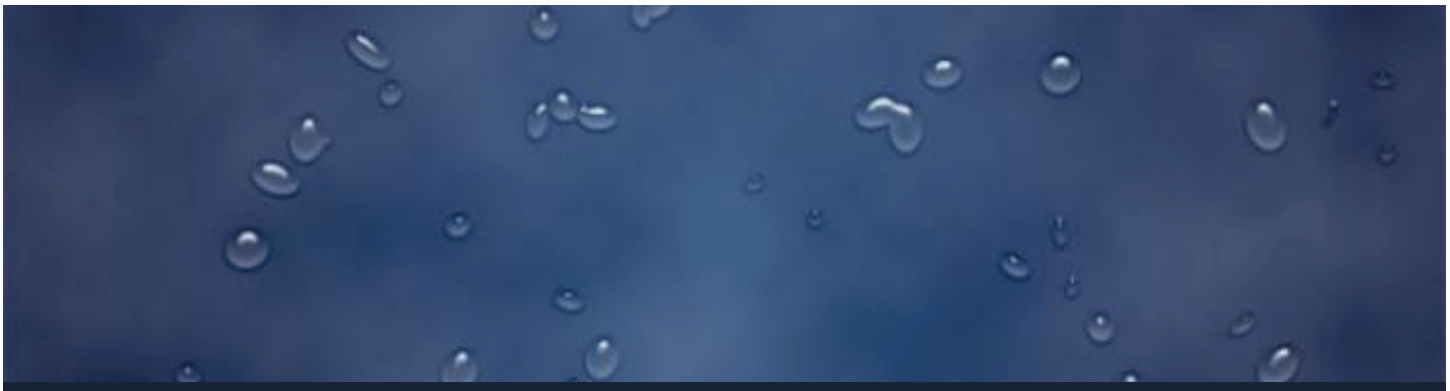

Integration of Residential Sprinklers with Water Supply Systems

A Survey of Twenty U.S. Communities

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NFPA®

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The authority on fire, electrical and building safety.

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- Aberdeen, MD
- Annapolis, MD
- Avondale, AZ
- Celina, TX
- Clarendon Hills, IL
- Cottonwood, AZ
- Galt, CA
- Glenwood, IL
- Libertyville, IL
- Monterey, CA
- Montpelier, VT
- Nolensville, TN
- Northbrook, IL
- Northstar Community, CA
- Ojai, CA
- Paradise Valley, AZ
- Piperton, TN
- Redmond, WA
- University Park, TX
- Westminster, MD

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Executive Summary

Residential fire sprinklers are becoming more widely adopted in new U.S. homes based on model building codes like the 2009 IRC and NFPA 5000, as well as community level initiatives to add sprinklers to homes. Like any significant change to the way homes are constructed, concerns exist as to how sprinklers can be effectively integrated with other existing systems in the home – particularly the home's water supply system. Local requirements regarding the connection of residential sprinklers to the water supply system can potentially have significant implications on sprinkler system design, operation, cost and maintenance.

The purpose of this research was to develop objective data which characterizes the manner in which residential fire sprinklers are integrated with local water supply systems in communities with a sprinkler ordinance. This study explored these issues in detail through interviews with twenty communities where residential sprinklers are required in all new homes. The interviews were conducted with a mix of local water providers, building departments and fire service staff to better understand sprinkler requirements and common practices.

The communities, which have had a sprinkler ordinance in place subsequent to 1999, have generally developed practical solutions for sprinkler integration with the water supply system. While sprinklers are still a fairly recent development in all of these communities, water supply integration practices and requirements have been put into place, and there are no examples of insurmountable problems or issues. In fact, design problems or any significant added costs have not resulted from water supply integration issues in most communities. Rather, water suppliers, building departments and fire service have developed practical approaches to meet the needs of both residential sprinklers and the local water supply. Major findings are noted below.

Sprinkler System Design: For those design issues where communities could reasonably adopt different approaches, such as whether or not to meter fire sprinkler flow, they have done just that. These decisions are sometimes based on technical factors, while in other cases communities try to stay consistent with nearby jurisdictions and thus adopt the same provisions. In fact communities in the same state generally adopt fairly uniform requirements on items like metering the flow to sprinklers, which makes the ordinance more predictable for stakeholders. More unusual design requirements, such as dual water service lines or dual water meters, are rare and typically driven by a local issue which would not apply in most other areas.

Cost Impacts on Sprinkler Systems which Result from Water Supply Integration: No cost impact resulted from sprinkler-induced changes to water meter size, the need for additional water meters, or changes to tap size in eleven of the twenty communities. These communities also did not have higher monthly service fees from the water

supplier for homes with sprinklers. Further, in the other communities where one or more of these factors did add cost (and the cost could also be calculated based on available data) the average added cost was about $400. In many cases, the occurrence and magnitude of a cost impact depends on what design practices were in place prior to the ordinance taking effect.

Cost implications for the items mentioned above are often intertwined with other local design practices and fee structures. For example, in one community the increase in the water connection fee from one domestic meter size to the next jumped by thousands of dollars. To avoid this much higher fee builders have developed a different sprinkler system connection scheme which does not increase the domestic water meter size (or the connection fee) but instead uses a second water meter to meter the flow to the sprinklers. This fee structure was not intended to penalize fire sprinklers (and pre-dates the ordinance), yet it has had an impact on system design.

Sprinkler System Administration Issues: The potential liability associated with shutting off domestic water supply to a residence (thus thereby disabling the fire sprinkler water supply) has received some discussion in communities with a sprinkler ordinance, but has generally not been a major concern given that the sprinkler system is primarily designed for life safety, and homes without domestic water supply are deemed uninhabitable.

Inspections of backflow devices in sprinkler systems are required in communities where state law requires such inspections (unless the system design does not involve a backflow prevention device) and where the community's ordinance requires this type of device. To overcome the challenges in administering these regular inspections, community approaches range from penalties for non-compliance, to tax assessment incentives for compliance, to moving toward system designs which avoid the need for backflow prevention devices all together.

In terms of "lost water" due to lower accuracy of larger domestic water meters (necessitated by the sprinkler system) or water theft from sprinkler systems, these were not reported to be significant issues in the communities.

As states and communities begin to adopt the residential sprinkler ordinances based on model building codes, it will be necessary to develop their particular approach for integrating sprinklers with the local water supply. The results of this study indicate that a range of reasonable approaches will work, while states/communities can leverage some flexibility to deal with issues of particular concern. Approaches which satisfy the needs of builders, water suppliers, and fire service are certainly within reach, and ideally communities can draw from this research to better understand key issues and form their particular strategy.

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I. Introduction

The purpose of this research was to develop objective data which characterizes the manner in which residential fire sprinklers are integrated with local water supply systems in communities with a sprinkler ordinance. The requirements of local water purveyors and building departments regarding the connection of residential sprinklers to the water supply system can potentially have significant implications on sprinkler system design, operation, cost and maintenance. This study explored these issues in detail to better understand how they are addressed in communities where residential sprinklers are required in all new homes.

This research is important because residential fire sprinklers are poised to become widely adopted in new U.S. homes based on model building codes such as the 2009 International Residential Code (IRC) and National Fire Protection Association (NFPA) 5000. Like any significant change to the way homes are constructed, there are a variety of issues that arise with the 2009 IRC now requiring residential fire sprinklers in new townhomes (2009) and one- and two-family dwellings (2011). The most effective approach to rationally addressing such issues and helping the industry move forward is objective research that identifies the significance of concerns and the best means for reconciling these concerns.

Twenty communities with residential fire sprinkler ordinances in effect were identified and contacted as part of this research. Interviews were conducted with water providers, building departments and fire service staff to gain an understanding of how sprinklers are integrated with the municipal water supply and the underlying reasons for these practices.

II. Research Methodology

Given the complexity of this topic and the variability in how different communities have addressed the implementation of residential sprinklers, a logical methodology was developed to evenly collect and analyze data from the communities. The steps involved in conducting this research study are described below.

A. Literature Review and Interview Guide

As an initial task, the project team conducted a literature review to gain a clear understanding of the most significant integration issues between residential sprinklers and the local water supply system. This literature review is included as Appendix A.

Based on this assessment of the key issues and concerns, the project team then developed an interview guide. The objective of this interview guide was to objectively identify and document (through a phone interview format) how communities manage the integration of residential sprinklers with the water supply to the home. The guide was designed for use with water purveyor staff, public works staff, local fire service officials and building departments who were contacted to understand a community's issues. The interview guide was completed in March 2009, and is included in this report as Appendix B. The interview guide served as a data collection tool during the interviews, and while it was not typically read verbatim the topics included in the guide were covered in each discussion.

B. Community Selection Criteria

The research scope called for identifying twenty communities to allow a broad spectrum of communities to be selected and assessed. The communities were selected based on several factors as listed in Table 1 and described below.

Table 1: Parameters for community inclusion in study

Requirements	Considerations
Residential fire sprinkler ordinance • All new single-family dwellings o Zero square footage • Enacted subsequent to 1999	Geographical location Water purveyor organizational structure Number of homes built since ordinance enacted

- **All New Single-Family Dwellings**: This research was focused on fire sprinkler water supply integration issues once sprinklers were applied on a broad scale in a community. Therefore only communities with a residential fire sprinkler ordinance were considered. The residential fire sprinkler ordinance needed to apply to all new single-family dwellings in the jurisdiction, regardless of square footage or location. Some fire sprinkler ordinances are structured to apply to buildings over a certain square footage, height or stories while other ordinances only apply to buildings located outside a fire response time zone or within a designated zone in a community. Ordinances that apply to all new dwellings despite square footage are often called zero-ordinances, for zero square footage.

  One example of a community with a square footage- and location-based sprinkler ordinance that prevented it from being included in the study is Altamonte Springs, FL. Altamonte Springs requires all new homes built within the activity district to have fire sprinklers regardless of size, while for new homes outside the activity district only those over 3,500 square feet are required to have fire sprinklers. Overall, the research team had to pass over several dozen communities due to ordinances that did not apply to all new homes in the community.

- **Recently Enacted Ordinance**: The community's residential fire sprinkler ordinance must have been placed into effect subsequent to 1999. This time limitation was enacted because some of the interview questions probed how sprinklers were handled *prior* to the ordinance taking effect. Thus, including communities with long-standing ordinances, such as 20 years, would make it unlikely that this type of information would have been recalled. At the other extreme, the research team encountered a few communities which had passed an ordinance *very* recently (e.g. 1 month prior) and had practically no experience implementing it. These communities were not included due to the very limited experience with how the ordinance was working.

- **Geographic Location**: The geographic location of the communities was also a contributing factor in identifying participants. To the extent possible, the research team sought to incorporate communities from different regions of the U.S. This effort was relatively successful, however in a large number of states it is unlikely that there are any communities which meet the research criteria since residential fire sprinklers are still uncommon in many areas. Thus the selected communities

tended to be grouped together in a subset of states in different parts of the country.

- **Type of Water Supplier**: The organizational structure of the water supplier was considered when selecting communities to participate in the study. Water suppliers can generally be classified as public or private. Public water suppliers are usually managed by the public works department or have appointed boards making them more similar to a non-profit organization than a city division or department. Private water suppliers can be found across the country but are more common in the western part of the United States. The water supplier organizational structure was identified for each participating community and is listed in Table 2.

