

Assessing the options to reduce the fire risk of mulch landscaping

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Certification Statement

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Abstract

The fire service responds to fires involving mulch landscaping on an annual basis. Often times these fires extend to structures which often catch owners and occupants off guard. Mulch is a popular landscaping material in the City of Harrisonburg due to its horticultural value, availability, price and its aesthetic value. Shredded wood chip, bark and nuggets being the predominant organic types of mulch utilized. The City of Harrisonburg does not regulate the use of mulch as landscaping around residences and businesses. As a result there have been fires that originated from mulch landscaping which extended to structures causing varying levels of monetary, personal and systemic loss. The problem addressed by this research is that the City of Harrisonburg allows mulch to be utilized for landscaping, while not having performed a risk assessment of this landscaping material. The purpose of this research was to assess the fire risk of mulch utilized as landscaping and to determine options to reduce this hazard in the City of Harrisonburg. The researcher used descriptive research methodology to answer the following questions in identifying the options to reduce the fire hazard of mulch landscaping:

1. What are the fire hazards of mulch?
2. What are the effects of mulch fires in the City of Harrisonburg?
3. What are the options to reduce the risk of fires involving mulch used as landscaping?

This research identified that organic mulch landscaping is combustible. With the right mixture of weather components such as high temperature, low humidity and high winds significantly increases the ignitability of mulch landscaping. There are several options to reduce the fire risk of mulch landscaping through fire prevention education or developing ordinances to prohibit its use in certain locations.

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Assessing the options to reduce the fire risk of mulch landscaping

The fire service responds to fires involving mulch landscaping on an annual basis. Many times these fires extend to structures which often catch owners and occupants off guard (Dahl, n.d.). Mulch is a popular landscaping material in the City of Harrisonburg due to its horticultural value, availability, price and its aesthetic value. Shredded wood chip, bark and nuggets are the predominant organic types of mulch utilized within Harrisonburg. The City does not regulate the use of mulch as landscaping around residences and businesses. As a result there have been fires that originated in mulch landscaping which extended to structures causing varying levels of monetary, personal and systemic loss.

The problem is the City of Harrisonburg allows mulch to be utilized for landscaping, while not having performed a risk assessment of this landscaping material. The purpose of this research is to assess the fire risk of mulch utilized as landscaping and to determine the options to reduce this hazard in the City of Harrisonburg.

The researcher used descriptive research methodology to answer the following questions in identifying the options to reduce the fire hazard of mulch landscaping:

4. What are the fire hazards of mulch?
5. What are the effects of mulch fires in the City of Harrisonburg?
6. What are the options to reduce the risk of fires involving mulch used as landscaping?

Background & Significance

The City of Harrisonburg covers 17.42 square miles and is located in the center of Rockingham County on the central west side of the Commonwealth of Virginia. The Harrisonburg Fire Department (HFD) has an Insurance Services Office (ISO) Public Protection

Classification of two. It provides emergency services to a 2013 estimated population of 51,395 in 17,684 housing units with 43.8% of these units being designed to house multiple families (United States Department of Commerce, United States Census Bureau, 2014). James Madison University (JMU) calls the City of Harrisonburg home. JMU is a state funded university that has a student attendance of 20,181 students. JMU covers 721 acres and has 34 residential living units on its properties (James Madison University, Facts & Figures website, 2013). A smaller private school, Eastern Mennonite University (EMU), also calls the City of Harrisonburg home. EMU has an enrollment of 1,500 students with 5 residential housing units (Eastern Mennonite University, Fast Facts website, 2013).

The HFD responded to 4,703 calls for service in 2013. With a total fire loss for 2013 of \$2,433,488 in 191 fire responses and a total property saved of \$88,162,114 (Harrisonburg Virginia, HFD Statistics, 2014). HFD responds from four fire stations strategically located throughout the City utilizing 4 engines, 1 tower ladder, and a Battalion Chief. The department is staffed with three shifts of 23 personnel, 6 part-time personnel, and thirteen administrative staff to include the Fire Chief and two Deputy Chiefs. HFD provides the following services fire suppression, hazardous materials, technical rescue, first response emergency medical services, and fire prevention which includes public education, inspections and investigations. The department operates with an annual budget of \$7,294,506 (*Harrisonburg 2014 budget*, 2013).

Since January 2008 the HFD has responded to 206 fires involving mulch landscaping. Of those 206 fires, 16 of them caused damage to structures. The City of Harrisonburg experiences a variety of weather throughout the year. Temperatures vary from highs in the mid 90's to lows around zero. Humidity levels vary depending on the season however from June 2013 to May 2014 there were recorded low humidity levels between 10% and 33%. High sustained winds

recorded during the same period ranged from 16-29 mile per hour (Weather Underground website, n.d.).

On April 23, 2014 the Harrisonburg Fire Department responded to two separate fires which originated in mulch and extended to structures. The first fire occurred at Copper Beach Townhomes. The fire was most likely started by a discarded cigarette into mulch landscaping. Once ignited the mulch fire extended to the vinyl siding resulting in an estimated \$2,500 in damage. The second fire occurred at O'Neil's Grill on University Boulevard. Witnesses stated the fire started from a patron discarding a cigarette into the mulch landscaping. The fire extended to the siding and into the crawl space of the business resulting in an estimated \$5,000 in damages (Delea, 2014).

Additionally a third fire occurred on April 10, 2014 at the Chestnut Ridge Apartments which resulted in an estimated \$250,000. A total of six apartments were damaged resulting in 20 people being temporarily left without housing. Deputy Chief Ian Bennett stated the fire appears to have been started by a discarded cigarette into the mulch landscaping which extended to the siding and up the building. Bennett indicated an obvious prevention would be not to dispose of cigarette butts into mulch and stated an alternative landscaping material would be rock (Delea, 2014).

Furthermore on May 5, 2014 a fire destroyed a home in Rockingham County, Virginia on Bethany Court. The fire started in the early morning hours and caused extensive damage to the home. The fire also caused damage to the attached townhome adjacent to it. Six people were sent to the hospital with non-life threatening injuries as a result of the fire. Firefighters stated a discarded cigarette into landscaping was the cause of the fire. The Rockingham/Harrisonburg area has been plagued with similar types of fires over the last few months (Delea, 2014).

