File #: 19-814B, **Version:** 1 **Meeting Date:** 9/18/2019

BUILDING REVIEW BOARD AGENDA ITEM

ACTION REQUESTED:
Consider a request by the Plastic Pipe & Fittings Association to repeal the City of Naperville's local amendment to Section 890.320 of the Illinois State Plumbing Code that prohibits the use of certain plastic pipe and fittings for domestic water distribution systems and continue discussion to the September 18, 2019 BRB meeting. - BRB Case #101 (Continued from 8/21/2019)

DEPARTMENT: Transportation, Engineering and Development

SUBMITTED BY: Peter Zibble, Operations Manager

BOARD/COMMISSION REVIEW:
N/A

BACKGROUND:
In 1996, the City of Naperville adopted the 1993 edition of the Illinois Plumbing Code with local amendments (Ord 96-014). At that time, numerous local amendments were proposed, including a local amendment to Section 890.320.I.2 to prohibit the use of certain plastic pipes and fittings.

> "Plastic pipe, joints and fitting made from Polyethylene (PE), Polyvinyl Chloride (PVC) or Polybutylene (PB) made by either solvent welding or fusion welded connections, compression or insert fittings, metal clamps and screws or threaded joints shall be prohibited for water service or the domestic water distribution system of any building except for the distribution and conveyance of distilled or deionized water."

Beginning in 2000, the City of Naperville chose to adopt the latest versions of the international family of building codes and other pertinent building codes every six years. The process, which takes the better part of a year, involves the review of the new codes and the preparation of local amendments to modify the codes to meet the specific needs of the city. Working groups comprised of city staff, representatives from the business, building and residential community, the Building Review Board, and City Council were formed to complete the work. In 2000, 2006, and 2012, the city conducted a review and adoption of the updated codes, and at each interval, the above local amendment to the plumbing code was reevaluated and approved.

In 2014, the Illinois Department of Public Health (IDPH) significantly revised the Illinois Plumbing Code and required all municipalities to adopt the code every three years. Local amendments to the code are permitted, but the amendments must be at least as stringent as the Illinois Plumbing Code, approved by IDPH, and formally adopted by the municipality. The following year, the city reviewed

the new Illinois Plumbing Code. It was adopted (Ord 15-179) with two local amendments: a new requirement to supply WaterSense fixtures and the original prohibition of certain plastic pipes and fittings. IDPH approved these two local amendments for a period of three years.

In 2018, city staff conducted a review and adoption of the 2018 International Building Codes including a review of the latest edition of the Illinois Plumbing Code. Working groups were established and the various building codes and local amendments were scrutinized. It was determined that the two local amendments to the plumbing code were still applicable, and they were submitted to IDPH for approval. IDPH approved the amendments for a period of five years. The Illinois Plumbing Code with local amendments was approved by the City Council by Ord. 18-032.

DISCUSSION:
Numerous times over the past 23 years, and as recently as last year, staff, local community members, Building Review Board members, and City Council members have reviewed and confirmed the city's desire to prohibit the use of certain types of plastic pipe and fittings in the City of Naperville. The request has been reviewed and approved by IDPH.

In arriving at its recommendation, the working groups considered information which showed that:

- Unlike copper, plastics are not shown to be bacteriostatic materials, that is, bacteria can grow on their surface. Copper has been shown to inhibit the growth of Pseudomonas fluorescens, Bacillus subtilis, and Bacteriophage MS2, which can cause gastrointestinal disturbance. Copper surfaces have also been shown to be inhospitable to other more serious bacteria such as Legionella, e. Coli and polio.
- Plastic products present the potential for many undesirable chemicals to leach into the drinking water.

This local amendment to prohibit plastic pipe is not uncommon. Numerous other municipalities in the area have similar restrictions.

References:
There are numerous articles and studies published and available for review that discuss the attributes of copper and plastic piping. Sources considered by staff include the following:

- Proctor (2014), *Effect of Various Water Chemistry Factors on* Legionella *Proliferation and the Premise Plumbing Microbiome Composition.*
- Stern & Logos (2007), *Scholarly Review, Are There Health Risks from the Migration of Chemical Substances from Plastic Pipe into Drinking Water? A Review.*
- Venerem (2014), *Drinking water odors, chemicals above health standards caused by 'green building' plumbing*

CONCLUSION:
City staff and the other members of the working groups having many years of experience in the industry, have reviewed published information on the topic and have made the best decisions they can make in the interests of public safety. The safety of public drinking water is a topic that is frequently in the news, from lead contamination to Legionnaire's Disease. Staff has opted for a more conservative approach to the plumbing code until such time as long-term studies can demonstrate that plastic is as safe as copper for domestic water supply.

CITY OF NAPERVILLE
Transportation, Engineering, & Development (T.E.D.) Business Group

APPLICATION TO BUILDING REVIEW BOARD

Municipal Code, Title II, Chapter 4, "Building Review Board"

DATE: Aug 2, 2019

ADDRESS OF SUBJECT PROPERTY: NA

APPLICANT NAME: Mike Cudahy - Plastic Pipe & Fittings Association PHONE: (630) 858-6540

APPLICANTS ADDRESS: 800 Roosevelt Road Bulding C Suite #312 ZIP CITY/STATE: Glen Ellyn, IL

CODE: 60137

E-MAIL ADDRESS: Mikec@cmservices.com FAX: _____

CONTACT NAME: Mike Cudahy PHONE: (630) - 858-6540

1. Application to the Naperville Building Review Board is hereby made for a:

   (X) RULING ( ) VARIATION

2. List the specific section(s) of the City of Naperville's Municipal Code, Title V, Building Regulations, from which a ruling of a variation is requested:

   Ordiance 18-032_____

3. City Departments, Officers and Employees whose statements and decisions have previously been sought are:

   a) Steve Chirico /Mayor of Naperville (d) _____

   b) Peter J. Zibble/ Operation Manager (T.E.D) City of Naperville (e)_____

   c) John Rutkowski City of Naperville (f) _____

4. The location of the site for which a ruling or variation is sought is:

   a) Subdivision and Unit: NA

   b) Lot Numbers(s): NA

   c) Street Address(es): NA

5. My short, concise statement of the question to be resolved, and my position on the question is as follows:

We request that the Naperville Building Review Board (BRB) send a positive recommendation to the Naperville City Council for the repeal of Naperville Ordiance 18-032. The reasons for seeking repeal are, at least in part, because 18-032 is inimical to the interests of Naperville residents and because the justification for 18-032, as submitted by the City of Naperville ("CITY") to the Illinois department of public health ("IDPH"), was based on false and misleading statements.

A.) 2 Copies of Application Required
B.) 2 Copies of Plans, include one 8 1/2X11
C.) 1 Plat of Survey With Legal Description

Authorized Signature – Applicant: Michael Cudahy $250 Application Fee Paid _____

Within fifteen (15) days from the date of filing of the application, the Business Group Leader shall determine any additional legal, technical, and staff expenses that may be incurred by the City in the course of the consideration, and obtain from the applicant a guarantee, in a manner acceptable to the Business Group Leader of these additional expenses

From: Chirico, Steve <ChiricoS@naperville.il.us>

To: ronald davis <ronald766@att.net>

Sent: Friday, July 19, 2019, 12:41:42 PM CDT

Subject: Re: repeal of naperville amendment to illinois plumbing code: ordinance no. 18-032

Thank you for your email regarding plastic plumbing. If you would like o pursue this issue, I suggest you set a hearing with the Naperville building review board (BRB). That board is the first step in a building code change. The BRB is a citizen board made of of subject matter experts. If they make a positive recommendation to the city council then a formal vote could be taken. Thank you again.

