7. EMERGENCY PREPAREDNESS AND RESPONSE PLANNING

Because of the large costs, it will likely take 50 years or more to substantially improve the seismic performance of SPU's water system, particularly the distribution and transmission pipeline systems. Improving SPU's earthquake emergency preparedness and response capabilities is a strategy that can be used to help mitigate earthquake effects until SPU's water system infrastructure can be made more seismically resilient. There are three aspects to improving SPU's emergency preparedness and response:

- Inventory current repair materials; determine what type and quantity of repair materials should be stockpiled, and obtain and stockpile those materials
- Develop an earthquake-specific response plan to reflect the findings of this report
- Review current plans/logistics, infrastructure, and equipment needed to supply emergency drinking water and enhance them to reflect the findings in this report

7.1 Post-earthquake Repair Resources

Depending on the pipeline size, pipe material, and earthquake scenario, it will take anywhere from a few days to months to obtain the pipeline repair materials and resources needed to repair the damage caused by a major earthquake, such as a M7.0 SFZ or M9.0 CSZ event. Based on the expected pipeline damage for the M7.0 SFZ and M9.0 CSZ scenarios, SPU staff has developed preliminary recommendations for pipeline repair material quantities that should be kept in stock in the event of a major earthquake. As storage logistics and normal pipeline repair material usage are better understood, these recommendations will likely be refined.

The pipeline repair material and resource needs were developed with the following considerations:

1. A major earthquake is a relatively low-probability event, meaning materials would likely not be used for 50 or more years.
2. Space is needed to store the repair materials, and the areas where the materials are stored need to provide a minimal level of protection from the environment so the materials do not prematurely degrade.
3. Ideally, the repair materials would be used over time during the normal course of business, so that the stockpiled materials get used before they become too old.
4. The repair resources would not need to repair everything, but would, at a minimum, provide low winter demand (water for needed for essential purposes) from the watersheds into the direct service area and wholesale turnouts. The resources would also be used to improve restoration of the distribution system.
5. After an event, the additional repair materials needed to complete the repairs could be ordered. Only enough repair materials would be needed until the post-earthquake requests for supplemental materials arrive. Supplemental repair materials may arrive within a week or so for a localized event, such as a Seattle Fault Zone event, but would

likely take longer if it were a Cascadia Subduction Zone event that impacted the entire Pacific Northwest coast.

The preliminary recommendations for transmission and distribution pipe repair materials are summarized in Tables 7-1 and 7-2. These tables also list the current pipe repair materials SPU had in stock as of March 2018.

The following auxiliary materials, equipment, and resources would also be needed to complete the pipe repairs:

- HDPE pipe installation
    - To install HDPE pipe, a heat-fusion machine and heat-fusion machine operator would be needed. Because 36-inch HDPE pipe is very thick, and the operating pressures approach 200 psi in some locations, some mechanical couplings are not practical. Preflanging the HDPE pipe and using bolted connections may be an option. Electrofusion may be another option. The materials needed to transition the HDPE pipe to pipe of different materials and diameters would also be needed.
- Auxiliary materials and parts
    - Timber, blocking, and backfill material would be needed. These materials may not need to be stockpiled, but the logistics for obtaining these materials immediately after a major earthquake would need to be developed and included in the emergency response plan.
    - Dished heads (used to plug or cap pipe) would be needed, sizes and quantities to be determined.
    - Cones, signs, shoring boxes, and steel plates would be needed. The current inventory of these items should be compared to the estimated maximum number of concurrent repair sites to determine if it would make sense to purchase more.
- Welders/Pipe Fitters
    - Welders who are also pipe fitters would be needed for the larger diameter pipe repairs. Currently, SPU does not have any welders who can fit pipe together. Local and more distantly located welders/pipe fitters who could promptly respond and weld larger diameter pipe should be identified and included in the emergency response plan. Consideration should be given to negotiating emergency work agreements with appropriately skilled and experienced contractors.
- Lifting equipment

SPU owns and operates backhoes that could be used to lift pipe as large as 89-inch-diameter, 15-foot-long pipe. In general, construction equipment would be in heavy demand after an earthquake. The SPU emergency response plan should identify sources of heavy equipment, including contractor-owned and -operated equipment that could be used after a major earthquake.