  It should also be noted that this study did not focus on sprinkler design and integration with on-site water supplies (well water). While these issues are important in many cases and may be prevalent in some communities, the focus of this study was sprinkler integration with municipal water supply systems.

Overall, dozens of communities were researched and contacted in the course of the community selection process. Based on the criteria listed above, the large majority of these communities were not included in the study. The most common factor preventing a community from inclusion in the study was that it only required sprinkler systems for homes of a certain square footage. In other cases, a given community had no fire sprinkler ordinance or a very recent ordinance and had little or no experience in applying it. Conversely, any community which was contacted and found to meet the selection criteria was subsequently interviewed and included in the study.

C. Interview Participants

The objective interviews were conducted over the phone with key groups related to fire sprinklers in residential dwellings. The key groups interviewed and typical job titles of interviewees are listed below.

- Building Department: Building inspector or code official
- Fire Service: Fire marshal or fire inspector
- Water Provider: Public works supervisor or account/region manager

On two occasions an individual from the water wholesaler was interviewed. In these two cases the water was supplied by a municipality that bought water from a wholesaler. The wholesaler was contacted to see if any additional requirements are placed on the community by the water wholesaler in relation to fire sprinkler integration.

For each of the twenty communities, at least two of the key groups identified above were interviewed. A total of 46 separate interviews were conducted for this research project. The key groups contacted for each community are listed in Table 2.

D. Interview Format and Findings

The interviews were conducted over the phone using a standardized interview guide (see Appendix B) and supplemented by email as needed to clarify responses and to obtain documents.

The interview guide and issues discussed during the interview were developed after conducting an extensive literature review (see Appendix A). The literature review focused on identifying issues related to integrating sprinklers to the water supply system for homes. The key issues from this review which were probed in the interview are listed below, in the order in which they are discussed.

- Whether sprinkler water flow is captured by a water meter
- Whether two water service lines are required
- Concern over unauthorized use of water from fire sprinklers
- Accuracy of water meters
- Costs associated with any changes in water meter size
- Impact on monthly service fees for water service
- Impact on domestic water consumption rates
- Change in water service tapping fee
- Liability associated with water service suspensions or terminations
- Reported water contaminations from sprinkler system backflow
- Post-occupancy inspection requirements
- Any changes made to the ordinance after it went into effect

The findings to these issues are discussed in greater detail in subsequent sections of the report.

III. Community Overview

The map below (Figure 1) shows the twenty communities included within the study while Table 2 provides key community data on the jurisdictions included in the survey.

Figure 1: Map of communities included in research study

Table 2: Key community data on the communities included in study				
Community	**Year of Ordinance Taking Effect**	**Sprinkler Ordinance Type**	**Water Supplier Structure**	**Key Groups Contacted**
Aberdeen, MD	2006	NFPA 13D	Public	Fire Service Public Works
Annapolis, MD*	2007	NFPA 13D or 13R with amendments	Public	Building Department Fire Service Water Provider
Avondale, AZ	2005	NFPA 13D with amendments	Public	Building Department Fire Service
Celina, TX	2008	NFPA 13D or 13R with amendments	Public	Fire Service Water Provider
Clarendon Hills, IL	2000	NFPA 13D with amendments	Public	Building Department Fire Service Water Provider Water Wholesaler
Cottonwood, AZ	2004	NFPA 13D with amendments	Public	Fire Service Water Provider
Galt, CA	2008	NFPA 13D	Public	Fire Service Water Provider
Glenwood, IL	2007	NFPA 13D	Public	Fire Service Water Provider
Libertyville, IL	2005	NFPA 13D or 13R with amendments	Public	Building Division Fire Service
Monterey, CA	2004	NFPA 13D	Private	Fire Service Water Provider
Montpelier, VT	2004	NFPA 13D or 13R	Public	Building Department Fire Service
Nolensville, TN	2006	NFPA 13D or 13R	Public	Building Department Fire Service Water Provider
Northbrook, IL	2007	NFPA 13D	Public	Fire Service Water Provider
Northstar Community, CA	2003	NFPA 13D	Public	Fire Service Water Provider
Ojai, CA – *County Wide Ordinance*	2006	NFPA 13D	Private	Building Official Fire Service Water Provider
Paradise Valley, AZ	2005	NFPA 13D with amendments	Private and Public	Building Official Water Provider
Piperton, TN	2007	NFPA 13D	Public	Fire Service Water Provider
Redmond, WA	2007	NFPA 13D and 13R	Public	Building Department Fire Service
University Park, TX	2008	NFPA 13D with amendments	Public	Building Department Fire Service Water Wholesaler
Westminster, MD – *County Wide Ordinance*	2006	NFPA 13D with amendments	Public	County Building Department Water Provider

* Annapolis is located in Anne Arundel County, which recently (2009) passed a zero square footage fire sprinkler ordinance, but Annapolis required fire sprinklers systems in homes before the county ordinance was enacted.

IV. Research Findings

The interview guide covered issues related to how residential fire sprinkler systems are integrated with the water supply system to a home. For many of these issues, there are a variety of options which a community can select as their standard practice or requirement. These options carry implications for the design, cost, operation and maintenance of sprinkler systems. Key findings on each issue are presented below along with a summary of the underlying issue.

A. Approach to Metering Water Flow to Sprinklers

Communities are nearly evenly divided with their approach to metering the water flow to sprinklers. Eleven require or typically use designs in which sprinkler flow is metered, and the other nine allow and typically use designs in which sprinkler flow is <u>not</u> captured by the water meter. In many cases these positions are supported by a mix of technical and operations-related issues, while some communities adopted the approach of a neighboring community.

Whether the flow to the sprinkler system is captured by the home's water meter is important because it affects the sprinkler system design. Also, this issue triggers several related factors which affect system design and cost, as illustrated by Table 3. Many of these related issues were included in the interview guide and are discussed further down in the report.

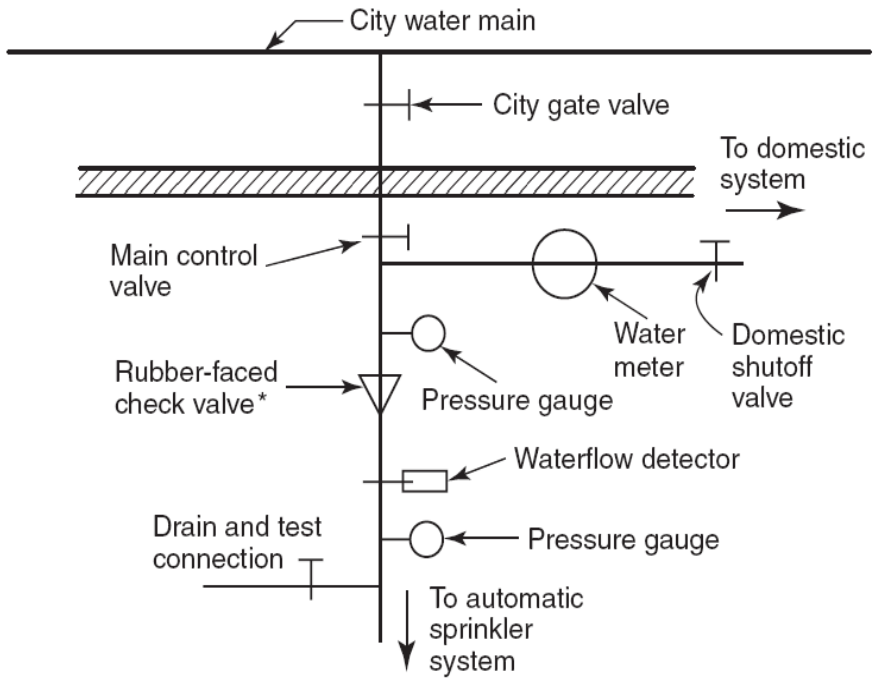
Table 3: Issues associated with whether or not sprinkler flow is metered

Issues of concern for systems where sprinkler flow is <u>not</u> metered	Issues of concern for systems where sprinkler flow <u>is</u> metered
• Unauthorized water use	• Meter accuracy • Meter costs • Increased peak flow capacity • Type of meter

The communities surveyed based their sprinkler ordinance on NFPA 13D – "Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes." Some communities also added amendments to NFPA 13D. NFPA 13D allows for the water flow to residential fire sprinkler systems to be either

metered or unmetered. The "preferable" NFPA 13D arrangement is to have the sprinkler water flow unmetered to avoid any restrictions which could possibly be introduced by the meter (Figure 2). Other configurations in NFPA 13D do show system layouts where water flow to the sprinklers is metered if that is a community's requirement. In these cases, the standard requires that the flow characteristics of the meter are to be included in the hydraulic calculations for the system.

Figure 2: "Preferable Arrangement" from NFPA 13D-2007, in which water flow to the sprinklers is not metered



* Rubber-faced check valves are optional.

Detailed results from the interview question on this issue are listed in Table 4.

Table 4: Do communities require sprinkler system designs that meter the water flow to the sprinkler system?		
Response	**Communities**	**Typical Reasons or Justifications**
Yes – Sprinkler flow is metered	Aberdeen, MD Annapolis, MD Avondale, AZ Cottonwood, AZ Monterey, CA Nolensville, TN Ojai, CA Paradise Valley, AZ Piperton, TN Redmond, WA University Park, TX*	• Modeled on neighboring community's ordinance for the sake of consistency • Used same approach as multi-family dwellings
No or Does Not Matter – Sprinkler flow does not have to be captured by the meter	Celina, TX Clarendon Hills, IL Galt, CA Glenwood, IL Libertyville, IL Montpelier, VT Northbrook, IL Northstar, CA Westminster, MD	• Did not want to restrict water flow with the meter • Adopted approach of a neighboring community for consistency

* University Park homes typically install a meter on the fire sprinkler flow, but it is not required.

In those communities where sprinkler flow is metered (11), consistency was often a key factor in adopting this approach. Specifically the communities expressed an interest in being consistent with the ordinance of a neighboring community or consistent with the way sprinklers have been previously addressed in commercial buildings or residential buildings prior to implementing a residential fire sprinkler ordinance.

As examples of consistency between communities, all four Illinois communities do not require fire sprinkler flow to be metered, while all three Arizona and both Tennessee communities do meter the sprinkler flow. A few other examples of communities which *do* meter the sprinkler flow are:

> **Aberdeen, MD**– Townhomes have required fire sprinklers since the mid-1980s and that water flow was metered, so they went with the townhouse approach when their ordinance expanded to cover single-family detached homes.
>
> **Avondale, AZ**– Modeled their ordinance and acceptable sprinkler designs on Scottsdale, AZ, a neighboring community. When developing the sprinkler requirement the city met with all the stakeholders to find a system design that would work. The stakeholders wanted consistent requirements so that builders

and contractors did not have to vary their approach based on the location of the project.

Preventing theft of water as an underlying reason for metering sprinkler flow was not a common response among those communities where metering is required.

On the other side of the issue, communities that *do not* meter the fire sprinkler service often stated that they wanted to limit the disturbances or obstructions in the water supply line running to the fire sprinklers.

B. Requirements for Dual Service Lines or Water Meters

Most communities do not require dual water service lines (one for domestic use and one for sprinklers) or dual water meters. In the few communities (four) where these practices are typical or required, underlying factors include municipal connection fees being tied to the size of the domestic water meter and a desire to be able to shut off domestic supply without interrupting sprinkler service flow.

