Beaverton School District Resilience Planning

Executive Summary

High School at South Cooper Mountain

Middle School at Timberland

BEAVERTON SCHOOL DISTRICT

seft CONSULTING GROUP

Report for the Beaverton School District from SEFT Consulting Group

Beaverton, Oregon
July, 2015

Note: This Executive Summary selects from the large number of detailed recommendations in the chapters of the Beaverton School District Resilience Planning Report. The full report is available online at the Beaverton School District website: https://www.beaverton.k12.or.us/depts/facilities/Documents/150710_Beaverton%20School%20Report.pdf

The Starfish Story

Once, on ancient Earth, there was a human boy walking along a beach. There had just been a storm, and starfish had been scattered along the sands. The boy knew the fish would die, so he began to fling the fish to the sea. But every time he threw a starfish, another would wash ashore. An old Earth man happened along and saw what the child was doing. He called out, "Boy, what are you doing?"

"Saving the starfish!" replied the boy.

"But your attempts are useless, child! Every time you save one, another one returns, often the same one! You can't save them all, so why bother trying? Why does it matter, anyway?" called the old man.

The boy thought about this for a while, a starfish in his hand; he answered, "Well, it matters to this one." And then he flung the starfish into the welcoming sea.

— Loren Eiseley, *The Star Thrower (1969)*

Foreword

At the behest of the State Legislature, the Oregon Seismic Safety Policy Advisory Commission completed *The Oregon Resilience Plan* in February 2013. This Plan outlines the risks and challenges facing Oregonians from the next Cascadia Subduction Zone mega-earthquake, which seismologists say is inevitable. The Plan provides very sobering predictions about the impacts from this earthquake, including durations for restoring the critical service lifelines of electricity, water, and highways ranging from months to a year or more in the Willamette Valley. *The Oregon Resilience Plan* is a call to action for all Oregonians, especially for those of us in public service.

Schools are different from most public facilities. Not only do they shelter thousands of our children, they are distributed in neighborhoods and walkable from homes nearby. With enlightened forward planning, they could be significant resources in helping their communities recover in the aftermath of the earthquake…if we plan.

Beaverton School District has a special opportunity—perhaps even a responsibility. Our community approved a very large capital construction bond program in 2014 that includes building three brand new school buildings and replacing four more. In order to better support our community during an emergency, our District has determined that we should build these seven schools to exceed building code requirements in certain critical aspects in order to respond to *The Oregon Resilience Plan*. Operating within a very compressed timeframe to keep our projects on schedule and within constrained budgets, we launched an effort to translate the concepts of the Plan for our first two schools into design criteria for our architects and engineers.

This report summarizes that effort and provides the conclusions we reached. It is imperfect, and will only affect seven of our 50 schools and only seven of the 1,200 public schools in Oregon. But we must start somewhere, with the hope that Oregon has decades to build many new schools and other public buildings before the mega-earthquake strikes. Beaverton School District hopes that publishing this report and sharing our work with other school districts will provide a beginning framework for creating a new standard for resilient school buildings.

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Executive Summary

Oregon has come to understand that there is an uncomfortably high probability that a Magnitude 9.0 Cascadia Subduction Zone earthquake will occur off the coast, triggering strong ground shaking that will last for 3 to 5 minutes and generating a tsunami that will cover the coast line, not unlike what happened in Japan in 2011. Seismologists tell us that this type of event has occurred 41 times in the last 10,000 years and there is no reason to expect that it will not occur again. Fortunately, the recently published *The Oregon Resilience Plan* has provided a comprehensive evaluation of what will happen and what can be done in the short and long term to mitigate our state's vulnerabilities to an acceptable level.