This research is of great importance to the HFD and City of Harrisonburg as a means to understand the risk involved with mulch landscaping and identifying potential means to reduce this hazard. In aligning with the Executive Analysis of Community Risk Reduction class offered by the National Fire Academy (NFA) this research empowers the Executive Fire Officer student the ability to lead community risk reduction through researching an identified risk in their local community which can possibly be reduced or eliminated by conducting this research. The research also aligns with the United States Fire Administration's (USFA) strategic plan by achieving the goal of reducing risk at the local level through prevention and mitigation. This research will identify the fire hazards of mulch landscaping and identify possible means to reduce and/or mitigate the identified risk.

Literature Review

Fire departments respond to thousands of mulch related fires on an annual basis in each state. Frequently the fires involve mulch that is up against structures. There are several factors that contribute to the risk of these types of fires, below average rainfall, extremely dry conditions, warm temperatures and abnormally strong winds. With the continued regulation of indoor smoking, people are smoking outside of businesses leading to more smoking material being discarded into mulch landscaping creating an ignition source. Studies have shown that exposure time to heat and ignition source increase the ignition potential of mulches. Most mulches burn under the surface in tunneling fashion and then opens to create a flame (Finucane, 2008).

Preventing mulch fires involves recognizing weather patterns that might increase the fire risk and creating an awareness among the general population of the signs of increased mulch fire risk. Building owners can begin to provide receptacles for smoking materials in an attempt to

discourage discarding into landscaping material. Not using mulch in designated smoking areas is another means of limiting the fire risk. By providing an 18 inch clearance between structures and combustible mulch, will help eliminate the risk if a fire occurs in the mulch from damaging the structure. Another recommendation is to utilize non-combustible mulch material around structures (Finucane, 2008).

A fire at the Mid-Atlantic Family Practice in Lewes, Delaware on April 24, 2014 caused \$1 million dollars in damages. The Delaware Fire Marshal's office stated the fire started in the mulch on the exterior of the building then ignited the exterior finish of the two story structure ("Mulch fire causes damage," 2014). The Malden Fire Department in Massachusetts responded to a two alarm fire involving a residence April 16, 2012 on Adams Street. Firefighters stated an elderly woman escaped the fire which started in the mulch landscaping and extended into the structure. The fire caused \$150,000 in damages. Weather conditions, dry, hot, and breezy, were cited as creating ideal conditions to spread the fire (Byrne, 2012).

The University of Nevada Cooperative Extension defines a combustible material as one that is capable of igniting and burning. They also went on to define mulch as any material used to cover soil surface for a variety of purposes. Mulch is classified as organic or inorganic. Organic material is made from plants, such as pine needles, wood chips, bark or rubber. Inorganic material consist of products such as rock, gravel, or brick chips (Quarles & Smith, 2007).

Throughout the country many commercial and public facilities no longer allow smoking indoors due to policies or laws. This has created instances where people exit the structures to smoke, thereby discarding their cigarettes creating an ignition source for the landscaping material. Steward, Sydnor, and Bishop (2003) studied the ignitability of 13 landscape mulches.

The types of mulches studied were pine bark, hardwood, cypress, yard waste, small pine bark nuggets, large pine bark nuggets, pine straw, recycled wooden pallets, coca shell, oat shell, and mixed grass sod along with inorganic materials of brick chips and shredded rubber tires. For the test, the mulches were not treated and allowed to settle for two weeks. They utilized three different types of ignition sources, three cigarettes, matches and propane torch. During the cigarette test the cigarettes were placed on the test mulch and allowed to sit for 20 minutes. During these test recycled pallets and composed yard waste ignited in four of the eight tests. Pine bark mulch ignited three out of the eight test. Shredded rubber, brick chips, and hardwood did not ignite during any of the test. Shredded hardwood and brick chips demonstrated the most resistive to all ignition methods used during the test. This test suggested that the time the mulch is exposed to the ignition source and the actual atmospheric temperature will affect the ignitability of the mulch (Steward, Sydor, & Bishop, 2003).

In 2008 the Carson City Fire Department conducted an evaluation regarding the combustibility of mulch. The following mulches utilized in residential settings were tested: western red cedar, composted wood chips, shredded rubber, pine needles, medium pine bark, and tahoe chips. They were tested for flame height, rate of spread and temperature produced. After two and half months, all mulches ignited in dry, hot, and moderate wind conditions. Each mulch was ignited by using a drip torch. All the mulches except composted wood chips produced an active flame, which created a smoldering fire as its primary means of combustions. The most hazardous mulches based on test measurements were shredded rubber, pine needles and western red cedar. With the least hazardous being composted wood chips and tahoe chips. Composted wood chips had the slowest fire spread rate, however this was at times obscured due to a non-burning surface layer with smoldering combustion on layers below (Quarles & Smith, 2007).

Another study on the flammability of mulch by Zipperer, Long, Hinton, Maranghides and Mell (2007) identified pine bark mulch created layers of oxygen throughout its depths due to the structure of the mulch. This oxygen layer created the ability for the mulch to burn through all layers and allow it to burn continually once ignited. Pine bark mulch burned at temperatures in excess of 350 degrees Fahrenheit (Zipperer, Long, Hinton, Maranghides, & Mell, 2007).

A study conducted by the University of Arizona Cooperative Extension conducted a test of the following mulches: wood chip, shredded bark, pine needle, grass sod, garden compost, bark nuggets, wheat straw, and decomposed granite, to compare their ignitability. For ignition sources they used a single cigarette to simulate a discarded ignition source, charcoal briquette to simulate a fire brand, and propane torch to simulate a flame front from a ground fire. All mulches exposed to the propane torch ignited during the test. During the charcoal briquette test straw and pine needles ignited over 67% of the time. However once the briquette was removed it created fire or smoldering in each mulch for the entire test period of 25 minutes. The single cigarette test did not ignite any of the mulches ("Comparing ignitability of mulch," 2007).

A key in many of the studies conducted to determine the fire hazards of landscaping mulches is that slope and wind speed were not taken into account. Slope and wind speed will have a significant effect on the behavior of fire spread in mulch as relative humidity and temperature does. One item that is consistent is that inorganic mulches do not support combustion, which helps to eliminate the possibility of fire spread (Beyler, Dinaburg, & Mealy, 2014).

