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Memphis Light, Gas and Water Division Strategic Seismic Planning: The Role of Tanks, Generators, and Distribution System Piping

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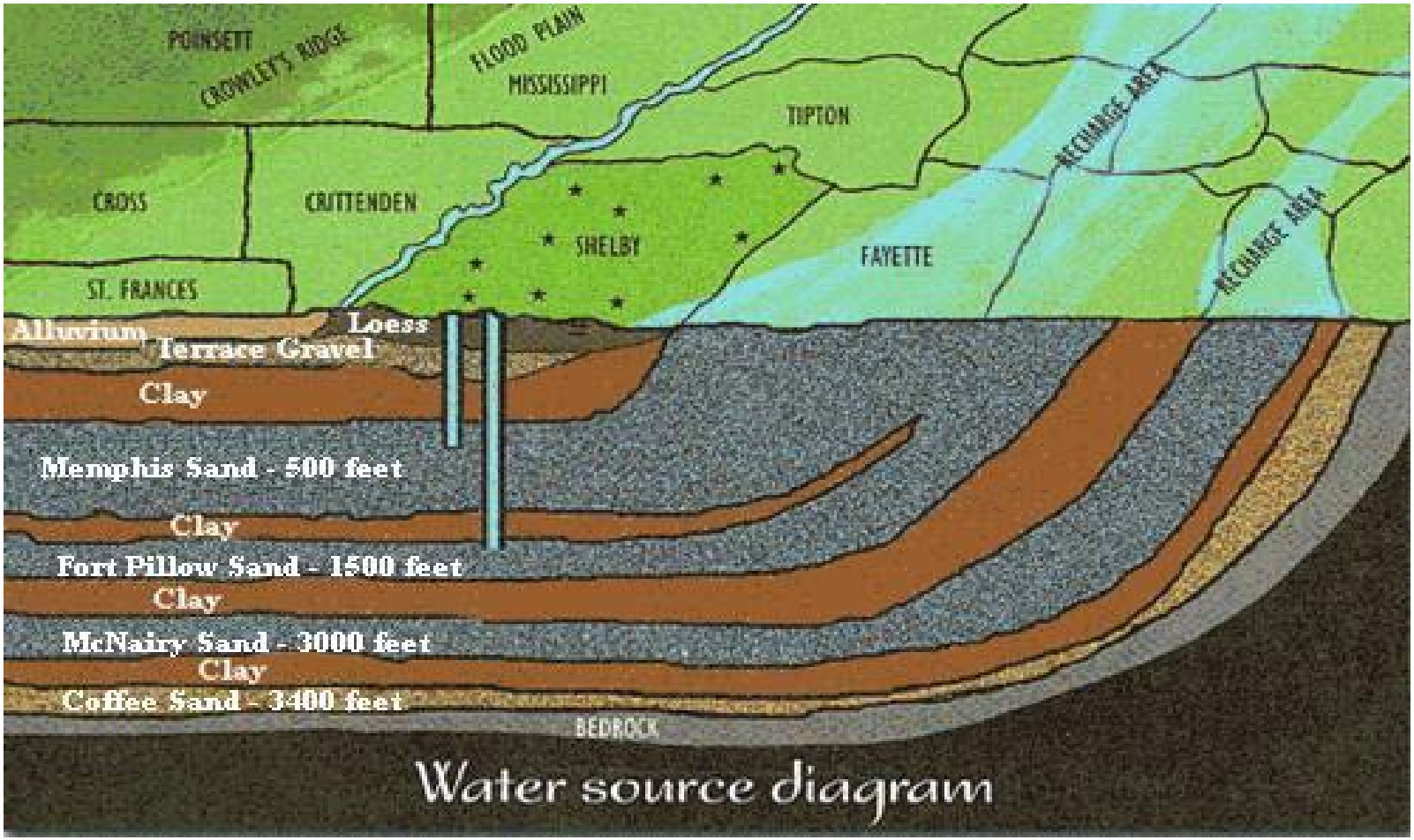
Memphis Light, Gas and Water Division System

- 8 Major Water Plants 30 MGD each
- 8 Major Well Fields (172 Wells 2 MGD each)
- 3 Minor Water Plants and Well Fields (less than 5 MGD)