Pipe Length/Size/Material	Notes	Current Inventory of Exact or Similarly Sized Pipe
1,000 feet of 36-inch pipe Dimension ratio = 11 (200 psi) HDPE	Float across CESSL Cedar River crossing; float across CRPL 4 Green River crossing (with 60 x 36 reducers/fittings); float across West Seattle Pipeline Duwamish River crossing (with 48 × 36 reducers/fittings); use for repairs on CESSL and TESSL; note that 36 inches is largest HDPE pipe with 200 psi rating	None
1,500 feet of 66-inch pipe welded steel	To replace one CRPL through MLK slide area and Renton liquefaction area; use in other repair areas	260 feet of 66-inch welded-steel pipe
200 feet of 60-inch pipe welded steel	General repair for 60-inch pipe; need fittings for odd-sized pipe and different materials	300 feet of 60-inch welded-steel pipe
200 feet of 54-inch pipe welded steel	General repair for 54-inch pipe; need fittings for odd-sized pipe and different materials	260 feet of 54-inch welded-steel pipe
200 feet of 48-inch pipe welded steel	General repair for 48-inch pipe; need fittings for odd-sized pipe and different materials	240 feet of 50-inch welded-steel pipe
200 feet of 42-inch pipe welded steel	General repair for 42-inch pipe; need fittings for odd-sized pipe and different materials	160 feet of 44-inch welded-steel pipe 91 feet of 38-inch welded-steel pipe 18 feet of 36-inch ductile-iron pipe 249 feet of 32-inch welded-steel pipe
60 feet of 81-inch pipe welded steel	For TPL 1	105 feet of 89-inch welded-steel pipe 120 feet of 76-inch welded steel pipe

Table 7-1. Recommended transmission pipeline repair pipe

Table 7-1 Notes:

1. Store in 20-foot segments for 66-inch-diameter and less pipe. Store in 15-foot lengths for 81-inch-diameter pipe.
2. Store two butt straps for each segment.

Use epoxy or polyurethane-interior coating. Most of the current spare inventory is cement-mortar lined.

Pipe Length/Size/Material/Other	Notes	Current Inventory of Exact or Similarly Sized Pipe
100 feet of 2-inch pipe HDPE	Five repairs at 20 feet per repair; low priority because of size; can order repair materials after event	
100 feet of 4-inch pipe ductile iron 10 repair clamps	Five repairs at 20 feet per repair; low priority because of size; can order repair materials after event	
100 feet of 6-inch pipe ductile iron 25 repair clamps	Five repairs at 20 feet per repair; low priority because of size; can order repair materials after event	40 feet of 6-inch PVC pipe
2,000 feet of 8-inch pipe ductile iron 75 repair clamps	100 repairs at 20 feet per repair; moderate priority because of size; can order repair materials after event	1,801 feet of 8-inch ductile- iron pipe 20 feet of 8-inch PVC pipe 831 feet of 10-inch ductile-iron pipe
2,000 feet of 12-inch pipe ductile iron 50 repair clamps	100 repairs at 20 feet/repair,	666 feet of 12-inch ductile-iron pipe 40 feet of 12-inch PVC pipe 72 feet of 14-inch ductile-iron pipe
1,000 feet of 16-inch pipe ductile iron 50 repair clamps	50 repairs at 20 feet per repair; high priority because of size	342 feet of 16-inch ductile-iron pipe
1,500 feet of 20-inch pipe ductile iron 50 repair clamps	75 repairs at 20 feet per repair; high priority because of size	
1,500 feet of 24-inch ductile iron 50 repair clamps	75 repairs at 20 feet per repair; high priority because of size	108 feet of 24-inch ductile-iron pipe 216 feet of 26-inch welded- steel pipe 378 feet of 25-inch welded- steel pipe
1,000 feet of 30-inch pipe 25 repair clamps	Significant amount of 30-inch pipe in liquefiable areas, such as Airport Way	

Table 7-2. Recommended distribution pipeline repair pipe

Table 7-2 Notes:

1. Store in 20-foot segments.
2. Store two MEGALUGS (joint restraint) for each segment.
3. Use epoxy or polyurethane-interior coating. Most of the current spare inventory is cement-mortar lined.
4. Need to determine appropriate quantities of mechanical joints and sleeve pipe.
5. The number and sizes of transition couplings and bends need to be determined.

7.2 Earthquake-Specific Emergency Preparedness and Response Planning

The overall strategic and programmatic approach to emergency management at Seattle Public Utilities is presented in the Seattle Public Utilities Comprehensive Emergency Management Plan (CEMP) and subordinate plans. The CEMP provides the planning and program guidance used to implement SPU's emergency management programs and plans. The CEMP is reviewed and revised every three to six years. The latest CEMP version is being reviewed in 2018.