Many investigators miss spontaneous ignition as a cause in many fires involving organic material. This is due to the destruction of evidence caused by this type of fire. Spontaneous combustion can occur in moist haystacks and wood chips. Spontaneous combustion is a

chemical reaction that results in smoldering or limited flame combustion. This chemical reaction is exothermic. This reaction occurs from decomposition or oxidation of an organic material. Wood material is known to create an exothermic reaction during its decomposition phase. When such material begins decomposition and is unable to cool itself, the spontaneous combustion process begins. And the time before ignition occurs can be seconds to weeks (Quintiere, Warden, Tamburello, & Minnick, 2012). Spontaneous combustion usually does not occur in thin layers of mulch, rather in thicker and larger layers. Once spontaneous combustion process has begun, even material that had been treated with fire retardant will only delay the fire spread five to ten minutes (Ferguson, n.d.).

When a material is self-heated to the temperature high enough to ignite, it has the ability to spontaneously combust. As the atmospheric temperature rises the speed of the internal temperature of the organic material also rises. This rise doubles for every 50 degrees Fahrenheit rise of atmospheric temperature. When the organic material begins to decompose, it becomes dry, and is insulated, which prevents air flow creating a recipe for spontaneous combustion. Most organic material controls heat through evaporation of the moisture within the material. Once the moisture content becomes too low it allows the internal temperature of the material to begin to rise towards its spontaneous combustion temperature. Once an organic material reaches a moisture range of 20-45% it will support spontaneous combustion ("Fire Compost & Organic Matter," 2006). Also when the temperature is above 86 degrees Fahrenheit and humidity is less than 30%, mulch fires are more likely to occur ("Mulch Fires," 2014).

Since all mulches tested in the University of Nevada Cooperative Extension's test were combustible, it is recommended that these types of mulches not be used within five feet of structures. They recommend using alternative material such as rock, gravel, concrete or pavers

(Quarles & Smith, 2007). Zipperer, Long, Hinton, Maranghides and Mell (2007) also recommends from their study that mulch should not be used next to flammable materials such as vinyl that may ignite or melt from heat produced. As a result of the test, they recommend that other decorative material such as gravel, stone or other non-flammable material be used as landscaping (Zipperer et al., 2007). Arizona Cooperative Extension recommends using granite, gravel, or rocks as landscaping next to flammable structural material to reduce the fire spread risk. It is also recommended that this fire proofing border be extended several feet from the structure. In addition, wood chips and bark nuggets should not be used within 15-30 feet of combustible structures. This is due to the fact these materials have a significant amount of air space between the material that creates the ability to spread potential fire to structures or plants over time ("Comparing ignitability of mulch," 2007).

Often fires involving structures result in injuries which require treatment at a health care facility. Health care expenses continue to rise, the average visit to a local emergency room can cost an individual 40% more than they pay in rent (Kliff, 2013). Going to the emergency room for treatment of common medical issues can vary in cost depending on the diagnoses. Average cost range from \$827 to \$3742. These expenses can be greater if there is significant treatments required (Abrams, 2013). According to Blue Cross and Blue Shield Association, an insured adult visiting the emergency room can expected to have out of pocket expenses of \$580 to \$700 for common treatments ("Cost for Medical Services," 2009).

Teaching fire prevention must be focused on increasing a person's threat perception through revealing the severity of the issue and their vulnerability to the problem. Fire prevention can no longer be done by just saying it, people must see and experience the problem. To reach people it is important to connect with a person's efficacy beliefs. If one increases a person's

realization to a threat it will not be beneficial unless a person's efficacy beliefs are increased.

The first reaction to a threat is to deny the risk and then to control one's emotions while averting attention away from corrective behaviors (Scheithaver, n.d.).

Fire prevention needs to utilize local media after every fire as an opportunity to prevent future occurrences of the risk. Media and social media must be utilized to amplify the problem as a means to bring attention to the problem. Several steps need to be used to persuade people to engage in self-protection. The person must be presented with the seriousness and vulnerability of the problem, which must be demonstrated through visually realistic scenarios. Once the seriousness and vulnerability is realized, then the behavior skills must be taught to enhance the person's self-efficacy and response efficacy (Scheithaver, n.d.).

Most people must go through several stages in the process of changing behavior including the pre-contemplation, contemplation, determination, action, and maintenance. The pre-contemplation phase is where the person has not considered changing behavior due to not understanding the behavior is damaging. Contemplation phase is where the person begins to think about the benefits of changing behavior, however the cost may still outweigh the perceived benefits (Cherry, n.d.). Determination phase is where the person is beginning to prepare mentally and physically to change behavior. Action phase is where the person makes the behavior change. Lastly, the maintenance phase is the process of reinforcing the behavior to ensure it becomes a habit (Lickeman, 2009). To change any behavior it is important to ensure the person is ready to change. This involves ensuring they have the resources and knowledge to make a lasting and successful change. Barriers to the change must be removed, this includes eliminating any and all things that might be used to prevent the behavior change (Cherry, n.d.).

Some jurisdiction chose to use local or state ordinances to combat the fire risk of mulch landscaping. May 13, 2010 the Town of Cary, North Carolina adopted a combustible landscaping ordinance. The ordinance went into effect immediately, prohibiting the use of pine straw or other landscape material that has a fire spread rate of 24 inches per minute from being placed or stored within 10 feet of buildings with combustible exterior coverings. The Town of Cary's ordinance provided an exception for single family residences. Any recognized violation must be resolved within 7 days of notice or the violator could face a \$250 fine per day if the violation is not corrected (Combustible Landscaping Ordinance, 2010).

Similarly to the Town of Cary, the City of Durham, North Carolina developed an ordinance restricting the use of pine straw mulch or other material that has a fire spread rate of 24 inches per minute. These materials cannot be used within 10 feet of buildings with combustible exteriors. This ordinance was adopted in 2011, however single family residences are exempt from being required to comply with this ordinance (Use of Pine Straw Mulch, 2011).

In addition, after a couple significant fires in 2010 involving pine straw mulch that extended to structures the City of Raleigh, North Carolina adopted an ordinance that bans the use of pine straw. Raleigh's ordinance does not apply to single family residences and carries a minimum of \$50 fine for non-compliance. Raleigh's Deputy Fire Marshal Ronald Campbell encourages everyone to use non-combustible material such as rock and brick chips or material that will not burn ("Warns against Pine Straw," 2014).

Spring time is the time for most people to start getting the landscape around their homes spruced up and for many this involves using mulch as landscaping. Massachusetts passed a regulation in September 2012 that prohibits the use of mulch within 18 inches of combustible exteriors of structures. This regulation does not apply to residential properties of six dwelling

units or less however, it does apply to commercial structures. Massachusetts State Fire Marshal encourages all homeowners to follow safety practices of not placing mulch within 18 inches of structures, instead use non-combustible material in that 18 inches, and provide proper receptacles for smoking materials ("Mulch Fire Safety," 2014).