The Memphis Light, Gas and Water Division System



Location of Water Treatment Plants and Station Capacity

1- Davis 30MGD

2- Allen 30MGD

3- Lichterman 30MGD

4- Sheahan 35MGD

5- Mallory 35MGD

6- McCord 35MGD

7- Morton 30MGD

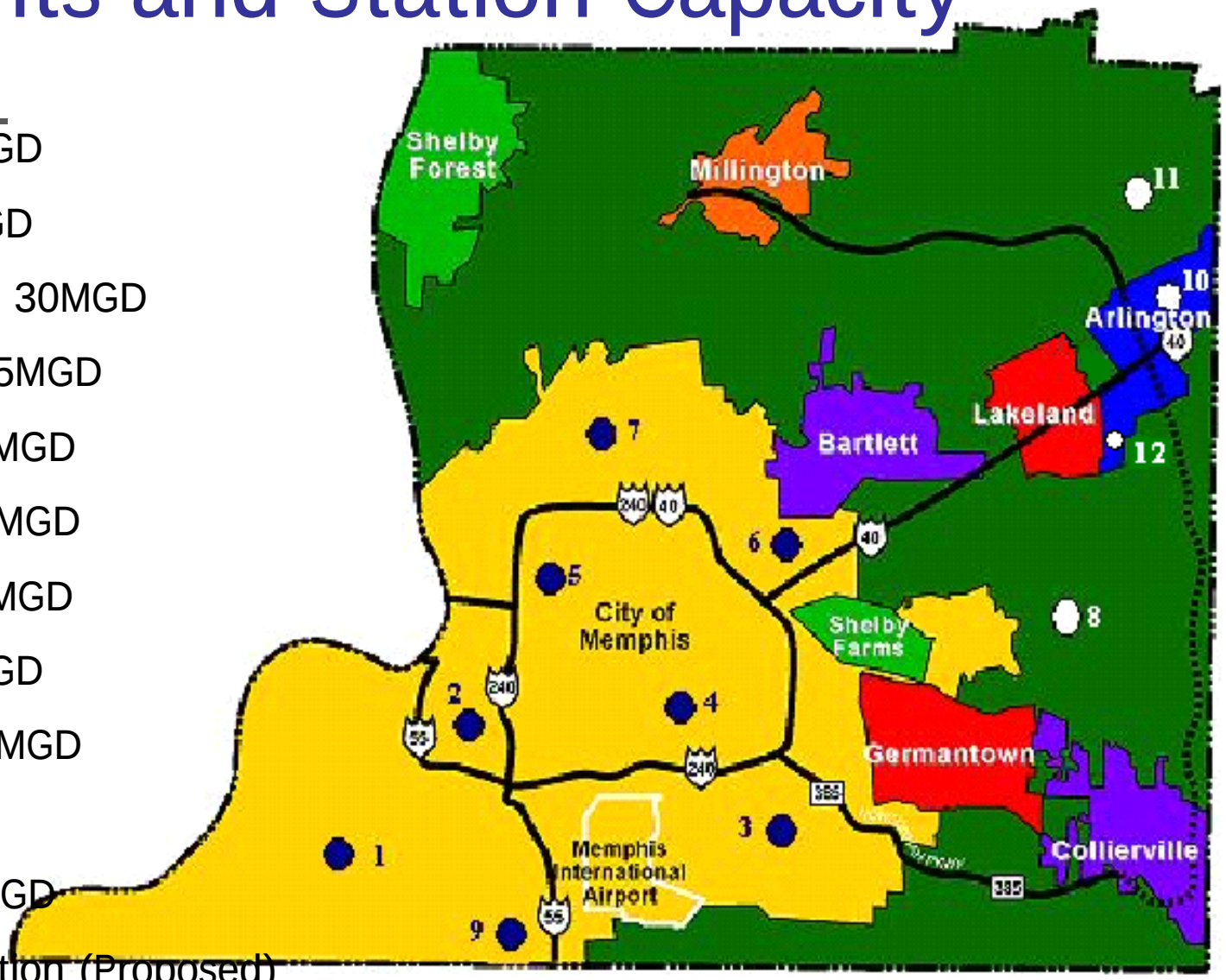
8- Shaw 30MGD

9- Palmer 5.5MGD

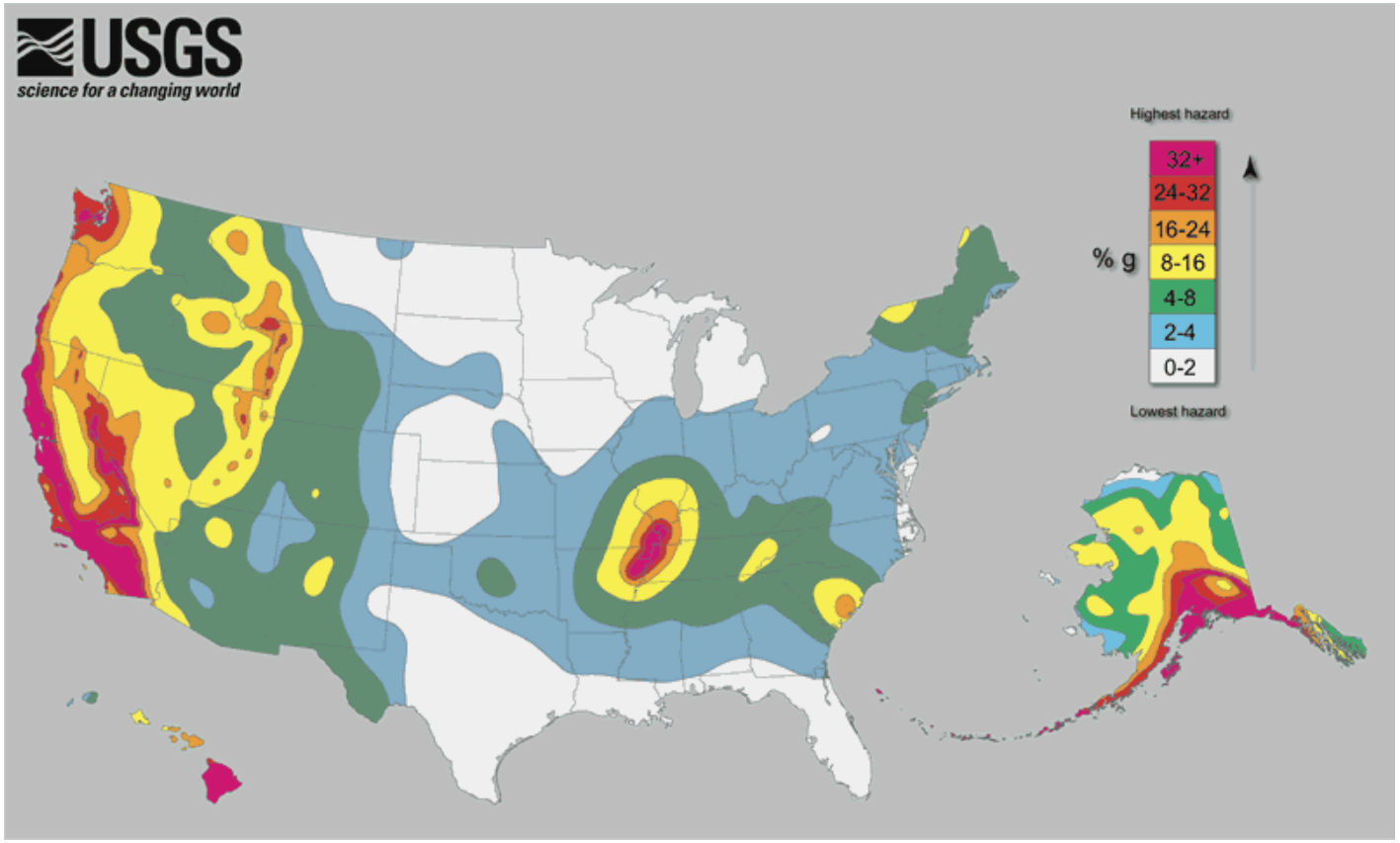
10- Arlington