Steve Chirico (Chair-ah-co)

Mayor

630-816-4642

Naperville

From: ronald davis <ronald766@att.net>

Sent: Friday, July 19, 2019 10:22 AM
To: Chirico, Steve
Subject: repeal of naperville amendment to illinois plumbing code: ordinance no. 18-032

Mayor Chirico,

i am writing to request a meeting to discuss repeal of naperville ordinance no. 18-032 ("18-032"), a copy of which is included in the attachment entitled "IDPH Approval...". the reasons for seeking repeal are, at least in part, because 18-032 is inimical to the interests of naperville residents and because the justification for 18-032, as submitted by the city of naperville ("CITY") to the illinois department of public health ("IDPH"), was based on false and misleading statements.

in summary, 18-032 prohibits use of plastic plumbing materials and effectively restricts plumbing systems in naperville to use of copper. plastic plumbing materials have been used in residential plumbing systems since the 1970s. plastic plumbing materials are approved for use in potable water systems in all 50 states. plastic plumbing systems allow consumers to enjoy substantially lower costs when compared to copper plumbing systems. plastic plumbing materials, such as cross-linked polyethylene (PEX, hereinafter, reference to "plastic plumbing materials" will specifically refer to PEX since PEX is the predominant plastic plumbing material in use), are less expensive than copper. but more signficantly, installation of copper plumbing materials requires substantially more labor time in comparison to installation of PEX. at least 2/3 of new residential construction projects in the US utilize PEX. however, 18-032 denies residents of the city of naperville ("RESIDENTS") of the ability to avail themselves of this more cost-effective alternative to copper (such as, during a kitchen or bathroom renovation project).

to better understand the rationale behind the adoption of 18-032 by the CITY, i first contacted the naperville code enforcement group. i was directed to contact the IDPH to obtain background information that supported 18-032. when i contacted the IDPH, Brian Cox, manager of the plumbing and water quality program at IDPH, sent me a copy of the ordinance submittal form ("OSF") that was submitted by the CITY to the IDPH, a copy of which is included in the attachment entitled "OSF.Naperville". with regard to the justification for 18-032, the OSF makes the following statements, the first statement articulating the purpose for 18-032 and the second statement ("STATEMENT") providing a justification for 18-032:

"The effect of this language is to limit the material for water service and distribution material to copper only."

"The primary reason for this requirement is the fact that copper is a bacteriostatic material; bacteria will not grow on its surface. Because of this characteristic, copper piping is the optimal material for the prevention of Legionnaire's and polio disease outbreaks. It is documented that copper surfaces are inhospitable to the growth of Legionella, e. Coli and polio bacteria. It has also been demonstrated that copper plumbing tube inhibits the growth of Pseudomonas fluorescens, Bacillus subtilis, and Bacteriophage MS2, which can cause gastrointestinal disturbance. In addition, unlike copper tube, plastic products, present the potential for many undesirable chemicals to leach through to the drinking water."

to get additional information, i next contacted Peter Zibble, operations manager at the naperville traffic, engineering and development group ("TED"), to obtain the information sources the CITY relied upon to support the STATEMENT. Mr. Zibble's email response is forwarded in this message. according to Mr. Zibble, the CITY relied upon two sources: 1)a master's degree thesis by a former student at virginia tech ("PROCTOR"), a copy of which is included in the attachment entitled "Copper Pipe - Thesis Paper"; and 2)a wikipedia entry dated october 13, 2014 ("WIKIPEDIA"), a copy of which is included in the attachment entitled "Copper Pipe - Antimicrobialpropertiesof copper".

it appears that the CITY relied on WIKIPEDIA to support assertions about the intrinsic bacteria and virus inhibiting properties of copper. WIKPIEDIA does not mention the legionella bacteria, but WIKPEDIA does indicate that copper must be combined with ascorbic acid to inactive the polio virus. this would render moot the assertion made in the STATEMENT that "copper piping is the optimal material" to prevent polio outbreaks because copper alone does not appear to be sufficient for the control of polio virus. WIKIPEDIA does not mention Pseudomonas fluorescens or Bacteriophage MS2, but the assertion: "copper plumbing tube inhibits the growth of Pseudomonas fluorescens, Bacillus subtilis, and Bacteriophage MS2, which can cause gastrointestinal disturbance"; is moot because copper tubing leaches copper into drinking water, and excessive levels of copper have also been shown to cause gastrointestinal disturbances. but most siginficantly, setting aside the highly dubious practice of relying on entries in wikipedia as a basis for policy making, one cannot read statements in WIKIPEDIA, about the interactions between copper and various bacteria and viruses in an isolated environment, and then jump to the conclusion that use of copper plumbing materials in the complex environment that exists in residential plumbing systems will produce the same results as reported in WIKIPEDIA.

the limitations of application of statements in WIKIPEDIA to results obtained in actual plumbing systems becomes readily apparent when one refers to PROCTOR. for example, PROCTOR notes: "Copper is known to be toxic to some bacteria, and the metal ion is utilized in building-level copper-silver ionization systems for disinfection (citations omitted). Copper from copper pipes, however, may not be beneficial for controlling regrowth, as it may require a higher disinfectant residual for control of regrowth issues than plastic pipes (citation omitted) (PROCTOR, at page 44).

it appears that the CITY relied on PROCTOR to support assertions about the legionella fighting properties of copper. however, PROCTOR reviewed scientific research literature comparing copper and plastic plumbing materials and reported the following: "studies have compared copper and plastic pipe materials directly, and found that with age of pipes greater than a couple of months, many measures of biological regrowth, including the occurrence of L(egionella) pneumophila, were not significantly different, although initial differences occurred" (PROCTOR, at page 56). PROCTOR further goes on the mention evidence that copper may even enhance growth of legionella bacteria: "a German survey indicated that homes with copper pipe were more likely to be contaminated by Legionella than homes with galvanized iron or plastics" (PROCTOR, at page 67). thus, the assertion made in the STATEMENT: "copper piping is the optimal material for the prevention of Legionnaire's and polio disease outbreaks"; while not necessarily outright false, is highly misleading.

however, the assertion made in the STATEMENT: "unlike copper tube, plastic products, present the potential for many undesirable chemicals to leach through to the drinking water"; is both outright false and highly misleading. this assertion is outright false in that it states that copper tubing does not leach "undesirable chemicals" into

drinking water. copper tubing leaches both copper and lead (from the solder used in the installation of copper tubing) into drinking water. as stated above, ingestion of excessive levels of copper can result in acute gastrointestinal symptoms. this assertion is highly misleading because it states that plastic plumbing leaches "undesirable chemicals" into drinking water but does not provide any information as to whether these "undesireable chemicals" exist in any significant quantities to pose a public health risk.

the bottom line is that all plumbing materials used in residential potable water systems are going to "leach" something into the drinking water. but to return to reality, it is highly unlikely that you will die, or suffer significant negative health consequences from drinking water distributed through copper plumbing systems. but the same is true with regard to drinking water distributed through plastic plumbing systems. the water division of NSF international (previously known as the national sanitation foundation) has established standard NSF-61 (also known as NSF/ANSI 61 because the standard has been adopted by ANSI), which sets standards for certification of for products that come into contact with drinking water. both copper and PEX products have been certified under NSF/ANSI 61. this is, at least in part, the basis by which all 50 states have approved the use of PEX in potable water plumbing systems.

