceed

with the language proposed by the Home Builders, with the exception of the trade-offs for smoke detectors and Arc Fault Circuit Interrupters (AFCI) in sprinkled houses. At that time, the division expressed a desire to have some policy in place with regard to sprinkling by July 2008.<sup>8</sup>

The division began to work with the “Appendix P” document, attempting to resolve outstanding areas of concern to stakeholders. After each revision, the document was presented to the Board for review and recommendations. The Board reviewed the document on April 2 and July 2, 2008, heard testimony, and made recommendations to the division.

### **C. Brief Overview Of Division Process**

To supplement the testimony given at the code committee and board levels, the division began a 6-month public process of collecting statements and testimony on fire sprinkler requirements. The division chose to work with the “Appendix P” document to avoid confusion, and to capitalize on the joint effort of the home builders and fire service, despite the fact that, as of the October Board action, the document was no longer being considered for adoption into the ORSC.<sup>9</sup> The division began meeting with interested parties to resolve the outstanding areas of concern. Public meetings were held on January 28, 2008, and May 16, 2008.

#### 1. January Public Meeting

In preparation for the public meeting in January, the division met with members of industry, representatives of the Land Conservation and Development Commission (LCDC), and building code and planning department employees to discuss options for scoping the provisions. The division presented a revised “Appendix P” document for comment at the January 28, 2008 public meeting. At that meeting, the division received comment on four primary areas of the document: (1) the scope of the provisions; (2) areas required to be sprinkled; (3) the secondary costs, particularly as they related to charges assessed by water purveyors; and (4) possible trade-offs and how they related to the urban-wildland interface. The division reiterated its intention to have something in place by July of 2008 and stated it would present a revised document to the Board on April 2, 2008, for further consideration.<sup>10</sup>

#### 2. May Public Meeting

The division again presented a document, revised on the basis of feedback received from the Board, stakeholder groups, and the public, at a public meeting on May 16, 2008. The division

explained that because the fire sprinkler provisions were not part of the ORSC, a separate process would be required. One option the division announced it was considering, was adoption of the sprinkler document (referred to as Appendix P) as a model code. This model code could then be adopted through a local ordinance by a jurisdiction.<sup>11</sup> In order to pursue this option, however, the division would be required to adopt the model ordinance through the rulemaking process, local variations would be precluded, and all aspects of policy would need to be decided to provide statewide consistency.

At the May meeting, the division received comments from the Home Builders and Fire Services stating they preferred incorporation of the fire sprinkler requirements into the ORSC for reasons of consistency. The division also received testimony against the adoption of any fire sprinkler requirement based on cost impacts. The division also received comments again on the scope of the provisions, and the secondary costs associated with water system development charges. The division announced that it would present a revised fire sprinkler document at the July 2, 2008 board meeting.

### 3. July 2<sup>nd</sup> Final Action

At the July 2, 2008 Residential Structures Board meeting, the division announced that it was concluding the public process for the fire sprinkling provisions. The division had been unable to reach consensus with regard to the policy aspects of the “Appendix P” document. Considering the distance between the stakeholders’ positions, the comments received, and the local nature of the policy considerations, the division determined the best path for municipalities wishing to mandate residential fire sprinklers was through requesting a local amendment to the state code as allowed under ORS 455.040.

## **II. Key Issues**

Interested parties testified on the provisions of the “Appendix P” document during the 2008 Residential Specialty Code adoption process, the October 3, December 11, January 23, April 2, and July 2nd, board meetings, and at open public meetings on January 28, and May 16, 2008. The division continually revised the “Appendix P” working document based on comments received over the year-long process. In total, there were 9 opportunities for public input. During the process, the key issues requiring resolution were:

- A. The scope of the provisions;
  - The effective date
  - Adoption options
- B. The areas required to be sprinkled;
- C. The secondary costs associated with system development charges.

This section briefly addresses these topics, and the revisions made to the document as a result of trying to reach consensus between the interested parties.

### **A. Scope**

The division received the most comments on the scope of the provisions - which dwellings the provisions would be applied to, and when they would apply. The division received testimony that the provisions should apply to all new dwellings, that manufactured homes should be included, and conflicting testimony on whether low cost housing should be covered.<sup>12</sup> Nearly all comments received by the division indicated it would be difficult to determine what type of remodeling would trigger fire sprinkler installation, and so only new construction should be covered. The division drafted a scope that would apply only to new residential dwellings.

On December 11, the Board recommended the following scope provision move forward through the public process:

“AP101 Scope. The provisions in this appendix apply only to new development within areas added to the jurisdictions original urban growth boundary (as directed to be implemented by the 1973 legislature).

Exceptions:

1. All lots of record within areas added to the 1972 urban growth boundary are exempt from the requirements of this appendix.
2. All new subdivisions (4 lots or more) that are approved for development five years after the date of adoption of this appendix by the local jurisdiction are subject to the requirements of this appendix.”

The division determined, after discussions with the LCDC and municipal stakeholders, that using urban growth boundaries to scope construction standards was unworkable and insufficient to address concerns over high growth areas.<sup>13</sup> Only cities, not unincorporated communities or counties, are required to institute and maintain urban growth boundaries and growth boundaries do not equate neatly into service areas. The division revised the scope to

cover all new one- and two-family subdivisions when fire sprinklers were required as a condition on the subdivision's final plat.<sup>14</sup> Dwellings in partitions (3 lots or less) were not included in the revised scope.<sup>15</sup> The division believed its proposed scoping provision allowed builders to predict costs of future developments while not requiring them to sprinkle developments that had already been platted. The provision also allowed communities to evaluate a proposed development's need for sprinklers based on overall community fire protection considerations. The division believed that it would provide a clear scope for the provisions, clarify remodels were not covered, but that manufactured dwellings were included.<sup>16</sup>

The division requested that the Board review and comment on the provisions at the April 2, 2008 board meeting. The Board voted to move forward with the revised language.<sup>17</sup>

### 1. Effective Date of Scope Provisions

The Board received testimony from the Home Builders that the provisions should not be applicable until July 2011. Alternately, the Fire Service testified that they would not support a 2011 effective date. On April 2, 2008, the Board recommended to the division that the provisions become effective July 2011. However, based on the revised scope and comments from municipalities wishing to require fire sprinklers, the division felt that July 1, 2009, was a more appropriate effective date. Because the division's proposed scope covered subdivision developments where fire sprinklers were required as a condition of the final plat, currently platted lots would not be affected. The scope assured that builders would not be subjected to surprise costs based on new requirements for previously platted, but not yet constructed, developments. In light of the delay between an application to partition land and when actual development could occur, the division felt that any additional delay was unnecessary.<sup>18</sup>

### 2. Adoption Options

The division received comments on how the provisions should be adopted. The document recommended by the Board contained a clause prefacing the document reading; "the provisions contained in this appendix are mandatory when this appendix is adopted by the jurisdiction." The document recommended by the Board also contained: "AP101.1 Local adoption. Modifications to this appendix by the local jurisdictions are only allowed when approved by the

Residential Structures Board.” The division struck these clauses as unnecessary and outside the legal authority of the Board.

ORS 455.040 requires that Oregon’s building code apply uniformly throughout the state. In addition, ORS 455.040 grants the director of the Department of Consumer and Business Services the authority to grant local amendments to the statewide code upon request of a municipality.<sup>19</sup> Though the Board decided against incorporating fire-sprinkling requirements into the 2008 ORSC, some stakeholders wanted to incorporate the provisions into the code. Because of the difficulty finding an acceptable means of dealing with the policy considerations of mandatory residential fire sprinklers, the division was forced to conclude that municipalities should consider and resolve these issues surrounding the applicability of fire sprinkler requirements at a local level. Because the division could not reach a consensus we believe that the local amendment process is the appropriate mechanism through which jurisdictions may request to use residential sprinkler systems as part of an overall community fire protection strategy. The local amendment process is discussed in detail in section IV, below.

## **B. Location Required to be Sprinkled**

The division received comments on what areas should be exempt from sprinkler coverage. Comments received from the Home Builders and the Fire Services indicated that the two groups generally agreed which areas could safely be exempted. In the document originally recommended by the Board, the clause exempting particular areas from sprinkler coverage read as follows:

AP102.3 Locations where sprinklers are required. Sprinklers shall be provided to protect all areas of dwelling unit, except the following:

1. Attics
2. Crawl spaces and closets that do not contain fuel-fired or electric appliances
3. Bathrooms of 110 square feet or less in area
4. Toilet rooms of 110 square feet or less in area
5. Garages and car ports
6. Closets 60 square feet or less in size

The Home Builders and Fire Services discussed this language during the process of developing a consensus document and generally agreed to the areas that should be exempt from

coverage.<sup>20</sup> There was disagreement as to the size restrictions on exempted areas. The division researched the subject and came to the conclusion that the proposal by the Fire Services, exempting smaller more specific areas, was likely to be closer to the national standard should one be adopted. The division brought the revised language to the Board on April 2, 2008.<sup>21</sup> The Board recommended moving forward with the Fire Services' proposed provision because it provided clearer parameters for areas exempted from coverage.<sup>22</sup>

### **C. Secondary Costs**

The division received numerous comments on the provision addressing fees assessed by water purveyors. The document recommended by the Board on April 2, 2008, contained the following provision related to secondary, or indirect costs, associated with water purveyor system development charges:

AP105.2 Fees. Where water purveyor fees, connection charges, impact and system development charges are based on the size of the water meter and/or water distribution piping needed to meet the design requirements of the potable water system serving a one- and two-family dwelling or individual townhouse unit, those valuations shall exclude any increases to the water system sizing due to the installation of an automatic sprinkler system.