11- LNG 1.1MGD

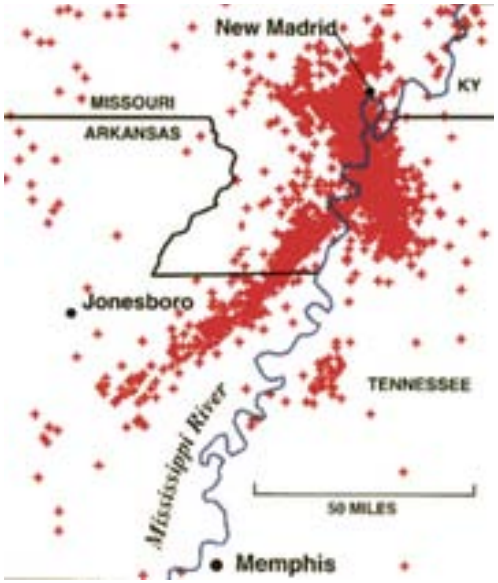
12- Pickel Station (Proposed)



Memphis Area Seismic Hazard



Memphis Area Seismic Hazard



- **Seismic Hazard is driven by New Madrid Seismic Zone**
- **Extends from the vicinity of Marked Tree, AR (approximately 35 miles NW of Memphis) to Southwest Missouri/southern tip of Illinois**

