2026 PNWS-AWWA Pre-Conference Seminar

Extending Water Treatment Seismic Resiliency to the Process Mechanical/Electrical Equipment Level



What happens NEXT is happening NOW.

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Willamette Water Supply
Our Reliable Water Future

CDM Smith

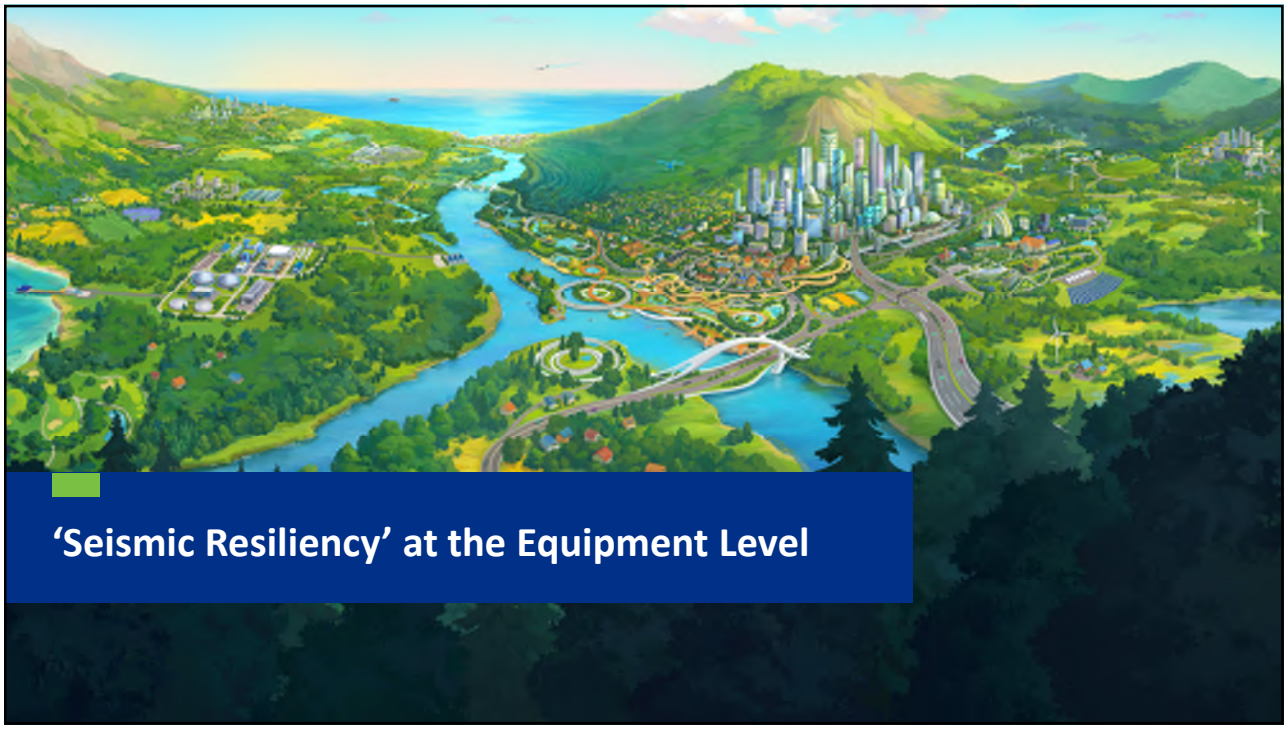
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Agenda



1. ‘Seismic Resiliency’ at the Equipment Level
2. WTP_1.0 Division 01 Requirements
3. Practical Considerations by WTP_1.0 Project Phase
4. What’s Next for the Industry

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‘Seismic Resiliency’ at the Equipment Level

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Non-Structural Components

Nonstructural elements can be divided into three broad categories according to their service and function, namely:

- Architectural elements, such as infill and partition walls, curtain walls, ceiling systems, and architectural ornamentations;
- Mechanical, electrical, and plumbing elements for example pumps, chillers, fans, air-handling units, motor control centers, electrical cabinets, distribution panels, transformers, and piping;
- Furniture, fixtures and equipment, and contents such as shelving and bookcases, industrial storage racks, medical records, computer and desktop equipment, wall- and ceiling-mounted TVs and monitors, industrial chemicals and hazardous substances, historical and cultural objects [FEMA E-74 in Zito et al., 2022].