Fire Services felt it was inappropriate to include a provision addressing these indirect fees, while the Home Builders testified that it was a pivotal issue needing to be addressed. Home Builders testified that system development charges could double with the inclusion of a sprinkler system, making the systems prohibitively expensive for both the developer and prospective buyer. They argued there was no evidence that a larger water meter installed to meet the technical pressure requirements of a sprinkler system translated to more water used. The Fire Service testified that they had been able to reach agreements in some municipalities where water purveyors waived or reduced costs associated with a larger meter required for sprinkler systems. They felt it was inappropriate to require municipalities, that may have no authority over system development charges, to fight with water purveyors.

The division received testimony from a number of water districts and some jurisdictions that the division lacks authority to dictate how water purveyors charge system development fees.<sup>23</sup> The division drafted language which allowed for recouping costs associated with the installation of a larger water meter to accommodate the pressure requirements of a fire sprinkler

system, but prevented assessment of the full charge for an “up-sized” meter installed only to meet the technical requirements of a mandated sprinkling system.

Representatives of the water purveyors submitted language that would require municipalities adopting sprinkling requirements to assess all costs associated with sprinkling, and defend to the division how they had chosen to address indirect costs. Water purveyors commented that some purveyors have been developing innovative ways to address costs associated with fire sprinkling. Some providers offer mid-sized meters that do not require a full cost up-side meter. The water purveyors testified that they prefer to continue to work with the jurisdictions to address the cost issue.

The division presented the Board with its revised provision and the provision proposed by the water purveyors, requesting a recommendation from the Board with regard to how secondary costs, particularly as they relate to system development charges, should be addressed. The Board voted against removing the provision, and recommended a modified version of language submitted by the division.<sup>24</sup>

#### **D. Timing of Amendments to the Fire Code Provisions**

Two provisions in the fire sprinkler document recommended by the Board appear in the Fire Code. Sections AP103 and 104 address fire apparatus access roads and fire protection water supplies respectively. The document recommended by the Board contained the following: “The provisions of AP103 are adopted by the Office of State Fire Marshal of the State of Oregon. Future modifications to this Section shall be made only through the Oregon Residential Code Change Process.” The provision for AP 104 is identical but for the section cited. Because these provisions generally relate to possible trade-offs where fire sprinklers are installed, they were included as “place holders” in the fire sprinkler document. The provision is unnecessary, since the division is not adopting a residential fire sprinkler requirement. The division will consider all of the related issues before making a decision on a local amendment request.

#### **E. Wildland Interface Areas**

The document recommended by the Board contained the following provision: “AP103.1.1 Residential developments. Where there are more than 30 dwelling units on a single public or private fire apparatus access road and all the dwelling units are equipped with an automatic sprinkler system installed in accordance

with Section AP102, access from two directions will not be required. The number of dwelling units on a single fire apparatus access road shall not be increased unless the fire apparatus road will connect with future development.

~~**Exception:** Developments located within urban-wildland interface areas as determined using criteria established by the Oregon Department of Forestry.~~

Based on testimony and comments received, the division felt it was inappropriate to waive the requirements for dual access in wildland-urban interface areas. The comments received led the division to amend the section to resolve concerns stakeholders expressed. In discussions with the Home Builders, the division discovered their main concern was that local jurisdictions could deem any green space surrounding developments as wildfire hazard zones and require dual access, despite the installation of fire sprinkler systems. Division research into the issue found while the heading in the Oregon Forestry Department's administrative rules, Chapter 660, Division 44, cites to "Wildland-Urban Interface," the text of both the underlying statute and the rules that implement it, use the term forestland-urban interface. The statute and accompanying rules focus on wildfire hazard areas and the special provisions for areas designated wildfire hazard areas under the rules. The division revised the provision to directly reference the administrative rules and requirements for designating wildfire hazard areas to ensure clarity.

The Board approved the revised provision on April 2, 2008.<sup>25</sup>

## **F. Plumbing Provisions**

The installation of a fire sprinkler system is considered plumbing. The document recommended by the Board contained provisions that intersected with provisions in the plumbing code. The division received testimony from UA Local 290 regarding the plumbing provisions contained in the fire sprinkler document. The board recommended that the division research the provisions and revise as necessary. The Board approved those revisions at the July 2, 2008 board meeting.<sup>26</sup>

## **III. Division's Analysis**

### **A. Summary**

During the process, the division attempted to resolve the outstanding policy issues involved in mandating fire sprinklers, but has been unable to facilitate agreement between the

parties involved. However, the division recognizes that jurisdictions have pressing reasons for wanting fire sprinklers. The complexity of the issues surrounding fire sprinklers, and the regulatory structure in Oregon, has limited the usual avenues of inclusion in the statewide building codes to mandate their use. Based upon the testimony submitted, research done by staff, and the fact that key stakeholder groups cannot reach consensus over appropriate provisions, the division has determined that the most appropriate way to address fire sprinkling is for local jurisdictions to apply for an amendment to the statewide code.

Under ORS 455.040, the director has the authority to approve local amendments to the statewide code. The division is committed to maintaining a uniform code and feels local considerations should be addressed prior to a request for a local fire sprinkler requirement. The division has drafted procedural rules for local amendment requests. The following section provides the division's analysis and represents the direction the division was leaning had it proceeded to adopt statewide residential fire sprinkler provisions.

## **B. Key Issues: Division's Analysis**

After careful consideration of all the testimony, the division provides the following analysis regarding: the possible scope for a fire sprinkler requirement; the code and standards that could be used to develop a fire sprinkler ordinance; possible trade-offs for sprinkled residences; and secondary cost considerations. The following summary is intended only to provide the benefits of the division's research to municipalities considering a residential fire sprinkler requirement. The division will assess a local fire sprinkling ordinance request as part of an overall community fire protection plan.

### 1. Scope

The testimony presented to the division, indicated that fire sprinkler requirements should apply to all residential structures, including manufactured homes, where fire sprinklers are considered an appropriate means of addressing community fire protection needs and included as a condition on a final plat. The Home Builders and Fire Service both discussed the fact that developments in outlying areas were a higher priority than in-fill areas for sprinkling. For that reason the parties discussed exempting in-fill developments from the scope of the fire sprinkler provisions. The division heard testimony that in-fill and partitions (developments of three lots or less) would benefit less from fire sprinklers than subdivisions (developments of four lots or

more) because they were generally within city service areas next to existing unsprinkled dwellings.

The division believed that a scope covering developments of four lots or more, where fire sprinklers are required as a condition on the final plat, would provide predictability and consistency. During the process the division was disinclined to apply the provision until after July 1, 2009. Encompassing remodels in the scope was generally considered unworkable.

## 2. Codes and Standards

Oregon's building codes conform as much as possible to the national uniform model codes while still addressing the unique requirements of the state. In keeping with the policy of consistency across the state, the division believed that a local fire sprinkler ordinance should conform as much as practical to national standards. Generally, the standard for residential fire sprinkler installations is NFPA 13D. The division recognized that the technical installation standards developed by the stakeholders would also be an acceptable standard (see Appendix). Had the division enacted a residential fire sprinkler requirement, it would have allowed a customer to choose between these two standards.

A local fire sprinkler amendment will need to address the installation standard options. Any local amendment will fall under the control and responsibility of the local building official. The local building official will have the final decision regarding interpreting and enforcing a local fire sprinkler ordinance. Local amendments are discussed further in Section IV, below.

## 3. Trade-offs

Based on the input received, the division believes that, in general, trade-offs can play an important part in the decision to require fire sprinklers. As a matter of public policy, the division felt that it was not an appropriate trade-off to exempt areas in wildfire hazard zones from the requirements for more than one means of vehicle access into or out of a sub-division.

The building official should make any decision regarding trade-offs, as the authority responsible for administering the building code. Issues such as access, water supply, and hydrants would be under the direction of the building official for any local amendment approved by the division.

## 4. Secondary Costs

After receiving considerable testimony on the subject of secondary costs, the division is conscious that requiring fire sprinkler systems entails increased costs, both in terms of the system

installation and in terms of associated secondary costs. Depending on the residence, a fire sprinkler system may require a larger water meter than a similarly sized, non-sprinkled, dwelling in order to meet technical pressure requirements. Where a larger water meter is required, water purveyors may assess an “up-charge.” The division was troubled by the fact that where a larger meter is required, fire sprinklers can be prohibitively expensive. This appears to shift the burden of community fire protection to the narrow group of individuals that purchase new residences.

The process revealed that system development charges vary from water district to water district. Some water purveyors have waived, or agreed to discount, up-charges associated with fire sprinkler systems, others, however, may not waive or reduce fees where a larger meter is necessary only to meet the requirements of a fire sprinkler system.

The division was unable to reach consensus with the parties involved as to how best to approach system development charges. The division believes that community fire protection should be a primary consideration and that it is unfair to shift the burden of community fire protection to the individual consumer. Based on the comments received, the division is concerned over the practice of adding an up-charge where a larger water meter is installed solely to meet the technical standards of a required fire sprinkler system. Any request for a local fire sprinkler ordinance should address this issue of secondary costs.