Procedures

The initial research for this topic was initiated while attending the National Fire Academy's Executive Analysis of Community Risk Reduction course May 19-31, 2014. The researcher utilized the descriptive research method to complete this applied research project. Methods involved literature review, analysis of HFD National Fire Incident Reporting System (NFIRS) data, and questionnaires.

The researcher utilized detailed analysis of literature that pertains to the fire risk of mulch landscaping to answer the first question, what is the fire hazards of mulch? Research of previous applied research projects with similar topics was conducted to identify potential reference material that could be utilized for this research. Other literature was located by using the NFA Learning Resource Center (LRC) online website at <http://www.usfa.fema.gov/library>. Another means of researching the topic was to use Google search using key words such as but not limited to, mulch fire, prevent mulch fire, mulch fire testing, and risk of mulch landscaping.

To answer question two, what are the effects of mulch fires in the City of Harrisonburg?, several methods were employed. A detailed analysis of the HFD NFIRS reports was conducted. This analysis was used to identify the number of mulch fire responses from 2008 until May 31, 2014. Once identified, the reports were analyzed to determine the estimated dollar loss, injuries related too, those that extended to a structure, and identify the last four HFD responses to structures damaged as a result of mulch fires. Once the last four structures were identified, those

reports were analyzed to determine the responsible insurance companies, occupants and owners of the structures. The insurance companies were sent questionnaires (Appendix A) to determine the companies' assessment of damages and actual pay out to the insured on each of the four fires. Tax records were reviewed to determine a base assessed value for the properties. Willing occupants and/or owners of the four structures were sent questionnaires (Appendix B) to determine any additional losses incurred from the fires that were not covered by insurance. Losses such as expenses for medical treatment, loss of income from rent payment, loss time at work, contents not covered by renters insurance, and any other items were identified during the interviews.

Question three of the research asked, what are the options to reduce the risk of fires involving mulch used as landscaping? To answer this question, a detailed literature review was conducted and a questionnaire (Appendix C) was sent to a random sampling of fire service organizations within the Commonwealth of Virginia, State of Maryland, State of West Virginia, and State of North Carolina. Literature review was conducted by searching through the NFA LRC and Google search using key words such as, mulch fire prevention, reducing mulch fire risk, fire safe landscaping, preventing mulch fires and Firewise. This literature review focused on programs or other means utilized to reduce the fire hazard of mulch landscaping. The questionnaire was designed to identify to what extent other localities and organizations are experiencing incidents involving mulch fires and to determine if they have implemented programs, ordinances, or fire codes that are effective in reducing this risk. Localities were selected randomly by looking at a map and developing a list of localities that would provide a generous geographic sampling within the given state. Once identified, Google search was used to find contact information for each localities Fire Chief or Fire Marshal. The identified fire

official was emailed asking for their assistance in the research by completing the questionnaire that was developed using SurveyMonkey. A link was provided in the e-mail to access the questionnaire. The questionnaire could be completed anonymously and a total of 30 localities were sent the e-mail request with the questionnaire link. A lack of adequate response from the localities regarding the e-mail request, required an additional method to obtain adequate participation for the research. The same request was posted on the International Fire Chiefs Associations (IAFC) KnowledgeNet at knowledge.iafc.org/home.

Limitations to the research were noted in answering question two and three. In answering question two, the researcher was limited to the willingness of the insurance company in participating in the research and answering the questionnaire. This same limitation was found in answering the questionnaire or even having the occupant and/or owner agree to participate in the research. A limitation to answering question three was that localities responding to the questionnaire were not able to or did not provide statistical information in regards to the effectiveness of the risk reduction program implemented. Due to the fact the questionnaire could be completed anonymously, the researcher could not determine which localities contacted actually participated in the research. Therefore sending reminder e-mails had to include all 30 localities originally contacted. The e-mail request received an inadequate response requiring an additional method to obtain adequate research information.

Results

The research indicates that organic material used as landscaping has varying levels of inherent fire risk however all will ignite. Research shows that effects of mulch fires within the City of Harrisonburg has the potential to be significant when the fire extends to structures. The

two most commonly used options to reduce the risk of mulch fires is public education and adopting local ordinances restricting the use of mulch landscaping.

Answering question one was completed by conducting a detailed literature review. Risk of mulch fires involves recognizing weather patterns and other factors that contribute to this increased risk, below average precipitation, dry windy conditions and warm temperatures (Finucane, 2008). Several tests were conducted to identify the risk of mulch landscaping. One test conducted utilized three cigarettes laid on the mulch for 20 minutes. This test showed that recycled pallets used as mulch ignited 50% of the time from the three cigarettes. Pine bark mulch ignited three times out of eight. A key finding in this test was that the time mulch is exposed to the ignition source and the atmospheric temperature being high greatly increases the ignitability of mulch (Steward et al., 2003). The University of Arizona Cooperative Extensions test in 2007 utilized one cigarette laid on the mulch for 20 minutes with no ignitions of the mulches being identified ("Comparing ignitability of mulch," 2007). In Quarles and Smith's (2007) test all mulches tested produced an active flame except composted wood which only produced a smoldering fire. They identified composted wood mulch as being one of the least hazardous of those tested however, the fire spread rate was misleading due to the fact of a non-burning surface layer and smoldering layers below (Quarles & Smith, 2007).

Another test identified pine bark mulch as having several layers of oxygen infiltrated throughout due to the structure of the mulch. This added oxygen within the mulch creating the ability for it to burn through all layers, with burn temperatures in excess of 350 degrees Fahrenheit (Zipperer et al., 2007). Beyler, Dinaburg, and Mealy (2014) recognized that the previous studies had not taken into account slope and wind. They state that slope and wind will have just as much effect on the behavior of mulch fires as humidity and temperature. One

consistency they noted in all the studies was that inorganic mulches would not support ignition (Beyler et al., 2014).

One means of ignition that is often overlooked is spontaneous combustion. Spontaneous combustion is the chemical reaction that results in smoldering or limited flame combustion, which is an exothermic reaction. Exothermic reactions occur when materials decompose. Wood material, which many mulches are made of, creates this exothermic reaction during its decomposition (Quintiere, Warden, Tamburello, & Minnick, 2012). As the atmospheric temperature rises the internal heating process within mulch will intensify as much as two times the rate for every 50 degrees Fahrenheit ("Fire Compost & Organic Matter," 2006). Once the spontaneous combustion process begins and the material is unable to cool itself, ignition will occur within seconds to weeks (Quintiere, Warden, Tamburello, & Minnick, 2012). When the temperatures are above 86 degrees Fahrenheit and relative humidity less than 30% the risk of mulch fires are significantly greater ("Mulch Fires," 2014).