Focus of this Presentation

Traditional ‘Nonstructural Components’ are becoming more well-defined across industries

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Damage of Non-Structural Components

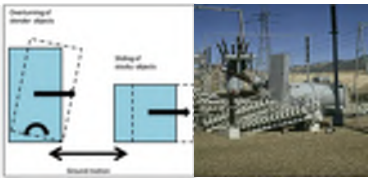


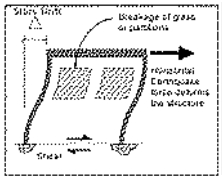
(Source: FEMA E-74)

"Nonstructural element damage may result in human losses and casualties, costly property damage to buildings and their contents, and functioning disruptions." (Zito et al, 2022)

- Inertial forces "or shaking effects cause sliding, rocking, or overturning"

(Source: FEMA E-74)



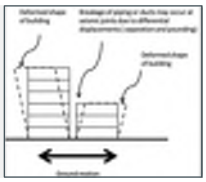


- Building deformations "damage interconnected nonstructural components"

(Source: FEMA E-74)

- Building separation "or pounding between separate structures damage nonstructural components crossing between them"

(Source: FEMA E-74)



The types of damage to nonstructural components are intuitive

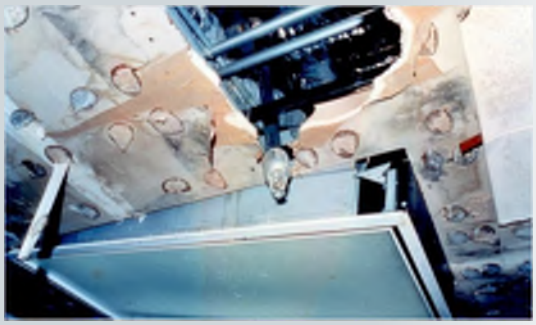
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Example of Non-Structural Component Damage



(Source: FEMA E-74)

"During the 1994 Northridge Earthquake, nonstructural damage caused temporary closure, evacuation, or patient transfer at ten essential hospital facilities. These hospitals generally had little or no structural damage were rendered temporarily inoperable, primarily because of water damage"



- Broken sprinkler pipe at Olive View Hospital in Sylmar, California as a result of the 1994 Northridge Earthquake (Source: FEMA E-74)

Interaction "between adjacent nonstructural components… [can] cause damage"

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Willamette Water Supply Program

***Mission Statement: Provide a cost-effective, reliable and resilient water supply system** by July 2026, that benefits current and future generations of the communities we serve and supports a vibrant local economy.*



30+ Miles of 66" & 48" Welded Steel Pipelines

~30 miles of 66-inch and 48-inch waterline installed to date



15 MG Storage Tanks



New Water Treatment Plant



Modified River Intake

It's important to think about this as a "system" when considering seismic resilience

For seismic certification it's about the facilities



Image from the Regional Water Providers Consortium

Willamette Water Supply
Our Reliable Water

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Water Treatment Plant WTP_1.0









Classified as "Semi-Critical" Systems (impractical to get seismic certification/not needed for primary water quality needs)