#### **IV. Local Amendment Process**

Because the division could not reach consensus on residential fire sprinkler requirements, the option left open to municipalities wishing to adopt a residential fire sprinkler requirement is to request a local amendment. The local amendment process is authorized under ORS 455.040. The statute allows the Director of the Department of Consumer and Business Services to authorize municipalities to address matters otherwise regulated by the uniform state code. These director approved local ordinance requests are not considered amendments to the state code.<sup>27</sup>

The division is currently finalizing procedures for jurisdictions requesting a local amendment. Jurisdictions will be required to submit a request containing the reason for the local amendment, a copy of the proposed ordinance or administrative rule, and the name of the building official responsible for interpreting and enforcing the ordinance. Prior to submitting the request, a municipality must hold a public hearing or meeting, address substantive issues that arise during the public input process, and submit a report to the division on the process followed. This document has laid out some of the substantive issues required to be addressed in a local

amendment request for residential fire sprinklers: the scope of the provisions; secondary costs; trade-offs; applicable code/standards for installation. Other issues that must be addressed concern fees, plan review and inspection protocols.

The director has the option of approving or denying all or part of the proposed ordinance or administrative rule. Once the director has approved the provisions of the ordinance, no part of the ordinance can be changed without the director's approval. The director has the option of reviewing the local ordinance occasionally, to ensure that the provisions remain appropriate.

Allowing municipalities to adopt fire sprinkler requirements through the local amendment process has the advantage of giving municipalities the ability to address unique circumstances, such as particularly steep grades, without requiring a one-size-fits-all approach. It requires jurisdictions to address stakeholder concerns and local conditions first, before requesting a local fire sprinkler amendment. The division hopes that this document, and the results of its research will provide a starting point for discussions of a local residential fire sprinkler requirement.

## **APPENDIX FIRE SPRINKLER SYSTEMS**

**General.** Fire sprinkler systems shall be permitted to be either a multipurpose systems that serve both fire sprinklers and domestic cold water plumbing fixtures or a stand-alone system that serve only fire sprinklers.

**Fire Sprinkler Systems:** Systems may be installed either according to NFPA 13D or the following standard.

**Locations where sprinklers are required.** Sprinklers shall be provided to protect all areas of dwelling unit.

**Exceptions:**

1. Attics, crawl spaces, and normally unoccupied concealed spaces that do not contain fuel-fired appliances do not require sprinklers. In attics, crawl spaces, and normally unoccupied concealed spaces that contain fuel-fired equipment, a sprinkler shall be provided above the equipment; however, sprinklers shall not be required in the remainder of the space.
2. Clothes closets, linen closets and pantries not exceeding 24 square feet in area, with the smallest dimension not greater than 3 feet and having wall and ceiling surfaces of gypsum board or equivalent non-combustible material.
3. Bathrooms not greater than 55 square feet in area.
4. Garages; carports; exterior porches; unheated entry areas, such as mud rooms, that are adjacent to an exterior door; and similar areas.

**Sprinklers.** Sprinklers shall be listed residential sprinklers and shall be installed in accordance with the sprinkler manufacturer's installation instructions.

**Temperature rating and separation from heat sources.** Except as provided in the provision for **Intermediate temperature sprinklers**, sprinklers shall have a temperature rating of not less than 135°F and not more than 170°F. Sprinklers shall be separated from heat sources as required by the sprinkler manufacturer's installation instructions.

**Intermediate temperature sprinklers.** Sprinklers shall have an intermediated temperature rating of not less than 175°F and not more than 225°F where installed in the following locations:

1. Directly under skylights when exposed to direct sunlight.
2. In attics.
3. In concealed spaces located directly beneath a roof.
4. Within the distance to a heat source as specified in Table FS-1

**Table FS-1  
Locations where Intermediate Temperature Sprinklers are Required**

| Heat Source                                   | Range of distance from heat source within which Intermediate Temperature Sprinklers are Required <sup>a,b</sup> (inches) |
|---|--|
| Fireplace, Side of Open or Recessed Fireplace | 12 to 36   |
| Fireplace, Front of Recessed Fireplace        | 36 to 60   |
| Coal and Wood Burning Stove                   | 12 to 42   |
| Kitchen Range Top                             | 9 to 18  |
| Oven  | 9 to 18  |
| Vent Connector or Chimney Connector           | 9 to 18  |
| Heating Duct not Insulated                    | 9 to 18  |
| Hot Water Pipe not Insulated                  | 6 to 12  |
| Side of Ceiling or Wall Warm Air Register     | 12 to 24   |
| Front of Wall Mounted Warm Air Register       | 18 to 36   |
| Water Heater, Furnace or Boiler               | 3 to 6   |
| Light Fixture up to 250 Watts                 | 3 to 6   |
| Light Fixture 250 Watts up to 499 Watts       | 6 to 12  |

- a. Sprinklers shall not be located at distances less than the minimum table distance unless the sprinkler listing allows a lesser distance.
- b. Distances shall be measured in a straight line from the nearest edge to the heat source to the nearest edge of the sprinkler.

**Freezing areas.** Piping shall be adequately protected from freezing. Where sprinklers are required in areas that are subject to freezing, dry-sidewall or dry-pendent sprinklers extending from a non-freezing area into a freezing area shall be installed.

**Sprinkler coverage.** Sprinkler coverage requirements and sprinkler obstruction requirements shall be in accordance with sections on **Coverage area limit** and **Obstructions to coverage**.

**Coverage area limit.** The area of coverage of a single sprinkler shall not exceed 400 square feet and shall be based on the sprinkler listing and the sprinkler manufacturer's installation instructions.

**Obstructions to coverage.** Sprinkler discharge shall not be blocked by obstructions unless additional sprinklers are installed to protect the obstructed area. Sprinkler separation from obstructions shall comply with the minimum distances specified in the sprinkler manufacturer's instructions.

**Additional requirements for pendent sprinklers.** Pendent sprinklers within 3 feet of the center of a ceiling fan, surface-mounted ceiling luminaire or similar object shall be considered to be obstructed, and additional sprinklers shall be provided.

**Additional requirements for sidewall sprinklers.** Sidewall sprinklers within 5 feet of the center of a ceiling fan, surface-mounted ceiling luminaire or similar object shall be considered to be obstructed, and additional sprinklers shall be provided.

**Sprinkler modifications prohibited.** Painting, caulking or modifying of sprinklers shall be prohibited. Sprinklers that have been painted, caulked, modified or damaged shall be replaced with new sprinklers.

**Sprinkler Piping system.** The sprinkler piping shall comply with all requirements for potable cold water distribution piping. Sprinkler pipe shall connect to and be part of the cold water piping system.

**Nonmetallic pipe and tubing.** Where nonmetallic pipe and tubing, such as CPVC and PEX, is used, it shall be listed for use in plumbing systems.

**Nonmetallic Pipe protection.** Nonmetallic pipe and tubing shall be protected from exposure to the living space by a layer of 3/8 inch gypsum wallboard, 1/2 inch plywood, or other material having a 15 minute fire rating.

**Exceptions:**

1. Pipe protection shall not be required in areas that are not required to be protected with sprinklers as specified in **Locations where sprinklers are required** section.
2. Pipe protection shall not be required where exposed piping is permitted by the pipe listing.

**Shutoff valves prohibited.** With the exception of shutoff valves for the entire water distribution system, valves shall not be installed in any location where the valve would isolate piping serving one or more sprinklers.

**Single dwelling limit.** Piping beyond the service valve located at the beginning of the water distribution system shall not serve more than one dwelling.

**Determining system design flow.** The flow for sizing the sprinkler piping system shall be based on the flow rating of each sprinkler in accordance with **Determining required flow rate for each sprinkler** section and calculated in accordance with **System design flow rate** section.

**Determining required flow rate for each sprinkler.** The minimum required flow for each sprinkler shall be determined using the sprinkler manufacturer's published data for the specific sprinkler model based on all of the following:

1. The area of coverage
2. The ceiling configuration
3. The temperature rating
4. Any additional conditions specified by the sprinkler manufacturer.

**System design flow rate.** The design flow rate for the system shall be based on the following:

1. The design flow rate for a room having only one sprinkler shall be the

flow rate required for that sprinkler, as determined by **Determining required flow rate for each sprinkler** section.

2. The design flow rate for a room having two or more sprinklers shall be determined by identifying the sprinkler in that room with the highest required flow rate, based on **Determining required flow rate for each sprinkler** section, and multiplying that flow rate by 2.
3. Where the sprinkler manufacturer specifies different criteria for ceiling configurations that are not smooth, flat and horizontal, the required flow rate for that room shall comply with the sprinkler manufacturer's instructions.
4. The design flow rate for the sprinkler system shall be the flow required by the room with the largest flow rate, based on Items 1, 2 and 3.
5. For the purpose of this section, it shall be permissible to reduce the design flow rate for a room by subdividing the space into two or more rooms, where each room is evaluated separately with respect to the required design flow rate. Each room shall be bounded by walls and a ceiling. Openings in walls shall have a lintel not less than 8 inches in depth and each lintel shall form a solid barrier between the ceiling and the top of the opening.

**Water supply.** The water supply shall provide not less than the required design flow rate for sprinklers in accordance with **System design flow rate** section at a pressure not less than that used to comply with **Pipe sizing** section.

**Water supply from individual sources.** Where a dwelling unit water supply is from a tank system, a private well system, or a combination of these, the available water supply shall be based on the minimum pressure control setting for the pump.

**Required capacity.** The water supply shall have the capacity to provide the required design flow rate for sprinklers for a period of time as follows:

1. 7 minutes for dwelling units less than 2,000 square feet in area
2. 10 minutes for dwelling units equal to or greater than 2,000 square feet in area.

Where a well system, a water supply tank system, or a combination thereof, is used, any combination of well capacity and tank storage shall be permitted to meet the capacity requirement.

**Pipe sizing.** The piping to sprinklers shall be sized for the flow required by **System design flow rate** section. The flow required to supply the plumbing fixtures shall not be required to be added to the sprinkler design flow.