In answering question two of the research a detailed review of HFD NFIRS reports was conducted. In reviewing NFIRS reports since January 2008 it was found that the HFD has responded to 206 fires involving mulch landscaping. Of those 206 fires, 16 of them involved damage to structures. HFD responded to 59 of the 206 mulch fires from January 1, 2013 thru May 31, 2014. It was noticed that approximately 78% of the 206 mulch fires occurred between the months of April through September. The month of April has incurred the most mulch fire incidents since 2008 with 63 responses, this accounts for 31% of all the reported mulch fires. See Figure 1 for mulch fire responses by month since 2008. The 16 fires involving structures caused over an estimated \$1 million in damages. Of the 16 structures damaged by fires which originated in mulch landscaping nine of them involved multi-family dwellings.

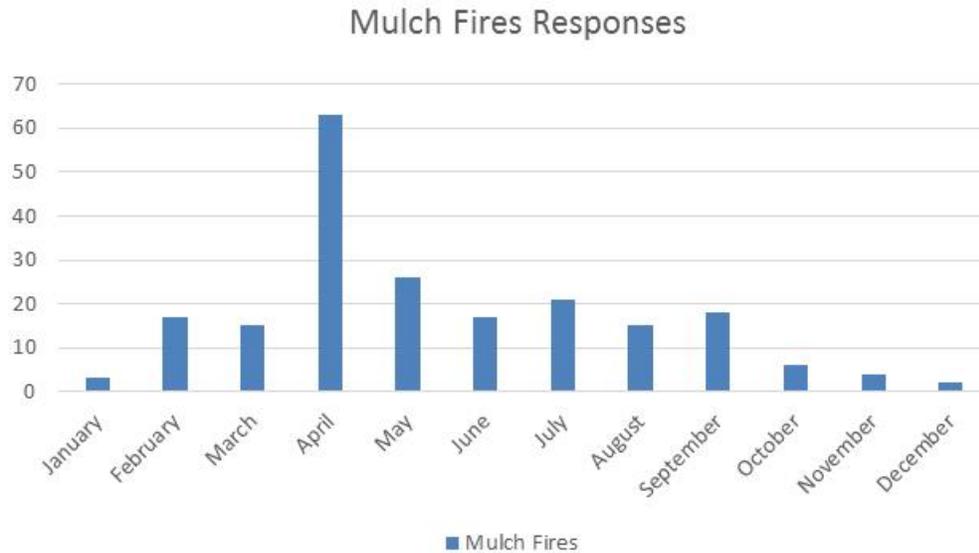


Figure 1. Mulch fire responses by month January 2008 through May 31, 2014 by HFD.

As part of answering question two, questionnaires were sent to insurance companies that held the policies for the last four structures damaged by mulch fires. On April 10, 2014 HFD responded to 131 Chestnut Ridge Drive for an apartment building fire which originated in the mulch landscaping. This fire had multiple insurance companies with interest involved due to the fact of the building being an apartment complex with renters. April 23, 2014 HFD responded to two separate mulch fires that extended to structures at 490 Copper Beach Circle and 221 University Boulevard. Copper Beach Circle fire involved a townhome and University Blvd involved a restaurant. The fourth fire was located on 3163 Bethany Court and involved a townhome which extended beyond the original home.

The fire at 131 Chestnut Ridge Drive involved an apartment building with 12 residential units. Origin and cause of the fire was determined to be in the mulch landscaping on the northeast corner of the structure and the most likely ignition source to be a discarded cigarette. This fire displaced 12 families, with only two of the families being relocated within the same apartment complex. The other 10 families had to locate other complexes to move to due to the

current complex not having any living units large enough for the families. The total payout by the insurer was \$912,000 for property loss. This payout includes but is not limited to demolition of the damaged property, construction of new property, repairs to exposed structures, landscaping, etc. Loss of rent from the 12 residential units is expected to be at least one year until construction is completed. These 12 units were three bedroom apartments that brought \$847 a month rent. Over the estimated year reconstruction property management estimates a loss of income of \$121,968 from rent payments. This resulted in a \$1,033,968 of identifiable monetary loss.

10 occupants affected by the Chestnut Ridge Fire which had to relocate to other properties were not able to be contacted and property management was not comfortable with disclosing their contact information. The two families that were relocated within the property, were given the researchers contact information and information concerning the research by property management. None of the occupants from Chestnut Ridge attempted to contact the researcher.

HFD response cost to the Chestnut Ridge fire is estimated at over \$4200. This fire was a two alarm fire that required mutual aid response. HFD responded with 4 Engines, 2 Trucks, and multiple support vehicles, staffed by 35 firefighters which includes off duty call back personnel.

The fire at 490 Copper Beach Circle involved an apartment building that consist of multiple townhomes with basement style apartments underneath. This fire originated in the mulch landscaping just outside of this apartment and extended up the exterior of the structure. The cause of the fire was determined to be most likely discarded cigarettes due to butts in the area of origin, the relative low humidity and high winds the day of the incident. Damage to this structure was repaired by property management without submitting a claim to their insurance

company. This was due to large deductibles and what was considered an inexpensive repair by property management. Total damages resulted in \$940. The occupant of 490 Copper Beach Circle had to be relocated to another apartment due to the damaged cause by the fire. These repairs for this structure only took one month thereby limiting loss of rent to one month. Rent for this apartment was \$735 per month and the apartment the occupant was moved into was the same. Thereby having a total rent payment loss of \$1,470. Total monetary loss for this fire was \$2,410.

A fire involving the restaurant property located at 221 University Boulevard was found to have originated in the mulch landscaping. The area of origin of this fire was directly next to an area outside of the structure utilized by patrons to smoke. There were multiple discarded cigarette butts located within the mulch landscaping. The fire extended to the exterior siding on the structure and then into the crawl space of the business. The owner of the business identified a total loss covered by insurance as \$21,000 for fire damages. The business was also closed for 21 days which resulted in a loss of revenue for that time period, which the business had not estimated at the time the questionnaire was completed. The owner identified another loss that was unable to be quantified which was the loss of several employees who were unable to go 3 weeks without income.