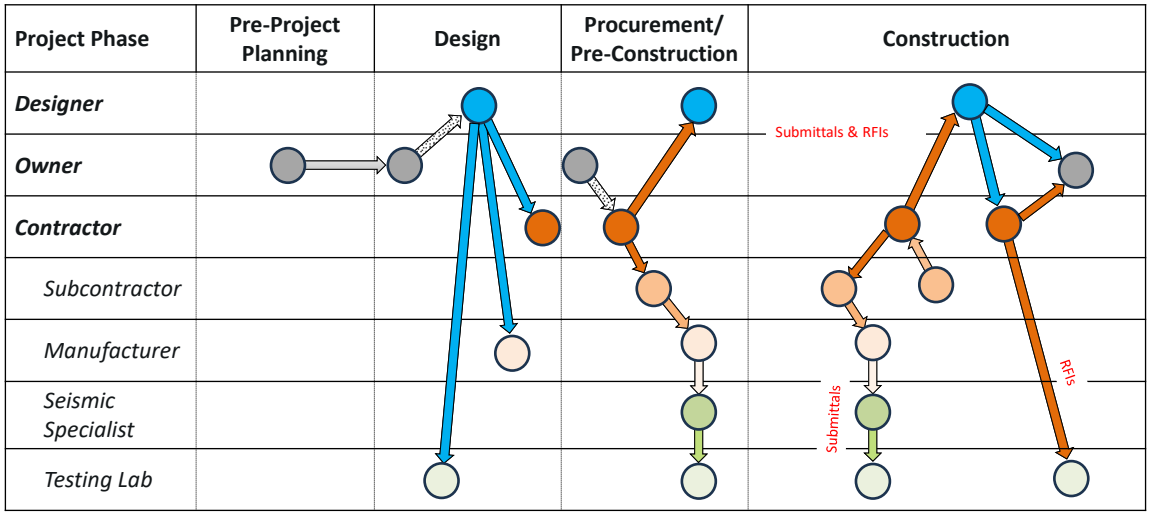
Classified as "Critical" Systems (seismic certification required)

At water/wastewater facilities, the extent of specialized/ equipment is significant

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Seismic Certification Process by Project Phase

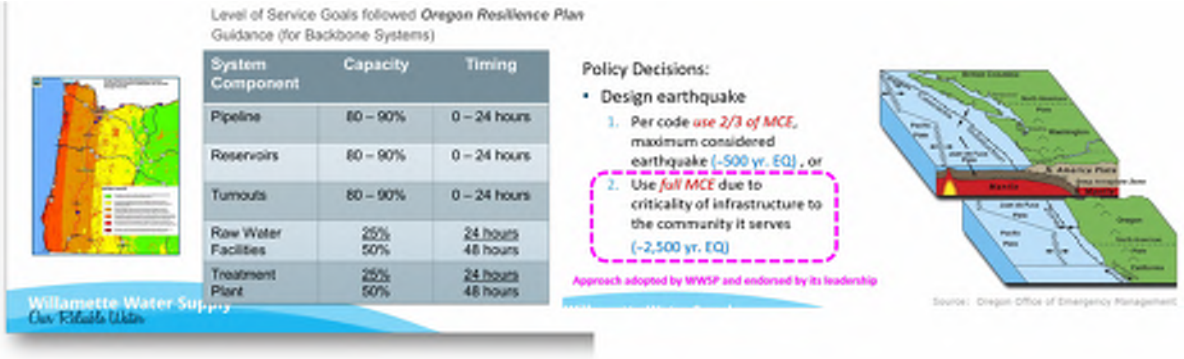


(Source: Britch 2024)

Each project phase involves unique activities by each party to drive toward common resiliency goals

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Pre-Project Planning



Owner clearly setting level of service goals during 'pre-planning' including operability following earthquake and local return period code impacts

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Pre-Planning Phase – Future Considerations

- Scope(s) of Work may be impacted by carrying more stringent LOS goals than might strictly be derived by code:
  - Dedicated design-phase workshops
  - Dedicated vendor outreach
- Owner may need to repeatedly reinforce objectives during VE and similar 'traditional' large infrastructure activities
- Owner needs a knowledgeable 'champion' in-house
- Be prepared to be flexible with anticipated procurement times (typical vendor 'lead time' estimates will not always apply

Owner has to have the stomach for it through all project phases

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Section 01 88 29

B. The following systems and components are Designated Seismic Systems based on their criticality in achieving the intended level of service (LOS) goals and specifically require Special Certification per ASCE 7-16, Section 13.2:

Description	Specification Section
Facility Aboveground Fuel-Oil Storage Tanks	23 13 23
Secondary Unit Substations with Switchgear Secondary	26 11 16.13
Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers	26 12 19
Medium-Voltage, Metal-Clad Switchgear	26 13 26
Medium Voltage Variable Frequency Motor Controllers	26 19 23
Low-Voltage Transformers	26 22 00
Low-Voltage Switchgear	26 23 00
Panelboards	26 24 16
Motor Control Centers	26 24 19
Diesel Standby Engine Generators	26 32 13.13
Butterfly Valves (for Filters)	40 05 64
Medium Voltage Motors for Process Equipment	40 05 93.13
Overflow Annunciator - Single Color Beacon Alarm Light and Alarm Horn	40 78 33
Stacked Beacon	40 78 33
Hydro-pneumatic Surge Arrestor System (Air Compressors and Surge Tanks)	40 92 21
Vertical In-Line Centrifugal Sample Water Pumps	43 23 31.31
End Suction Process Pumps (Flush Mix)	43 23 41
Rotary Lobe Pumps	43 23 56
Peristaltic Hose Pumps	43 23 80
Vertical Turbine Short-Set Pumps	43 24 16.15
Submersible Solids Handling Pumps	43 25 13
Fiberglass Reinforced Plastic Tanks	43 41 46

'LOS Critical' equipment requires substantiated seismic certification/qualification

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Section 01 88 29 Cont'd

C. The following additional systems and components are believed to be generally available with special seismic certification and shall also be provided with documentation of such Special Certification per ASCE 7-16, Section 13.2 as required by their individual Specification Sections despite their designation as equipment that is not LOS critical for purposes of this Project:

Description	Specification Section
Post-Installed Anchors and Reinforcing Bars	05 05 19
Cross-laminated timber (CLT) panels	06 17 19
Metal Storage Shelving	10 56 13
Electric Traction Elevators	14 21 00
Inline, Domestic Water Pumps	22 11 16
Sanitary Waste and Vent Piping	22 11 23.21
General Service Air Compressors and Receivers	22 15 19
Electric Domestic Water Heaters	22 33 00
Tankless Process Water Heaters	22 33 13
HVAC Motors	23 05 13
Hangers and Supports for HVAC Equipment	23 05 29
Hydronic Pumps	23 21 23
Centrifugal HVAC Fans	23 34 16

'LOS Semi-Critical' equipment desires substantiated seismic certification/qualification

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Seismic Certification Process by Project Phase

Project Phase	Pre-Project Planning	Design	Procurement/ Pre-Construction	Construction
Designer				
Owner				
Contractor				
Subcontractor				
Manufacturer				
Seismic Specialist				
Testing Lab				

(Source: Britch 2024)

Each project phase involves unique activities by each party to drive toward common resiliency goals

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Design Phase

- Timing of vendor outreach
  - Common versions of specifications circulated at few dates
  - Keep contacts and feedback current by repeating vendor outreach
- Dedicated, project-specific testing is preferred
- Conservatism of seismic design impacts eligibility for qualifying by “experience”
- Some level of analysis is likely desirable for any project customizations

1. Qualification by testing.
2. Qualification by experience.
3. Qualification by analysis.

Not every type of equipment is a good candidate to be qualified by every certification approach

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Design Phase – Highly Specialized Equipment

- If/when no practical seismic qualification methods are identified for a given piece of equipment:
  - Target ‘rapidity of recovery’ (e.g., partial bypassing)
  - Separate/protected spare parts/storage
  - Consider external provisions (e.g., base isolation)



Limit operational impacts when your Operators are already responding to many fronts simultaneously

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Procurement Phase

- Consider Div 1 coordination conference in equipment seismic qualification requirements as early-proceed construction activity
- Include dedicated submittals by major subcontractor, vendor and/or work package
- Provide a template for LOS critical equipment seismic submittals and require submittal against DIV 1 spec
- The more 'specialized' the equipment:
  - the longer the lead time
  - the more likely shake table testing would need to use a production unit