Historical Regional Earthquakes New Madrid Seismic Zone

- 3 Great earthquakes 1811-1812
  - December 16, 1811; M7.9
  - January 23, 1812;M7.6
  - February 7, 1812; M8.0
- 15 Major aftershocks, >M7.0
- Smaller earthquakes in 1843 & 1895

Presentation Overview

- **Chemical Tank Restraint System**
- Emergency Generators
- Distribution System Piping

Chemical Storage Tanks

- **SAFE-Tank Storage and Containment System and Peace of Mind Chemical Storage**
  - 110% Minimum Containment
  - Full Sidewall Protection
  - Double Wall Protection
  - Protected Containment Area
  - Isolate Reactive Chemicals
  - Crosslink Polyethylene
  - Manufactured by Poly Processing

Double-Wall Containment “Tank within a Tank”

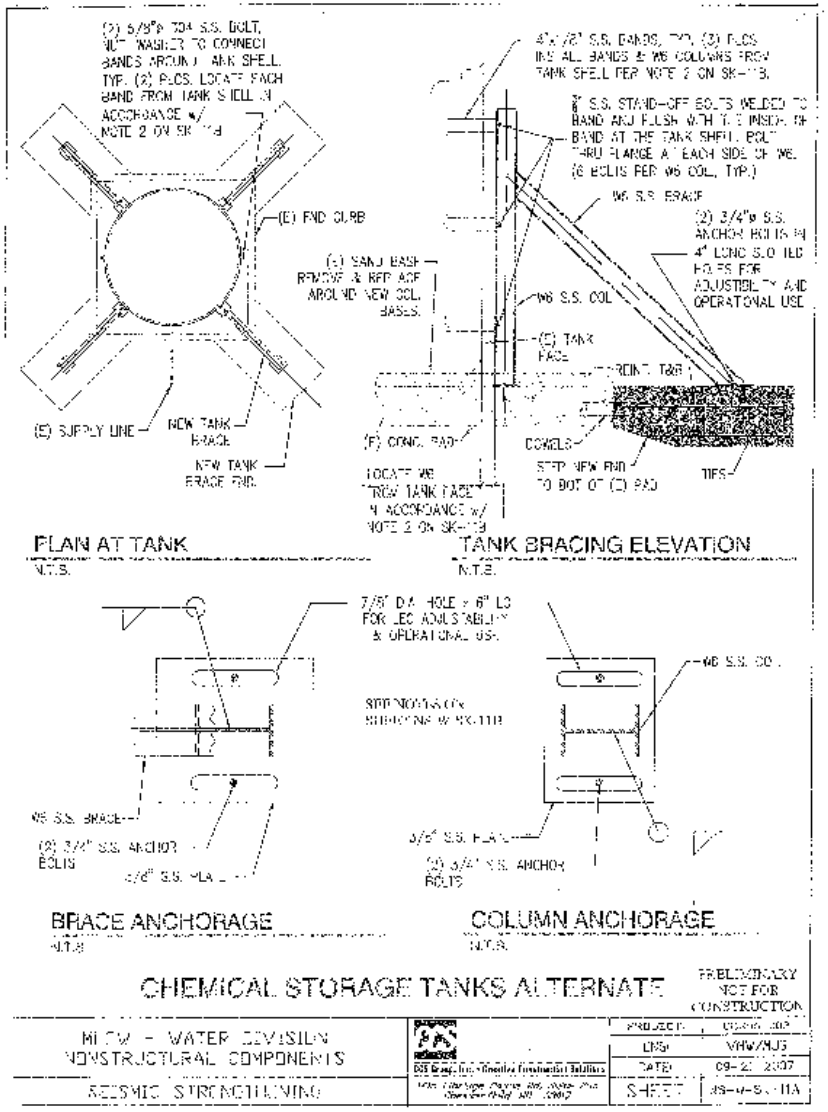
SAFE-Tank System

Lichterman Pump Station Storage Tanks