Mr. Cox, of the IDPH, made the following statement with regard to naperville's restriction of plumbing materials to copper only:

The Department offers advisement to units of local government establishing plumbing ordinances, in accordance with Sections 36 and 38 of the Plumbing License Law. The Department includes PEX amongst other approved materials noted under Title 77 IAC 890 Appendix A, Table A. Therefore, the Department does not feel that these materials present a significant risk to public health when installed in accordance with the Illinois Plumbing Code. That being said, a Governmental Unit establishing an ordinance to exclude PEX is ultimately more stringent than the Illinois Plumbing Code, therefore the Department's ability to restrict such an ordinance is limited.

in other words, the fact that IDPH approved 18-032 was because IDPH did not feel that they had a legal basis under the plumbing licence law to reject the requested exception to the illinois plumbing code contained in 18-032. the approval of 18-032 by IDPH is not an indication that the justification provided by the CITY in the OSF had substantive merit. when i expressed to Mr. Cox that the STATEMENT contained statements that were false and misleading, he responded by advising me that the proper course of action would be for me to raise my concerns with representatives of the CITY. this email message constitutes my raising of my concerns about 18-032 to representatives of the CITY.

the impression that i got from Mr. Zibble, is that TED does not intend to review the substance of 18-032 until 2024. but that would mean 5 more years of adherence to an ordinance, which is based on false and misleading statements. that would mean 5 more years of RESIDENTS needlessly paying higher costs for plumbing work. the naperville city council sets the work priorities for the staff members working for the CITY. the naperville city council can set priorities for TED, such that 18-032 can be reconsidered now, and not 5 years from now.

one of the problems with building codes is that these things fly under the radar for the typical RESIDENT. i only discovered the existence of 18-032 when i recently replaced the hot water heater in my house. to do this work, i applied for a permit for which i had to have both electrical and plumbing inspections. i installed the hot water

heater in accordance with my understanding of the illinois plumbing code and the national electrical code. while i passed the electrical inspection, i was shocked when i failed the plumbing inspection because i used PEX for the final segment hookup to the hot water heater. the inspector then showed me the exception granted to the CITY by the IDPH (18-032) that formed the basis for the rejection. i then began to investigate the genesis of 18-032. the more i saw, the less i liked what i saw.

naperville building regulations should be centered on advancing the interests of RESIDENTS. naperville building regulations should not be utilized to advance the parochial interests of plumbing contractors and copper plumbing material producers. 18-032 does not advance the interests of RESIDENTS. for that reason, i request to schedule a meeting to discuss with you the repeal 18-032.

regards,

ronald davis

ORDINANCE NO. 96 - 14

AN ORDINANCE AMENDING CERTAIN PROVISIONS OF ARTICLE E. (PLUMBING CODE) OF CHAPTER 1 (BUILDING CODES) OF TITLE 5 (BUILDING REGULATIONS) OF THE NAPERVILLE MUNICIPAL CODE

WHEREAS, the City of Naperville has adopted by reference various building and life safety codes including, without limitation, the Illinois State Plumbing Code, 1969 Edition, issued by the Department of Public Health, State of Illinois, and

WHEREAS, the City of Naperville has determined to amend and revise the City's Building Codes to adopt a more recent version of the Illinois Plumbing Code to reflect advances in the plumbing industry and to meet the particular needs of construction within the City of Naperville, and

WHEREAS, said amendments and revisions would be in the best interest of the safety and welfare of the citizens of the City of Naperville.

NOW THEREFORE BE IT ORDAINED BY THE MAYOR AND CITY COUNCIL OF THE CITY OF NAPERVILLE, DUPAGE AND WILL COUNTIES, ILLINOIS, in exercise of its home rule powers that:

SECTION 1 The provisions of Article E (Plumbing Code) of Chapter 1 (Building Codes) of Title 5 (Building Regulations) of the Naperville Municipal Code are hereby amended to delete the stricken words and add the underlined words as follows

5-1E-1: ~~STATE~~ ILLINOIS PLUMBING CODE ADOPTED: The Illinois ~~State~~ Plumbing Code, ~~1969~~ 1993 Edition, issued by the Illinois Department of Public Health~~, State of Illinois,~~ is hereby adopted by reference, except as to those revisions

and changes hereinafter set forth~~;~~ ~~there having been on file for more than thirty (30) days prior to the passage of this Article, not less than t~~Three (3) copies of said Code~~, for public inspection, with the City Clerk~~ shall be kept on file in the City Clerk's office for public inspection.

5-1E-2: * * * *

5-1E-3: REVISIONS AND CHANGES TO ~~STATE~~ THE ILLINOIS PLUMBING CODE:

Section 5-1E-3 is hereby stricken and deleted in its entirety and replaced by the following The Illinois Plumbing Code, 1993 is hereby amended as revised as it applies within the City of Naperville as follows.

SUBPART C: JOINTS AND CONNECTIONS

Section 890.320 Types of Joints

a) This subsection is hereby amended by adding the following words at the end of the paragraph Caulked joints shall be permitted above or below grade.

b) This subsection is hereby amended by adding the following words at the end of the paragraph Threaded/screwed joints shall be prohibited below grade unless protected from corrosion.

c) This subsection is hereby amended by adding the following words at the end of the paragraph. Wiped joints shall be permitted above or below grade.

d) This subsection is hereby amended by adding the following words at the end of the paragraph: Soldered joints shall be prohibited below grade.

e) This subsection is hereby amended by adding the following words at the end of the paragraph· Plastic pipe and tubing are prohibited unless a pre-manufactured

fitting is used. Plastic flared joints shall be prohibited below grade. Flared joints fitted with soft rolled copper tubing shall be permitted above or below grade. However, only type K soft rolled copper tubing shall be permitted below grade.

f) This subsection is hereby amended by adding the following words at the end of the paragraph Hot poured joints shall be permitted above or below grade.

g) This subsection is hereby amended by adding the following words at the end of the paragraph Precast joints shall be permitted below grade only.

h) * * * *

i) * * * *

j) This subsection is hereby amended by adding the following words at the end of the paragraph Burned lead (welded) joints shall be permitted above or below grade.

k) This subsection is hereby amended by adding the following words at the end of the paragraph Bituminized fiber pipe joints shall be permitted below grade only.

l) This subsection is hereby amended as follows.

1) * * * *

2) This subsection is deleted and replaced by the following text:

Plastic pipe, joints and fitting made from Polyethylene (PE), Polyvinyl Chloride (PVC) or Polybutylene (PB) made by either solvent welded or fusion welded connections, compression or insert fittings, metal clamps and screws or threaded joints shall be prohibited for water service or the domestic water distribution system of any building except for the distribution and conveyance of distilled or deionized water.

