



2024 EWTS

## Building Water Commissioning: Tools for Establishing Safe, Efficient, and Sustainable Water Management Programs

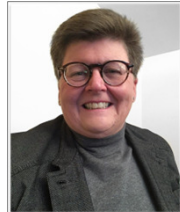





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### Today's Speaker



**Molly M. Scanlon, PhD, FAIA, FACHA**  
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### Scanlon Formula for Sustainable Building Water

#1




WATER QUALITY & SAFETY

+




WATER EFFICIENCY

=




SUSTAINABLE WATER SUPPLY

#2




BUILDING WATER PLANNING & DESIGN

+



GENERAL CONTRACTOR & SUBTRADES

=





SAFE & EFFICIENT WATER SYSTEMS

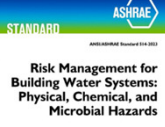
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### Key AHJ's & Regulatory Documents & Resources

**Legionellosis: Risk Management for Building Water Systems**




**Risk Management for Building Water Systems: Physical, Chemical, and Microbial Hazards**

**Developing a Water Management Program to Reduce Legionella Growth & Spread in Buildings**

**Toolkit for Controlling Legionella in Common Sources of Exposure (Legionella Control Toolkit)**



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### WMP Risk Management Requirements

Step 1)  
Form WMP Team

Step 2)  
Describe Building Water Distribution System(s)

Step 3)  
Identify Hazards & Assess Risk

Step 4)  
Identify Control Measures

Step 5)  
Monitoring & Corrective Actions

Step 6)  
Confirmation includes Verification + Validation

Step 7) Continuous WMP Documentation / Records


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### Training for Building Water Management CDC Prevent Legionnaires' Disease

**Module A: Getting Started – Introduction to Legionella**  
**Module B: Hazard Analysis**  
**Module C: Hazard Control**  
**Module D: Confirmation** describing verification, validation, & documentation

- 3 hour course "run" time
- 1 hour video additional case study examples
- Certificate of Completion available
- Hosted through University of Arizona Public Health Training Center





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### Key Parameters of Water Quality

**Think STAR**

- S** Minimize Soil/Sediment: Soil and organic substances, Chemicals such as copper & lead
- T** Adequate Temperature (hot & cold): Hot = 113° F (45°C) to 120° F (48.9°C), Cold = ≤ 77° F (25°C)
- A** Low Water Age: ≤ 24 hours, ≤ 7 days (weekly flushing goals/objectives), ≤ 30 days, > 30 days
- R** Adequate Disinfectant Residual: 0.2 ppm – 4.0 ppm chlorine, 0.5 ppm – 4.0 ppm monochloramines

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### ASHRAE Standard 188 Requirements w/Construction & Commissioning Activities

#### Section 4.2 Building Owner Requirements

The building owner shall survey each existing building, **new building, and any renovation, addition, or modification to an existing building** and its water systems as described in Section 5.

The survey and conformance with the compliance requirements of Section 4 shall be completed **prior to occupancy of a new building and before construction begins on renovations, additions, or modifications to existing buildings.**

ASHRAE Standard 188-2019  
**Legionellosis: Risk Management for Building Water Systems**

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### Typical Range of Construction Projects

Range of Construction Project Types

Typically smaller scale projects; less than 30 days of water stagnation | Typically larger scale projects; greater than 30 days of water stagnation

<b>Non-invasive Investigation of concealed engineering conditions</b>	<b>Maintenance &amp; Repair</b>	<b>Replacement</b> In-kind (1:1 or like for like)	<b>Remodeling</b> Surface upgrades	<b>Renovation</b> A/E System changes or upgrades	<b>Expansion</b> Building additions	<b>New Construction</b>
						<ul style="list-style-type: none"> <li>Freestanding</li> <li>Greenfield</li> <li>Tenant Improvements</li> </ul>

Minimal Disruption & Low Water Age | Range of BWDS Disruption | High Disruption & High Water Age