The fire at 3163 Bethany Court involved a townhome with one exposure attached on the north side of the structure. Fire originated in the mulch landscaping in the front of the structure and extending up the exterior and into the structure. This fire occurred at 1:21 a.m. while the structure was occupied by 7 family members. All occupants suffered minor injuries related to the fire and 6 were transported to the local hospital. The fire caused significant damage to the structure and minor damage to the exposure structure. In contacting the insurance claim agent

for this property he was unwilling to give any detailed information regarding losses, stating privacy concerns. The owner of the property uses English as a second language, therefore creating some communication issues, but indicated he was unwilling to participate in the research. In reviewing the Rockingham County property tax records this property has an assessed value of \$150,100 (Rockingham County Interactive GIS website, 2014). The HFD NFIRS report estimates an 83% total loss of the structure, which results in an estimated \$124,583 loss.

Question three was designed to explore the options available to reduce the risk of mulch fire landscaping. A detailed literature review was conducted and a questionnaire was formulated to be answered by willing localities. The initial response to the questionnaire was only 11 of the 30 localities sent the e-mail request. Thereby requiring the questionnaire being added to IAFC's KnowledgNet, which resulting in over 125 responses to the questionnaire.

In the University of Nevada Cooperative Extensions mulch testing found that all mulch tested was combustible. They recommend combustible mulches not be used within five feet of structures. Rock, gravel, and concrete are recommended as substitutes for organic mulch (Quarles & Smith, 2007). Zipperer, Long, Hinton, and Maranghides (2007) recommended in their study on mulch fire hazards, that mulch not be utilized next to materials such as vinyl which will melt and combust. As with the University of Nevada's study they recommend gravel, stone, or other non-flammable material be used in place of combustible mulches (Zipperer et al., 2007). Again in the Arizona Cooperative Extensions study it was recommended that granite, gravel, or rock be utilized as a substitute to organic mulches. This study goes on to recommend that wood chip and bark mulch not be used within 15 to 30 feet of combustible structures due to the air

space created by these mulches which increases the potential of fire spread to structures ("Comparing ignitability of mulch," 2007).

A person must go through several processes to change behavior which can take considerable time (Cherry, n.d.). Fire prevention must change the person's perception in regards to their threat to the problem. For most people changing their behavior does not work by just saying it, they must see it and experience the problem. It is important that a person's efficacy beliefs be connected with the problem. People will first deny any risk and then they will move their attention away from corrective behavior. It is essential to present the person with how serious the problem is and what exactly their vulnerability to the problem is. This can be done by demonstrating the seriousness and vulnerability through realistic scenarios. And once the person realizes their vulnerability, behavior skills must be taught to change and enhance one's self-efficacy and response efficacy (Scheithaver, n.d.).

The Town of Cary, NC adopted an ordinance restricting the use of pine straw or other combustible material which has a fire spread rate of 24 inches per minute or greater. This material cannot be placed within 10 feet of combustible exteriors with an exception for single family dwellings (Combustible Landscaping Ordinance, 2010). The City of Durham, NC adopted a similar ordinance restricting the use of pine straw and combustible material (Use of Pine Straw Mulch, 2011). A ban on the use of pine straw was adopted in the City of Raleigh, NC. The restriction does not apply to single family dwellings. Raleigh fire officials encourage the use of rock, brick chips, or other material that will not burn in place of combustible mulch ("Warns against pine straw," 2014). Massachusetts passed a regulation prohibiting the use of mulch within 18 inches of structures. This regulation applies to properties with greater than six dwelling units and commercial properties. Massachusetts recommends that non-combustible

material be used within the 18 inches and provide receptacles for smoking material ("Mulch Fire Safety," 2014).

The questionnaire was designed to identify localities experiencing risk from mulch fires. Once identified, the questionnaire inquired as to the type of property most effected and the fire loss experienced. Localities experiencing these fires were asked as to how they have chosen to reduce this risk. The final two questions of the questionnaire were designed to determine the effectiveness of their selected risk reduction method and to gain access to programs or documentation concerning their reduction method.

Question one asked, has your organization experienced fires originating in mulch landscaping which has extended to structures? A majority of those responding, 69%, indicated their locality has experienced damage to structures from fires originating in mulch. Question two identified the leading type of structure damaged by mulch fires that extend to structures is single family dwellings, see figure 2.

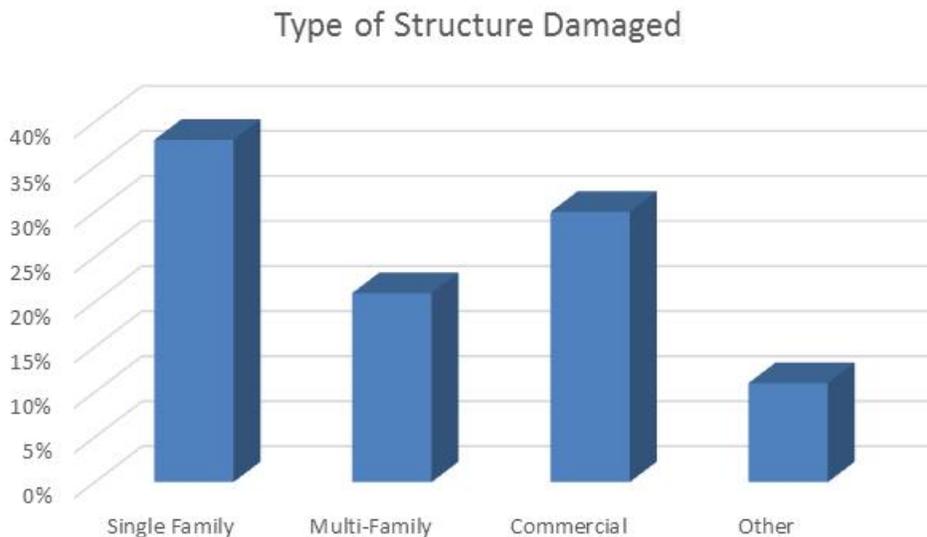


Figure 2. What was the leading type of structure damaged by this type of fire?

Question three identified that 54% of those responding to the questionnaire experienced minimal damages from mulch fires affecting structures. With 14% experiencing significant damages, see figure 3.



Figure 3. What is the average fire loss in these fires?

Question four was used to identify the various types of risk reduction methods localities utilized in response to mulch fires. Public education was identified as the preferred method utilized by localities that have chosen to initiate a risk reduction program in regards to mulch fires. However a majority of those responding to the questionnaire have chosen not to take action or have not taken action at the time of the research, see figure 4.