3) This subsection is hereby amended by adding the following words at the end of the paragraph:

Plastic pipe and joints in waste and vent systems shall be permitted above grade only.

m) * * * *

n) * * * *

o) Compression Type Joints

1) This subsection is hereby amended by adding the following words at the end of the paragraph: Hub and spigot cast iron soil pipe shall be permitted below grade only.

2) This subsection is hereby amended by adding the following words at the end of the paragraph: Copper water tube or brass tube shall be permitted above or below grade.

p) * * * *

SUBPART F: PLUMBING FIXTURES

Section 890.640 Prohibited Fixtures

a) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows

Drinking fountains and mop sinks or laundry tubs shall not be installed in ~~public~~ any toilet rooms.

Section 890.720 Drinking Fountains

f) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows.

Substitution Whenever a drinking fountain is required by this part, bottled drinking water or a water dispensing faucet (water station, kitchen sink and faucet) may be substituted for a drinking fountain, provided it is readily accessible to the public When bottled drinking water is provided in lieu of a drinking fountain, the bottled water used must be commercially sealed in accordance with the Bottled Water Act (~~Ill Rev Stat 1991, ch 111½, par 121 100 *et seq*~~ 815 ILCS 310, *et seq*.)or must comply with the Department's "Public Area Sanitary Practice Code" (77 Ill Adm Code 895)

Section 890.810 Minimum Number of Plumbing Fixtures

This Section is hereby amended by adding the underlined words as follows

a) * * * *

b) Required Restroom Facilities and Drinking Fountains

1) Employee Restrooms and Drinking Fountains

A) * * * *

i) * * * *

ii) This subsection is hereby amended by adding the underlined words as follows

If there are no more than five (5) employees working at any time, one (1) restroom may service both sexes A restroom must have a minimum of one (1) water closet, one (1) urinal, and one (1) lavatory

iii) * * * *

iv) * * * *

B) * * * *

C) * * * *

2) * * * *

SUBPART I: WATER SUPPLY AND DISTRIBUTION

Section 890.1190 Water Supply control Valves and Meter

a) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows.

A full-port shut-off valve shall be located near the curb or property line and immediately inside the building, ~~either~~ on ~~the inlet or outlet~~ each side of the water meter ~~When underground, this valve shall be located in a stop box or meter vault (See Appendix I Illustration H)~~ A drain valve must be located within two feet of the discharge side of the water meter.

Section 890.1200 Water Service Sizing

a) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows

Water Service Pipe Sizing The water service pipe from the street main (including the tap) to the~~m~~ water distribution system for the building shall be sized in accordance with Appendix A, Tables M, N O, P and Q Water service pipe and fittings shall be at least ~~three fourths (3/4)~~ one (1") inch diameter If flushometers or other devices requiring a high rate of water flow are used, the water service pipe shall be designed and installed to provide this addition flow

SUBPART K: VENTS AND VENTING

Section 890.1580 Size and Length of Vents

b) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows

Size of Individual Vents The diameter of an individual vent shall be at least ~~one and one quarter (1¼)~~ one and one-half (1½") inches or one half (½) the diameter of the drain to which it connects, whichever is greater

c) This subsection is hereby amended by adding the following words at the end of the paragraph In no instance may the vents be less than one and one-half (1½") inches.

d) This subsection is hereby amended by adding the following words at the end of the paragraph In no instance may the vents be less than one and one-half (1½") inches.

Section 890. Appendix A PLUMBING MATERIALS, EQUIPMENT, USE RESTRICTIONS, AND APPLICABLE STANDARDS

TABLE A Approved Building Drainage/Vent Pipe

1) This subsection is deleted in its entirety

TABLE A Approved Materials for Building Sewer

1) This subsection is deleted in its entirety
2) This subsection is deleted in its entirety
3) This subsection is deleted in its entirety
6) This subsection is deleted in its entirety
7) This subsection is hereby amended by deleting the stricken words and adding the underlined words as follows

Polyvinyl Chloride (PVC) Pipe	~~ASTM D 2665 - 1988~~
	~~ASTM D 2949 - 1987~~
	ASTM D 2241 - 1988
	ASTM D 3034 - 1988
Joints	ASTM D 2855 - 1983
Primer	~~ASTM F - 656 - 1988~~
Solvent Cement	~~ASTM D 2564 - 1988~~

TABLE A Approved Materials for Water Service Pipe

1) This subsection is deleted in its entirety
4) This subsection is deleted in its entirety
7) This subsection is deleted in its entirety
8) This subsection is deleted in its entirety
9) This subsection is deleted in its entirety
10) This subsection is deleted in its entirety
11) This subsection is deleted in its entirety

TABLE A Approved Materials for Water Distribution Pipe

2) This subsection is deleted in its entirety
5) This subsection is deleted in its entirety
7) This subsection is deleted in its entirety

5-1E-4: LICENSE AND REGISTRATION REQUIREMENTS: No person shall engage in the plumbing business in the City or represent himself as a plumbing contractor or plumber, except as provided in this Code or the ~~State~~ Illinois Plumbing Code adopted herein by reference, without having complied with the Illinois Plumbing License Law, ~~S H A ch. 111, §§1101 et seq~~ 225 ILCS 320/1 *et seq*

5-1E-4: * * * *

5-1E-5: * * * *

5-1E-6: * * * *

5-1E-7: * * * *

5-1E-8: * * * *

SECTION 2 This Ordinance shall be in full force and effect from and after February 1, 1996

PASSED this 6th day of February, 1996.

AYES LESAGE, MACRANE, PRICE, PRADEL, ELLINGSON, GALLAHER, KRAUSE

NAYS SIDDALL, VON BEHREN

ABSENT. NONE

APPROVED this 7th day of February, 1996.

A. George Pradel

A George Pradel
Mayor

ATTEST

Suzanne L. Gagner
City Clerk
t\ordinanc\building\plumbing amd2/29/9610 35 AM

ORDINANCE NO. 15 – 179

AN ORDINANCE AMENDING TITLE 5 (BUILDING REGULATIONS) CHAPTER 1 (BUILDING CODES), ARTICLE E (PLUMBING CODE) OF THE NAPERVILLE MUNICIPAL CODE

BE IT ORDAINED BY THE MAYOR AND CITY COUNCIL OF THE CITY OF NAPERVILLE, DUPAGE AND WILL COUNTIES, ILLINOIS, in the exercise of its home rule powers that:

SECTION 1: Title 5 (Building Regulations), Chapter 1 (Building Codes), Article E (Plumbing Code), of the Naperville Municipal Code is hereby amended by adding the following underlined words and deleting the stricken language as follows:

5-1E-1: - ADOPTION:

The Illinois State Plumbing Code (77 Ill. Adm. Code 890), current edition, issued by the Illinois Department of Public Health, ~~and the 2012 International Plumbing Code and referenced standards and appendices B, C, D, and F,~~ is ~~are~~ hereby adopted by reference, except as to those revisions and changes hereinafter set forth. One (1) copy of said codes shall be kept on file in the City Clerk's Office for public inspection. ~~The International Plumbing Code shall be used in conjunction with the Illinois State Plumbing Code. Where a condition imposed by any provision of one code is more restrictive than a comparable condition imposed by the other code, the provision that is most restrictive or imposes the higher standard or requirement shall apply~~.