**Method of sizing pipe.** Piping supplying sprinklers shall be sized using the prescriptive method in **Prescriptive pipe sizing method** section or by hydraulic calculation in accordance with NFPA 13D. The minimum pipe size from the water supply source to any sprinkler shall be 3/4 inch nominal. Threaded adapter fittings at the point where sprinklers are attached to the piping shall be a minimum of 1/2 inch nominal.

Exception: Listed network piping systems may use 1/2 inch nominal piping.

**Prescriptive pipe sizing method.** Pipe shall be sized by determining the available pressure to offset friction loss in piping and identifying a piping material, diameter and length using the equation in **Available Pressure Equation** section and the procedure in **Calculation procedure** section.

**Available pressure equation.** The pressure available to offset friction loss in the interior piping system ( $P_t$ ) shall be determined in accordance with the Equation 29-1.

**(Equation 29-1)**

$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

Where:

$P_t$  = Pressure used in applying Tables for **Allowable Pipe Length** (4) through (9).

$P_{sup}$  = Pressure available from the water supply source.

$PL_{svc}$  = Pressure loss in the water-service pipe.

$PL_m$  = Pressure loss in the water meter.

$PL_d$  = Pressure loss from devices other than the water meter.

$PL_e$  = Pressure loss associated with changes in elevation.

$P_{sp}$  = Maximum pressure required by a sprinkler.

**Calculation procedure.** Determination of the required size for water distribution piping shall be in accordance with the following procedure:

**Step 1 - Determine  $P_{sup}$**

Obtain the supply pressure that will be available from the water main from the water purveyor, or for an individual source, the available supply pressure shall be in accordance with **Water supply from individual sources** section. The

pressure shall be the residual pressure available at the flow rate used when applying Table for **Water Service Pressure Loss** (1).

**Step 2 – Determine  $PL_{svc}$**

Use Table for **Water Service Pressure Loss** (1) to determine the pressure loss in the water service pipe based on the selected size of the water service.

**Step 3 – Determine  $PL_m$**

Use Table for **Minimum Water Meter Pressure Loss** (2) to determine the pressure loss from the water meter. based on the selected water meter size.

**Step 4 – Determine  $PL_d$**

Determine the pressure loss from devices, other than the water meter, installed in the piping system supplying sprinklers, such as pressure-reducing valves, backflow preventers, water softeners or water filters. Device pressure losses shall be based on the device manufacturer's specifications. The flow rate used to determine pressure loss shall be the rate from **System design flow rate** section, except that 5 gpm shall be added where the device is installed in a water-service pipe that supplies more than one dwelling. As an alternative to deducting pressure loss for a device, an automatic bypass valve shall be installed to divert flow around the device when a sprinkler activates.

**Step 5 – Determine  $PL_e$**

Use Table for **Elevation Loss** (3) to determine the pressure loss associated with changes in elevation. The elevation used in applying the table shall be the difference between the elevation where the water source pressure was measured and the elevation of the highest sprinkler.

**Step 6 – Determine  $P_{sp}$**

Determine the maximum pressure required by any individual sprinkler based on the flow rate from **Determining required flow rate for each sprinkler** section. The required pressure is provided in the sprinkler manufacturer's published data for the specific sprinkler model based on the selected flow rate.

**Step 7 – Calculate  $P_t$**

Using Equation 29-1, calculate the pressure available to offset friction loss in water-distribution piping between the service valve and the sprinklers.

**Step 8 – Determine the maximum allowable pipe length**

Use Tables for **Allowable Pipe Length** (4) through (9) to select a material and size for water distribution piping. The piping material and size shall be acceptable if the developed length of pipe between the service valve and the most remote sprinkler does not exceed the maximum allowable length specified by the applicable table. Interpolation of  $P_t$  between the tabular values shall be permitted.

The maximum allowable length of piping in Tables for **Allowable Pipe Length** (4) through (9) incorporates an adjustment for pipe fittings, and no additional consideration of friction losses associated with pipe fittings shall be required.

**Instructions and signs.** An owner's manual for the fire sprinkler system shall be provided to the owner. A sign or valve tag shall be installed at the main shutoff valve to the water distribution system stating the following: "Warning, the water system for this home supplies fire sprinklers that require certain flows and pressures to fight a fire. Devices that restrict the flow or decreases the pressure or automatically shut off the water to the fire sprinkler system, such as water softeners, filtration systems, and automatic shutoff valves, shall not be added to this system without the issuance of a valid plumbing permit and review by the local jurisdiction's plumbing department. Do not remove this sign."

**Inspections.** The water distribution system shall be inspected in accordance with Sections for **Pre-concealment Inspection** and **Final Inspection**.

**Pre-concealment Inspection.** The following shall be verified prior to the concealment of any sprinkler system piping:

1. Sprinklers are installed in all areas as required by **Locations where Sprinklers are Required** section.
2. Where sprinkler water spray patterns are obstructed by construction features, luminaires or ceiling fans, additional sprinklers are installed as required by **Obstructions to Coverage** section.
3. Sprinklers are the correct temperature rating and are installed at or beyond the required separation distances from heat sources as required by **Temperature rating and separation from heat sources** and **Intermediate temperature sprinklers** sections.
4. The pipe size equals or exceeds the size used in applying Tables for **Allowable Pipe Length** (4) through (9) or, if the piping system was hydraulically calculated in accordance with **Determining required flow rate for each sprinkler** section, the size used in the hydraulic calculation.
5. The pipe length does not exceed the length permitted by Tables for **Allowable Pipe Length** (4) through (9) or, if the piping system was hydraulically calculated in accordance with **Determining required flow rate for each sprinkler** section, pipe lengths and fittings do not exceed those used in the hydraulic calculation.
6. Non-metallic piping that conveys water to sprinklers is listed for potable water use.
7. Piping is supported in accordance with the pipe manufacturer's and sprinkler manufacturer's installation instructions.
8. The piping system is tested in accordance with the plumbing code.

**Final Inspection.** The following shall be verified upon completion of the sprinkler system:

1. Sprinkler are not painted, damaged, obstructed, or otherwise hindered from operation.

2. Where a pump is required to provide water to the system, the pump starts automatically upon system water demand.
3. Pressure reducing valves, water softeners, water filters or other impairments to water flow that were not part of the original design have not been installed.
4. The sign or valve tag required by **Instructions and signs** section is installed and the owner's manual for the system is present.

***NOTE: Tables (1) through (9) are attached at the end of this document.***

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<sup>1</sup> Available on the division's website at: [http://www.bcd.Oregon.gov/committees/08orsc/code\\_changes.html](http://www.bcd.Oregon.gov/committees/08orsc/code_changes.html)

<sup>2</sup> The Committee heard testimony that measures 5 and 50, tightening the requirements for increasing tax revenues, had led to disparities in what local Oregon communities could afford in terms of public services. In some localities, though population has drastically increased, the number of fire service personnel is the same as it was in 1979. Fire Services noted that some of the highest growth communities were experiencing difficulty responding to the increasing number of emergency calls and even having difficulty staffing local fire departments.

<sup>3</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/committees/08orsc.html>

<sup>4</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/boards/rsb/package.html>

<sup>5</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/boards/rsb/package.html>

<sup>6</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/bcd/boards/rsb/package.html>

<sup>7</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/boards/rsb/package.html>

<sup>8</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/boards/rsb/package.html>

<sup>9</sup> The division wanted it to be clear to all parties that the fire sprinkler provisions going through the public process were the same provisions that stakeholders had been discussing and honing throughout the code adoption process.

<sup>10</sup> Archived video of the meeting is available at the division's website at: [http://www.bcd.Oregon.gov/info\\_public\\_mtgs.html](http://www.bcd.Oregon.gov/info_public_mtgs.html)

<sup>11</sup> Archived video of the meeting is available at the division's website at: [http://www.bcd.Oregon.gov/info\\_public\\_mtgs.html](http://www.bcd.Oregon.gov/info_public_mtgs.html)

<sup>12</sup> Archived video of the meeting is available at the division's website at: [http://www.bcd.Oregon.gov/info\\_public\\_mtgs.html](http://www.bcd.Oregon.gov/info_public_mtgs.html)

<sup>13</sup> The Urban growth boundaries proposed by the Home Builders are part of Oregon's Land Use laws. The division contacted LCDC to determine if UGBs could provide a reasonable scope for fire sprinkling. Based on discussions with LCDC, the division determined that a scope that only included new developments added to an original UGB was insufficient to address those municipalities that testified in favor of sprinkling requirements. Some cities have never increased their boundaries. When a city chooses to expand their boundary, they have to incorporate areas in a particular order of priority, "reserve areas" are the highest priority for incorporation followed by "exception areas," those with no or little resource value. These two types of areas are generally already developed and some limited development is allowable. The proposed scope provision would effectively prohibit counties from adopting fire-sprinkling provisions. There are approximately 400 unincorporated communities that fall outside the requirements for a UGB that would fall outside the scope provisions.

<sup>14</sup> Subdivisions are defined as 4 or more lots. Partitions are 3 lots or less.

<sup>15</sup> The Home Builders and Fire Service both discussed the fact that in-fill areas were not a high-priority in terms of residential sprinkler requirements as developments in outlying areas. For that reason the parties discussed exempting in-fill developments from the scope of the fire sprinkler provisions. Though Fire Services would exempt in-fill for five years the Home Builders preferred a total exemption. The division heard testimony that in-fill and partitions would benefit less from the fire sprinkler provisions because they were generally within city service areas and next

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to existing unsprinkled dwellings. These areas were less likely to be hampered by narrow streets, steep grades, lack of water, or long fire service response times.