Overall this finding is important because it further illustrates how local sprinkler designs are closely intertwined with local issues and fee structures for new construction projects.

Table 5: Do homes with sprinkler systems have two meters or service lines for a residence – one for the sprinkler system supply and one for domestic water supply?

	Communities	Typical Reasons or Justifications
Yes – Dual service lines are required, but a meter is only installed on the domestic line	Northstar, CA	• Allows them to maintain sprinkler system operation when domestic service is shut off
Yes – Dual service lines - each with a water meter - are typically installed	University Park, TX	• A separate line and meter for fire sprinklers is installed in conjunction with the lawn irrigation water supply to avoid sewer charges on the water used for lawn irrigation • Using a dedicated service line and meter for the fire sprinklers avoids the need for backflow valves and periodic inspections
Yes – Single service line with two meters is required	Monterey, CA*	• Want a separate water meter for domestic supply for the flexibility to limit domestic flow in the future if necessary
Yes – Single service line with two meters is typically installed	Redmond, WA	• Connection fees are based on the size of the domestic water meter and are significantly higher for a larger meter; thus builders opt to separately meter the two systems which keeps the domestic meter size smaller (and the connection fee lower)
No – Dual service lines or two meters are not required or typically installed	Aberdeen, MD Annapolis, MD Avondale, AZ Celina, TX Clarendon Hills, IL Cottonwood, AZ Galt, CA Glenwood, IL Libertyville, IL Montpelier, VT Nolensville, TN Northbrook, IL Ojai, CA Paradise Valley, AZ Piperton, TN Westminster, MD	• No direct need or incentive to use dual service lines or meters

* Monterey has moved to separate meters for fire and domestic service, but no new homes have been built under the newly enacted dual water meter requirement.

Of the four communities that typically install two lines or two meters, only one *requires* dual service lines and only one *requires* two meters on a single supply line. The other two communities that commonly design systems in this manner do so because of other cost issues not directly related to fire sprinkler systems and are discussed below.

University Park, Texas typically installs two lines with a water meter on each line. The local water provider does not charge sewer fees on water used for irrigation. By supplying and metering the flow to the lawn irrigation and fire sprinklers separately from the domestic supply, any sewer charges for lawn irrigation water are avoided. Thus homeowners avoid sewer fees on the water they use for lawn irrigation. Even before the fire sprinkler ordinance took effect, many homes opted for the dual service line and meter strategy to avoid sewer charges on irrigation water.

Systems in Redmond, Washington typically have a unique water supply configuration because the connection fee pricing structure gives builders an incentive to install two smaller water meters instead of one larger one. The connection fee in Redmond is based on the size of the domestic water meter, and the fee difference between a 5/8" meter and a 1" meter for a new home in the City of Redmond is over $14,000. Therefore, builders have opted for a sprinkler connection design that reduces the domestic water meter size. The connection design typically installed involves a 2" water supply line which provides both domestic and fire water service to two homes. Each home will use a ¾" water line for domestic water feeding into a 5/8" meter and a 1" water line and meter for the fire sprinkler service for each home. Under the above scenario, a home will pay for two meters (5/8" and 1") and one tap fee (5/8"), although there is actually only one 2" tap servicing two homes. This configuration also avoids a larger domestic water meter, thereby avoiding the jump in connection fees. It should be noted that connection fees of this magnitude could also represent a new construction impact fee which uses the water meter size as a proxy for the size of the new building. This unique system configuration is discussed further in subsequent sections of the report.

C. Unauthorized Water Usage from Residential Sprinklers

In those communities where sprinkler flow is not metered (and thus there could be potential for unauthorized use from the sprinkler), there are no reports that water theft from sprinklers is a significant concern or problem.

As the provider of a commodity, water purveyors have a natural concern about people illegally tapping into water lines to obtain water which is not metered or paid for. Residential fire sprinkler systems, and in particular designs in which water flow to the sprinklers is not captured by a water meter, could present an opportunity for unauthorized use.

However, no respondent could recall any instance of individuals stealing water from a residential fire sprinkler system, metered or not metered. The following quote is a typical response.

> **Monterey, CA**- "We have never really had any backflow issues or unauthorized water use from sprinklers. I have been here 41 years and tapping into our hydrants is a bigger issue than domestic use."

Table 6: For those communities where sprinkler system flow is not typically metered, is there a concern about unauthorized water use from the sprinkler system?

	Communities	Reasons why the issue is/is not seen as relevant.
The unauthorized water use issue has not been a significant topic of discussion	Celina, TX Galt, CA Glenwood, IL Montpelier, VT	• Not many systems installed • Water theft is not an issue in the community
The unauthorized water use issue has come up in discussions, but has not resulted in any specific policies or practices	Clarendon Hills, IL Libertyville, IL Northbrook, IL Northstar, CA Westminster, MD	• Shutoff happens infrequently and occupants are barred from living in a home without water supply if shutoff does occur • Shut-off valve is before split between sprinklers and domestic supply
The unauthorized water use issue has come up in discussions, and has resulted in specific policies or practices	None	

This finding does not dismiss the concern of unauthorized water use for water suppliers, but it does illustrate that the existence of a fire sprinkler ordinance in a community (and where sprinklers are not metered) does not significantly increase the risk in the views of water suppliers and building departments.

D. Accuracy of Larger Domestic Meters

The communities surveyed are not significantly concerned or affected by the issue of residential fire sprinklers driving the use of larger, less accurate water meters. In several of the communities where this could be a potential issue, the use of sprinklers does not create the need for a larger water meter. In three communities the accuracy of larger meters was deemed acceptable, while in two others the fire sprinkler flow was metered separately so the domestic meter size was not impacted by the sprinklers.

The accuracy of water meters is affected by the size of the meter as well as the flow rate. Stakeholders in residential sprinkler discussions have expressed concern that if a water service line supplying both domestic and fire sprinklers is metered and also requires a larger water meter to accommodate the fire sprinkler flow rates, then the meter's accuracy at measuring the lower flows typical of domestic use will suffer. This reduced accuracy of the larger meter could then lead to discrepancies in accounting for the water supplied to buildings.

The community interviews revealed that of the eight communities that have a single water service line with one meter for both the fire sprinkler and domestic flow, half of these did not see an increase in the typical meter size with the advent of the sprinkler ordinance. In other words, the typical meter size in a new home was the same with or without sprinklers in these communities. In these scenarios because the presence of the sprinkler system did not drive the use of a larger water meter, any potential meter accuracy issues are beyond the impact of the sprinkler system.

For example, many communities either require 1" water meters on all new homes (e.g., Annapolis, MD enacted this requirement prior to their sprinkler ordinance) or require homes over a certain square footage to install a 1" meter (e.g., Cottonwood, AZ). Even communities that do not meter the fire sprinkler flow indicated that new homes commonly have 1" or larger water meters solely for the domestic water flow, as the quote below illustrates.

> **Libertyville, IL**– "We only do 1" and 1 ½" lines…. even if we didn't have sprinklers it would still be the same size."

Specific responses on this issue are noted in Table 7 below.

Table 7: For communities where the fire sprinkler service line is required to be metered, has there been concern or discussion about the ability of the water meters used to accurately measure the domestic flow rates which the meters will typically experience?

	Communities	Reasons why the issue is/is not seen as relevant.
Metering the fire service line typically does not increase the water meter size	Annapolis, MD Avondale, AZ Ojai, CA Paradise Valley, AZ	• System designs do not typically exceed previous water meter size used prior to the sprinkler ordinance
The increase in meter size (from metering sprinkler flow) has not resulted in discussions on meter accuracy	Aberdeen, MD Cottonwood, AZ Nolensville, TN	• Market has responded and has made better meters
The increase in meter size (from metering sprinkler flow) has resulted in discussions on meter accuracy, but has not resulted in any specific policies or practices	Piperton, TN	• Water supplier is concentrating more on automated leak detection in its supply system to residences, as this issue is deemed more significant
The meter on the fire sprinkler service line does not measure domestic water use	Monterey, CA Redmond, WA University Park, TX	• There are two meters on the home, so any accuracy issues on the domestic meter are beyond the sprinkler system's scope of impact

Thus in several of the communities (four) where the sprinkler flow must be metered, this design requirement does not drive the need for a larger-than-usual water meter. And in those communities where metering sprinkler flow *has* increased the typical meter size (four), the concern over meter accuracy has been limited (three), or discussions on the topic have not resulted in any specific changes to design requirements or meter specifications (one).

E. Increase in Water Meter Cost

The research found that three-quarters of the communities surveyed *did not* experience an increase in the cost of purchasing water meters because of the residential fire sprinkler ordinance.

Water providers and communities generally charge customers more for larger water meters. If the fire sprinkler water flow is metered, the cost of purchasing a potentially larger, or even an additional, water meter could increase system costs for the builder and homeowner. Of the twenty communities surveyed, eleven communities typically meter the fire sprinkler supply line (this was a *requirement* in ten communities and the

common practice in the eleventh). Conversely, nine communities do not meter flow to the fire sprinklers and therefore the domestic meter size (and price) is not impacted by the fire sprinklers.

In those eleven communities where sprinkler flow is metered, only four stated that the common domestic water meter size increased from either $^5/_8$" or ¾" up to 1" as the result of a sprinkler ordinance taking effect. The price differences between the typical "pre-ordinance" meter and the meter size used once sprinklers became mandatory in these four communities are $105, $120, $200 and $500. (Note: These figures were calculated using meter prices at the time the study was conducted, not meter prices at the time of enactment). Thus, for these four communities the average price of a larger domestic water meter (necessitated by the need to meter sprinkler flow) was about $230.

Table 8: For communities that typically meter the fire service line, has this resulted in an increased price for the water meter(s)?

	Communities	Typical Reasons or Justifications
Yes – Sprinkler system requirements typically result in a larger meter, which are more expensive	Aberdeen, MD Cottonwood, AZ Nolensville, TN Piperton, TN	• Moved from $^5/_8$" to 1" meter • Moved from ¾" to 1" meter
Yes – Resulted in the purchase of a second water meter for the sprinkler system	Redmond, WA	• Commonly use a 1" meter on the sprinkler line branch
No – Water meters are free	Monterey, CA	
No – The second water meter was already commonly purchased prior to the sprinkler ordinance	University Park, TX	• Commonly used a 1 ½" water meter dedicated to lawn irrigation systems prior to fire sprinkler ordinance. Now fire sprinkler flow is on this same meter.
No – The water meter size (and thus the price) is the same	Annapolis, MD Avondale, AZ Ojai, CA Paradise Valley, AZ	• All our homes had 1" or larger lines before the ordinance • System designs do not commonly exceed previous water supply line size

In the one community (Redmond, Washington) that commonly involves the purchase of an additional meter, it is important to note that two meters are not required by the ordinance. The connection fee pricing structure is based on the size of the meter on the domestic water flow line, and a jump in the size of the domestic meter can increase this

fee by thousands of dollars. Thus it is cheaper in Redmond to branch the water supply line into two separately metered lines. This way an individual will only pay the connection fee associated with a 5/8" domestic water meter, instead of the fee associated with a 1" domestic water meter. This saves the builder approximately $14,000 for a new home in the City of Redmond. At the same time, the cost to purchase the second meter for the fire sprinkler service line is $500 (and no connection fees are charged for a separately metered fire line).