~~**5-1E-2: - ADMINISTRATIVE AUTHORITY:**~~

~~As used in the Illinois State Plumbing Code and this Code, the "administrative authority" shall mean the City Manager or a duly authorized designee.~~

~~(Ord. No. 02-31, 2-19-2002, eff. 4-8-2002)~~

5-1E-~~3~~ 2: - AMENDMENTS TO THE ILLINOIS STATE PLUMBING CODE ~~AND THE INTERNATIONAL PLUMBING CODE~~:

The Illinois State Plumbing Code, current edition, ~~and the 2012 International Plumbing Code, are~~ is hereby amended as ~~they~~ it apply~~-~~ies within the City of Naperville as follows:

Section 890.320 Types Of Joints

~~a)~~ ~~This subsection is hereby amended by adding the following words at the end of the paragraph: Caulked joints shall be permitted above or below grade~~.

~~b)~~ ~~This subsection is hereby amended by adding the following words at the end of the paragraph: Threaded/screwed joints shall be prohibited below grade unless protected from corrosion.~~

~~c) This subsection is hereby amended by adding the following words at the end of the paragraph: Wiped joints shall be permitted above or below grade.~~

~~d) This subsection is hereby amended by adding the following words at the end of the paragraph: Soldered joints shall be prohibited below grade.~~

~~e) This subsection is hereby amended by adding the following words at the end of the paragraph: Plastic pipe and tubing are prohibited unless a pre-manufactured fitting is used. Plastic flared joints shall be prohibited below grade. Flared joints fitted with soft rolled copper tubing shall be permitted above or below grade. However, only type K soft rolled copper tubing shall be permitted below grade.~~

~~f) This subsection is hereby amended by adding the following words at the end of the paragraph: Hot poured joints shall be permitted above or below grade.~~

~~g) This subsection is hereby amended by adding the following words at the end of the paragraph: Precast joints shall be permitted below grade only.~~

~~h) No amendments.~~

~~i) No amendments.~~

~~j) This subsection is hereby amended by adding the following words at the end of the paragraph: Burned lead (welded) joints shall be permitted above or below grade.~~

~~k) This subsection is hereby amended by adding the following words at the end of the paragraph: Bituminized fiber pipe joints shall be permitted below grade only.~~

l) This subsection is hereby amended as follows:

2. This subsection is deleted and replaced by the following text: Plastic pipe, joints and fittings made from polyethylene (PE), polyvinyl chloride (PVC) or polybutylene (PB) made by either solvent-welded or fusion-welded connections, compression, or insert fittings, metal clamps and screws, or threaded joints shall be prohibited for water service or the domestic water distribution system of any building except for the distribution and conveyance of distilled or deionized water.

~~o) Compression type joints.~~

~~1) This subsection is hereby amended by adding the following words at the end of the paragraph: Copper water tube or brass tube shall be permitted above or below grade.~~

Section 890.610 General Requirements – Material and Design

This subsection is hereby amended as follows:

1. Pursuant to 17 Ill. Adm. Code 3730.307 (c) 4) and subject to the Illinois Plumbing Code (77 Ill. Adm. Code 890) and the Lawn Irrigation Contractor and Lawn Sprinkler System Registration Code (77 Ill. Adm. Code 892), be it hereby ordained that in the City of Naperville, all new plumbing fixtures and irrigation controllers installed after the effective date of this ordinance shall bear the WaterSense label (as designated by

the U.S. Environmental Protection Agency WaterSense Program), when such labeled fixtures are available.

~~Section 890.520 Gasoline, Oil, And Flammable Liquids: Change subsection c) to read as follows:~~

~~All facilities that generate fuel oil or flammable waste shall meet one of the following requirements:~~

~~Section 890.640 Prohibited Fixtures~~

~~a) This subsection is hereby amended to read as follows: Drinking fountains, mop sinks or laundry tubs shall not be installed in any toilet rooms.~~

~~Section 890.1140 Special Applications And Installations: Delete the following:~~

~~h)~~

~~1) B) The allowance for "an atmospheric vacuum breaker"~~

~~Section 890.1190 Water Supply Control Valves and Meter~~

~~a) This subsection is hereby amended to read as follows: A full port shut-off valve shall be located near the curb or property line and immediately inside the building, on each side of the water meter. A drain valve must be located within two feet of the discharge side of the water meter.~~

~~b) This subsection is hereby amended to read as follows: The utility meter must be installed within the building. The meter shall have unions on the inlet/outlet openings. A full port valve with an open area at least that of the water service shall be provided for all meters (see appendix I: illustrations H and I).~~

~~Section 890.1200 Water Service Sizing~~

~~a) This subsection is hereby amended to read as follows: Water Service Pipe Sizing. The water service pipe from the street main (including the tap) to the water distribution system for the building shall be sized in accordance with appendix A, tables M, N, O, P and Q. Water service pipe and fittings shall be at least one inch (1") diameter. If flushometers or other devices requiring a high rate of water flow are used, the water service pipe shall be designed and installed to provide this additional flow.~~

~~Section 890. Appendix A Plumbing Materials, Equipment, Use Restrictions, And Applicable Standards~~

~~TABLE A Approved Materials For Water Service Pipe~~

~~1) This subsection is deleted in its entirety.~~

~~4) This subsection is deleted in its entirety.~~

~~7) This subsection is deleted in its entirety.~~

~~8) This subsection is deleted in its entirety.~~

~~9) This subsection is deleted in its entirety.~~

~~10) This subsection is deleted in its entirety.~~

~~11) This subsection is deleted in its entirety~~.

~~TABLE A Approved Materials For Water Distribution Pipe~~

~~2) This subsection is deleted in its entirety.~~

~~5) This subsection is deleted in its entirety.~~

~~7) This subsection is deleted in its entirety~~.

~~International Plumbing Code Section 715.1 This subsection is deleted in its entirety.~~

~~International Plumbing Code Section 802.3 This subsection is deleted in its entirety~~.

~~5-1E-5: RESERVED~~

~~Editor's note~~ ~~Ord. No. 12-159, § 1(Exh. A), adopted December 18, 2012, repealed the former Section 5-1E-5 in its entirety, which pertained to bonds, and derived from Ord. No. 06-301, adopted December 19, 2006~~.

5-1E-~~6~~ 3: - PERMIT FEE SCHEDULE:

The fees for plumbing permits issued pursuant to this Title shall be established by the City Council from time to time, and shall be specified in Title 1, Chapter 9, Article H of this Code.

~~5-1E-7: WORK DONE BY HOMEOWNERS:~~

~~Bona fide homeowners will be permitted to alter, modify, or install piping, fixtures, appurtenances and appliances for the distribution and use of water within their own homes where they reside, provided each homeowner satisfies the administrative authority with adequate evidence that he is able to accomplish a safe and satisfactory job. Such evidence may be determined by oral or written examination. Homeowners who obtain permission of the administrative authority, whether by examination or by other satisfactory evidence, will be required to file with the City Clerk an application for a limited "certificate of registration for a homeowner" desiring to do his own plumbing upon a form provided for that purpose, accompanied with payment of a plumbing permit fee. These requirements are in addition to those provided for in Section "3(1)(2) Administration" of the Illinois State Plumbing Code~~.

5-1E-~~8~~ 4: - BUILDING SEWERS:

Building sewer lines shall conform to the provisions of Title 8, Chapter 2, Article B of this Code.