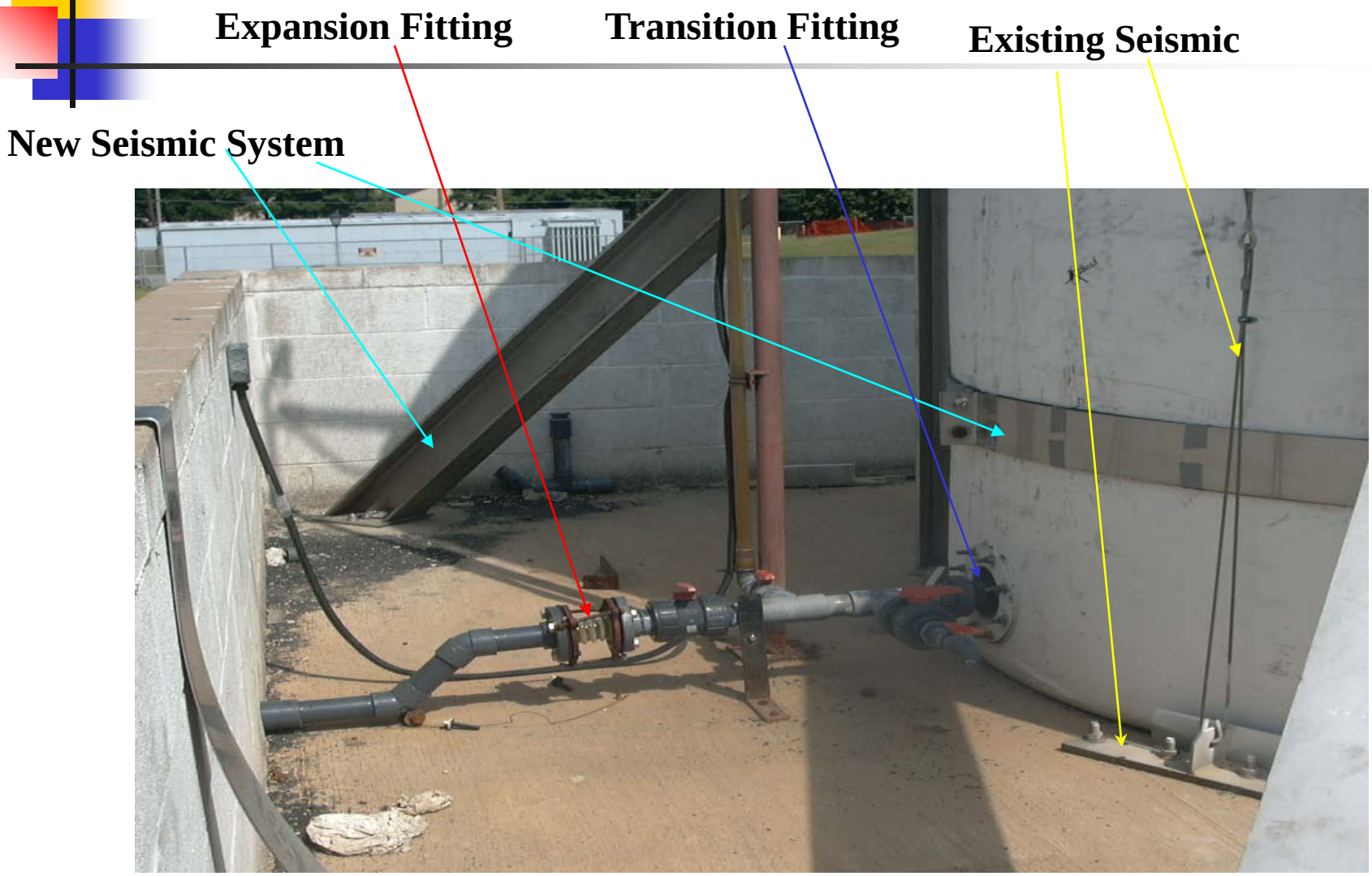
Hydrofluosalicic Acid

Sodium Hypochlorite

Band Type Seismic Restraint System Not Recommended by Consultant



Lichterman Storage Sodium Hypochlorite Tank



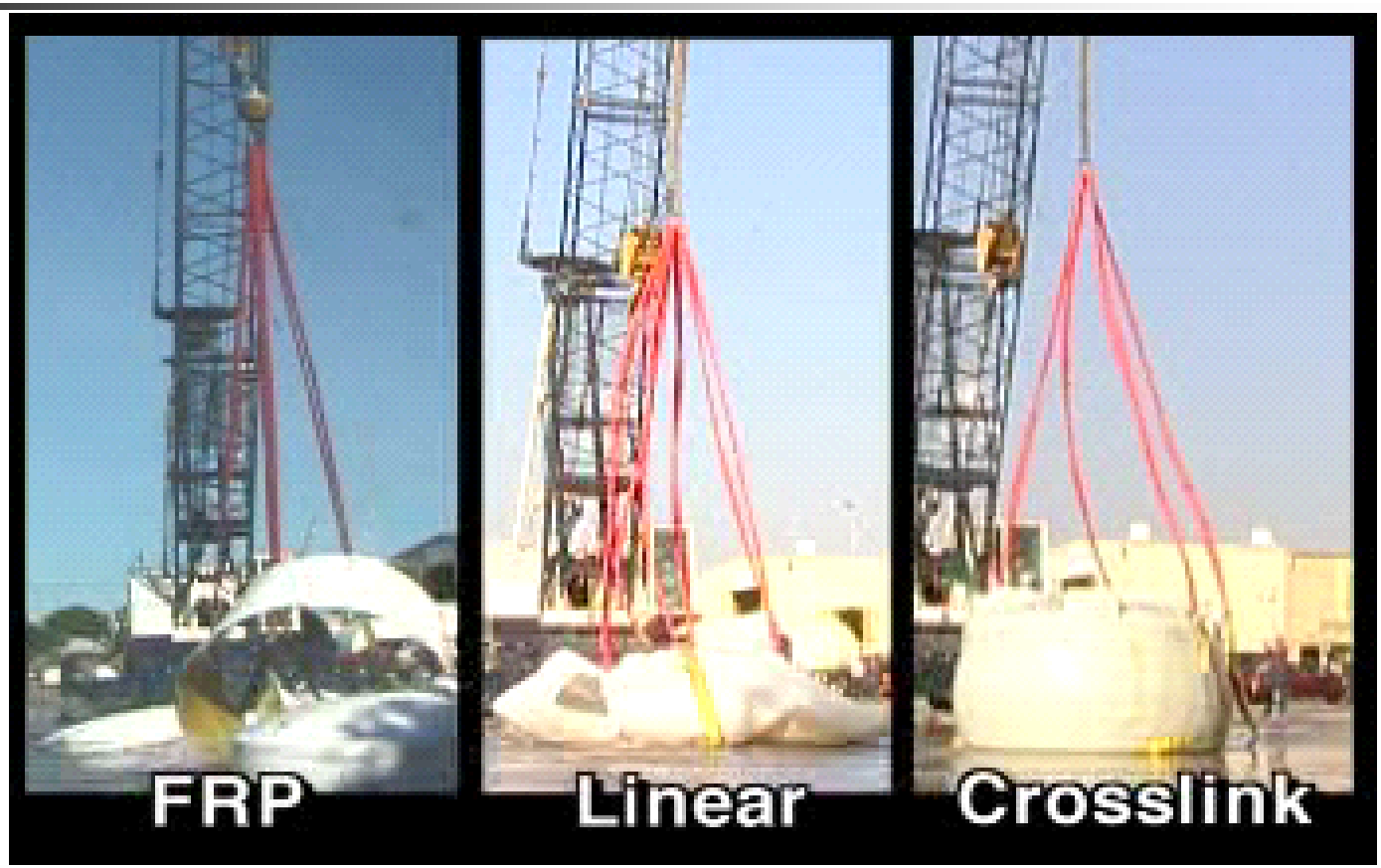
Poly Processing Drop Test

- Demonstrates Strength of Tank
- Three Types of Material
  - Fiber Reinforced Plastic
  - High Density Polyethylene
  - Cross Linked High Density Polyethylene
- Simulation of Force that Tank Can Handle

Drop Test Simulation Similar to a Seismic

Specifically recommended for Sodium Hypochlorite

PolyProcessing Impact Resistance



HDXLPE = Ultimate IMPACT Performance

Presentation Overview

- Chemical Tank Restraint System
- **Emergency Generators**
- Distribution System Piping

Emergency Generator Systems

- Generator locations: 7 of 8 major pumping stations
- Generator sizes: 1250 kW, 1500 kW, or 2000 kW
- Switchgear house interface for existing electrical switchgear.
- 10,000 – 20,000 gallon underground storage tanks

Emergency Generator Installation

Generator Installations

- Shaw (1250 kW) in 1989
- Mallory and Allen (1500 kW) in 1991
- Davis (1500 kW) in 1998
- Lichterman (1500 kW) in 2000
- McCord (2000 kW) in 2005
- Morton (2000 kW) in 2007

Generator Seismic Features

- Engine generator set and frame mounted components including the base frame and base vibration isolators

- Engine exhaust system and supporting structure.

Generator Seismic Features

- Engine start batteries and supporting structure.
- Engine start batteries battery charger.
- Fuel oil day tank and supporting structure.