Builders in University Park, Texas commonly install two metered water lines to avoid sewer charges on water used for irrigation. This was a common practice prior to the sprinkler ordinance in this community. Thus, when this second service line also became the means to supply and meter the sprinkler system, it was determined that the sprinkler ordinance did not drive the need for another meter since it was already common practice.

In December 2008 the Monterey Peninsula Water Management District mandated that residential fire sprinkler service lines split from the domestic water service line and be metered separately. Prior to this requirement homes would use a single water service line that branched after the water meter. Both the domestic and fire sprinkler water line meters are provided to the homeowner or builder free of charge by the water purveyor. Meters were provided free of charge before the design change mentioned above.

The following tables list the meter prices for the communities included in this study.

Table 9: Meter prices in communities where meter costs increased due to larger/additional meters						
	Water Meter Size Changed				Standalone Meter	
Meter Size	**Aberdeen**	**Cottonwood**	**Nolensville**	**Piperton**	**Monterey**	**Redmond**
5/8"		$275	$3,000*		Meters are provided free of charge.	N/A
¾"	$370-$400˚	N/A	N/A	$185		$425
1"	$580˚	$400	$3,500*	$305		$500
1 ¼"						N/A
1 ½"						$730

No Change in Domestic Meter Size (Includes communities that don't meter fire sprinkler supply lines)														Stand-alone Meter
Meter Size	**Annapolis**	**Avondale**	**Celina**	**Clarendon Hills**	**Galt**	**Glenwood**	**Libertyville**	**Montpelier**	**North-brook**	**Northstar**	**Ojai**	**Paradise Valley**	**West-minster**	**University Park∞**
5/8"		N/A	N/A			$300		No fee, city owns the meter	N/A	Contractor provides meter		$1,442*		
¾"		$450	$800*			$300			$110		$1,500*[a]	$1,442*	$300	
1"	$1,800*	$530	$850*	$303.98	$400	$300	$330		$145		$1,500*[a]	$1,893*	$355	$450*
1 ¼"		N/A		N/A		$300	N/A		N/A			N/A		N/A
1 ½"		$750		$303.98		$300	$465		$290			$2,322*		$1,525 or $1,675*

* Includes both the tap fee and meter price

[a] Prices start at $1,500 and go up, but a quote is needed for each job from the local office

˚ Prices are approximations; exact prices couldn't be obtained for hypothetical dwelling

∞ Homes typically purchased a domestic meter and a 1 ½" meter for fire/irrigation service prior to the sprinkler ordinance

F. Service Fees on Sprinkler Systems

Homes with local water service typically pay a monthly charge to cover administrative fees associated with providing water service. Ninety percent of the communities surveyed did not experience an increase in monthly service fees with the advent of residential sprinklers. For the two communities where higher service fees typically resulted from the use of sprinklers in homes, the average monthly cost impact was $6.05.

Service fees are a concern because of the potential for sprinkler systems to incur a monthly charge even though the sprinklers will rarely, if ever, draw water from the local supply system. For this study, a service fee was interpreted to mean the minimum amount a homeowner has to pay for service even if no water usage occurred for the month.

Only two communities in the study have an increase in service fees as a result of homes having sprinklers. In both of these communities new homes typically have two water meters – which triggers the higher fee. One community requires two meters, while in the other community two meters are typically installed due to the connection fee structure in place (see discussion above in Sections B and E). While the presence of a second meter did trigger a higher service fee for a home in these communities, water providers from both communities charge a reduced service fee for the meter on the fire sprinkler service line (see Table 11).

For those communities where service fees did not increase as a result of homes having sprinkler systems, this was due to several factors including:

- Some water providers implemented policies that have kept monthly service fees at pre-sprinkler ordinance levels, such as the City of Cottonwood
- About one-half of the communities charge the same monthly fee for multiple sized water meters, so even if sprinklers drive the need for a larger meter the service fee does not increase
- In many of the communities the domestic water meter size or tap size did not change, nor was there a need for a second meter, so monthly fees did not increase

It appears that citizens in communities that require all new homes to have fire sprinkler systems will not necessarily face increased monthly fees. It is also evident that water providers are willing to reduce monthly fees if the fire sprinkler system flow requirements are the only reason for the increased fee (as recommended by the AWWA Research Foundation and KIWA[1]). Table 10 lists the responses to this interview topic, while Table 11, which follows, lists the monthly service fees for the communities included in this study.

Table 10: Are homes with fire sprinklers commonly assessed a higher standby/monthly fee compared to a comparable home without fire sprinklers?

	Communities	Typical Reasons or Justifications
Yes – But the standby/monthly fee on the dedicated fire sprinkler line is reduced	Monterey, CA Redmond, WA	• Fee is reduced because it is a fire sprinkler line
No – Homes have typically installed a second meter on the lawn irrigation line, even prior to the sprinkler ordinance. Because this line was metered there was already an associated monthly fee. Now this line also supplies the sprinkler system	University Park, TX	• Pay monthly fee for second service line/meter for irrigation and fire sprinkler water service
No – Homes with sprinklers pay the same standby/monthly fee rate as other homes	Aberdeen, MD Annapolis, MD Avondale, AZ Celina, TX Clarendon Hills, IL Cottonwood, AZ* Galt, CA Glenwood, IL Libertyville, IL Montpelier, VT Nolensville, TN Northbrook, IL Northstar, CA Ojai, CA Paradise Valley, AZ Piperton, TN Westminster, MD	• Service fee is based on domestic demands even if meter size is increased due to fire sprinklers* • Meter and tap size are not impacted by sprinklers, so fee is not impacted either • Service fee same for multiple meter sizes, so even if the meter is larger due to sprinklers - the service fee is the same

** Cottonwood charges a monthly fee based on a 5/8" meter to homes that actually use a 1" meter – ONLY IF they use the 1" meter due to sprinkler demands. However, if home is required to have a 1" meter because of home size or fixture demands, then the occupant pays the service fee for a 1" meter.*

[1] AWWA Research Foundation and KIWA. (2002). *Impacts of Fire Flow on Distribution System Water Quality, Design, and Operation*. Published by AWWA Research Foundation and American Water Works Association.

The following table lists the monthly fee a water customer pays for having a water service. The monthly fee has numerous names including, standby, base and service fees. Sometimes the monthly fee includes a certain amount of water usage while others do not; therefore, a home's monthly bill is dependent upon the monthly fee plus the fee attached to water consumption.

Table 11: Monthly standby, base or service fees

	Communities Where Water Meter Size Changed as a Result of Sprinklers				Communities Where a Fee is Charged on Both Meters (Domestic and Fire Service)					No Fee on Dedicated Sprinkler Line
Meter Size	Aberdeen^	Cottonwood*	Nolensville	Piperton	Monterey		Redmond		University Park	Northstar
					Domestic	Fire Service	Domestic	Fire Service		
5/8"	$13.26	$23.59	$12.04		$7.24	N/A	N/A	N/A	$9.35	
¾"	$13.26	N/A	$12.04	$13.50	$10.86	N/A	$10.97	$3.30	$9.35	
1"	$13.26	$28.00	$12.04	$13.50	$18.11	$8.15	$22.03	$3.95	$10.25	$27.99
1 ¼"					N/A	N/A	$40.47	$6.25	N/A	$27.99
1 ½"					$36.21	$12.23	$62.60	$9.00	$13.35	$27.99

No Change in Meter Size (Includes communities that do not meter fire sprinkler supply lines)												
Meter Size	Annapolis	Avondale	Celina	Clarendon Hills	Galt	Glenwood	Libertyville	Montpelier	Northbrook	Ojai	Paradise Valley	Westminster^
5/8"		N/A	N/A			$7.43	$11.35	N/A	Only pay a usage fee of $4.20 per thousand.	$29.20	$4.64	
¾"		$10.12	$12.60			$7.43	$11.35	$7.29		$43.80	N/A	$19.45
1"	$12.60	$1818	$12.60	$10.00	$2.12	$7.43	$11.35	$7.29		$73.00	$5.21	$19.45
1 ¼"	N/A	N/A	$12.60	N/A	$3.95	$7.43	$11.35			N/A		$19.45
1 ½"	$12.60	$32.68	$12.60	$15.00		$7.43	$11.35			$146.00		$19.45

** If sprinkler water flow requirement is the only reason for 1" meter, occupant is charged 5/8" fee.*

^ This fee also includes the sewer fee.

G. Domestic Water Consumption Rates

In the twenty communities surveyed, there were no instances where residents paid higher rates for domestic water consumption because a larger domestic meter was installed in the home to accommodate the sprinkler system.

Water customers are billed for the amount of water that they use. With the introduction of residential sprinkler ordinances in communities, there has been some concern that if domestic water meters increase in size due to the sprinkler system, then this larger meter would trigger a different (and more expensive) rate schedule for homeowners. However, this research found that none of the twenty communities surveyed applied higher domestic consumption rates to homes with sprinklers. This was true for all of the communities, even in those instances where the domestic meter size was indeed larger due to the need to meter sprinkler flow.

Table 12: Are homes that saw their domestic water meter size increase due to sprinklers billed at a higher rate for domestic water consumption compared to a home with a smaller meter and no fire sprinklers?

	Communities	Typical Reasons or Justifications
Yes – Homes with sprinklers pay higher water usage rates if their domestic water meter is larger		
No – Homes with sprinklers typically pay the same domestic water usage rates as other homes, even if the domestic meter is larger due to the sprinklers	Aberdeen, MD Cottonwood, AZ Nolensville, TN Piperton, TN	• Charge same rate for residential water usage regardless of meter size

The table above illustrates that higher domestic consumption rates are not an issue in those communities where the domestic water meter size increases due to fire sprinklers. For the remainder of the twenty communities, sprinklers did not impact the domestic water meter size so any concern over higher domestic usage rates did not apply.

H. Tapping Fee Increases

Three-quarters of the communities surveyed did not see an increase in tapping fees because the home had a fire sprinkler system. Of the five which did see an increase in tap fee, four of these were due to a larger tap size and one was due to a requirement of dual service lines (and thus a second tap).

When a new home taps into the water supply line, or water main, a tapping fee is commonly charged. The tapping fee varies based on the community and tapping procedures. Some communities do not charge a tapping fee and instead the builder hires a contractor to actually tap into the water main. Other communities charge a flat tapping fee regardless of the water line size, while others base the fee on site characteristics such as charging more for tapping under sidewalks or roads.

This research found that fifteen of the twenty communities surveyed did not see an increase in tapping fees because a home had a fire sprinkler system. This finding is strongly driven by two common scenarios:

- Homes with sprinklers typically have the same size tap as non-sprinklered homes did in the past, thus the tap fee was the same
- Homes with sprinklers do indeed have larger tap sizes, but the community's fee structure does not charge a higher fee for this larger tap

Table 13 highlights a few different scenarios which lead to no change in tap fees in homes with sprinklers, but the two factors listed above account for ten of the communities where the tap fee *did not increase*.

For those five communities where sprinklers did result in a *higher* tap fee, this occurred for two reasons:

- Sprinklered homes have larger service lines than non-sprinklered homes did in the past, and a higher tap fee results from the larger line.
- A second, additional tap fee is incurred because homes with sprinklers are required to have a separate water service line for the fire sprinklers. Note that the community with this requirement does not charge a monthly service fee on this line or require it to be metered.

The average additional tap fee cost, based on the available data from these communities, was $576.