The SPU Continuity of Operations Plan (COOP) is used to ensure SPU's mission-essential operations are performed efficiently and with minimal disruption during an emergency. The COOP is used to maintain, restore, and sustain essential functions identified in the COOP in the event of a threatened or actual interruption. The COOP is updated annually and revised every four or five years. The next COOP revision will be released in 2018.

The SPU Emergency Operations Plan (EOP) defines how an incident's impacts will be managed so that essential services can be stabilized and restored. The SPU draft EOP is scheduled to be completed in early 2019.

In conjunction with the EOP, SPU has developed

- All-Hazard response plans for emergencies such as water shortages, water quality and debris management
- Hazard specific response plans for hazards such as spill response, freeze response and West Nile Virus
- Site-specific response plans such as dam emergency action plans and emergency facility response procedures

Although there are some common issues among different types of emergencies, there are some that are unique or more likely to affect response during earthquake emergencies. Those unique issues need to be addressed in earthquake-specific preparedness and response planning. Currently, SPU does not have an earthquake-specific plan in its EOP plan portfolio.

An earthquake-specific response plan needs to be added to SPU's hazard specific response plan portfolio. This earthquake-specific plan should include:

- Developing procedures and protocols for remaining in or entering facilities that may be damaged or unsafe due to either structural failure, chemical release, or electrical hazards
- Encouraging home earthquake preparedness and response planning for SPU employees so they are more likely to be available after an earthquake
- Continuing to work with the City's Office of Emergency Management to encourage home earthquake preparedness and response planning for the public so they are more likely to be prepared following an earthquake

- Continuing to work with the Seattle Fire Department on identifying common goals and planning scenarios.
- Considering early warning systems that are being developed and ways they can be immediately shared with all SPU staff and used to mitigate earthquake effects
- Determining whether USGS ShakeMaps, remote sensing, and other rapid response software, such as One Concern, could be used to help identify where damage is most likely
- Addressing repair material storage hazards in OCC Warehouse
- Considering aftershock effects and using aftershock-forecast maps that the USGS is developing in response to the issue of employee safety while responding to the original earthquake
- Continuing to account for employee mobility issues (e.g., for employees that live out of town and may have trouble responding to an emergency) in earthquake emergency response
- Developing plans for post-earthquake response given that other critical lifeline systems, such as power, transportation, and communications, are likely to be severely compromised
- Developing post-earthquake response plans and strategies for prioritizing and carrying out water system repairs
- Continuing to work with the City's Office of Emergency Management on developing post-earthquake response plans and strategies for community shelter and resource sites
- Strengthening emergency contracting with regional and out-of-area heavy contractors, and mutual-aid relationships with similar utilities
- Reducing ignition sources that could ignite leaking gas, if the water supply is nonpotable, by asking residents to disinfect water with chemicals or filters instead of boiling it.

7.3 Emergency Drinking Water

One of the findings from the 2016 Cascadia Rising exercise was that it may take up to two weeks for outside aid to supply emergency drinking water (Washington Military Department 2017).

SPU currently has six portable emergency drinking water distribution (EWD) stations. Each system consists of a 1,700-gallon blivet and dispensing equipment. This equipment includes valves, piping, sanitizing equipment, and a manifold table that can be used to fill custom, one-gallon, aseptic water bags for the public. The system can be run in one of three configurations: directly off a hydrant, from a hydrant to a pump, which regulates water pressure, and from a blivet. The EWD stations do not have treatment capability. Water issued from the EWD stations would need to be disinfected if the EWD water source is nonpotable.

The emergency stations are operationally intensive. It takes up to twelve people per shift to staff each station and to manage and provide traffic control at the distribution site. Because there are approximately 700,000 residents in SPU's direct service area, even if staffing were available for each station, more than six stations would likely be needed to supply emergency drinking water

in SPU's direct service area. SPU should revaluate current capabilities and develop an improved plan and approach to provide and distribute emergency drinking water following a major earthquake.

As part of federal disaster response, acquisition and regional distribution of potable water is the responsibility of the Defense Logistics Agency. Acquisition and distribution of potable water is overseen by the Washington State Department of Commerce and coordinated within the State Emergency Coordination Center logistics unit. Distribution is carried out by county and local resources to community points of distribution, in conjunction with food and other commodities.

It is critical for SPU to support community emergency preparedness programs for the public to prepare and store at least two weeks of water. This includes storage of potable water, and strategies to leverage additional water sources for nonpotable needs.