Logistics of shake table testing can drive procurement and installation lead times

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Construction Phase Considerations

- 'Unifying' individual/subcontractor carrying coordination scope across other disciplines/subcontractors/CSI Divisions
- Assign conservative timelines for:
  - Shake table testing laboratories (repeated for each candidate equipment)
  - Likelihood of multiple re-submittals
  - Incorporating modifications identified via shake table testing
  - Performing third-party analyses in equipment vendor scopes
- There may be value in testing "loose" equipment to inform analysis of "coupled equipment"

The WTP_1.0 project leveraged specified methods to achieve seismic certification or equivalency

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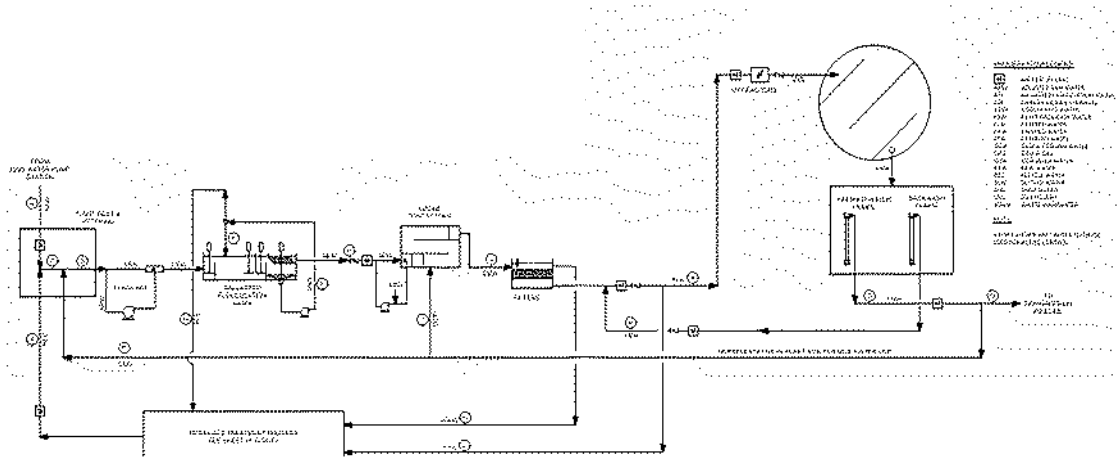
Final Approaches Implemented at WTP_1.0

Type of Equipment	Shake Table Testing	Experience / Database	Analysis **(Calcs, FEA, etc.)**
1500 HP Vertical turbine pumps:			
Motors		x	
Discharge head/connections			x
Shaft			x
'Heavy' electrical:			
MCCs		x	
Switchgear		x	
Transformers		x	
Chemical pumps:			
Pumping unit only	x		
Suction/discharge piping/valves			x
Other mechanical:			
Submerged components			x
Other electrical:			
LED light fixtures	x		
SCADA Panels	x		