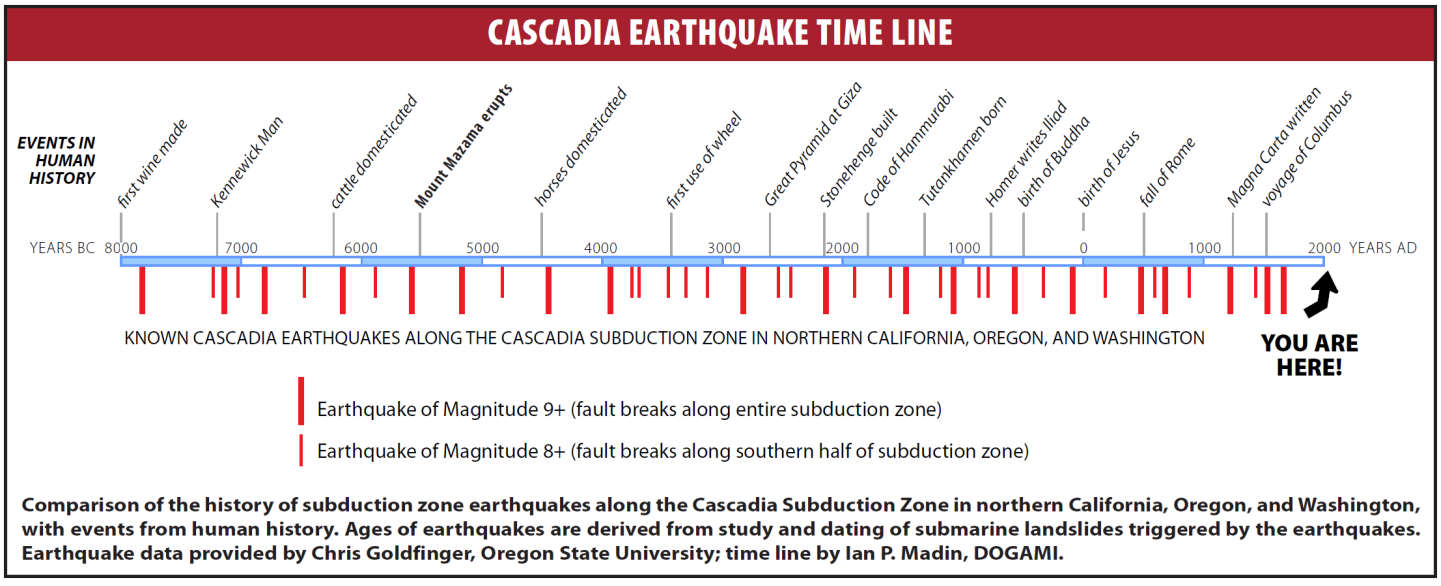
Elementary, middle, and high schools will have an important role in the response and recovery of the state from this catastrophic event. Because of their location and layout, they are perfectly suited to serve as emergency shelters and community resource centers within 72 hours after the event and during the response period. Once the initial response period passes in a few weeks, schools need to re-open and contribute to their communities return to normalcy. For this to occur, the school buildings need to be "safe and usable" immediately after the event and served by the infrastructure systems they depend on (including transportation, energy, water, wastewater, communication, and information systems). Unfortunately, current design standards and codes do not provide for this level of performance.

In February of 2013, the Oregon Seismic Safety Policy Advisory Commission submitted a report to the 77th Legislative Assembly entitled *The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami*. The report discusses the risk that is faced by the citizens of Oregon from an impending Cascadia Subduction Zone earthquake and accompanying tsunami, and the gaps that exist between the current state of Oregon's infrastructure and where it needs to be. *The Oregon Resilience Plan* goes on to outline steps that can be taken over the next 50 years to bring the state closer to resilient performance through a systematic program of vulnerability assessments, capital investments in public infrastructure, new incentives to engage the private sector, and policy changes that reflect current understanding of the Cascadia threat.

The Oregon Resilience Plan established a goal of opening shelters almost immediately and re-opening schools within 30 days following a large earthquake. The plan estimates that Oregon's existing school buildings and emergency shelters may take up to 18 months to reopen in the Coast and Valley regions.

In 2014, voters within the Beaverton School District passed a major bond measure to help reduce school overcrowding and modernize schools. This has provided the District a unique opportunity to not only address daily operational needs, but also respond to the findings of *The Oregon Resilience Plan*. This effort is establishing the Beaverton School District as a leader in the design and construction of disaster resilient schools that are also capable of supporting their surrounding communities as emergency shelters.