<sup>16</sup> The division felt it was inconsistent with the statewide code to exempt lower cost developments or manufactured houses from fire sprinkler requirements. All citizens should receive the same protections under the applicable building code.

<sup>17</sup> Minutes are available at the division's website at: <http://www.bcd.Oregon.gov/boards/rsb/package.html>. The division's revised scope is provided for convenience: "**Scope.** These provisions apply to new one and two family dwellings and townhouses in subdivisions where fire sprinklers are a condition or standard recorded on the final plat for the lot on which the dwelling or townhouse is to be located. The jurisdiction may apply these provisions to tentative plats submitted after July 1, 2009. Once the final plat for a lot has been approved it shall not be modified to require fire sprinklers, except that if there is an application for re-platting fire sprinklers may be added as a condition of the final re-plat.

Exception:

Where a parcel is divided into 3 lots or less, fire sprinklers shall not be required, except as a trade-off under OAR 918-480-0120.

Manufactured dwellings are covered under these provisions."

<sup>18</sup> The division was aware that the ICC code committee had also considered a proposal for a future implementation date for fire sprinkling. The ICC committee decided a future date for the adoption of the provisions was too confusing. Additionally, the division had already expressed that it hoped to have fire sprinkler provisions in place by July 2008.

<sup>19</sup> The local amendment process has only rarely been used. The boards do not have statutory authority to grant amendments to the code it is under the exclusive authority of the director.

<sup>20</sup> There was testimony that attics should not be exempt from sprinkling requirements because during the San Diego fires in 2007 some dwellings caught fire because of sparks that reached attics by way of open vents.

<sup>21</sup> The division's revised text is provided for convenience: "**Locations where sprinklers are required.** Sprinklers shall be provided to protect all areas of dwelling unit.

**Exceptions:**

1. Attics, crawl spaces, and normally unoccupied concealed spaces that do not contain fuel-fired appliances do not require sprinklers. In attics, crawl spaces, and normally unoccupied concealed spaces that contain fuel-fired equipment, a sprinkler shall be provided above the equipment; however, sprinklers shall not be required in the remainder of the space.

2. Clothes closets, linen closets and pantries not exceeding 24 square feet in area, with the smallest dimension not greater than 3 feet and having wall and ceiling surfaces of gypsum board or equivalent non-combustible material.

3. Bathrooms not greater than 55 square feet in area.

4. Garages; carports; exterior porches; unheated entry areas, such as mud rooms, that are adjacent to an exterior door; and similar areas."

<sup>22</sup> The division had also modified the Fire Service's proposed provision to extend possible construction materials beyond gypsum and to other non-flammable materials based on comments received from building officials.

<sup>23</sup> The philosophy behind the fees is that new development should contribute to a share of the costs of developing the infrastructure to ensure adequate water for growing needs. Water purveyors are granted the right to assess system development charges by ORS 223.297 through 223.304.

<sup>24</sup> The division attempted to get at reasonable costs by preventing each sprinkler head being counted as a separate fixture for the purpose of calculating costs. The Board recommended the division's revision but struck the language prohibiting individual sprinkler heads from being assessed as individual fixtures. The division's revised language is provided for convenience: "**System Development Charges.** No additional fees shall be assessed beyond the costs for a "standard" (i.e. ¾ inch) meter when a larger meter (i.e. 1 inch meter) is installed only to meet the requirements of §102. Water purveyors may recoup the actual cost associated with the larger meter, but where all other considerations remain the same, the standards required in this ordinance shall not result in system development fees greater than those assessed for a meter that would have been sufficient if no fire sprinkler system had been mandated."

<sup>25</sup> The revised text is provided for convenience: "**Residential developments.** Access from two directions will not be required where there are more than 30 dwelling units on a single public or private fire apparatus access road and all the dwelling units are equipped with an automatic sprinkler system installed in accordance with Section AP102 .

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The number of dwelling units on a single fire apparatus access road shall not be increased unless the fire apparatus road is connected to another development.

**Exception:** Developments located within forestland-urban interface areas as determined using criteria established by the Oregon Department of Forestry for determining wildfire hazard zones and set out in OAR 629-044-200 through 629-044-1110 must be provided with access from two directions.”

<sup>26</sup> Archived video of the meeting is available at the division’s website at:

[http://www.bcd.Oregon.gov/info\\_public\\_mtgs.html](http://www.bcd.Oregon.gov/info_public_mtgs.html)

<sup>27</sup> ORS 455.040.

# Tables

**Table (1)**  
**Water Service Pressure Loss (PL<sub>svc</sub>)<sup>a,b</sup>**

| Flow Rate <sup>c</sup><br>(gpm) | 3/4" Water Service Pressure Loss (psi) |            |             |              | 1" Water Service Pressure Loss (psi) |            |             |              | 1-1/4" Water Service Pressure Loss (psi) |            |             |              |
|---------------------------------|--|------------|-------------|--------------|--------------------------------------|------------|-------------|--------------|--|------------|-------------|--------------|
|                                 | 40' or Less                            | 41' to 75' | 76' to 100' | 101' to 150' | 40' or Less                          | 41' to 75' | 76' to 100' | 101' to 150' | 40' or Less                              | 41' to 75' | 76' to 100' | 101' to 150' |
| 8                               | 5.1                                    | 8.7        | 11.8        | 17.4         | 1.5                                  | 2.5        | 3.4         | 5.1          | 0.6                                      | 1.0        | 1.3         | 1.9          |
| 10                              | 7.7                                    | 13.1       | 17.8        | 26.3         | 2.3                                  | 3.8        | 5.2         | 7.7          | 0.8                                      | 1.4        | 2.0         | 2.9          |
| 12                              | 10.8                                   | 18.4       | 24.9        | NP           | 3.2                                  | 5.4        | 7.3         | 10.7         | 1.2                                      | 2.0        | 2.7         | 4.0          |
| 14                              | 14.4                                   | 24.5       | NP          | NP           | 4.2                                  | 7.1        | 9.6         | 14.3         | 1.6                                      | 2.7        | 3.6         | 5.4          |
| 16                              | 18.4                                   | NP         | NP          | NP           | 5.4                                  | 9.1        | 12.4        | 18.3         | 2.0                                      | 3.4        | 4.7         | 6.9          |
| 18                              | 22.9                                   | NP         | NP          | NP           | 6.7                                  | 11.4       | 15.4        | 22.7         | 2.5                                      | 4.3        | 5.8         | 8.6          |
| 20                              | 27.8                                   | NP         | NP          | NP           | 8.1                                  | 13.8       | 18.7        | 27.6         | 3.1                                      | 5.2        | 7.0         | 10.4         |
| 22                              | NP                                     | NP         | NP          | NP           | 9.7                                  | 16.5       | 22.3        | NP           | 3.7                                      | 6.2        | 8.4         | 12.4         |
| 24                              | NP                                     | NP         | NP          | NP           | 11.4                                 | 19.3       | 26.2        | NP           | 4.3                                      | 7.3        | 9.9         | 14.6         |
| 26                              | NP                                     | NP         | NP          | NP           | 13.2                                 | 22.4       | NP          | NP           | 5.0                                      | 8.5        | 11.4        | 16.9         |
| 28                              | NP                                     | NP         | NP          | NP           | 15.1                                 | 25.7       | NP          | NP           | 5.7                                      | 9.7        | 13.1        | 19.4         |
| 30                              | NP                                     | NP         | NP          | NP           | 17.2                                 | NP         | NP          | NP           | 6.5                                      | 11.0       | 14.9        | 22.0         |
| 32                              | NP                                     | NP         | NP          | NP           | 19.4                                 | NP         | NP          | NP           | 7.3                                      | 12.4       | 16.8        | 24.8         |
| 34                              | NP                                     | NP         | NP          | NP           | 21.7                                 | NP         | NP          | NP           | 8.2                                      | 13.9       | 18.8        | NP           |
| 36                              | NP                                     | NP         | NP          | NP           | 24.1                                 | NP         | NP          | NP           | 9.1                                      | 15.4       | 20.9        | NP           |

NP - Not Permitted. Pressure loss exceeds reasonable limits

- a. Values are applicable for underground listed underground piping material and are based on an SDR of 11 and a Hazen Williams C Factor of 150.
- b. Values include the following length allowances for fittings: 25% length increase for actual lengths up to 100 feet and 15% length increase for actual lengths over 100 feet.
- c. Flow rate from Section AP..... Add 5 gpm to the flow rate where the water-service pipe supplies more than one dwelling.

**Table (2)**  
**Minimum Water Meter Pressure Loss (PL<sub>m</sub>)<sup>a</sup>**

| <b>Flow Rate<br/>(gpm)</b> | <b>5/8" Meter Pressure<br/>Loss (psi)</b> | <b>3/4" Meter<br/>Pressure Loss<br/>(psi)</b> |
|----------------------------|---|---|
| 8                          | 2   | 1   |
| 10                         | 3   | 1   |
| 12                         | 4   | 1   |
| 14                         | 5   | 2   |
| 16                         | 7   | 3   |
| 18                         | 9   | 4   |
| 20                         | 11  | 4   |
| 22                         | NP  | 5   |
| 24                         | NP  | 5   |
| 26                         | NP  | 6   |
| 28                         | NP  | 6   |
| 30                         | NP  | 7   |
| 32                         | NP  | 7   |
| 34                         | NP  | 8   |
| 36                         | NP  | 8   |

NP – Not permitted unless the actual water meter pressure loss is known.

a. This table establishes conservative values for water meter pressure loss for installations where the meter loss is unknown. Where the actual water pressure loss is known, P<sub>m</sub> shall be the actual loss.