Scanlon, M.M.; Gordon, J.L.; Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionello and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. <https://doi.org/10.3390/buildings13102533>

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### Water Disruptive Events

Man-made and Natural Disasters (inclusive of construction)

Four Foundational Peer-Review Articles + Supplemental Tools

<b>Article #1:</b> Systematic Review Water Management for Construction (WMC) Risk Factors	<b>Article #2:</b> WQSRA Water Quality and Safety Risk Assessment (university & schools – nonhealthcare)	<b>Article #3:</b> WMC-ICRA Infection Control Risk Assessment (healthcare occupancy)	<b>Article #4:</b> BWQC Building Water Quality Commissioning Project Scheduling (healthcare occupancy)

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### Article #1: Water Management for Construction: Evidence for Risk Characterization in Community and Healthcare Settings: A Systematic Review

#### HOW DO CONSTRUCTION ACTIVITIES CONTRIBUTE TO GROWTH & SPREAD OF WATERBORNE PATHOGENS?

SYSTEMATIC REVIEW

**Search Terms:** Pathogens of Interest, Construction Types, Settings

**Results:** n = 31 studies 1965 to 2019, Legionella, NTM, Sporangium, Fusarium, 894 Disease Cases, 112 Deaths, 9 Construction Activity Risk Factors

**Findings:**

- Incorporate construction activities into water management programs
- Implement water management commissioning practices
- Raise public agency awareness
- Obtain proper education & training
- Improve construction policies for evidence-based water safety plans

Scanlon, M.M.; Gordon, J.L.; McCoy, W.F.; Cain, M.F. Water Management for Construction: Evidence for Risk Characterization in Community and Healthcare Settings: A Systematic Review. *Int. J. Environ. Res. Public Health* 2020, 17, 2168.

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### Known Construction Risk Factors

Ranked in association of risk severity with disease cases

- 1) **Lack of BWDS commissioning process**
- 2) Excavation
- 3) Re-pressurization
- 4) Demolition
- 5) Water efficiency devices
- 6) Underground utility connections
- 7) Construction Equipment w/ water reservoirs
- 8) Water main breaks
- 9) Vibration

Scanlon, M.M.; Gordon, J.L.; McCoy, W.F.; Cain, M.F. Water Management for Construction: Evidence for Risk Characterization in Community and Healthcare Settings: A Systematic Review. *Int. J. Environ. Res. Public Health* 2020, 17, 2168.

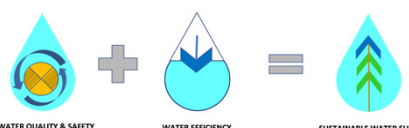
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### Article #2: WQSRA (university/schools/non-healthcare)

Water Quality and

- Risk decision matrix design
- Green building design
- Public policy
- Education campuses and municipal water supply systems
- Liability, financial risk, and reputational harm



WATER QUALITY & SAFETY + WATER EFFICIENCY = SUSTAINABLE WATER SUPPLY

Griffin SC, Scanlon MM, Reynolds KA. Managing Building Water Disruptions in a Post-COVID World: Water Quality and Safety Risk Assessment Tool for Academic Institutions and School Settings. *Buildings*. 2023; 13(4):921. <https://doi.org/10.3390/buildings13040921>

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### Article #2: Building Water Disruptive Event Risk Decision Matrix

X-axis = Severity or Consequence of Situation

Y-axis = Likelihood or Frequency

Risk Decision Matrix	Basic cell format 3 x 3 cells			Possible expansion cell format	
	Low Impact	Minimal	Medium	Major	Failure
Very Unlikely	RML 1	RML 1	RML 2	RML 4	RML 4
Unlikely	RML 1	RML 2	RML 3	RML 4	RML 4
Possible	RML 2	RML 2	RML 3	RML 4	RML 5
Probable	RML 2	RML 3	RML 4	RML 5	RML 5
Certainty	RML 3	RML 3	RML 5	RML 5	RML 5