This report summarizes resilience planning activities that have been conducted in support of the design of the new High School at South Cooper Mountain and the new Middle School located at the Timberland Development. SEFT Consulting Group has coordinated with the Beaverton School District, various stakeholder groups (city and county emergency managers, American Red Cross, Portland General Electric, Tualatin Valley Water District, Clean Water Services,



Historic Cascadia Subduction Zone Earthquake Timeline (Source: Oregon Department of Geology and Mineral Industries)

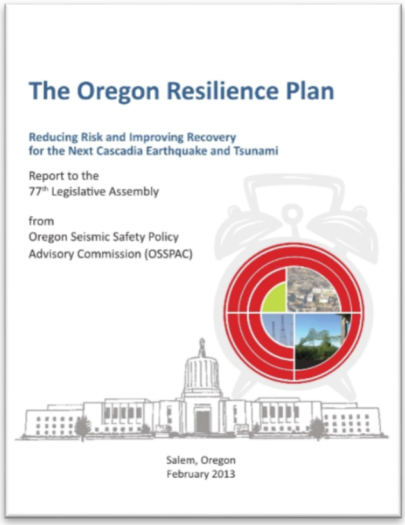
etc.) and the design teams (led by Boora Architects and Mahlum Architects) for the two new schools to establish resilient design features that can reasonably be incorporated in design and construction, given project schedule and budget limitations.

It was determined that an emergency shelter at the high school could accommodate approximately 860 people and at the middle school could accommodate approximately 725. This represents a significant population that can remain in their neighborhood and speed the return of the neighborhood to normalcy after the earthquake.

The stakeholder workshop and subsequent meetings identified a wide variety of features that could be added to the projects that would improve the school's ability to be used as shelters and re-open in a few weeks for teaching. The American Red Cross made it clear that, as a minimum, they only need a willing building owner and a secure facility that could be naturally ventilated, would get people out of the weather and keep them warm. Beyond that, the availability of electricity for lighting and cooking, water and removal of waste water would be significant additions that would improve the efficiency and livability for the shelter.

The key resilience features that are recommended for both schools to support that population and allow the schools to re-open quickly include the following. These recommendations represent an affordable balance between permanent and temporary (brought in after the earthquake) solutions:

- Design structural systems of the schools as essential facilities (Risk Category IV) resulting in improved seismic performance over typical Risk Category III school design (which is intended to achieve life-safety performance, and will likely require lengthy and costly repair prior to re-occupation);
- Design seismic bracing or anchorage for nonstructural components per Risk Category III requirements, provided that those components needed for use of the school as an emergency shelter satisfy Risk Category IV seismic design requirements;
- Confirm equipment that is expected to be operational after an earthquake (emergency generator, automatic transfer switch, ventilation fans, etc.) satisfy the special certification requirements of Section 13.2.2 of ASCE 7-10: *Minimum Design Loads for Buildings and Other Structures* (i.e., seismic rated);
- Increase the size and fuel capacity of the emergency generator to the level needed to support shelter operations including additional outlets in the kitchen;



(Source: Oregon Seismic Safety Policy Advisory Commission)

- Provide building connection points to hook up an external water supply tank, in lieu of adding bulk water storage on site;
- Provide water piping from the school building to the utility piping that is better able to resist earthquake ground displacement to allow water to be supplied to the school more reliably after water utility system resilience improvements are completed;
- Provide wastewater piping from the school building to the utility piping that is better able to resist earthquake ground displacement to allow wastewater to be discharged into the wastewater utility system and minimize the need for holding tanks; and
- Plan for the use of open areas on the grounds to support community relief efforts.

The cost of these additions was estimated to be about $900,000 for the high school and $750,000 for the middle school.

The report goes on to recommend that (1) all new and existing Beaverton School District campuses undergo the same type of stakeholder resilience planning workshop, (2) reasonable resilience features be implemented with a proper design, detailed peer review and plan check during design, and comprehensive inspection during construction, and (3) Beaverton School District develop a site-specific post-event inspection procedure that allows the rapid and conclusive assessment of the buildings. New schools should have similar features added to the project scope and existing schools should be retrofitted to these performance levels during their eventual rehabilitation. The report also recommends continued collaboration with the various stakeholder groups including the development of memorandum of understanding with each utility provider regarding the timing for the restoration of service.