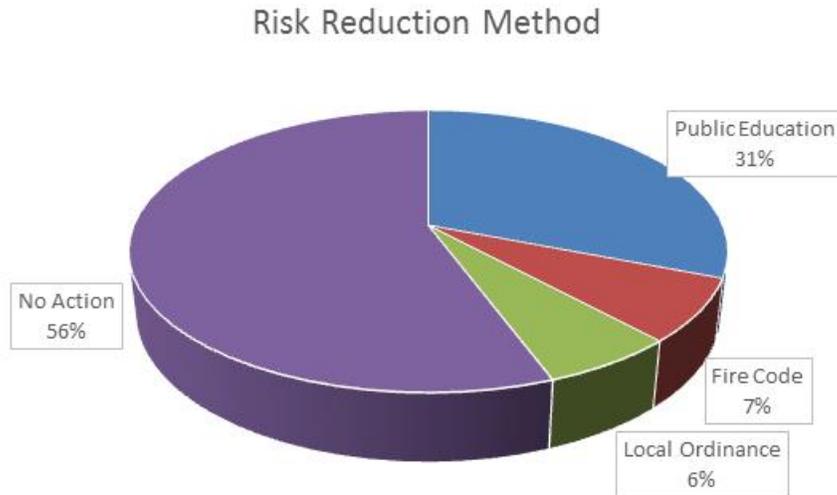


Figure 4. How has your organization or locality choose to reduce this risk?

In response to question five which asked the success of the localities chosen risk reduction method, a commonality was a lack of data to provide accurate feedback. Those that chose to use public education used a variety of educational tools to reach their target audience. Educational tools ranged from using premade material from state forestry, neighborhood informational meetings, public service announcements, Facebook and Twitter campaigns, to literature encouraging replacing mulch with non-combustible material. Most responding to the question five as using public education as the means of reduction only identified minimal to no reduction in mulch fire responses. However one locality identified an 80% reduction of mulch fires in a 1 year time frame from using public service announcements through newspapers and television stations.

Only 6% of those answering the questionnaire identified utilizing a local or state ordinance to regulate the use of mulch landscaping as a risk reduction method. All the localities enacting an ordinance identified a reduction in mulch fire responses with several localities nearly eliminating damage to structures from these fires. One locality classified their reduction of

mulch fires as significant while another has not had any multiple family dwellings damaged by fire originating in mulch landscaping.

Discussion

Mulch landscaping material is popular due to its horticultural value, availability, price, and its aesthetic value. However, on an annual basis the fire service responds to many fires involving mulch landscaping. Often these fires extend to structures which often catch owners and occupants off guard (Dahl, n.d.). The HFD is not absent of this issue, in fact it has been a significant contributor to the fire responses by the department.

Testing of mulch indicates that the time it is exposed to the ignition source and a higher atmospheric temperature increases its ignitability (Steward et al., 2003). A discarded cigarette can correlate to an extended exposure to an ignition source if discarded into mulch. However other studies showed that cigarettes lying on the mulch for up to 20 minutes did not ignite ("Comparing ignitability of mulch," 2007). Another test identified composted wood chips as one of the safest, however due to the burning underneath the surface layer this test can be misleading (Quarles & Smith, 2007). Part of this burning under the surface layer can be contributed to layers of oxygen that is infiltrated throughout (Zipperer et al., 2007). Many test did not take into consideration variable weather condition. When temperatures exceed 86 degrees Fahrenheit with humidity levels less than 30%, the chances of mulch landscaping igniting is much greater ("Mulch Fires," 2014). Another commonly overlooked cause of ignition in mulch landscaping is its ability to spontaneously combust. Due to decomposition and the oxygen layers within the mulch it can create a situation allowing the mulch to reach its ignition temperature. Decomposition creates an exothermic reaction that allows the mulch to create its own heat (Quintiere et al., 2012). With most test relating to the ignitability of mulch

indicating that mulch landscaping will ignite and mulch's ability in the right atmosphere to spontaneous combust it can be concluded, mulch landscaping falls within the definition of combustible material since it is capable of igniting and maintaining combustion (Quarles & Smith, 2007).

All the tests that were conducted to determine the combustibility of mulch landscaping all suggest using it cautiously or not at all. University of Nevada Cooperative Extension recommends not using mulch within five feet of a structure (Quarles & Smith, 2007). Due to the fact mulch landscaping has the ability to have a large amount of oxygen pockets within the material which creates the ability for fire to spread, increases its risk if an ignition source is introduced. It is recommended that non-combustible material such as gravel or rock be used close to combustible structures ("Comparing ignitability of mulch," 2007). With multiple studies suggesting combustible mulch not be utilized near structures, it indicates that non-combustible material would dramatically reduce the risk from fire.

Since January 2008 a majority of the fires responded to by HFD involved mulch landscaping. 16 of these fires extended to structures. These fires resulted in over \$1 million in damages. Within the past year HFD has responded to 4 mulch fires that extended to structures causing considerable damage. All of these fires involved what is classified through NFIRS as multiple family dwellings and a restaurant. The month of April accounts for 31% fires involving mulch landscaping which commonly experiences lower relative humidity rates and higher winds. Mulch fires occur regularly within the City of Harrisonburg, however fires that extend to structures occur at a much lower rate. When mulch fires extend to structures in the City of Harrisonburg they tend to create moderate to significant damage.

The last 4 fires evaluated for damages and other monetary losses reflect that there can be significant losses when these fires occur. These fires resulted in an estimated \$1,186,181 in structural damage. The fires displaced 14 different families. Some had to find new locations for housing while other families had to relocate temporarily until repairs could be made to their respective structures. Several of the fires involved rental properties which due to the damage and reconstruction resulted in loss of income for property owners from rent payments. Chestnut Ridge fire resulted in close to \$122,000 in estimated rent losses until construction is completed.

Many times injuries result from fires of significant magnitude. Such a fire occurred with the Bethany Court fire, it sent 6 family members to the hospital for minor injuries. Health care expenses can become very expensive and burdensome for many. An average emergency room visit can cost several thousand dollars (Abrams, 2013). If the person receiving the care is insured they still can expect to pay more than \$500 for that visit ("Cost for Medical Services," 2009). For many families this \$500 can be a significant challenge.

The fire at 221 University Boulevard resulted in \$21,000 dollars in fire damages that was repaired via insurance claims. However the most significant cost, which had not been estimated by the owner, is the 21 days of lost business due to being shut down from the fire damages and repairs. Another impact that has multiple ramifications is the loss of employees due to the significant amount of days the business was shut down and the cost to hire and train new employees. These employees loss of income could result in a loss of tax revenue from monies spent for groceries, household supplies, etc.