Table 13: How are the water service line tapping fees handled for homes with sprinklers?		
	Communities	**Typical Reasons or Justifications**
No tapping fee	Avondale, AZ Galt, CA	
Sprinklered homes generally have the same size tap as non-sprinklered homes did in the past, so the tapping fees are the same	Annapolis, MD Celina, TX Glenwood, IL Libertyville, IL Northbrook, IL Ojai, CA Paradise Valley, AZ	• Most homes had 1" or larger taps before sprinkler requirement
Sprinklered homes have larger taps than non-sprinklered homes did in the past, but do not have a higher tapping fee	Aberdeen, MD Cottonwood, AZ Piperton, TN	• Tap fee is same for ¾" and 1" • Tap fee is same for 5/8" and 1" • Connection fee is set for residential dwellings and is not based on water supply line size
Sprinkled homes commonly installed two water service lines before ordinance; therefore, second tap fee is not a direct result of sprinkler systems	University Park, TX	• 1 ½" line for both the fire sprinkler and irrigation systems and separate 1" domestic line
Sprinklered homes have two meters, but tap fee is based on the domestic meter size. And the domestic water meter size did not change because of sprinklers, so there is no impact on the tap fee	Monterey, CA Redmond, WA	
Sprinklered homes have larger service lines than non-sprinklered homes did in the past, and therefore a higher tap fee	Clarendon Hills, IL Montpelier, VT Nolensville, TN Westminster, MD	• 1" tap but ¾" meter, because sprinkler line branches before water meter
Sprinklered homes are required to have dual service lines, and therefore incur a new second tap fee	Northstar, CA	

Table 14: Tap fees from communities surveyed									
	Communities Where Tap Size Increased							Separate Service Line for Sprinklers	
								Tap Fee	
Meter Size	Aberdeen	Clarendon Hills	Cottonwood	Montpelier	Nolensville	Piperton	Westminster	Northstar	University Park
5/8"	$8,400		$1,500	Quote is required	$3,000*				
¾"	$8,400					$3,250	$800		
1"	$8,400	$251.39	$1,500		$3,500*	$3,250	$850	$1,389.98	$450*
1 ¼"		$616.03						$1,389.98	N/A
1 ½"								$1,389.98	$1,525 or $1,675*

	Sprinkler Line Does Not Impact Tap Fee									Two Meters, Single Line No Tap Fee			
										Monterey		Redmond	
Meter Size	Annapolis	Avondale	Celina	Galt	Glenwood	Libertyville	Northbrook	Ojai	Paradise Valley	Domestic Line	Fire Sprinkler Line	Domestic Line	Fire Sprinkler Line
5/8"		No tap fee is charged	N/A	No tap fee is charged	$1,500		N/A		$1,442*	Quote is required – but meter size didn't change	No tap fee is charged	N/A	No tap fee is charged
¾"			$800*		$1,500		N/A	$1,500*[a]	$1,442*			$9,876	
1"	$1,800*^		$850*		$1,500	$355	$200	$1,500*[a]	$1,893*			$24,434	
1 ¼"	N/A				$1,500	N/A	N/A		N/A			N/A	
1 ½"	$2,250*^				$1,500	$475	$200		$2,322*			$48,696	

* Includes tap fee and meter price.

^ $400 credit if tap installed by applicant.

[a] Prices start at $1,500 and go up, but a quote is needed for each job from the local office.

I. Liability Concerns from Water Shut-Off

Potential liability associated with shutting off domestic water supply to a residence (and thereby also disabling the fire sprinkler water supply) has received some discussion in communities with sprinkler ordinances, but has generally not been a major concern. Only two communities have developed any specific policy or design requirement to address this issue. In most of the communities the concern was limited because sprinklers are viewed as a life safety system and homes may not legally be inhabited once domestic water supply is turned off, and also because water turn-off scenarios are rare.

A fire sprinkler system is a life safety device. However, sprinklers depend on water flow to control a fire. This research found that there is generally not great concern about the potential liability if a fire occurs in a home that has had the water service suspended. Most respondents indicated that this issue is not a major concern for their community because:

- Homes where the water supply has been shut-off are deemed uninhabitable and occupants are not permitted in the dwelling.
- Water shut-off issues are rare in the community, so the issue does not come up.

Of the two communities that indicated that they have developed specific policies to address the issue of liability, the specific policies were:

- Developed a water supply design where the fire sprinkler supply water bypasses the shut-off valve, so the sprinkler systems are still active even when domestic supply is shut off.
- Modified their water service termination letters to mention that the fire sprinkler system will become inactive once water service is terminated.

Table 15 shows the distribution of community perspectives on this issue. The responses are only presented for those communities where fire sprinklers are not supplied by a dedicated service line.

Table 15: For those communities where dual service lines not required or typically installed, how has the liability associated with turning off the domestic water supply to a residence (due to maintenance or failure to pay) been handled?		
	Communities	**Typical Reasons or Justifications**
The liability issue has not been a significant topic of discussion	Avondale, AZ Celina, TX Clarendon Hills, IL Cottonwood, AZ Glenwood, IL Libertyville, IL Montpelier, VT Ojai, CA Westminster, MD	• Home is inhabitable if water service is suspended • Sprinklers are primarily a life safety device not property protection • Treat same way as commercial buildings • Water shut-offs are uncommon
The liability issues has come up in discussions, but has not resulted in any specific policies or practices	Annapolis, MD Monterey, CA Northbrook, IL Piperton, TN Redmond, WA	• Stayed with same process before ordinance • Home is inhabitable if water service is suspended
The liability issue has come up in discussions, and has resulted in specific policies or practices	Aberdeen, MD Galt, CA	• Developed sprinkler design to bypass the shut-off valve • Include mention in water termination notification letter

Not discussed for Nolensville, TN. and Paradise Valley, AZ.
Dual service line communities are: Northstar, CA. and University Park, TX.

Lastly, the location of the main shut-off valve determines if the fire sprinkler system is still operational even if domestic service has been terminated. Most main shut-off valves are located near the street and single service line systems usually split the sprinkler supply lines inside the home and/or as close to the meter as possible. Therefore, just because a community does not meter the fire sprinkler water flow does not necessarily mean the fire sprinkler system will be operational when domestic water service is suspended.

J. Potential Water Quality Issues from Fire Sprinklers

Of the 46 subjects interviewed for this survey, none have heard of a water contamination issue associated with residential fire sprinkler systems in their community.

Water providers and users are always concerned about water quality. Water supply connections for a residential fire sprinkler system, just like any other connection, need to be designed in a manner that prevents water quality problems. The primary issue of

concern for residential sprinkler systems is preventing standing water in sprinkler system pipes from flowing back ("backflow") from the sprinkler supply piping into the potable water supply. Preventing backflow from the sprinklers is typically addressed through the use of a backflow prevention device (see Figure 2) or a design which avoids this issue (e.g. a "combination system" in which domestic supply and sprinklers share supply lines).

This research study found that of the 46 subjects interviewed for this survey, no individual has heard of a water contamination issue associated with fire sprinkler systems in their community.

Table 16: Have any water contamination or backflow issues resulted from a residential sprinkler system in the community?

	# of Communities	Details on Any Incidents
Yes		
No, or none that the respondents were aware of	20	

During the interviews it was mentioned that using a combined system (or a flow-through design), where fire sprinklers and domestic water supply within the home use the same supply piping, is a good design strategy to avoid standing water in fire sprinkler supply lines. By avoiding standing water these systems can mitigate water quality hazards in the view of these respondents.

K. Backflow Devices & Inspections

About one-half of the communities surveyed do require periodic inspections of backflow devices. For the other half which do not have requirements for regular inspections, a common reason is their use of system designs which avoid the need for a backflow device.

Backflow from fire sprinkler systems, described in Section J above, is addressed in residential sprinkler systems in various ways. In some system configurations, fire sprinkler system backflow is prevented through the use of a check valve, an RPZ valve, or similar device which prevents water from flowing "backwards." Communities often stipulate the exact requirements for backflow prevention devices, as NFPA 13D is flexible on the need for this feature (e.g. in Figure 2 above the check valve is optional).

Periodic inspection of this device (typically on an annual cycle) is used to help ensure that it is in proper working order.

About half (nine) of the communities in this study do have requirements for regular inspections of the backflow prevention device. Many of the communities have this requirement due to state law requiring inspection of backflow prevention devices. However it should be noted that in some cases, a community in a state with an inspection law may actually not have annual inspections because their typical system design does not incorporate backflow prevention devices (e.g. Monterey, CA). Thus no inspection is necessary. Also, states with inspection laws require that backflow inspectors be certified by the state (Table 18).

The interviews revealed that for a few communities the inspections have been somewhat challenging due to the administrative effort to manage the process and ensure that the inspections are indeed being completed as required. Access to homes is the underlying issue.

In terms of solutions, some communities simply notify homeowners that their annual inspection is due soon and require that they (the homeowners) arrange for such an inspection. The homeowner then selects a certified inspector, completes the inspection, and submits the inspection certificate to the community. Penalties such as water service termination could be used as an incentive to promote responsiveness by the homeowners.

Another solution can be seen in the approach used by Montpelier, Vermont. Montpelier does not actually require inspections by incentivizes homeowners to have them done. In this community, the city offers a ten percent reduction in the property assessment value to homes with fire sprinklers when calculating the property taxes. Occasionally the homeowner needs to submit paper work to justify the ten percent property assessment reduction. The paper work is reviewed to see if the backflow valves have been regularly inspected.

In one final example of alternative approaches to handle backflow device inspections, one community (Nolensville, TN) has actually changed its ordinance to require combination systems. In a combined system, since the supply piping is shared between the domestic supply and fire sprinkler systems, the issue of standing water in sprinkler pipes flowing back into the domestic lines is avoided. Thus no inspections are required.

While in many all of the communities a combination system would be permitted, in Nolensville they will become the standard.

Table 17: Are regular inspections required for backflow prevention devices on the sprinkler system?		
	Communities	**Typical Reasons or Justifications**
Yes – Regular inspections are required	Celina, TX Clarendon Hills, IL Glenwood, IL Libertyville, IL Northbrook, IL Northstar, CA Ojai, CA Redmond, WA University Park, TX	• Required by state law • Systems have antifreeze in them and require annual servicing and backflow valve inspections
No – Regular inspections are not required	Aberdeen, MD Annapolis, MD Avondale, AZ Cottonwood, AZ Galt, CA Monterey, CA Montpelier, VT Nolensville, TN Paradise Valley, AZ Piperton, TN Westminster, MD	• Use a system design (e.g., combination systems) where a backflow device is not part of the system • After the initial test it is up to homeowner ensure that testing/inspection take place • Have not started an annual inspection program • Not required by 13D

Table 18: For those communities where regular inspections are required, who is permitted to perform the inspection?		
	# of Communities	**Typical Reasons or Justifications**
Local Plumbing Inspector	0	
Certified Inspector	9	State Law
Fire Sprinkler Contractor	0	
Third-Party Inspector	0	
Homeowner	0	

L. Changes to Sprinkler Ordinance Following its Enactment

Overall the communities surveyed were relatively comfortable with their fire sprinkler ordinance language as drafted and it appears that these communities enacted sprinkler ordinances that have been manageable to work within.