~~5-1E-9: AMENDMENTS TO THE INTERNATIONAL PLUMBING CODE:~~

~~Section 101.1 Title: Insert city of Naperville~~
~~Section 108.5 Fee Schedule: Delete in its entirety~~

~~Section 113.2 Notice Of Violation: Change to read~~:

~~Persons who shall violate a provision of this code or shall fail to comply with any of the requirements thereof or who shall erect, install, alter, or repair work in violation of the approved construction documents or directive of the code official, or of a permit or certificate issued under the provisions of this code shall be cited and fined not less than $50.00 and not more than $500.00. Each day can be considered a separate offense.~~

~~Section 108.5 Stop Work Orders: Insert: not less than $50.00 and not more than $500.00.~~

SECTION 2: This Ordinance shall be in full force and effect upon its passage and approval.

PASSED this 17th day of November, 2015.

AYES: CHIRICO, ANDERSON, BRODHEAD, COYNE, GALLAHER, GUSTIN, KRUMMEN, OBARSKI

NAYS: NONE

ABSENT: HINTERLONG

APPROVED this 18th day of November, 2015.

Steve Chirico
Mayor

ATTEST:

Nancy A. Bright
Deputy City Clerk

ORDINANCE NO. 18- 032

AN ORDINANCE ADOPTING ARTICLE E (PLUMBING CODE) OF CHAPTER 1 (BUILDING CODES), TITLE 5 (BUILDING REGULATIONS) OF THE NAPERVILLE MUNICIPAL CODE

WHEREAS, state law requires the City of Naperville to adopt the Illinois State Plumbing Code every three years;

WHEREAS, the City of Naperville last approved the Illinois State Plumbing Code with certain exceptions on November 17, 2015;

WHEREAS, the Naperville City Council has determined it to be in the best interest of the City to adopt the current Illinois State Plumbing Code with certain amendments;

THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF NAPERVILLE, DUPAGE AND WILL COUNTIES, ILLINOIS, in the exercise of its home rule powers that:

SECTION 1: The Illinois State Plumbing Code is hereby adopted with amendments as Title 5 (Building Regulations), Chapter 1 (Building Codes), Article E (Plumbing Code), of the Naperville Municipal Code as follows:

5-1E-1: - ADOPTION:

The Illinois State Plumbing Code (77 Ill. Adm. Code 890), current edition, issued by the Illinois Department of Public Health, is hereby adopted by reference, except as to those revisions and changes hereinafter set forth. One (1) copy of said codes shall be kept on file in the City Clerk's Office for public inspection.

5-1E-3 2: - AMENDMENTS TO THE ILLINOIS STATE PLUMBING CODE:

The Illinois State Plumbing Code, current edition, is hereby amended as it applies within the City of Naperville as follows:

Section 890.320 Types of Joints

l) This subsection is hereby amended as follows:

2. This subsection is deleted and replaced by the following text: Plastic pipe, joints and fittings made from polyethylene (PE), polyvinyl chloride (PVC) or polybutylene (PB) made by either solvent-welded or fusion-welded connections, compression, or insert fittings, metal clamps and screws, or threaded joints shall be prohibited for water service or the domestic water distribution system of any building except for the distribution and conveyance of distilled or deionized water.

Section 890.610 General Requirements - Material and Design

This subsection is hereby amended as follows:

1. Pursuant to 17 Ill. Adm. Code 3730.307 (c) 4) and subject to the Illinois Plumbing Code (77 Ill. Adm. Code 890) and the Lawn Irrigation Contractor and Lawn Sprinkler System Registration Code (77 Ill. Adm. Code 892), be it hereby ordained that in the City of Naperville, all new plumbing fixtures and irrigation controllers installed after the effective date of this ordinance shall bear the WaterSense label (as designated by the U.S. Environmental Protection Agency WaterSense Program), when such labeled fixtures are available.

5-1E-3: - PERMIT FEE SCHEDULE:

The fees for plumbing permits issued pursuant to this Title shall be established by the City Council from time to time, and shall be specified in Title 1, Chapter 9, Article H of this Code.

5-1E-4: - BUILDING SEWERS:

Building sewer lines shall conform to the provisions of Title 8, Chapter 2, Article B of this Code.

SECTION 2: Effective Date. This ordinance shall be in full force and effect from and after its passage, approval and publication as required by law.

PASSED this 3rd day of April, 2018

AYES: CHIRICO, ANDERSON, BRODHEAD, COYNE, GUSTIN HINTERLONG, KRUMMEN, OBARSKI, WHITE

APPROVED this 4th day of April, 2018.

Steve Chirico
Mayor

ATTEST:

Pam Gallahue, Ph.D.
City Clerk

IDPH
ILLINOIS DEPARTMENT OF PUBLIC HEALTH

525-535 West Jefferson Street • Springfield, Illinois 62761-0001 • www.dph.illinois.gov

April 19, 2018

Michael Gross
Senior, Certified Plumbing Inspector
Technical Engineering Department
City of Naperville
400 S. Eagle Street
Naperville, Illinois 60540

RE: IDPH Review of Plumbing Ordinance with Local Amendments – City of Naperville

Dear Mr. Gross,

The Illinois Department of Public Health ("IDPH" or the "Department") has received a certified copy of the City of Naperville's (the "City") plumbing ordinance adopted on April 3, 2018, attached and referenced here. Pursuant to Sections 36 and 38 of the Illinois Plumbing License Law (the "Law"; 225 ILCS 320) and Section 750.800(b) of the Illinois Plumbing Licensing Code (the "Code"; 68 Ill. Adm. Code 750), units of local government should seek advisement for the adoption of a local plumbing ordinance.

As authorized by the Law and Code, the Department hereby approves the City of Naperville's adoption of the amendments relative to the following sections of the Illinois Plumbing Code ("ILPC"; 77 Ill. Adm. Code 890):

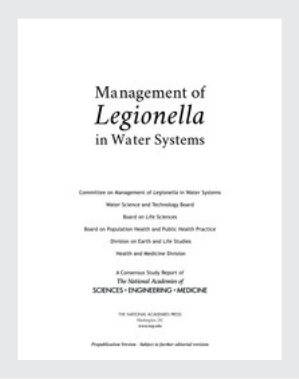
- Section 890.320 Types of Joints
- Section 890.610 General Requirements – Material and Design

The amendments shall be approved until five years after the date of the adoption of the subject ordinance or until the promulgation of subsequent revisions of the amended sections of the ILPC by the Department. The Department neither approves nor disapproves of administrative language added by the City in these sections.

If you have any further questions concerning the City's adoption of amendments to the Illinois Plumbing Code, please contact the Plumbing and Water Quality program at (217) 524-0791 or at dph.plumbing@illinois.gov.