**Table (3)**  
**Elevation Loss (PL<sub>e</sub>)**

| <b>Elevation (feet)</b> | <b>Pressure Loss (psi)</b> |
|-------------------------|----------------------------|
| <b>5</b>                | <b>2.2</b>                 |
| <b>10</b>               | <b>4.4</b>                 |
| <b>15</b>               | <b>6.5</b>                 |
| <b>20</b>               | <b>8.7</b>                 |
| <b>25</b>               | <b>10.9</b>                |
| <b>30</b>               | <b>13</b>                  |
| <b>35</b>               | <b>15.2</b>                |
| <b>40</b>               | <b>17.4</b>                |

**Table (4)**  
**Allowable Pipe Length for ¾ inch Type M Copper Water Tubing**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |     |     |     |     |     |     |     |     |     |
|--|--------------------------------|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|  |                                | 15   | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |     |     |     |     |     |     |     |     |     |
| 8                                      | ¾                              | 217  | 289 | 361 | 434 | 506 | 578 | 650 | 723 | 795 | 867 |
| 9                                      | ¾                              | 174  | 232 | 291 | 349 | 407 | 465 | 523 | 581 | 639 | 697 |
| 10                                     | ¾                              | 143  | 191 | 239 | 287 | 335 | 383 | 430 | 478 | 526 | 574 |
| 11                                     | ¾                              | 120  | 160 | 200 | 241 | 281 | 321 | 361 | 401 | 441 | 481 |
| 12                                     | ¾                              | 102  | 137 | 171 | 205 | 239 | 273 | 307 | 341 | 375 | 410 |
| 13                                     | ¾                              | 88   | 118 | 147 | 177 | 206 | 235 | 265 | 294 | 324 | 353 |
| 14                                     | ¾                              | 77   | 103 | 128 | 154 | 180 | 205 | 231 | 257 | 282 | 308 |
| 15                                     | ¾                              | 68   | 90  | 113 | 136 | 158 | 181 | 203 | 226 | 248 | 271 |
| 16                                     | ¾                              | 60   | 80  | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 241 |
| 17                                     | ¾                              | 54   | 72  | 90  | 108 | 125 | 143 | 161 | 179 | 197 | 215 |
| 18                                     | ¾                              | 48   | 64  | 81  | 97  | 113 | 129 | 145 | 161 | 177 | 193 |
| 19                                     | ¾                              | 44   | 58  | 73  | 88  | 102 | 117 | 131 | 146 | 160 | 175 |
| 20                                     | ¾                              | 40   | 53  | 66  | 80  | 93  | 106 | 119 | 133 | 146 | 159 |
| 21                                     | ¾                              | 36   | 48  | 61  | 73  | 85  | 97  | 109 | 121 | 133 | 145 |
| 22                                     | ¾                              | 33   | 44  | 56  | 67  | 78  | 89  | 100 | 111 | 122 | 133 |
| 23                                     | ¾                              | 31   | 41  | 51  | 61  | 72  | 82  | 92  | 102 | 113 | 123 |
| 24                                     | ¾                              | 28   | 38  | 47  | 57  | 66  | 76  | 85  | 95  | 104 | 114 |
| 25                                     | ¾                              | 26   | 35  | 44  | 53  | 61  | 70  | 79  | 88  | 97  | 105 |
| 26                                     | ¾                              | 24   | 33  | 41  | 49  | 57  | 65  | 73  | 82  | 90  | 98  |
| 27                                     | ¾                              | 23   | 30  | 38  | 46  | 53  | 61  | 69  | 76  | 84  | 91  |
| 28                                     | ¾                              | 21   | 28  | 36  | 43  | 50  | 57  | 64  | 71  | 78  | 85  |
| 29                                     | ¾                              | 20   | 27  | 33  | 40  | 47  | 53  | 60  | 67  | 73  | 80  |
| 30                                     | ¾                              | 19   | 25  | 31  | 38  | 44  | 50  | 56  | 63  | 69  | 75  |
| 31                                     | ¾                              | 18   | 24  | 29  | 35  | 41  | 47  | 53  | 59  | 65  | 71  |
| 32                                     | ¾                              | 17   | 22  | 28  | 33  | 39  | 44  | 50  | 56  | 61  | 67  |
| 33                                     | ¾                              | 16   | 21  | 26  | 32  | 37  | 42  | 47  | 53  | 58  | 63  |
| 34                                     | ¾                              | NP   | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| 35                                     | ¾                              | NP   | 19  | 24  | 28  | 33  | 38  | 42  | 47  | 52  | 57  |
| 36                                     | ¾                              | NP   | 18  | 22  | 27  | 31  | 36  | 40  | 45  | 49  | 54  |
| 37                                     | ¾                              | NP   | 17  | 21  | 26  | 30  | 34  | 38  | 43  | 47  | 51  |
| 38                                     | ¾                              | NP   | 16  | 20  | 24  | 28  | 32  | 36  | 40  | 45  | 49  |
| 39                                     | ¾                              | NP   | 15  | 19  | 23  | 27  | 31  | 35  | 39  | 42  | 46  |
| 40                                     | ¾                              | NP   | NP  | 18  | 22  | 26  | 29  | 33  | 37  | 40  | 44  |

NP – Not Permitted

a. Flow rate from Section

**Table (5)**  
**Allowable Pipe Length for 1 inch Type M Copper Water Tubing**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |      |      |      |      |      |      |      |      |      |
|--|--------------------------------|--|------|------|------|------|------|------|------|------|------|
|  |                                | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |      |      |      |      |      |      |      |      |      |
| 8                                      | 1                              | 806  | 1075 | 1343 | 1612 | 1881 | 2149 | 2418 | 2687 | 2955 | 3224 |
| 9                                      | 1                              | 648  | 864  | 1080 | 1296 | 1512 | 1728 | 1945 | 2161 | 2377 | 2593 |
| 10                                     | 1                              | 533  | 711  | 889  | 1067 | 1245 | 1422 | 1600 | 1778 | 1956 | 2134 |
| 11                                     | 1                              | 447  | 596  | 745  | 894  | 1043 | 1192 | 1341 | 1491 | 1640 | 1789 |

|    |   |     |     |     |     |     |      |      |      |      |      |
|----|---|-----|-----|-----|-----|-----|------|------|------|------|------|
| 12 | 1 | 381 | 508 | 634 | 761 | 888 | 1015 | 1142 | 1269 | 1396 | 1523 |
| 13 | 1 | 328 | 438 | 547 | 657 | 766 | 875  | 985  | 1094 | 1204 | 1313 |
| 14 | 1 | 286 | 382 | 477 | 572 | 668 | 763  | 859  | 954  | 1049 | 1145 |
| 15 | 1 | 252 | 336 | 420 | 504 | 588 | 672  | 756  | 840  | 924  | 1008 |
| 16 | 1 | 224 | 298 | 373 | 447 | 522 | 596  | 671  | 745  | 820  | 894  |
| 17 | 1 | 200 | 266 | 333 | 400 | 466 | 533  | 600  | 666  | 733  | 799  |
| 18 | 1 | 180 | 240 | 300 | 360 | 420 | 479  | 539  | 599  | 659  | 719  |
| 19 | 1 | 163 | 217 | 271 | 325 | 380 | 434  | 488  | 542  | 597  | 651  |
| 20 | 1 | 148 | 197 | 247 | 296 | 345 | 395  | 444  | 493  | 543  | 592  |
| 21 | 1 | 135 | 180 | 225 | 270 | 315 | 360  | 406  | 451  | 496  | 541  |
| 22 | 1 | 124 | 165 | 207 | 248 | 289 | 331  | 372  | 413  | 455  | 496  |
| 23 | 1 | 114 | 152 | 190 | 228 | 267 | 305  | 343  | 381  | 419  | 457  |
| 24 | 1 | 106 | 141 | 176 | 211 | 246 | 282  | 317  | 352  | 387  | 422  |
| 25 | 1 | 98  | 131 | 163 | 196 | 228 | 261  | 294  | 326  | 359  | 392  |
| 26 | 1 | 91  | 121 | 152 | 182 | 212 | 243  | 273  | 304  | 334  | 364  |
| 27 | 1 | 85  | 113 | 142 | 170 | 198 | 226  | 255  | 283  | 311  | 340  |
| 28 | 1 | 79  | 106 | 132 | 159 | 185 | 212  | 238  | 265  | 291  | 318  |
| 29 | 1 | 74  | 99  | 124 | 149 | 174 | 198  | 223  | 248  | 273  | 298  |
| 30 | 1 | 70  | 93  | 116 | 140 | 163 | 186  | 210  | 233  | 256  | 280  |
| 31 | 1 | 66  | 88  | 110 | 132 | 153 | 175  | 197  | 219  | 241  | 263  |
| 32 | 1 | 62  | 83  | 103 | 124 | 145 | 165  | 186  | 207  | 227  | 248  |
| 33 | 1 | 59  | 78  | 89  | 117 | 137 | 156  | 176  | 195  | 215  | 234  |
| 34 | 1 | 55  | 74  | 92  | 111 | 129 | 148  | 166  | 185  | 203  | 222  |
| 35 | 1 | 53  | 70  | 88  | 105 | 123 | 140  | 158  | 175  | 193  | 210  |
| 36 | 1 | 50  | 66  | 83  | 100 | 116 | 133  | 150  | 166  | 183  | 199  |
| 37 | 1 | 47  | 63  | 79  | 95  | 111 | 126  | 142  | 158  | 174  | 190  |
| 38 | 1 | 45  | 60  | 75  | 90  | 105 | 120  | 135  | 150  | 165  | 181  |
| 39 | 1 | 43  | 57  | 72  | 86  | 100 | 115  | 129  | 143  | 158  | 172  |
| 40 | 1 | 41  | 55  | 68  | 82  | 96  | 109  | 123  | 137  | 150  | 164  |