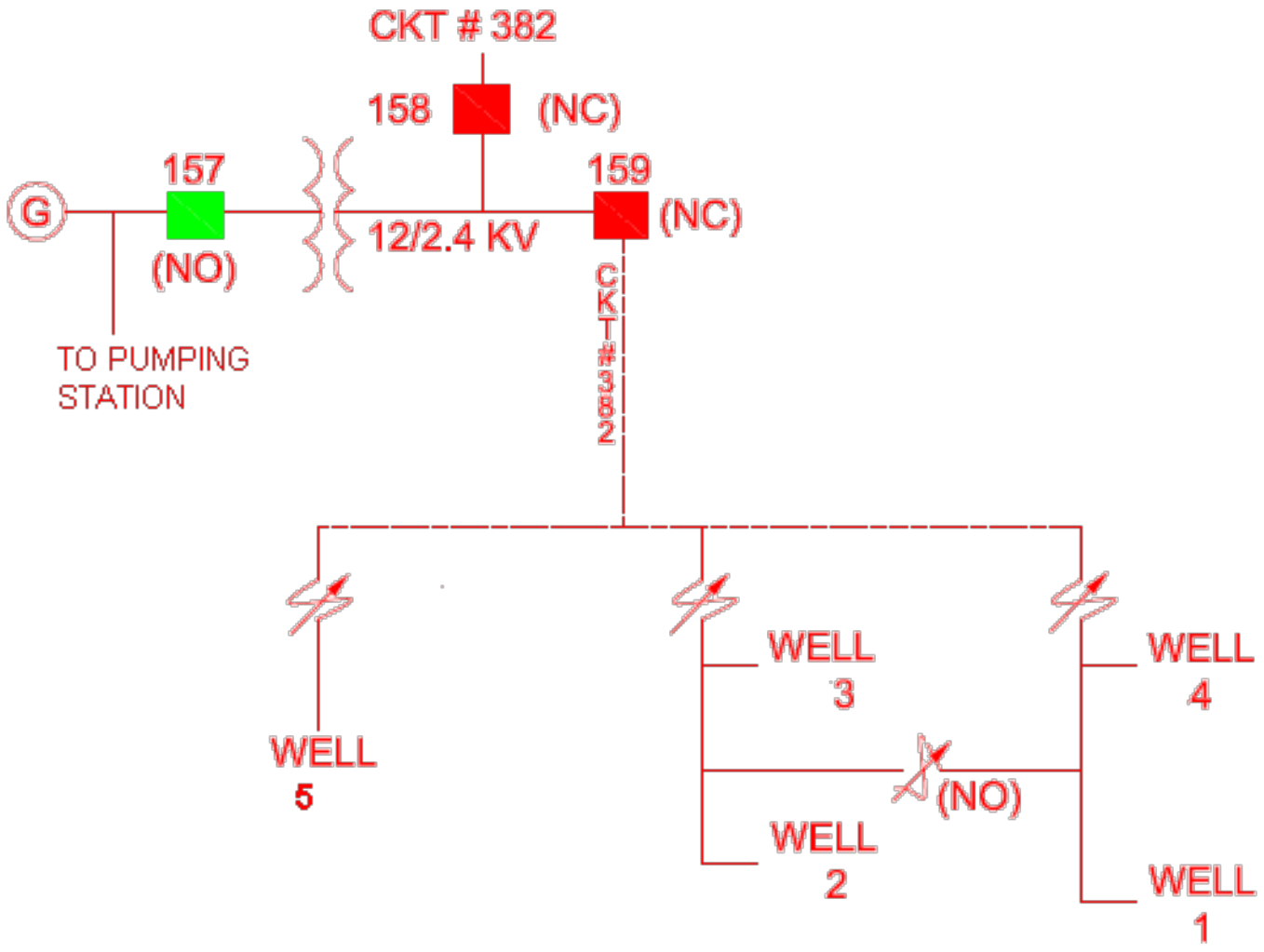
Generator Seismic Features

- Underground storage tank, electrical equipment, and switchgear house.

Switchgear House

- Switchgear house interface for existing electrical systems
- 12 kV and 23 kV electrical systems
- Required at Mallory, Davis, Lichterman, McCord, and Morton
- Reservoir High Service Pumps
- Well electric circuits

Example Generator One-line



Significant Hazards in Memphis

- 1994 – Ice storm
- 2003 – Hurricane force winds
- 2008 – Tornado
- 2009 – Straight-line winds and tornado

Presentation Overview

- Chemical Tank Restraint System
- Emergency Generators
- **Distribution System Piping**