Sincerely,

Brian W. Cox, P.E.
Manager, Plumbing and Water Quality Program



Management of Legionella in Water Systems (2019)

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CONTRIBUTORS

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Management of *Legionella* in Water Systems

Committee on Management of *Legionella* in Water Systems

Water Science and Technology Board

Board on Life Sciences

Board on Population Health and Public Practice

Division on Earth and Life Studies

Health and Medicine Division

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Contents

Stagnation. Stagnant areas in premise plumbing support more cultivable legionellae (including *L. pneumophila*) than other parts of premise plumbing (Fisher-Hoch et al., 1982; Tobin et al., 1981). Ciesielski et al. (1984) showed that hot-water tanks with stagnant water support higher *L. pneumophila* numbers (10^5 to 10^6 CFU/L) compared to hot-water tanks in which water was continuously replaced (less than 10^4 CFU/L). Compared to non-stagnant water, stagnant water has lower or no disinfectant residual (Fisher-Hoch et al., 1982; Wang et al., 2012), lower water temperatures (Patterson et al., 1994), higher concentrations of organics (LeChevallier et al., 1996; Wang et al., 2012), lower dissolved oxygen concentrations (Wang et al., 2012), higher biomass concentrations (Lautenschlager et al., 2010), altered microbial community composition (Dai et al., 2018a; Lautenschlager et al., 2010), and higher numbers of protozoan hosts (Wang et al., 2015b)—factors that all influence *L. pneumophila* growth.

Corrosion. The impact of corrosion products on *Legionella* proliferation is multifaceted (Brazeau and Edwards, 2013). By consuming residual disinfectant, these compounds create a more favourable environment for *Legionella* growth. Increased bioavailability of various metal corrosion products, such as iron, may also upregulate virulence in legionellae, stimulate general biofilm growth (Buse et al., 2012), and contribute to *Legionella* growth in hot-water heaters (Dai et al., 2018b; Ji et al., 2017; Proctor et al., 2017). Iron released during the recent massive corrosion event in Flint, Michigan, contributed to loss of chlorine residual and, as a required nutrient (Reeves et al., 1981; States et al., 1985; Warren and Miller, 1979), this metal was also hypothesized to stimulate *Legionella* growth (Rhoads et al., 2017a). Van der Lugt et al. (2017) also recently reported that iron rust in stainless-steel shower heads resulted in increased *Legionella anisa* plate counts. Corrosion products can also promote heterotrophic biofilm growth by producing electron donors, such as hydrogen, and by stimulating autotrophic metabolism and fixation of organic carbon in the system (Rhoads et al., 2017b).

Pipe Materials. Pipe material may influence growth of *L. pneumophila*. For example, rubber material in a model pipe system enhanced growth of *L. pneumophila*, except when a biocide (thiuram) was present in the rubber material (Niedeveld et al., 1986). Plastic pipe materials can also enhance growth of *L. pneumophila*, especially those used in premise plumbing, such as soft PVC (PVC-P), polyethylene, polypropylene, or polybutylene materials (Rogers et al., 1994a,b; van der Kooij et al., 2002). The biofilm concentration on each type of pipe material correlates with *L. pneumophila* load (Learbuch et al., 2019). Therefore, pipe materials most likely affect *L. pneumophila* growth indirectly: higher biofilm concentrations support more protozoan hosts, which generate higher counts of *L. pneumophila* (van der Kooij et al., 2017). European standardized laboratory tests have demonstrated that, compared to an inert material such as glass, rubber (natural and synthetic), soft PVC (i.e., PVC-P), polyethylene, polypropylene, and polybutylene significantly enhance microbial growth (Hambsch et al., 2014) because of the growth-promoting organic compounds that these materials release. In contrast, stainless steel, PVC-C, and PVC-U did not enhance growth of *L. pneumophila* in these laboratory tests. A field study of several buildings demonstrated that the highest cultivable legionellae numbers were present in the biofilm on rubber components of taps (van Hoof et al., 2014), consistent with various laboratory test results.

In premise plumbing, the impact of copper pipes on legionellae is not consistent among studies, possibly due to differences in biofilm microbiota and the physiological status of cells. Several laboratory studies report that copper inhibits growth of *L. pneumophila* (e.g., Learbuch et al., 2019; Rogers et al., 1994b; Schoenen et al., 1988). In addition, Danish buildings with copper premise plumbing showed lower cultivable legionellae counts than buildings with iron pipes (Pringler et al., 2002). In contrast, others observed enhanced growth of *L. pneumophila* on copper compared to PVC-U or PVC-C (Buse et al., 2014a,b; Gião et al., 2015; van der Kooij et al., 2002). Likewise, by comparing bacteria growing in

tubing downstream of biofilm reactors with copper versus PVC-U coupons, Lu et al. (2014) also noted that injected *L. pneumophila* actually survive better downstream of copper. A companion paper by the same group (Buse et al., 2014a) further indicated that the copper coupons were colonized by and released a greater number of *L. pneumophila* when co-inoculated with *Acanthamoebae polyphaga* and measured by qPCR, but *L. pneumophila* were only cultivable from PVC-U coupons.

There are several possible explanations for the apparent enigma of net effects of copper plumbing on *Legionella*. First, van der Kooij and colleagues (2005) observed that new unused copper material initially inhibited growth of *L. pneumophila* due to the release of copper ions, but when the copper material was corroded, release of copper ions was reduced and inhibition of *L. pneumophila* no longer occurred. Interactions of the copper pipe with the local water chemistry is also important to consider. Proctor et al. (2017) noted that benefits of copper pipe for depressing *L. pneumophila* levels were only apparent at or below 41°C. Above 53°C, *L. pneumophila* were no longer detectable, and thus pipe material did not matter. Buse et al. (2017) noted that a higher pH (greater than 8.2), which limits dissolution, can also limit antimicrobial activity of copper pipe. Build-up of corrosion byproducts over time also limits the antimicrobial activity of copper toward *Legionella* (van der Kooij et al., 2005). In addition to having stronger antimicrobial properties than solid Cu, free Cu^{2+} in solution can induce other reactions, such as corrosion and associated hydrogen production, which could indirectly impact *Legionella* (Proctor et al., 2017; Rhoads et al., 2017b).

Copper might also induce a VBNC-like state for *L. pneumophila*, as has been suggested for *Pseudomonas aeruginosa* (Flemming et al., 2014). Induction of a VBNC-like state through copper exposure decreased the number of *L. pneumophila* detected by cultivation (Learbuch et al., 2019; Rogers et al., 1994a; Schoenen et al., 1988; van der Kooij et al., 2002), but not the number quantified by DNA-based methods (Buse et al., 2014a,b; Gião et al., 2015). Consistent with this hypothesis, after batch incubations with copper ions, Proctor et al. (2017) reported sharper decreases in *L. pneumophila* numbers by plate counts versus qPCR. Also, copper (and other) materials influence the microbial composition of premise plumbing biofilms (Buse et al., 2014a; Proctor et al, 2018), with copper resulting in less biofilm growth than various hard and soft plastics (Proctor et al., 2018; van der Kooij et al., 2017). Interestingly, while less biofilm may accumulate on copper materials than on plastics, the types of bacteria and amoeba present could be more supportive of *L. pneumophila* growth than those on plastics (Buse et al., 2014a,b; Gião et al., 2015). In particular, *V. vermiformis* is the *L. pneumophila* host most often associated with warm- and hot-water (largely copper-pipe) systems (Buse et al., 2017; Ji et al., 2017). Hence, along with biofilm concentration, the species composition of the biofilm is important for growth of amoebae that favor *L. pneumophila* replication. Overall, *L. pneumophila* growth appears enhanced in biofilms dominated with α-Proteobacteria, key prey for protozoan hosts (van der Kooij et al., 2018).