Each of the communities was asked about any changes which might have been made to the terms of their original sprinkler ordinance. Four of the twenty communities surveyed mentioned that they have modified the original ordinance. Most of the changes relate to sprinkler system design (Table 19). As one example, Nolensville, TN now requires a combination system configuration to avoid the need for backflow prevention devices. In another instance, Northstar, CA has eliminated the requirement for fire department notification when the sprinkler system activates, in response to resistance on the monthly fee which was assessed for this service. This service is still available as an option.

Most of the respondents indicated that they based their original sprinkler ordinance off a neighboring community's ordinance. Based on the relatively low level of post-enactment changes it appears that these communities enacted sprinkler ordinances that have been manageable.

Table 19: What changes have been made to the residential fire sprinkler ordinance since the sprinkler ordinance was passed?

Ordinance Change	Communities	Typical Reasons or Justifications
Now require a combination system to avoid the need to use and subsequently inspect backflow prevention devices	Nolensville, TN	• Eliminates the need to inspect backflow devices annually
Allow for a sprinkler system that alerts fire department to be an option - instead of mandatory	Northstar, CA	• This issue is a trade-off between a faster response time for home owner versus monthly fee
Adjust design standards so that lawn irrigation systems work even when domestic service is shut off by occupants when they are away	Avondale, AZ	• Community has lots of 2nd homeowners who turn off water when they are gone but still want to water the yard
Adjusted water supply designs to require two meters; one for domestic and one for fire sprinkler service	Monterey, CA	• Want to have the capability to restrict domestic flow at the meter without simultaneously affecting fire system flow

V. Conclusions

This research study was conducted to gather objective data on how residential fire sprinklers are integrated with local water supply systems. Objective interviews with twenty communities with a residential sprinkler ordinance for all new homes has revealed that overall, these towns have arrived at practical solutions for bringing sprinklers into homes. These solutions satisfy:

- the needs of builders for consistent and reasonable design requirements,
- the needs of water suppliers to integrate sprinklers with their system without negative or unintended consequences, and
- the needs of the fire service to provide reliable and effective sprinkler systems in homes.

Based on very minor changes to the original ordinances adopted by the communities (which have had the ordinance in place an average of 3 years), major problems or headaches associated with the ordinance's introduction have been rare or nonexistent.

While some flexibility exists in how a community might chose to integrate sprinklers with local water supply (e.g., whether the water flow to sprinklers must be metered), groups of communities located in the same state have generally adopted consistent provisions. This adds uniformity and predictability to the regional landscape, making sprinkler requirements the same in one town as they are in a neighboring town. And assuming that the earlier adopters have constructed reasonable ordinances, this practice eases the adoption "learning curve" for newer communities and also can help to formulate appropriate state-level provisions.

Major conclusions from the community response are noted below:

<u>Sprinkler System Design</u>

- For those design issues where communities could reasonably adopt different approaches, such as whether or not to meter fire sprinkler flow, they have done just that. These decisions are sometimes based on technical factors while in other cases communities try to stay consistent with nearby communities and thus adopt the same provisions. Communities in the same area/state generally adopt the same provisions for consistency.

- For more unusual design requirements, such as dual water service line or dual water meter requirements, such instances were rare. And in the cases where such requirements did exist there was usually a local issue of concern driving the requirement (e.g. dual water meters in Monterey due to concerns about being able to control domestic water use in the future).

Cost Impacts on Sprinkler Systems which Result from Water Supply Integration

- No cost impact resulted from sprinkler-induced changes to water meter size, the need for additional water meters, or changes to tap size in eleven of the twenty communities. These communities also did not have higher monthly service fees from the water supplier for homes with sprinklers. Further, in the other communities where one or more of these factors added cost (and the cost could also be calculated based on available data) the average added cost was about $400, which includes a $1400 data point for an additional water tap in the average (Northstar, CA). In many cases, the occurrence and magnitude of a cost impact depends on what design practices were in place prior to the ordinance taking effect. Table 20 on the following page contains a summary table of these cost impacts.
- Cost implications for the items mentioned above get intertwined with other local design practices and fee structures. For example, in one community it was common practice to use two meters and two service lines prior to the fire sprinkler ordinance in order to separately supply and meter lawn irrigation water. Thus when fire sprinklers came along they could “piggyback” on this common design without creating additional costs over common practice.

  In another community the increase in the water connection fee from one meter size to the next jumped by thousands of dollars. To avoid this much higher fee builders have developed a different sprinkler system connection scheme which does not increase the domestic water meter size (or the connection fee) but instead uses a second water meter. This fee structure was not intended to penalize fire sprinklers (and pre-dates the ordinance), yet it has had an impact on system design.
- No community reported that homes with sprinkler systems which end up with larger domestic water meters (due to the sprinklers) are subject to higher consumption rates for domestic water consumption.

Table 20: Summary of cost impacts from water supply integration

Community	Total Increase in Meter Costs	Total Increase in Monthly Service Fee	Increase in Tap Fee	Total Added Costs from Water Supply Integration Issues
Aberdeen, MD	$180 to $200˚	$0	$0	~$190
Annapolis, MD	$0	$0	$0	$0
Avondale, AZ	$0	$0	No tap fee is charged	$0
Celina, TX	$0	$0	$0	$0
Clarendon Hills, IL	$0	$0	$364.64	$365
Cottonwood, AZ	$125	$0	$0	$125
Galt, CA	$0	$0	No tap fee is charged	$0
Glenwood, IL	$0	$0	$0	$0
Libertyville, IL	$0	$0	$0	$0
Monterey, CA	Meters are provided free of charge.	$8.15	$0	$8
Montpelier, VT	No fee, city owns the meter	$0	Quote is required	N/A
Nolensville, TN	$500*	$0	$500*	$500*
Northbrook, IL	$0	$0	$0	$0
Northstar Community, CA	$0	$0	$1,389.98	$1400
Ojai, CA	$0	$0	$0	$0
Paradise Valley, AZ	$0	$0	$0	$0
Piperton, TN	$120	$0	$0	$120
Redmond, WA	$500	$3.95	$0	$504
University Park, TX	$0	$0	$0	$0
Westminster, MD –	$0	$0	$50	$50

˚ Prices are approximations; exact prices couldn't be obtained for hypothetical dwelling

* Price includes both the tap fee and meter price, therefore total increase is $500 for tap and meter together not separately or $500 for each.

Sprinkler System Administration Issues

- The potential liability associated with shutting off domestic water supply to a residence (and thereby also disabling the fire sprinkler water supply) has received some discussion in communities with sprinkler ordinances, but has generally not been a major concern. The main underlying reasons are that homes without domestic water supply in place are deemed uninhabitable and sprinklers are a life safety device, water shut-offs in a given community are rare, or the system design allows for domestic shut-off without disabling sprinklers. For communities where this is a sensitive issue, there are two examples where communities have developed a proactive response.
- Inspections of backflow devices in sprinkler systems are required in communities where state law requires such inspections (unless the system design does not involve a backflow prevention device). To overcome the challenges in administering these inspections, community approaches range stiff penalties for non-compliance, to tax assessment incentives for compliance, to moving toward system designs which avoid the need for backflow prevention.
- In terms of "lost water" due to lower accuracy of larger domestic water meters (necessitated by the sprinkler system) or water theft from sprinkler systems, these were not reported to be significant issues in the communities.

As states and communities begin to adopt model building codes which require residential sprinklers or introduce sprinklers through other mechanisms, it will be necessary to develop their particular approach for integrating sprinklers with the local water supply. The results of this study indicate that a range of reasonable approaches will work, while communities or groups of communities can leverage some flexibility to deal with any issues of particular concern. Approaches which satisfy the needs of builders, water suppliers, and fire service are certainly within reach, and ideally communities can take from this research to help understand key issues and form their particular strategy.

Appendix A – Literature Review

Appendix A: Literature Review of Issues Related to Water Purveyors from the Adoption of Residential Sprinkler Systems

Introduction

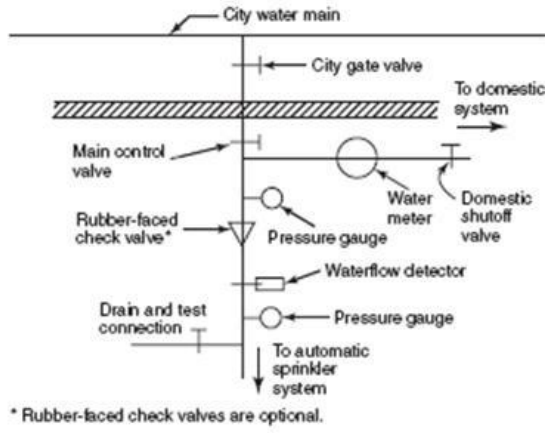
The International Code Council will issue a new set of residential building codes which will require sprinkler systems in all new single-family dwellings in 2011. Community leaders, home builders, sprinkler contractors, and water purveyors will be able to develop sensible policies that do not drastically increase the cost of sprinkler systems by having a clear understanding of the issues and concerns of their local water purveyor. The following sections of this paper provide a brief overview of the most significant issues associated with residential sprinkler systems that impact water purveyors. Future research will involve interviewing stakeholders in communities that currently have residential sprinkler system ordinances to identify the strategies used to overcome the issues identified in this paper.

Metering

- **Larger meters, which are sometimes required in homes with sprinklers, could increase the amount of water a purveyor cannot account for because larger meters are less accurate at measuring lower flow rates than smaller meters.** *(National Fire Sprinkler Association, Inc 2006; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008)*
- **The larger meters needed when metering fire sprinkler supply lines could cost more to purchase than smaller meters needed to meter only the domestic water supply and are sometimes assigned commercial usage rates.** *(Dewar 2006; AWWA Research Foundation and KIWA 2002; Oregon Building Codes Division 2008; Schunk 2008; Washington Water Utilities Council 2008)*
- **Metering sprinkler lines is seen by some water purveyors as way to deter/detect unauthorized water use.** *(Washington Water Utilities Council Guide 2008)*
- **Larger meters allow for more water usage in all uses, decreasing the water purveyor's ability to forecast and plan for water usage, especially during peak times.** *(Schunk, 2008; Gilman,White & Hardiman 2001; Washington Water Utilities Council 2008; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Washington Water Utilities Council 2008; Oregon Building Codes Division 2008)*
- **There are a limited number of meter manufacturers capable of providing meters listed for fire service.** *(National Fire Sprinkler Association, Inc 2006; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008; Washington Water Utilities Council 2008)*

This list of meter-related issues is significant because depending on how these issues are handled within a community, the overall cost of a residential sprinkler system can be greatly impacted. Before each of these issues is discussed below, it is important to note that several of these issues are impacted by how and where the water meter is integrated with the domestic and fire sprinkler water systems of the home.

NFPA 13D Preferable Arrangement



Extracted from: National Fire Sprinkler Association, Inc (2006) Water Purveyor's Guide to Fire Sprinklers in Single Family Dwellings, p. 8.

System configuration options provided in NFPA Standard 13D allow sprinkler system flow to be either metered or not metered. For example, this diagram shows Standard 13D's Preferable Arrangement for a sprinkler system with regard to the water meter, while 13D also shows two other "Acceptable Arrangements" in which the sprinkler flow is metered (National Fire Sprinkler Association, Inc 2006).

Depending on whether the sprinkler flow is captured in metered flow or not, several issues related to the water meter may or may not be relevant. The chart below illustrates this concept, and is then followed by descriptions of the various meter-related issues.

