Disaster Resilience Framework
Section 9
Water and Wastewater Systems

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Introduction - Interdependencies

- Power – pumping
- Transportation – staff, supplies, emergency response
- Communication – SCADA, Radio/Cellular
- Buildings – Offices, Customers
- Petroleum - generators

Water Infrastructure

All components operable to deliver water

- Supply
- Transmission
- Treatment
- Pumping
- Storage
- Distribution

Water Infrastructure

- Supply
  - Groundwater – wells
    - Flood - contamination
    - Earthquake – casing, connecting pipe, power supply
  - Surface Water – snow melt, runoff
    - Spills, flood – contamination- Elk River West Virginia MCHM impacting supply for 300,000 people
    - Wild fires – sediment
    - Landslides

Water Infrastructure

- Transmission
  - Landslide
  - Earthquake – liquefaction
- Treatment
  - Earthquake – Loma Prieta 1989, Northridge 1994
  - Flooding – Des Moines 1991

Water Infrastructure

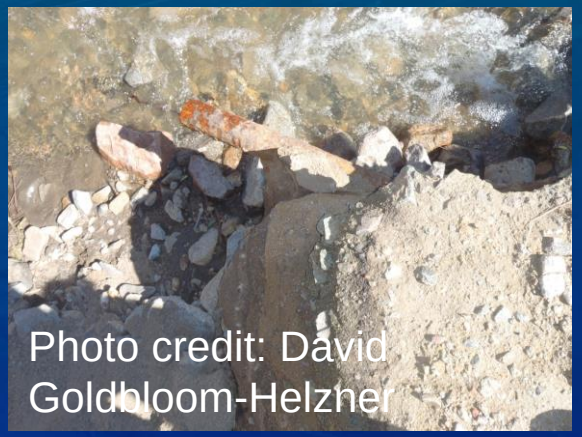
- Pumping
  - Flood inundation
  - Earthquake
- Storage
  - Hurricane -
  - Earthquake - buckling


Photo credit: FEMA

Photo credit: David Goldbloom-Helzner

Water Infrastructure

- Distribution
  - Flood – Jamestown CO



  - Earthquake – Kobe Japan

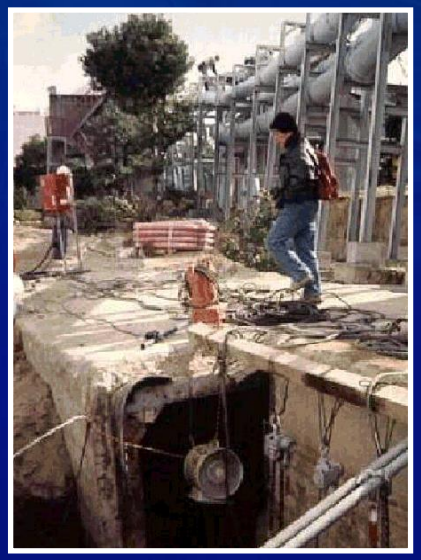
Wastewater Infrastructure

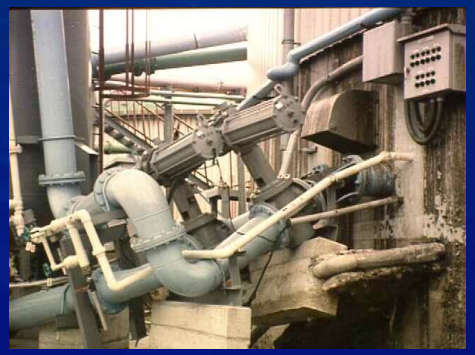
Only collection needs to be operable to address public health

- Collection
- Conveyance
- Pumping
- Treatment
- Discharge

Wastewater Infrastructure

- Collection, Conveyance
  - Flooding, inundation
  - Earthquake liquefaction causes flotation
- Pumping
  - Flooding, inundation
  - Earthquake - flotation
- Treatment
  - Flooding
  - Earthquake





Example Performance Goals - Expected

Functional Category: Cluster	Overall Recovery Time for Hazard and Level Listed						
	Expected Hazard Level						
	Short-Term - Days			Intermediate - Wks		Long-Term - Mos	
	0	1	1 - 3	1 - 4	8 - 12	4	4 - 24
Source							
Raw or source water and terminal reservoirs			90%				
Raw water conveyance (pump stations and piping to WTP)				90%			X
Potable water at supply (WTP, wells, impoundment)	30%		60%	90%		X	
Water for fire suppression at key supply points	90%			X			
Transmission (including Booster Stations)							
Backbone transmission facilities (pipelines, pump stations,	90%				X		
Control Systems							
SCADA or other control systems	30%		60%	90%	X		
Distribution							
Critical Facilities							
Wholesale Users (other communities, rural water districts)		60%	90%				
Hospitals, EOC, Police Station, Fire Stations		60%	90%		X		
Emergency Housing							
Emergency Shelters		60%	90%		X		
Housing/Neighborhoods							
Drink water available at community distribution centers			60%	90%			
Water for fire suppression at fire hydrants				90%			X

Water and Wastewater Infrastructure – Regulatory Environment

- Federal – little direction for extreme events
- State – primacy for Federal programs
- Codes and Standards
  - International Building Code – structures
  - ASCE-7 Minimum Design Loads for Buildings and Other Structures
  - AWWA, ACI – tanks
  - No pipeline codes or standards
- Guidelines

Water and Wastewater Infrastructure – Historic Recovery Levels

- Great Flood of 1993 – Des Moines WTP inundated,
  - 12 days non-potable, 19 days potable
- Northridge 1994, Kobe 1995 – both had 1,000+ pipeline failures
  - Northridge 12 days full service; Kobe 60 days
- Christchurch NZ and Tohoku Japan 2011
  - Both had outages greater than 40 days

Water and Wastewater Infrastructure – Quantify Expected Performance

- Tier 1 – high level, workshop setting
- Tier 2 – published scenarios (USGS) HAZUS-MH (FEMA), ALA (American Lifelines Alliance)
- Tier 3 – detailed assessments
- AWWA J100 – *Standard for Risk and Resilience Management of Water and Wastewater Systems*

Water and Wastewater Infrastructure – Workshop Questions

- Feedback on “Framework”
- Recovery - the weakest link?
- Water versus wastewater importance
- Community interaction – who takes the lead
  - Cities, counties,
  - Private - public
- Economic impacts – FEMA, other