Fire prevention regularly attempts to change the behavior of the target audience in attempt to achieve the desired behavior. As part of changing the behavior, a person's threat perception must be harnessed to reveal their vulnerability. The first reaction is to deny the risk

and avert their attention away from the desired corrective behavior (Scheithaver, n.d.). Changing this behavior requires the target audience go through several phases before this behavior will change. Before someone's behavior can change they must be ready to change. To ensure proper change all barriers to the change must be removed and the audience be supplied with the resources and knowledge to succeed (Cherry, n.d.). This suggest that changing behavior can be time consuming and require a steady inflow of behavior changing training which can require many man hours.

Many localities being affected by similar fire hazards from mulch landscaping have chosen to adopt local or state laws that reduce this hazard. The City of Cary in North Carolina adopted an ordinance which prohibits any landscaping material with a fire spread rate of 24 inches per minute within 10 feet of combustible structures (Combustible Landscaping Ordinance, 2010). A similar mulch restriction was adopted by the City of Durham in North Carolina. Both ordinances provide an exception for single family residences (Use of Pine Straw Mulch, 2011). The City of Raleigh in North Carolina adopted an ordinance that restricted the use of pine straw mulch. Since the adoption they have not responded to a fire involving a multiple family dwelling which originated in the pine straw mulch ("Warns against pine straw," 2014). The Commonwealth of Massachusetts adopted a statewide law that prohibits mulch within 18 inches of combustible structures. Residential units with 6 or less living units are exempt ("Mulch Fire Safety," 2014). All of these ordinances or laws prohibit mulch landscaping in multiple family dwellings and commercial properties. One thing these properties have in common are they involve multiple persons and families that interact with the property. Whereas a single family residence there is one family. Therefore a fire in multiple family dwellings or commercial

property have the capability to adversely affect more people than those involving single family dwellings.

Recommendation

The goal of this research was to assess the fire risk of mulch landscaping while identifying options to reduce this risk within the City of Harrisonburg. This research identified that organic mulch landscaping, such as wood chips and bark, are combustible. Depending on atmospheric conditions this fire risk is substantially multiplied. When organic mulch landscaping is located close to combustible structures the resulting fire can have significant impacts to owners, occupants, and the community at large.

Fires resulting from mulch landscaping that extend to structures have the ability to affect multiple people. Especially when a fire occurs in a multiple family dwelling or commercial property. Damages can result not only in monetary loss from damages of property but loss of one's home, personal injury, loss of employment and tax revenues within the community. The key too many of the fires that occur within multiple family dwellings and commercial properties is, that when a fire occurs multiple persons or families are affected. Unlike when a fire occurs at a single family dwelling only one family is commonly affected. Fire prevention education can take significant efforts and time to change behavior. When dealing with a single family this can occur at a much quicker pace than when dealing with multiple persons and families. Therefore due to the amount of time and monies it would take to affect a behavior change in multiple family dwellings and commercial properties, that have multiple different persons accessing the property, it is recommended that a local ordinance restricting the use of organic mulch landscaping be developed and enacted. This ordinance should restrict the use of mulch landscaping at multiple family dwelling structures and commercial structures. It is

recommended that this be done in conjunction with prevention education efforts. These efforts should look at means to reach the general population to bring awareness as to the fire risk of mulch landscaping and educate the public in regards to the combustible mulch ordinance.

Restricting the use of organic mulch landscaping at multiple family dwellings and commercial properties would significantly reduce the potential effects of mulch fires that extend to structures. Thereby reducing potential monetary loss to the citizens and business owners within the City of Harrisonburg.

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Appendix A

Applied Research Project – Insurance Questionnaire

The purpose of this questionnaire is to collect data for an Applied Research Project for the National Fire Academy's Executive Fire Officer Program. No names will be utilized in this research, just ask for honest answers. Thank you for your support with data collection for this project.

Please submit your answers to Captain Stephen Morris at steve.morris@harrisonburgva.gov or mail to Harrisonburg Fire Department C/O Captain S.E. Morris, 101 N. Main Street, Harrisonburg, VA 22802.

1. What was the total payout for property loss for the covered property?
2. Was there any medical expenses paid out as a result of the fire?
3. Was there any other monetary pay outs as a result of the fire?

Appendix B

Applied Research Project – Occupant/Owner Questionnaire

The purpose of this questionnaire is to collect data for an Applied Research Project for the National Fire Academy's Executive Fire Officer Program. No names will be utilized in this research, just ask for honest answers. Thank you for your support with data collection for this project.

Please submit your answers to Captain Stephen Morris at steve.morris@harrisonburgva.gov or mail to Harrisonburg Fire Department C/O Captain S.E. Morris, 101 N. Main Street, Harrisonburg, VA 22802.

1. What was the total property loss covered by your insurance after the fire?
2. Was there any loss of work time as a result of the fire?
3. Was there any medical expenses incurred as a result of the fire?
4. Did you incur in other monetary losses as a result of the fire that were not covered by insurance?

Appendix C

Applied Research Project – Other Jurisdictions Questionnaire

The purpose of this questionnaire is to collect data for an Applied Research Project for the National Fire Academy's Executive Fire Officer Program. No names or department information is required, just honest answers. Thank you for your support with data collection for this project.

Please submit your answers to Captain Stephen Morris at steve.morris@harrisonburgva.gov or mail to Harrisonburg Fire Department C/O Captain S.E. Morris, 101 N. Main Street, Harrisonburg, VA 22802.

1. Has your organization experienced fires originating in mulch landscaping which has extended to structures?
 - a. Yes
 - b. No
2. What was the leading type of structure that was damaged by this type of fire?
 - a. Single family dwelling
 - b. Multiple family dwelling
 - c. Commercial
 - d. Other
3. What is the average fire loss in these fires?
 - a. Low <\$5,000
 - b. Moderate \$5001 – 49,999
 - c. Severe >\$50,000
4. How has your locality or organization choose to reduce this risk?
 - a. Education
 - b. Fire Code
 - c. Ordinance
 - d. Have not taken any actions
5. Has your chosen risk reduction been successful?
 - a. Yes
 - b. No
 - c. If yes can you quantify the reduction?
6. If your localities has an education program, fire code or ordinance regulating use of mulch, can you please send copy to steve.morris@harrisonburgva.gov or direct as how to obtain these materials.