Z box = resultant for establishing risk mitigation level (RML)

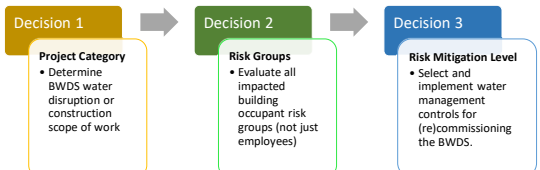
Griffin SC, Scanlon MM, Reynolds KA. Managing Building Water Disruptions in a Post-COVID World: Water Quality and Safety Risk Assessment Tool for Academic Institutions and School Settings. *Buildings*. 2023; 13(4):921. <https://doi.org/10.3390/buildings13040921>

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### Article #2 and Article #3 Building Water Risk Conceptual Framework

Three Step Risk Decision Matrix



**Decision 1: Project Category**

- Determine BWDS water disruption or construction scope of work

**Decision 2: Risk Groups**

- Evaluate all impacted building occupant risk groups (not just employees)

**Decision 3: Risk Mitigation Level**

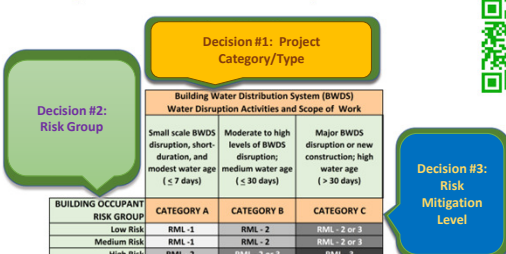
- Select and implement water management controls for (re)commissioning the BWDS.

Griffin SC, Scanlon MM, Reynolds KA. Managing Building Water Disruptions in a Post-COVID World: Water Quality and Safety Risk Assessment Tool for Academic Institutions and School Settings. *Buildings*. 2023; 13(4):921. <https://doi.org/10.3390/buildings13040921>

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### Article #2: WQSRA 3 x 3 Risk Decision Matrix (university/schools/non-healthcare)



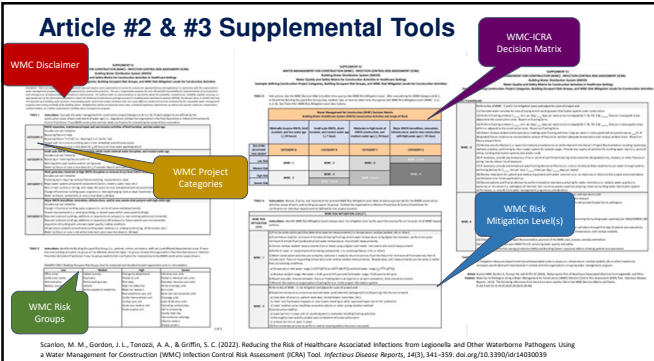
BUILDING OCCUPANT RISK GROUP	BUILDING WATER DISTRIBUTION SYSTEM (BWDS) Water Disruption Activities and Scope of Work		
	CATEGORY A	CATEGORY B	CATEGORY C
Low Risk	RML - 1	RML - 2	RML - 2 or 3
Medium Risk	RML - 1	RML - 2	RML - 2 or 3
High Risk	RML - 2	RML - 2 or 3	RML - 3

Griffin SC, Scanlon MM, Reynolds KA. Managing Building Water Disruptions in a Post-COVID World: Water Quality and Safety Risk Assessment Tool for Academic Institutions and School Settings. *Buildings*. 2023; 13(4):921. <https://doi.org/10.3390/buildings13040921>

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### Article #2 & #3 Supplemental Tools