Expect the experience to vary by individuals/firms involved

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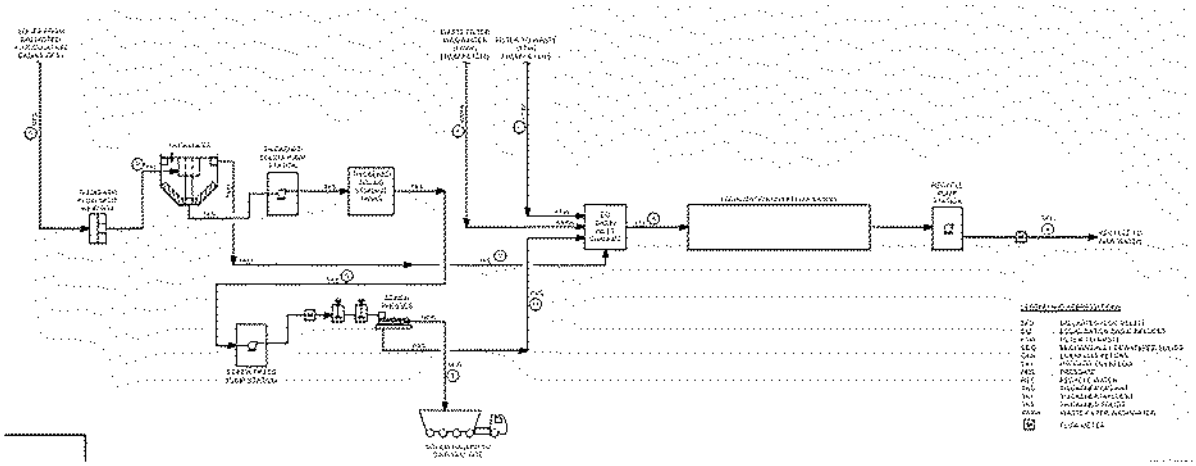
Final Approaches Implemented at WTP_1.0



Unique approaches for select main treatment processes

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Final Approaches Implemented at WTP_1.0



Unique approaches for select residuals management processes

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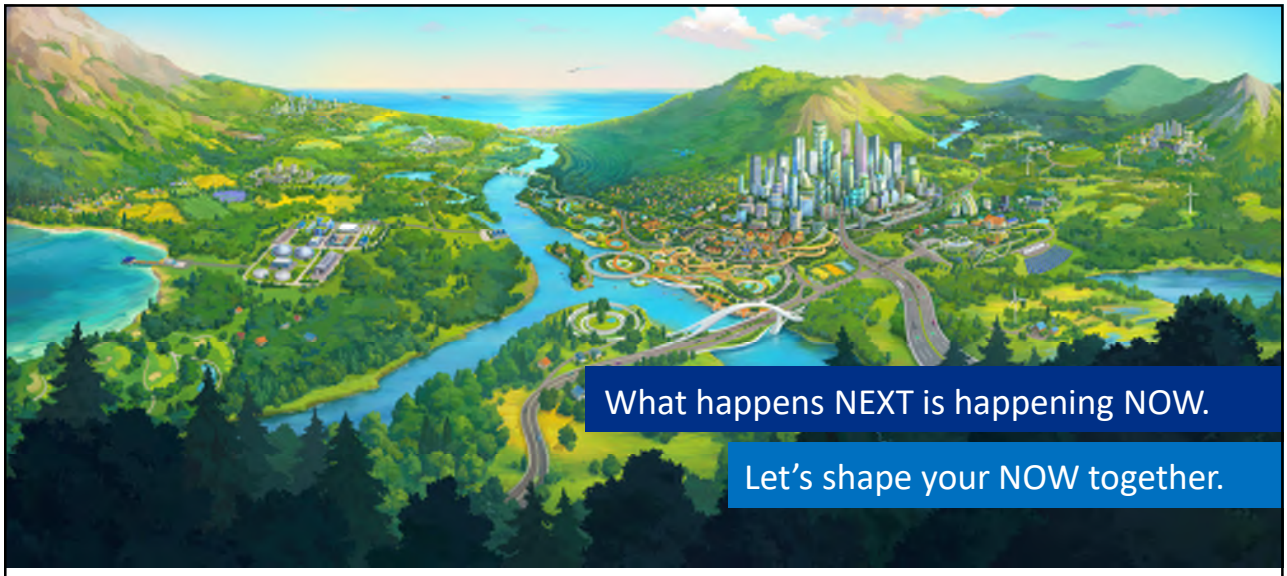
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What Is Next for the Industry

- Increasing library of project specifications targeting equipment seismic resiliency requirements
- Increasing library of specialized water/wastewater process equipment with a history of meeting project requirements
- Future focus on interconnecting elements – especially external connections of otherwise rugged components
- A defined workflow with templates that can be customized and scaled by project/client and shared across municipalities



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