Issues of Concern for Systems where Sprinkler Flow is <u>not</u> Metered (e.g. NFPA 13D Preferable Arrangement)	**Issues of Concern for Systems where Sprinkler Flow <u>is</u> Metered**
• Unauthorized water use	• Meter accuracy • Meter costs • Increased peak flow capacity • Durability • Type of meter
Metering Configuration of Water Supply Flow to a Residential Sprinkler System and the Associated Water Suppliers Issues	

Meter Accuracy

Probably the biggest concern of water purveyors when sprinkler flow is metered is the fact that 1" or larger meters are less accurate in measuring the low-flow rates characteristic of residential usage, compared to the ¾" or 5/8" inch meters commonly installed in residential dwellings without sprinkler systems (National Fire Sprinkler Association, Inc 2006). Water purveyors are concerned about the accuracy of meter readings because of the requirement to account for all the water they supply. Water purveyors are able to account for some variance between the actual water supplied and the water billed for through a leakage rate credit, but water purveyors fear that the larger meters required for homes with fire sprinklers will increase the amount of unaccounted-for water. If a water purveyor exceeds the allowable leakage rate a penalty may be imposed by the agency which regulates the purveyor. If a community, region, or state determines to meter the water in residential sprinkler systems, one option is to adjust upward the allowable leakage rate for purveyors, as recommended in Washington State's TAG's final report (Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008).

Meter Costs

Water purveyors often charge customers more for a 1" water meter than for a ¾" water meter. It is understandable that larger meters cost more than smaller meters, but occasionally the meter pricing structure is not based on material/product costs, but rather on the potential for water withdrawal of the meter. One-inch water meters have commonly been classified as a commercial meter size; therefore, customers who purchase 1" or larger water meters could also be charged commercial customer usage rates instead of residential usage rates (Dewar 2006; Schunk 2008; Washington Water Utilities Council 2008). A possible solution to the meter cost issue is to <u>not</u> assess "the full charge for an "up-sized" meter installed only to meet the technical requirements of a mandated sprinkling system" (Oregon Building Codes Division 2008, p.11). The rationale for this solution is supported in AWWA Research Foundation and KIWA's book *Impacts of Fire Flow on Distribution System Water Quality, Design, and Operation* (2002), which recommends that the "[d]isincentives for installation of sprinkler systems, such as water meter surcharges for sprinklered buildings should be removed" (p.150).

Unauthorized Water Use

Another issue which water purveyors are concerned about is how to prevent or detect residents from tapping into a residential sprinkler system if the water supply line feeding the sprinklers is not metered (e.g., "free" water). This issue is particularly important for a dwelling that has had the domestic water service terminated over a payment issue. **"**In general, utilities have opted to meter the separate fire service so that any unauthorized use can be detected" (Washington Water Utilities Council Guide 2008, p.8). No reports or numbers have been offered by stakeholders on how common unauthorized water use is; therefore, research into the unauthorized use of water sprinkler system water is necessary to fully evaluate this issue.

A simple, cost-effective solution to detection and prevention is to place a flow sensor on an unmetered sprinkler line. The sensor will detect unauthorized water use and can be integrated with alarms and alerting devices, so that if water is flowing through sprinkler supply lines an alert of some type is generated.

It should also be noted that the unauthorized water use concern is only relevant to system designs in which the sprinkler supply water is not metered; in many instances sprinkler supply water *will* be metered which nullifies this issue.

Increased Peak Flow Capacity

Residential units with fire sprinklers need larger water supply lines to accommodate design sprinkler flow rates (on the order of 28 gallons per minute to accommodate two sprinklers), compared to dwellings without sprinklers (Gilman, White & Woodward 2001). Homes without sprinkler systems are typically sized with supply lines capable of drawing between 5-7 gallons per minute. "It is recognized by water purveyors that an enlarged meter for a RFSS [residential fire sprinkler system] will also result in higher flows to the property during peak times associated with lawn irrigation and fixture loading" (Voluntary Private Residential Fire Sprinkler Systems Final Report 2008, p.14). The potential for greater water usage decreases a water purveyor's accurarcy in predicting and planing for water usage, especially during peak times.

To illustrate, homes that do not have the sprinkler system metered can only withdrawal a maximum of 7 gallons per minute for domestic use while homes that do have the sprinkler

system supply lines metered (and thus have a larger water meter) could withdrawal 7, 9, or even 13 gallons per minute for domestic use (Schunk 2008; Washington Water Utilities Council 2008). “For most utilities the sizing of the standard service line and meter is, in part, a means to limit peak demands on the system; and increasing the size of a single-service configuration to address fire sprinkler flow allows the potential for a greater peak demand” (Washington Water Utilities Council 2008, p.8). However, when discussing residential sprinkler system legislation in Oregon, homebuilders “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” (Oregon Building Codes Division 2008, p.10). In addition to the debate on the water usage impact of larger meters used in conjunction with sprinkler systems, a related question is how to allocate the cost for the potential of higher peak flows in the form of fees or other charges.

Type of Meter

There is a concern that not enough competition within the meter manufacturing market exists to provide adequate options to water purveyors and customers when selecting water meters. The number of companies offering meters listed for fire service is even more limited. This fact has been recognized by the National Fire Safety Association, who endorses the use of meters not listed for fire service because meters listed for fire service “will increase the cost” (National Fire Sprinkler Association, Inc 2006, p.4). The availability of meter types could become an issue as more purveyors demand meters capable of transmitting water data via radio signals or other methods for remote monitoring and billing purposes (Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008; Washington Water Utilities Council 2008).

Water Purveyor Fees

- **Fees are inconsistent among water purveyors and justifications for fees are not always easily attributed to costs stemming from sprinkler systems.**
  (Residential Fire Sprinkler/Water Supply Task Force 2008; Wood 1995; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008)

The charging of standby and service fees is an issue that will need to be addressed, in coordination with the water purveyor, at the local level by each community (Residential Fire Sprinkler/Water Supply Task Force 2008). A survey of Florida water purveyors “revealed that 20 water utility agencies in Broward County and Palm Beach County do not charge a standby

water fee/user fee" (Wood 1995, p.182) for residences with sprinkler systems. The same study in Florida also found that if the standby fees directly attributed to sprinkler systems were eliminated and the loss of revenue was transferred to all customers, every water bill would increase by $0.52 (Wood 1995).

A 2008 survey of water purveyors in Washington State found that the majority of water purveyors charge a fee from $0 to $250 to provide water service for residential sprinkler systems. But, 21 water purveyors that operate in jurisdictions that require residential sprinkler systems reported charging a fee over $1,000. However, the survey also found only 14 water purveyors that operate in jurisdictions that require residential sprinkler systems reported the cost to provide service to residential sprinkler systems to be over $1,000. This survey clearly indicates that some water purveyors could be charging fees in excess of the cost to provide the service to sprinklered homes. The water purveyors who responded to the Washington survey indicated that the main costs to the purveyor are related to developing storage capacity, covering the cost of the second connection, and providing ready capacity (Voluntary Private Residential Fire Sprinkler Systems Final Report 2008).

Below is a list, compiled by the United States Fire Administration (USFA), of the common reasons for charging additional fees to customers with residential sprinklers:

- Administrative costs
- Mapping of connections and street valves
- Annual inspection and maintenance of street valves
- Actual water used for inspection and flushing fire sprinkler systems
- Estimate for water that could be used if the building caught fire
- Charges to maintain fire flow capability for the entire system
- Contingency funding for the eventual replacement of pipes and valves
  (Wood 1995, p.177)

Water Supply

- **Water purveyor is unable to handle the increased fire flow demands and storage capacity needed to accommodate sprinkler systems.**
  (Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Washington Water Utilities Council 2008; Automatic Sprinklers: A 10 Year Study 1997)

Some water purveyors are worried about the ability to provide adequate pressure and water flow to communities and neighborhoods that require residential sprinkler systems. Washington

State surveyed water purveyors throughout the state and found that some purveyors felt their system was too small to handle the mass implementation of sprinkler systems and "several were concerned about the potential fire flow exceeding system capability" (Voluntary Private Residential Fire Sprinkler Systems Final Report Appendix A 2008, p.22). This issue is of particular concern for purveyors who are not currently providing service to fire hydrants (Washington Water Utilities Council 2008).

Scottsdale, AZ was one of the first communities in America to implement a community wide residential sprinkler system ordinance. In 1997, the city released *Automatic Sprinklers: A 10 Year Study* which indicated that the water purveyor and fire department were able to accommodate growth *better* because the sprinkler system requirement reduced the overall fire flow requirements and limited the number of fire stations and firefighters needed to handle the growth. Further research is needed to explore the issue of long-term growth benefits directly attributed to sprinkler requirements in order to offer guidance to other communities.

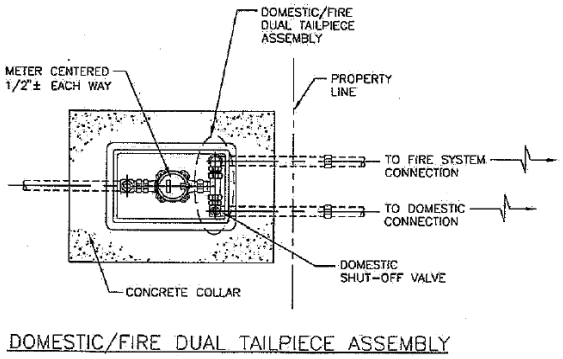
Liability

- **If the water service has been shut off to a residence and a fire occurs and the sprinklers do not activate - could the water purveyor be held responsible?** *(NAHB Research Center 1995; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Washington Water Utilities Council Guide 2008; Las Vegas Valley Water District 2007; Dewar 2001; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008)*

Water purveyors are concerned that if water service had been shut off to a dwelling when a fire occurred and the fire sprinklers did not activate, then the water purveyor could be held responsible (NAHB Research Center 1995; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Washington Water Utilities Council Guide 2008; Las Vegas Valley Water District 2007; Dewar 2001; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008). The suspension of water service to a residence generally occurs due to failure to pay bills, regularly scheduled maintenance, or emergency shut off due to line breaks and other unforeseen circumstances.

One remedy to this liability concern is to require that two water service lines enter the house from the municipal water supply – one for sprinkler water and one for domestic water. Another design option, implemented by the Las Vegas Valley Water District, is to use a dual tailpiece assembly that branches the sprinkler line from the domestic line after the water meter but has a shut-off valve on the domestic line because it provides "a means of shutting off the domestic supply without impacting the service to the residential fire sprinkler systems" (Las Vegas Valley Water District 2007, p.1). While these designs allow the domestic supply to be shut down while still maintaining flow to the sprinkler system, these approaches can add considerable cost to the overall system compared to the NFPA 13D Preferred Arrangement discussed earlier.

Las Vegas' Dual Tailpiece Assembly



Extracted from: Las Vegas Valley Water District. (2007). Residential Fire Service Tail Pieces Assemblies p.1.

Water purveyors typically view terminating water service over a payment issues as a last option. However, if the customer knows their sprinkler system will also become inactive when water service is disconnected (which is the case with single-supply line designs) it could serve as a bigger incentive to address the payment issue (Washington Water Utilities Council Guide 2008).

Further research is needed into how the liability issue is handled by jurisdictions currently requiring sprinkler systems in residential and commercial buildings. From a cost-effectiveness standpoint, it is desirable that alternative solutions to requiring dual service lines (one for domestic, one for sprinklers) to all homes with sprinklers are developed.