About the Report

A resilience planning approach looks not just at the individual needs of a building or community, but looks at dependencies that underlie these needs. Being able to use a building following an earthquake depends not just on the building performance being structurally adequate, but also the various systems in the building need to survive and be usable. But even this is not sufficient for the building to be usable. A community still needs to be able to travel to and from the site, as well as provide water, eliminate waste, and provide power and telecommunications. This means that it is necessary to look outside to the utility providers to understand how they provide these services to the site/building. The impacts of the damage to roads, bridges, fuel distribution, and other infrastructure systems also need to be taken into account.

Since knowledge of the risk of a Cascadia earthquake is recent, most of Oregon's infrastructure systems were not designed and built with this in mind. This means that our current vulnerabilities are quite high. With the current low resilience level, the *Oregon Resilience Plan* estimated that if the Cascadia event occurs in the near-term, then there will be a need for emergency shelters for a significant portion of the population. It set a 50-year time frame for Oregon to become resilient, at which time the need for emergency shelters would be reduced because the majority of individuals would be sheltering in-place in their homes. These two Beaverton School District projects are two small but significant steps in providing the shelters that are needed now.

Due to the expected variability in community resilience and shelter demands over the next 50 years, this resilience planning project for the Beaverton School District has considered short-, intermediate-, and long-term strategies for emergency shelter needs. In the short-term, before significant resilience improvements have been made to utility systems, the plan assumes that the school building will be safe to use as a shelter, but utility services and other necessities will need to be provided by emergency management agencies. In the long-term, after the 50-year resilience targets are achieved, the school building will be safe to use as a shelter and utility services are expected to be quickly restored to the shelter. This approach is intended to strike a balance between current and future emergency shelter needs of the community, and limited economic resources available to invest in resilience improvements.

The resilience planning process conducted as part of this project has involved four key steps: (1) work with BSD to determine the appropriate performance goals and functional recovery for Beaverton School District school buildings; (2) coordinate with the county and surrounding cities to determine desirable emergency shelter needs; (3) work with the Beaverton School District to explore potential funding sources to cover the financial gap between a standard school design and the community emergency shelter needs; and (4) coordinate with the infrastructure systems to understand their resilience plan and assist the Beaverton School District to develop a long-term strategy and an interim solution. It will require a community partnership among the county, the cities, and infrastructure system providers to meet the needs for school buildings to be effectively used as emergency shelters.

To serve as a shelter, a building needs to meet certain requirements established by the shelter provider. The essential requirement is that the building be safe and usable. One approach that may be used to provide a high probability that the building will be safe to occupy after a large earthquake, is to design the building as an essential facility (Risk Category IV) per the requirements of the currently adopted Oregon Structural Specialty Code (OSSC). Schools are currently required to meet Risk Category III seismic design standards. The school buildings are intended to achieve life safety performance objective (i.e., ensuring building

(Source: National Institute of Standards and Technology)

Red Cross Shelter in Gymnasium (Source: American Red Cross)

occupants will not suffer life-threating injuries), and will likely be damaged and may not be usable without potentially lengthy and costly repair. While making the full building meet Risk Category IV is preferred, one option is to only upgrade common spaces to meet this standard, and count on using only these areas for shelter use. This option would only be possible if the facility was divided into multiple buildings separated by seismic joints that permit relative movement between the individual buildings.

It is also important that non-structural components (building skin, partition walls, ceiling systems, storage cabinets, mechanical equipment, electrical equipment, plumbing equipment, etc.) be adequately braced or anchored. Components that are required for use of the school as an emergency shelter should satisfy Risk Category IV requirements. Equipment that is expected to be operational after an earthquake (emergency generator, automatic transfer switch, ventilation fans, etc.) should satisfy the special certification requirements of the current edition of ASCE 7: *Minimum Design Loads for Buildings and Other Structures*, referenced by the OSSC. Appendix B of the full report describes the differences in seismic design requirements for nonstructural components in Risk Category III (i.e. school) and Risk Category IV (i.e. emergency shelter) buildings.