a. Flow rate from Section

**Table (6)**  
**Allowable Pipe Length for 3/4 inch CPVC Pipe**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |     |     |     |     |     |      |      |      |      |
|--|--------------------------------|--|-----|-----|-----|-----|-----|------|------|------|------|
|  |                                | 15   | 20  | 25  | 30  | 35  | 40  | 45   | 50   | 55   | 60   |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |     |     |     |     |     |      |      |      |      |
| 8                                      | 3/4                            | 348  | 465 | 581 | 697 | 813 | 929 | 1045 | 1161 | 1278 | 1394 |
| 9                                      | 3/4                            | 280  | 374 | 467 | 560 | 654 | 747 | 841  | 934  | 1027 | 1121 |
| 10                                     | 3/4                            | 231  | 307 | 384 | 461 | 538 | 615 | 692  | 769  | 845  | 922  |
| 11                                     | 3/4                            | 193  | 258 | 322 | 387 | 451 | 515 | 580  | 644  | 709  | 773  |
| 12                                     | 3/4                            | 165  | 219 | 274 | 329 | 384 | 439 | 494  | 549  | 603  | 658  |
| 13                                     | 3/4                            | 142  | 189 | 237 | 284 | 331 | 378 | 426  | 473  | 520  | 568  |
| 14                                     | 3/4                            | 124  | 165 | 206 | 247 | 289 | 330 | 371  | 412  | 454  | 495  |
| 15                                     | 3/4                            | 109  | 145 | 182 | 218 | 254 | 290 | 327  | 363  | 399  | 436  |
| 16                                     | 3/4                            | 97   | 129 | 161 | 193 | 226 | 258 | 290  | 322  | 354  | 387  |
| 17                                     | 3/4                            | 86   | 115 | 144 | 173 | 202 | 230 | 259  | 288  | 317  | 346  |
| 18                                     | 3/4                            | 78   | 104 | 130 | 155 | 181 | 207 | 233  | 259  | 285  | 311  |
| 19                                     | 3/4                            | 70   | 94  | 117 | 141 | 164 | 188 | 211  | 234  | 258  | 281  |
| 20                                     | 3/4                            | 64   | 85  | 107 | 128 | 149 | 171 | 192  | 213  | 235  | 256  |
| 21                                     | 3/4                            | 58   | 78  | 97  | 117 | 136 | 156 | 175  | 195  | 214  | 234  |
| 22                                     | 3/4                            | 54   | 71  | 89  | 107 | 125 | 143 | 161  | 179  | 197  | 214  |
| 23                                     | 3/4                            | 49   | 66  | 82  | 99  | 115 | 132 | 148  | 165  | 181  | 198  |
| 24                                     | 3/4                            | 46   | 61  | 76  | 91  | 107 | 122 | 137  | 152  | 167  | 183  |
| 25                                     | 3/4                            | 42   | 56  | 71  | 85  | 99  | 113 | 127  | 141  | 155  | 169  |
| 26                                     | 3/4                            | 39   | 52  | 66  | 79  | 92  | 105 | 118  | 131  | 144  | 157  |
| 27                                     | 3/4                            | 37   | 49  | 61  | 73  | 86  | 98  | 110  | 122  | 135  | 147  |
| 28                                     | 3/4                            | 34   | 46  | 57  | 69  | 80  | 92  | 103  | 114  | 126  | 137  |
| 29                                     | 3/4                            | 32   | 43  | 54  | 64  | 75  | 86  | 96   | 107  | 118  | 129  |
| 30                                     | 3/4                            | 30   | 40  | 50  | 60  | 70  | 81  | 91   | 101  | 111  | 121  |
| 31                                     | 3/4                            | 28   | 38  | 47  | 57  | 66  | 76  | 85   | 95   | 104  | 114  |
| 32                                     | 3/4                            | 27   | 36  | 45  | 54  | 63  | 71  | 80   | 89   | 98   | 107  |
| 33                                     | 3/4                            | 25   | 34  | 42  | 51  | 59  | 68  | 76   | 84   | 93   | 101  |
| 34                                     | 3/4                            | 24   | 32  | 40  | 48  | 56  | 64  | 72   | 80   | 88   | 96   |
| 35                                     | 3/4                            | 23   | 30  | 38  | 45  | 53  | 61  | 68   | 76   | 83   | 91   |
| 36                                     | 3/4                            | 22   | 29  | 36  | 43  | 50  | 57  | 65   | 72   | 79   | 86   |
| 37                                     | 3/4                            | 20   | 27  | 34  | 41  | 48  | 55  | 61   | 68   | 75   | 82   |
| 38                                     | 3/4                            | 20   | 26  | 33  | 39  | 46  | 52  | 59   | 65   | 72   | 78   |
| 39                                     | 3/4                            | 19   | 25  | 31  | 37  | 43  | 50  | 56   | 62   | 68   | 74   |
| 40                                     | 3/4                            | 18   | 24  | 30  | 35  | 41  | 47  | 53   | 59   | 65   | 71   |

a. Flow rate from Section

**Table (7)**  
**Allowable Pipe Length for 1 inch CPVC Pipe**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |      |      |      |      |      |      |      |      |      |
|--|--------------------------------|--|------|------|------|------|------|------|------|------|------|
|  |                                | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |      |      |      |      |      |      |      |      |      |
| 8                                      | 1                              | 1049   | 1398 | 1748 | 2098 | 2447 | 2797 | 3146 | 3496 | 3845 | 4195 |
| 9                                      | 1                              | 843  | 1125 | 1406 | 1687 | 1968 | 2249 | 2530 | 2811 | 3093 | 3374 |
| 10                                     | 1                              | 694  | 925  | 1157 | 1388 | 1619 | 1851 | 2082 | 2314 | 2545 | 2776 |
| 11                                     | 1                              | 582  | 776  | 970  | 1164 | 1358 | 1552 | 1746 | 1940 | 2133 | 2327 |
| 12                                     | 1                              | 495  | 660  | 826  | 991  | 1156 | 1321 | 1486 | 1651 | 1816 | 1981 |
| 13                                     | 1                              | 427  | 570  | 712  | 854  | 997  | 1139 | 1261 | 1424 | 1566 | 1709 |
| 14                                     | 1                              | 372  | 497  | 621  | 745  | 869  | 993  | 1117 | 1241 | 1366 | 1490 |
| 15                                     | 1                              | 328  | 427  | 546  | 656  | 765  | 874  | 983  | 1093 | 1202 | 1311 |
| 16                                     | 1                              | 291  | 388  | 485  | 582  | 679  | 776  | 873  | 970  | 1067 | 1164 |
| 17                                     | 1                              | 260  | 347  | 433  | 520  | 607  | 693  | 780  | 867  | 954  | 1040 |
| 18                                     | 1                              | 234  | 312  | 390  | 468  | 546  | 624  | 702  | 780  | 858  | 936  |
| 19                                     | 1                              | 212  | 282  | 353  | 423  | 494  | 565  | 635  | 706  | 776  | 847  |
| 20                                     | 1                              | 193  | 257  | 321  | 385  | 449  | 513  | 578  | 642  | 706  | 770  |
| 21                                     | 1                              | 176  | 235  | 293  | 352  | 410  | 469  | 528  | 586  | 645  | 704  |
| 22                                     | 1                              | 161  | 215  | 269  | 323  | 377  | 430  | 484  | 538  | 592  | 646  |
| 23                                     | 1                              | 149  | 198  | 248  | 297  | 347  | 396  | 446  | 496  | 545  | 595  |
| 24                                     | 1                              | 137  | 183  | 229  | 275  | 321  | 366  | 412  | 458  | 504  | 550  |
| 25                                     | 1                              | 127  | 170  | 212  | 255  | 297  | 340  | 382  | 425  | 467  | 510  |
| 26                                     | 1                              | 118  | 158  | 197  | 237  | 276  | 316  | 355  | 395  | 434  | 474  |
| 27                                     | 1                              | 111  | 147  | 184  | 221  | 258  | 295  | 332  | 368  | 405  | 442  |
| 28                                     | 1                              | 103  | 138  | 172  | 207  | 241  | 275  | 310  | 344  | 379  | 413  |
| 29                                     | 1                              | 97   | 129  | 161  | 194  | 226  | 258  | 290  | 323  | 355  | 387  |
| 30                                     | 1                              | 91   | 121  | 152  | 182  | 212  | 242  | 273  | 303  | 333  | 364  |
| 31                                     | 1                              | 86   | 114  | 143  | 171  | 200  | 228  | 257  | 285  | 314  | 342  |
| 32                                     | 1                              | 81   | 108  | 134  | 161  | 188  | 215  | 242  | 269  | 296  | 323  |
| 33                                     | 1                              | 76   | 102  | 127  | 152  | 178  | 203  | 229  | 254  | 280  | 305  |
| 34                                     | 1                              | 72   | 96   | 120  | 144  | 168  | 192  | 216  | 240  | 265  | 289  |
| 35                                     | 1                              | 68   | 91   | 114  | 137  | 160  | 182  | 205  | 228  | 251  | 273  |
| 36                                     | 1                              | 65   | 87   | 108  | 130  | 151  | 173  | 195  | 216  | 238  | 260  |
| 37                                     | 1                              | 62   | 82   | 103  | 123  | 144  | 165  | 185  | 206  | 226  | 247  |
| 38                                     | 1                              | 59   | 78   | 98   | 117  | 137  | 157  | 176  | 196  | 215  | 235  |
| 39                                     | 1                              | 56   | 75   | 93   | 112  | 131  | 149  | 168  | 187  | 205  | 224  |
| 40                                     | 1                              | 53   | 71   | 89   | 107  | 125  | 142  | 160  | 178  | 196  | 214  |