Distribution System

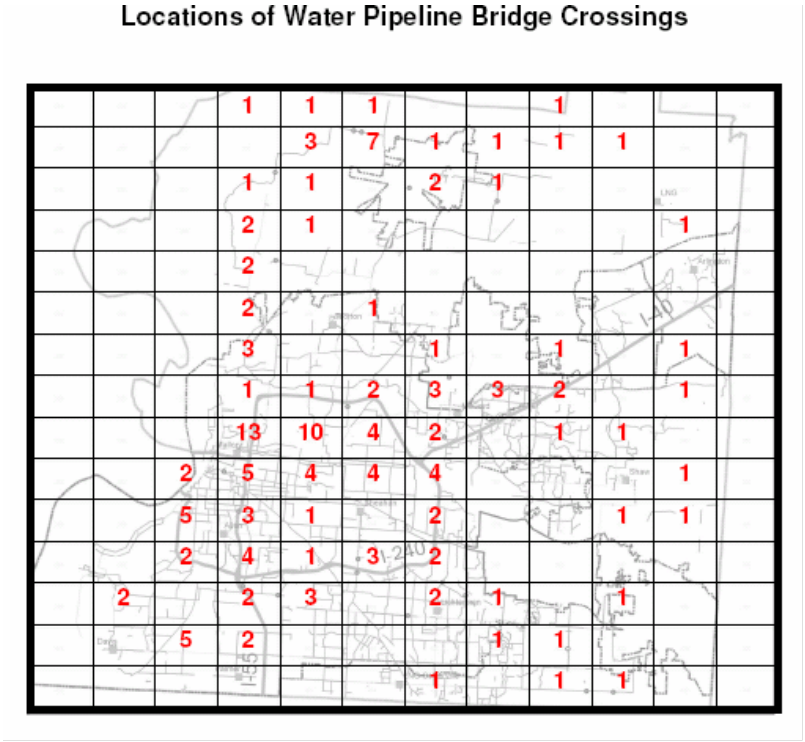
- 3710 miles of Distribution Main
  - 30”-36” = 55 miles
  - 12-24” = 850 miles
  - <12” = 2805 miles
- 41 miles of Collecting Main
- 43,000 Valves

Distribution Piping

- System wide pipe vulnerability assessment
  - Levels of ground shaking
  - Soil conditions
  - Pipe Characteristics (Materials, Size, Joint types,etc)

All estimates are probabilistic

Bridge Crossings



- 149 total pipelines on Bridges
- Used MLGW FIS mapping data
- Confirmed by Google Earth
- Narrowed to Key Bridge Crossings of >12”

Typical Bridge Crossing

Typical Bridge Crossing

Pipeline Repair Estimates

- Scenario Earthquakes, M6.2, M7.0, M7.7
- Categorized by “All” and >12” and <10” Pipe sizes

TableII

Summary of Water Pipeline Repair Estimates for Three Earthquake Scenarios

	M6.2			M7.0			M7.7		
	ALL	12+	10-	ALL	12+	10-	ALL	12+	10-
CI/DI	174	41	133	434	103	332	1293	329	963
PVC	2.8	0.0	2.8	7.2	0.0	7.1	25	0.1	25
UNSPEC	0.6	0.0	0.6	1.5	0.0	1.5	5.3	0.1	5.2
AC	0.2	0.0	0.2	0.6	0.0	0.6	2.0	0.0	2.0
CU	0.2	0.0	0.2	0.6	0.0	0.6	2.1	0.0	2.1
STEEL	0.1	0.0	0.0	0.1	0.0	0.0	0.8	0.5	0.3
GAL	0.2	0.0	0.2	0.4	0.0	0.4	1.1	0.0	1.1
Total Non-Service Repairs	180	40	140	440	100	340	1330	330	1000
Services	35	--	--	90	--	--	265	--	--
Total All Repairs	215			530			1595		

Notes:

1. 12+ indicates pipe size of 12 inches or larger
2. 10- indicates pipe size of 10 inches or less
3. Total non-service repairs and service repairs rounded to nearest 10 and nearest 5, respectively.

Service Restoration Estimates

- Lack of AMI will make initial estimates difficult
- System must be stabilized before repairs can begin
- # of personnel available
- Highly redundant system

References

- **Cramer et al (2004): The Memphis, Shelby County, Tennessee Seismic Hazard Maps, USGS Open File Report (OFR 2004-1924)**
- **FEMA 356: Prestandard and Commentary for Seismic Rehabilitation of Buildings, FEMA (2000)**
- **MLGW Multi-Hazard Risk Assessment, Seismic Performance Objectives, March 2, 2007**
- **MLGW Seismic Mitigation Plan 2003 for Earthquake Preparedness of Critical Water System Facilities**

Acknowledgements

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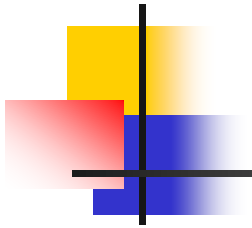

Questions and Discussion