WMC Disclaimer

WMC Project Categories

WMC Risk Groups

WMC-ICRA Decision Matrix

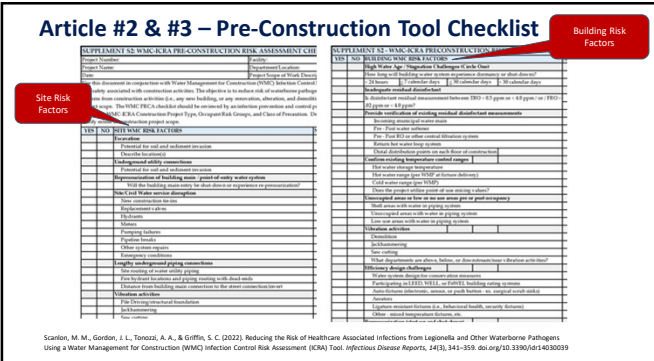
WMC Risk Mitigation Level(s)

Scanlon M. M., Gordon J. L., Torozzi A. A., & Griffin, S. C. (2022). Reducing the Risk of Healthcare Associated Infections from Legionella and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, 24(3), 341-359. doi.org/10.3390/idr24030349

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### Article #2 & #3 – Pre-Construction Tool Checklist



Site Risk Factors

Building Risk Factors

Griffin SC, Scanlon MM, Reynolds KA, Gordon J, Torozzi A, & Griffin, S. C. (2022). Reducing the Risk of Healthcare Associated Infections from Legionella and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, 24(3), 341-359. doi.org/10.3390/idr24030349

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### Article #3: WMC-ICRA 4 x 4 Risk Decision Matrix (HEALTHCARE occupancy)

**Step #1:** Evaluate the BWDS construction activities and scope of work to be performed, the duration of project, and level of water age for the project. Determine the WMC Category (A, B, C, or D).

**Step #2:** Identify the Building Occupant Risk Group(s) impacted by the BWDS construction activities, scope of work, and level of water age. Include analysis of patient care areas located adjacent, above, or below the designated construction zone.

**Step #3:** Determine the WMC Risk Mitigation Level (WMC - 1, 2, 3, or 4) for hazard control strategy to be implemented over the entire duration of the construction project scope. WMC - 1 is less stringent and WMC - 4 is the highest level of risk mitigation strategies.

BUILDING OCCUPANT RISK GROUP	Building Water Distribution System (BWDS) Construction Activities and Scope of Work			
	Category A	Category B	Category C	Category D
Minimally Invasive BWDS, brief duration, and low water age (< 5 days)	WMC - 1	WMC - 2	WMC - 3	WMC - 3 or 4
Low Risk	WMC - 1	WMC - 2	WMC - 3	WMC - 3 or 4
Medium Risk	WMC - 2	WMC - 3	WMC - 3 or 4	WMC - 4
High Risk	WMC - 3	WMC - 3 or 4	WMC - 4	WMC - 4
Severe Risk	WMC - 4	WMC - 4	WMC - 4	WMC - 4

Scanlon, M.M., Gordon, J.L., Tonozzi, A.A., & Griffin, S.C. (2022). Reducing the Risk of Healthcare Associated Infections from Legionella and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, 24(1), 341-359. doi.org/10.3390/idr24010349

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### Article #4: BWQC Project Scheduling Method (healthcare & non-healthcare occupancy)

Scanlon, M.M., Gordon, J.L., Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionella and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. https://doi.org/10.3390/buildings13102533

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### Article #4: Table 1 – Key Project Tasks and Milestones

PROJECT PHASE	KEY TASK	TEAM LEADERS	TASK DESCRIPTION
Overall Project	Project Kick-off	GC, BOR	The first day the GC is contractually engaged to perform work on the construction project [1].
	Water Activation	GC, CVA, BOR	The first date water is flowing in any section or component of BWDS beyond the building, a main point of entry [1,4].
	Beneficial Occupancy	GC, CVA, BOR, IM	The date GC has substantially completed the construction project and the building owner's staff can legally and safely occupy the building. It is also referred to as the date of substantial completion for fire and life safety conditions [1,7].
	Water Quality Approval	BOR, CL, IPC, OES, WMC, CVA, IM	The building owner formally accepts the water quality results from the GC, and deems the water quality appropriate for patient care operations [1].
Building Shell and Core	First Day of Construction	GC, IM, CL, A/E	A date on which the building owner plans to begin legal healthcare operations after approvals from local, state, or national (M) and admit patients to the healthcare facility [1].
	The Construction Review Meeting	GC, SUB, A/E, BOR, IM, WMS	Similar to other core building systems, conduct a review of the BWDS design documents to ensure the system and its components meet the building owner's WMP performance criteria (e.g., incoming water, hot and cold water distribution systems, hot water storage, and fixture types). Next, coordinate a specific meeting for the WMP/BWQC safety team to review project goals and objectives, using the overall construction project schedule as a document for discussion and agreement [14].