a. Flow rate from Section

**Table (8)**  
**Allowable Pipe Length for 3/4 inch PEX Tubing**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |     |     |     |     |     |     |     |     |     |
|--|--------------------------------|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|  |                                | 15   | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |     |     |     |     |     |     |     |     |     |
| 8                                      | 3/4                            | 93   | 123 | 154 | 185 | 216 | 247 | 278 | 309 | 339 | 370 |
| 9                                      | 3/4                            | 74   | 99  | 124 | 149 | 174 | 199 | 223 | 248 | 273 | 298 |
| 10                                     | 3/4                            | 61   | 82  | 102 | 123 | 143 | 163 | 184 | 204 | 225 | 245 |
| 11                                     | 3/4                            | 51   | 68  | 86  | 103 | 120 | 137 | 154 | 171 | 188 | 205 |
| 12                                     | 3/4                            | 44   | 58  | 73  | 87  | 102 | 117 | 131 | 146 | 160 | 175 |
| 13                                     | 3/4                            | 38   | 50  | 63  | 75  | 88  | 101 | 113 | 126 | 138 | 151 |
| 14                                     | 3/4                            | 33   | 44  | 55  | 66  | 77  | 88  | 99  | 110 | 121 | 132 |
| 15                                     | 3/4                            | 29   | 39  | 48  | 58  | 68  | 77  | 87  | 96  | 106 | 116 |
| 16                                     | 3/4                            | 26   | 34  | 43  | 51  | 60  | 68  | 77  | 86  | 94  | 103 |
| 17                                     | 3/4                            | 23   | 31  | 38  | 46  | 54  | 61  | 69  | 77  | 84  | 92  |
| 18                                     | 3/4                            | 21   | 28  | 34  | 41  | 48  | 55  | 62  | 69  | 76  | 83  |
| 19                                     | 3/4                            | 19   | 25  | 31  | 37  | 44  | 50  | 56  | 62  | 69  | 75  |
| 20                                     | 3/4                            | 17   | 23  | 28  | 34  | 40  | 45  | 51  | 57  | 62  | 68  |
| 21                                     | 3/4                            | 16   | 21  | 26  | 31  | 36  | 41  | 47  | 52  | 57  | 62  |
| 22                                     | 3/4                            | NP   | 19  | 24  | 28  | 33  | 38  | 43  | 47  | 52  | 57  |
| 23                                     | 3/4                            | NP   | 17  | 22  | 26  | 31  | 35  | 39  | 44  | 48  | 52  |
| 24                                     | 3/4                            | NP   | 16  | 20  | 24  | 28  | 32  | 36  | 40  | 44  | 49  |
| 25                                     | 3/4                            | NP   | NP  | 19  | 22  | 26  | 30  | 34  | 37  | 41  | 45  |
| 26                                     | 3/4                            | NP   | NP  | 17  | 21  | 24  | 28  | 31  | 35  | 38  | 42  |
| 27                                     | 3/4                            | NP   | NP  | 16  | 20  | 23  | 26  | 29  | 33  | 36  | 39  |
| 28                                     | 3/4                            | NP   | NP  | 15  | 18  | 21  | 24  | 27  | 30  | 33  | 36  |
| 29                                     | 3/4                            | NP   | NP  | NP  | 17  | 20  | 23  | 26  | 28  | 31  | 34  |
| 30                                     | 3/4                            | NP   | NP  | NP  | 16  | 19  | 21  | 24  | 27  | 29  | 32  |
| 31                                     | 3/4                            | NP   | NP  | NP  | 15  | 18  | 20  | 23  | 22  | 28  | 30  |
| 32                                     | 3/4                            | NP   | NP  | NP  | NP  | 17  | 19  | 21  | 24  | 26  | 28  |
| 33                                     | 3/4                            | NP   | NP  | NP  | NP  | 16  | 18  | 20  | 22  | 25  | 27  |
| 34                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | 17  | 19  | 21  | 23  | 25  |
| 35                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | 16  | 18  | 20  | 22  | 24  |
| 36                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | 15  | 17  | 19  | 21  | 23  |
| 37                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | NP  | 16  | 18  | 20  | 22  |
| 38                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | NP  | 16  | 17  | 19  | 21  |
| 39                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | NP  | NP  | 16  | 18  | 20  |
| 40                                     | 3/4                            | NP   | NP  | NP  | NP  | NP  | NP  | NP  | 16  | 17  | 19  |

NP – Not Permitted

a. Flow rate from Section

**Table (9)**  
**Allowable Pipe Length for 1 inch PEX Tubing**

| Sprinkler Flow Rate <sup>a</sup> (gpm) | Water Distribution Size (inch) | Available Pressure – P <sub>t</sub> (psi)                                |     |     |     |     |     |     |      |      |      |
|--|--------------------------------|--|-----|-----|-----|-----|-----|-----|------|------|------|
|  |                                | 15   | 20  | 25  | 30  | 35  | 40  | 45  | 50   | 55   | 60   |
|  |                                | Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet) |     |     |     |     |     |     |      |      |      |
| 8                                      | 1                              | 314  | 418 | 523 | 628 | 732 | 837 | 941 | 1046 | 1151 | 1255 |
| 9                                      | 1                              | 252  | 336 | 421 | 505 | 589 | 673 | 757 | 841  | 925  | 1009 |
| 10                                     | 1                              | 208  | 277 | 346 | 415 | 485 | 554 | 623 | 692  | 761  | 831  |
| 11                                     | 1                              | 174  | 232 | 290 | 348 | 406 | 464 | 522 | 580  | 638  | 696  |
| 12                                     | 1                              | 148  | 198 | 247 | 296 | 346 | 395 | 445 | 494  | 543  | 593  |
| 13                                     | 1                              | 128  | 170 | 213 | 256 | 298 | 341 | 383 | 426  | 469  | 511  |
| 14                                     | 1                              | 111  | 149 | 186 | 223 | 260 | 297 | 334 | 371  | 409  | 446  |
| 15                                     | 1                              | 98   | 131 | 163 | 196 | 229 | 262 | 294 | 327  | 360  | 392  |
| 16                                     | 1                              | 87   | 116 | 145 | 174 | 203 | 232 | 261 | 290  | 319  | 348  |
| 17                                     | 1                              | 78   | 104 | 130 | 156 | 182 | 208 | 233 | 259  | 285  | 311  |
| 18                                     | 1                              | 70   | 93  | 117 | 140 | 163 | 187 | 210 | 233  | 257  | 280  |
| 19                                     | 1                              | 63   | 84  | 106 | 127 | 148 | 169 | 190 | 211  | 232  | 253  |
| 20                                     | 1                              | 58   | 77  | 96  | 115 | 134 | 154 | 173 | 192  | 211  | 230  |
| 21                                     | 1                              | 53   | 70  | 88  | 105 | 123 | 140 | 158 | 175  | 193  | 211  |
| 22                                     | 1                              | 48   | 64  | 80  | 97  | 113 | 129 | 145 | 161  | 177  | 193  |
| 23                                     | 1                              | 44   | 59  | 74  | 89  | 104 | 119 | 133 | 148  | 163  | 178  |
| 24                                     | 1                              | 41   | 55  | 69  | 82  | 96  | 110 | 123 | 137  | 151  | 164  |
| 25                                     | 1                              | 38   | 51  | 64  | 76  | 89  | 102 | 114 | 127  | 140  | 152  |
| 26                                     | 1                              | 35   | 47  | 59  | 71  | 83  | 95  | 106 | 118  | 130  | 142  |
| 27                                     | 1                              | 33   | 44  | 55  | 66  | 77  | 88  | 99  | 110  | 121  | 132  |
| 28                                     | 1                              | 31   | 41  | 52  | 62  | 72  | 82  | 93  | 103  | 113  | 124  |
| 29                                     | 1                              | 29   | 39  | 48  | 58  | 68  | 77  | 87  | 97   | 106  | 116  |
| 30                                     | 1                              | 27   | 36  | 45  | 54  | 63  | 73  | 82  | 91   | 100  | 109  |
| 31                                     | 1                              | 26   | 34  | 43  | 51  | 60  | 68  | 77  | 85   | 94   | 102  |
| 32                                     | 1                              | 24   | 32  | 40  | 48  | 56  | 64  | 72  | 80   | 89   | 97   |
| 33                                     | 1                              | 23   | 30  | 38  | 46  | 53  | 61  | 68  | 76   | 84   | 91   |
| 34                                     | 1                              | 22   | 29  | 36  | 43  | 50  | 58  | 65  | 72   | 79   | 86   |
| 35                                     | 1                              | 20   | 27  | 34  | 41  | 48  | 55  | 61  | 68   | 75   | 82   |
| 36                                     | 1                              | 19   | 26  | 32  | 39  | 45  | 52  | 58  | 65   | 71   | 78   |
| 37                                     | 1                              | 18   | 25  | 31  | 37  | 43  | 49  | 55  | 62   | 68   | 74   |
| 38                                     | 1                              | 18   | 23  | 29  | 35  | 41  | 47  | 53  | 59   | 64   | 70   |
| 39                                     | 1                              | 17   | 22  | 28  | 33  | 39  | 45  | 50  | 56   | 61   | 67   |
| 40                                     | 1                              | 16   | 21  | 27  | 32  | 37  | 43  | 48  | 53   | 59   | 64   |

a. Flow Rate From Section