Health

- **Residential sprinkler systems introduce another connection that needs attention to prevent backflow and other cross-contamination occurrences.**
  (Quinn, Marcantonio & Hardiman 2009; Gilman,White & Hardiman 2001; Residential Fire Sprinkler/Water Supply Task Force 2008; Voluntary Private Residential Fire Sprinkler

Systems Final Report 2008; Dewar 2006; NAHB Research Center 1995; Schunk 2008; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008; Besner, Servais & Camper 2005)

- **The quality of water could be impacted by dead ends and longer residence time in larger pipes.**
  (Washington Utilities Council Guide 2008; National Fire Sprinkler Association, Inc 2006; Besner, Servais & Camper 2005; Hickey 2008 V.II; Home Fire Sprinkler Coalition 2008; AWWA Research Foundation and KIWA 2002; Dewar 2006)

Water purveyors are under strict EPA regulations to provide safe potable water. Residential fire sprinkler systems introduce another connection to the water distribution system that needs attention. The main health concern associated with sprinkler systems is preventing water already in the sprinkler system from back-flowing into the domestic water supply line. Similar to the health concerns stemming from any connection to the water supply system, water purveryors and city officials are concerned about sprinkler system cross-contamination issues and require backflow valves on some sprinkler designs (Quinn, Marcantonio & Hardiman 2009; Gilman, White & Hardiman 2001; Residential Fire Sprinkler/Water Supply Task Force 2008; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Dewar 2006; NAHB Research Center 1995; Schunk 2008; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008). But an investigation of 84 wet-pipe sprinkler systems showed "that total coliforms were mostly absent from those systems and that the main risk of microbial contamination of the distribution system through backflow remains directly linked to the intrusion of sewage or raw water" (Besner, Servais & Camper 2005, p.34).

There is also a concern that sprinkler systems combined with domestic water systems require pipes with "a larger diameter than normally used to serve only domestic uses. The greater volume of water in these pipes can lead to a higher loss rate of residual chlorine at points of use, due to a longer residence time for the water within the warmth of the home. Further, if copper piping is used there could also be greater potential for copper corrosion, affecting Lead and Copper Rule (LCR) compliance" (Washington Utilities Council Guide 2008, p.3). No studies were obtained that confirmed this hypothesis and "[r]esearch sponsored by the United States Fire Administration and conducted by Worcester Polytechnic Institute showed that water that sits for long periods of time in fire sprinkler systems is not hazardous as long as the pipe is an approved potable piping material" (National Fire Sprinkler Association, Inc 2006, p.6).

Fully sprinklered communities, neighborhoods, and developments may actually *reduce* water quality concerns because "[i]f the required fire flows can be reduced, then it may be possible to reduce the pipe diameter necessary to deliver such flows and in turn improve water quality" (AWWA Research Foundation and KIWA 2002, p.xix; Home Fire Sprinkler Coalition 2008; Residential Fire Sprinkler/Water Supply Task Force 2008).

> *"Typically, electing to provide fire flows and fire hydrants results in increased water supply pipe diameters, leading to higher capital costs and greater provision for reliability and redundancy in the distribution system. It may also, however, have some negative water quality implications.This oversizing to meet what some consider to be relatively infrequent fire events can result in increased water resident times in larger size pipe, thus increasing the possibility of residual disinfectant loss, and enhancing the formation of disinfection byproducts and bacterial growth in the water mains. Larger diameter pipes also result in lower water flow velocities in the water system that lead, in turn, to the deposit of sediments." (Hickey 2008 V.II, p.119)*

Water purveyors and regulatory officials will need to balance water supply quality with preventive costs passed on to homebuyers and builders. However, no evidence has been presented that indicates sprinkler systems pose a greater risk for cross-contamination than garden hose connections or sewage lines. For more detail, Dewar's report titled *Fire Protection System Water Supply Issues: A White Paper* (2006) presents a concise overview on addressing backflow and contamination.

Maintenance

- **Backflow valves require annual testing and maintenance that water customers ultimately pay for either directly through a one-time maintenance charge or indirectly through a service fee.**
  (Washington Water Utilities Council Guide 2008; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Dewar 2006; Gilman, White & Woodward 2001)

Backflow valves require testing and maintenance that water customers ultimately pay for either directly through a one-time maintenance charge or indirectly through a service fee (Washington

Water Utilities Council Guide 2008; Voluntary Private Residential Fire Sprinkler Systems Final Report 2008; Dewar 2006; Gilman, White & Woodward 2001; Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008). Valve inspections are typically performed by the water purveyor, but jurisdictions could allow homeowners or plumbers to inspect backflow valves if certain procedures are followed, typically NFPA 25 (Dewar 2006). Depending on which one of these approaches is adopted, physical access to the house and the backflow valve is an important consideration that can add costs to and complicate the inspection process.

While the cost of backflow valve inspections can be significant, as entire sub-divisions are built with residential sprinkler systems fewer fire hydrants could be needed and "the comparable cost in maintenance to a design with the usual number of hydrants would be much less" (Gilman, White & Woodward 2001, p.9; Dewar 2006). Thus, the added cost for backflow valve inspections could be partially offset by savings in hydrant upkeep.

Communities that have implemented residential fire sprinkler requirements have also explored the idea of adjusting the testing frequency of backflow devices from one year to two or three years (Voluntary Residential Fire Sprinkler Systems Technical Advisory Group: Meeting Minutes, July 15, 2008). The inspection and maintenance of backflow valves is important and each community will need to work with their water purveyor to develop an inspection strategy that is cost-effective, maintains the quality of the water, and ensures each sprinkler system is operational.

Reclaimed Water

- **Water supply issues could increase the use of reclaimed water for fire suppression activities.**
  (AWWA Research Foundation and KIWA 2002; Hickey 2008 V.I)

Reclaimed water is being used in fire hydrants but not residential sprinkler systems. As the cost of accessing, cleaning, and disinfecting water continues to rise the use of reclaimed or non-potable water for residential sprinkler systems may be explored. Although dual water supplies, one for potable and one for non-potable, for sprinkler systems is not a pressing issue today it will become a consideration, particularly in communities facing water shortages and that are

already exploring non-potable water distribution systems for irrigation and toilet flushing (AWWA Research Foundation and KIWA 2002; Hickey 2008 V.I).

Conclusion

Fire sprinkler systems will soon be required in all news homes, per the 2009 International Residential Building Code. This paper provides stakeholders with an understanding of the issues that could impact water purveyors with the mass implementation of residential sprinkler systems. Water purveyors are responsible for providing safe water to citizens and adequate flow and pressure to support fire suppression activities. Water purveyors, city officials, and the home construction industry will need guidance to develop local solutions that addresses the issues presented in this paper and the needs of their community.

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Appendix B – Interview Guide

Appendix B: Interview Template for Residential Sprinkler Systems & Water Purveyor Issues Research

CITY, STATE

Sprinkler Information
Year Ordinance Enacted: Special Details of Ordinance: (e.g. “13D+”, only applied to certain building types) Water Purveyor Name: Water Purveyor Structure: (Public, private, non-profit, etc) *If community has multiple water purveyors, note others here*.

Interview Template

Date:	
Time:	
Interviewer:	
Contact Info:	

Questions:

Objective: Identifying the interviewee:
What is your **name and title**?
How long have you been in your **position**? - List general role/responsibilities - Other notes

Objective: Gain an understanding of the local sprinkler ordinance.
We understand that sprinklers have been required in [community] since [year]. Can you describe how the implementation of sprinklers on a broad scale played out? Probe issues related to water supply

Objective: To discover how specific issues that commonly affect the water purveyor are handled and addressed.
The sprinkler system design requirements in [community] require [cite requirements – 13D or 13D+] – is this correct? Are multi-purpose systems allowed to be used?
Within your community's design requirements for sprinkler systems, are any of the

following design details REQUIRED?

- The water flow through a home's sprinkler system MUST be captured by the home's water meter. Y/N *[check this response against the multi-purpose system response]*

- Houses must have 2 separate water service lines entering the home Y/N?

- Sprinklers systems (those which are not multi-purpose) must have a backflow valve. Y/N

For [community], we understand that water supply is handled by [purveyor]. Is this correct?

- Is the water supplier; public, private, non-profit?

- Are there differences in metering, costs, and fees among them?

(Ask following questions for each water purveyor involved, if more than one)

For [purveyor name], can you generally describe how residential sprinklers are handled in terms of fees, service lines requirements, and metering requirements?

Broad question – let them expand as much as possible in their reply

Compared to a house WITHOUT sprinklers, is a home WITH sprinklers assessed with any additional fees related to the water service? These could be standby fees or any other type of recurring fee.

- What kind of fee?

- How much is it?

- How much more is it than a non-sprinklered home?

Probe rationale

What about **tapping fees?** Has the cost for a new home to tap into the water supply line changed for homes with sprinkler systems?

- If yes, why and how much?

Probe rationale behind any increases

IF SPRINKLER WATER MUST BE METERED:

<u>Primary Issues</u>

- What is the typical size of this meter?

- Has the availability of meters suited for this application been a problem?

- Because of this larger meter size, would a residence pay for its water use based on a different fee schedule than a non-sprinklered home?

- About how much more does this meter cost than the meter which would have been used if sprinkler flow was not metered? (E.g., 13D's Preferable Arrangement).
    - Is there a pricing sheet for meters?

<u>Secondary Issues (more qualitative)</u>

- Has there been any discussion on the potential for larger meters to not be as accurate measuring the low flows typical of residences?

- Has there been any change to the water purveyor's leakage allowance?

- Have the larger water meters which result from capturing sprinkler flow given rise to any other issues with operating the water supply system?

IF SPRINKLER WATER <u>DOES NOT</u> HAVE TO BE METERED

How was the potential for **unauthorized water use** addressed?

- Are you aware of any cases locally where a resident tried to tap into the sprinkler line for domestic use?

IF HOUSES ARE <u>NOT</u> REQUIRED TO HAVE 2 SEPARATE SERVICE LINES

How are liability issues handled (e.g. water service is shut off and then a fire occurs and sprinklers do not operate)?

- Are you aware of any cases locally where a home's sprinklers were disabled due to a service shut-off, and a fire occurred at the residence?

Objective: Investigate the impact of the sprinkler ordinance has had on the community since passage.
Are **regular inspections** required for sprinkler systems? - Note frequency – annual? - What components do these inspections cover (e.g. backflow valves, meters, sprinkler heads)? - Who conducts these inspections? - How are they paid for? One-time charge or included in bill, service fee?
Have any water **contamination or backflow issues** resulted from a residential sprinkler system in the community?
Has the sprinkler ordinance had any **impacts on operating costs** on the fire department?
Has the implementation of residential sprinklers had a positive effect on the ability of the water supplier to meet fire flow requirements?
Have any **changes been made to the ordinance** since it was passed? - If so, why? - Who proposed the change?

Objective: Probe whether the sprinkler-related requirements explored above were handled in a drastically different manner BEFORE the community adopted a sprinkler

ordinance.
For the sprinkler requirements we discussed here – were any of these issues handled in a much different way prior to [community] adopting its ordinance? E.g. – were meter issues handled the same way? Were fees for sprinklered home about the same? Look for any flags and probe the issues further.

Are there other contacts we should talk to about [community] sprinkler requirements and how they have been integrated with the water supply system?

- Contact info?
- Why?

Thank you for your time.