Scanlon, M.M., Gordon, J.L., Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionella and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. https://doi.org/10.3390/buildings13102533

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### Article #4: Option A - BWQC Early Water Activation

Scanlon, M.M., Gordon, J.L., Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionella and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. https://doi.org/10.3390/buildings13102533

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### Article #4: Option B - BWQC Delay Water Activation

Scanlon, M.M., Gordon, J.L., Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionella and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. https://doi.org/10.3390/buildings13102533

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### Article #4: Supplemental BWQC Checklist

Supplemental Building Water Quality Commissioning (BWQC) Project Portfolio Checklist (page 1 of 2)

Checklist Item	YES/NO	START DATE	FINISH DATE	PERFORMER	MILESTONE	NOTES/STATUS
1. Develop and review the WMP/BWQC project plan.						
2. Review and approve the WMP/BWQC project plan.						
3. Review and approve the WMP/BWQC project plan.						
4. Review and approve the WMP/BWQC project plan.						
5. Review and approve the WMP/BWQC project plan.						
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19. Review and approve the WMP/BWQC project plan.						
20. Review and approve the WMP/BWQC project plan.						


Scanlon, M.M., Gordon, J.L., Reynolds, K.A. Building Water Quality Commissioning in Healthcare Settings: Reducing Legionella and Water Contaminants Utilizing a Construction Scheduling Method. *Buildings* 2023, 13 (10): 2533. https://doi.org/10.3390/buildings13102533

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### What other A/E/C process impacts should you consider?

- 1) Design guidelines for building water systems and fixtures
- 2) Owner contracts – general conditions/requirements, supplemental instructions to the contractor
- 3) Specification Section on building water quality commissioning
- 4) Utility disruption procedures
- 5) Safety or infection control and mitigation policies
- 6) Specialty or medical equipment installation procedures
- 7) Test and inspection requirements
- 8) Transition planning
- 9) Licensing or accreditation for patient care operations
- 10) Emergency or water disruptive events

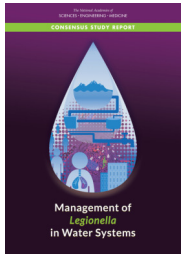


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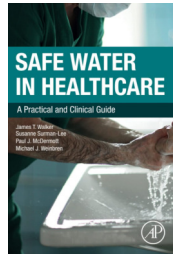
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### Other Resources?

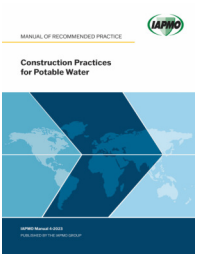
NASEM Legionella 2020 Report



Book / UK-European Authors



Best Practices Manual



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### 4 Foundational Research Articles + Supplemental Tools

<p><b>Article #1:</b> Systematic Review Water Management for Construction (WMC) Risk Factors</p> 	<p><b>Article #2:</b> WQSRA Water Quality and Safety Risk Assessment (university &amp; schools – nonhealthcare)</p> 	<p><b>Article #3:</b> WMC-ICRA Infection Control Risk Assessment (healthcare occupancy)</p> 	<p><b>Article #4:</b> BWQC Building Water Quality Commissioning Project Scheduling (healthcare occupancy)</p> 
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## Questions?



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*Thank you for supporting safe building water management!*



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