Once within the complex plumbing of a large building, *L. pneumophila* may persist given the right combinations of temperature, stagnation, and subsequent loss of residual disinfectant, often exacerbated by the presence of iron oxides/hydroxioxides/humics (Butterfield et al., 2002) and other pipe corrosion products (Rhoads et al., 2017b). *L. pneumophila* strains have remained detectable in simulated building water systems for a long time (i.e., up to 2.4 years) (Paszko-Kolva et al., 1992; Skaliy and McEachern, 1979; Wadowsky and Yee, 1985), with the one apparent clone in buildings causing outbreaks over decades (Garcia-Nunez et al., 2008). This prolonged survival in water has been attributed to the organism's ability to produce and store poly-3-hydrobutyrate, a carbon/energy source when nutrients are scarce (James et al., 1999; Mauchline et al., 1992). Recently, Shaheen and Ashbolt (2019) showed that viable cells of a *L. pneumophila* serogroup 1 strain remained in a dormant-like state associated with amoebae for over two years in drinking water. Such persistence may be associated with the expression of a Type II

Iron Corrosion and Inorganic Nutrients

Much of U.S. water distribution systems consist of century-old unlined iron mains, which are beyond their designed lifespan and subject to substantial corrosion as well as intrusion during water main breaks. Corrosion of pipe surfaces provides not only a habitat for bacterial proliferation and protection from chlorine disinfectant residuals but also a source of nutrients. Aerobic microbial respiration consumes oxygen, resulting in a reduced redox environment that can accelerate corrosion and produce a disinfectant demand. Corrosion of pipe surfaces and deposition of corrosion products can also create tubercles and surface roughness that protect biofilm organisms from hydraulic shear (Characklis and Marshall, 1990). The resulting turbulent flow can help transport nutrients and detritus, further enhancing the biofilm environment.

Growth of certain microbes is also promoted by other inorganic substances can also serve as electron donors or acceptors including methane, ferrous iron, reduced sulfur compounds, hydrogen gas, manganese, ammonia, and nitrite. These substances can stimulate autotrophs to fix organic carbon into the system, leading to more bacterial cells and associated organic matter. The accumulation of organic carbon and reduced inorganic compounds (e.g., iron, nitrite, sulfides) in biofilms can create a disinfectant demand that protects the attached microbes from being inactivated. In particular, iron-oxidizing bacteria oxidize ferrous iron to produce ferric iron oxides. Not only is iron a known nutrient for *Legionella*, it also reacts with chlorine, thereby increasing microbial risk by removing the disinfectant residual.

Plumbing Materials

Plumbing materials are an important factor to consider in *Legionella* control. Common plumbing materials in buildings include copper, iron, and numerous plastics, with cross-linked polyethylene (PEX) and cross-linked polyvinyl chloride (PVC) being particularly suitable for hot-water plumbing because of their tolerance of higher temperatures. Each pipe material will influence the building-level water chemistry and shape the biofilms that colonize premise plumbing in a unique manner (Ji et al., 2015). Being able to identify a pipe material that most effectively limits proliferation of *Legionella* for a given water chemistry and building type would be valuable as a passive barrier. It is important to recognize that water chemistry varies regionally, seasonally, and as dictated by various upstream water treatment processes (Dai et al., 2018), making it difficult to predict how incoming water will react with different pipe materials.

Although copper pipe has well-known antimicrobial properties, it does not universally control *Legionella*. Indeed, copper has been associated with decreased, increased, and comparable numbers of *Legionella* relative to other pipe materials (Rhoads et al., 2017b). As described in Chapter 2, the age of copper pipe, temperature, pH, and general water chemistry influence the dissolution chemistry and overall antimicrobial action of copper towards *Legionella*. The composition of the biofilm community also matters, e.g., interactive effects of amoebae and copper appear to favor survival of *Legionella* (Buse et al., 2017; Ji et al., 2017). Thus, it is clear that copper pipe cannot be the sole agent to control *Legionella*; other microbiological, chemical, and site-specific factors needs to be considered.

PEX and other heat-tolerant flexible polymeric plastic materials have gained popularity for their ease of use for hot-water plumbing. These materials, however, are well known to leach organic carbon and can stimulate bacterial growth (Proctor et al., 2018). In particular, flexible pipe materials commonly employed to plumb showerheads are especially vulnerable to biofilm formation and microbial growth, producing total bacterial cell counts ranging from 10^6 (PE-Xc—applied as a rigid control plastic) to 10^8

systems, such as wastewater treatment plants, because of the nature and scale of these systems. Other competing goals, such as commitment to water and energy savings for green building certification, must also be taken into consideration. Water management plans (discussed in detail in Chapter 5) are essential to *Legionella* control for any water system, as they provide the opportunity to adapt and tailor the strategy to the specific system of concern and employ and integrate all applicable barriers (see Table 4-6).

Two rows in Table 4-6 do not correspond precisely to controls discussed in this chapter. First, source water quality is listed (rather than the narrower nutrient limitation), as there are important water quality considerations at each stage of a building's life cycle and multiple control strategies will affect water quality. Second, there is a final row on water management plans for protecting a building from a *Legionella* outbreak because having a plan itself is a critical control. (Such plans are discussed in detail in Chapter 5.)

The conclusions and recommendations below highlight key lessons regarding *Legionella* control strategies for the building and device types discussed in this chapter.

For all types of buildings, hot-water heater temperature should be maintained above 60°C (140°F) and the hot-water temperature to distal points should exceed 55°C (131°F). Maintaining temperature outside *Legionella's* preferred growth range is the paramount *Legionella* control strategy for all buildings that provide hot water and has been proven successful by numerous longitudinal field studies. Temperature control is most effective in large, complex hot-water systems that are hydraulically balanced, with dead-end pipes removed and faulty devices that compromise the distribution of hot water identified and replaced.

There is growing evidence that, compared to free chlorine, a monochloramine residual better controls *Legionella* risk from building water systems, although the reasons for the improved performance are not yet clear. It is possible that amoebae trophozoites are more sensitive to monochloramine, causing the amoebae to encyst and thus preventing the proliferation of *Legionella* within their host. Additional research is needed to examine the precise action of monochloramine on *Legionella* persistence and growth within pipeline biofilms. Better understanding of the potential for nitrification in building plumbing is also required, as this reaction could negatively impact the effectiveness of a chloramine residual for *Legionella* management.

Additional research is needed to evaluate the potential for nutrient limitation (concentration and composition) to control *Legionella* growth in distribution and building water systems. These studies should examine, in full-scale drinking water systems, the impact of nutrient reduction on the concentration and composition of the microbiome in biofilms and water including amoebae growth and life stages and the subsequent effect on occurrence and decrease of pathogenic *Legionella* species.

New NSF/ANSI standards regarding microbial growth potential of materials are needed so that water utilities, plumbers, and building contractors can include *Legionella* control when making decisions about pipe material usage. Certain plastic components (e.g., PEX) tend to lead to bacterial proliferation. Iron components in distribution systems and premise plumbing should be replaced or otherwise managed with appropriate corrosion control to avoid disinfectant decay and release of iron as a nutrient for *Legionella*. Because of conflicting accounts in the literature about their role in *Legionella* growth, copper pipes cannot be relied on as a barrier to *Legionella* colonization and growth. More research is needed to identify circumstances when copper's antimicrobial properties are enhanced.