Achieving a safe and usable performance level in these buildings requires identifying an appropriate performance-based design criteria (as stated above) along with a proper design, detailed peer review and plan check during design, and comprehensive inspection during construction. The need for this multi-faceted process is illustrated in every major earthquake when it is observed that excessive damage is caused by a deficiency in one or more of these areas.

The American Red Cross indicated that once the question of a having a safe and usable building is addressed, the minimum shelter requirements are very basic:

- Thermal Comfort: A wide temperature range is acceptable.
- Natural Ventilation: Being able to bring in fresh air is important.
- Lighting: They can make do with battery lanterns and flashlights if necessary.

Other desirable shelter features include:

- Emergency Power: A source of electricity for lighting, powering medical devices and recharging personal electronic devices.
- Water Supply: A source of water for drinking and personal hygiene.
- Wastewater: An operating wastewater system or holding tank if building restroom and shower facilities are being utilized.

Due to budget and design schedule limitations, not all the resilience features that were discussed as part of this project could be incorporated into the design, construction, and operation of the High School at South Cooper Mountain and the Middle School at Timberland. The resilience features that have been adopted are summarized in the following tables. The intent behind these selected options was to build-in as much flexibility as possible in order to facilitate future resilience upgrades as funding becomes available.

The resilient design features being implemented as part of this project are intended to provide a building structure that is safe to occupy after a large earthquake and that incorporates certain features (limited emergency power, ventilation fans in common areas, building connections for portable water tanks, etc.) that will reasonably facilitate use of the High School at South Cooper Mountain and the Middle School at Timberland as emergency shelters.

As additional funding becomes available or the cost of certain technology (photovoltaics, inverters, storage batteries, etc.) decreases, it may be possible to provide additional resilience features that will make using the school as an emergency shelter easier or enable additional services to be provided by the shelter.

> "We cannot solve our problems with the same thinking we used when we created them." — Albert Einstein

Adopted Resilience Design Features – High School at South Cooper Mountain *(330,000 SF, 2,200 students, 3-story plus partial basement, building cost: $90M)*	
Resilience Feature	**Cost Estimate**
1) Design building structure's lateral-force resisting system for seismic Risk Category IV	$500,000
2) Provide 500 kW emergency generator with 96-hour run time fuel storage. Emergency generator, switch gear, ventilation fans, and other equipment that is expected to be operational after an earthquake should satisfy the special certification requirements of ASCE 7-10, which is referenced by the OSSC	$330,000
3) Provide electrical service to power lighting and ventilation fans in common areas and gymnasium on emergency power; does not provide heated or conditioned air	$8,000
4) Provide stub-outs at building exterior to allow use of portable water tank and associated pump to supply water to key building areas: kitchen, locker rooms & showers, drinking fountains in common spaces and restrooms serving the Dining Commons	$15,000
5) Provide two electrical outlets in kitchen on emergency power to allow hot plates for water boiling, etc.	$5,000
6) Provide natural gas seismic shutoff valve at meter	Negligible
7) Provide hardened water service line from the Beaverton Water District (BWD) water line to building	TBD
8) Provide hardened sanitary sewer service line from Clean Water Services (CWS) sewer line to building	TBD
9) Provide seismic bracing/anchorage design of nonstructural components based on Risk Category III requirements except that those components required for use of the school as emergency shelter (as specified in Sections 5.5 and 5.6) satisfy Risk Category IV requirements	Negligible
Approximate Total	**$900,000**

Middle School Aerial View – 12/30/15 (Courtesy BSD)

High School Aerial View - 3/7/16 (Courtesy BSD)

Adopted Resilience Design Features – Middle School at Timberland *(165,000 SF, 1,100 students, 2-story, building cost: $43M)*	
Resilience Feature	**Cost Estimate**
1) Design building structure's lateral-force resisting system for seismic Risk Category IV	$310,000
2) Provide 450 kW emergency generator with 96-hour run time fuel storage. Emergency generator, switch gear, ventilation fans, and other equipment that is expected to be operational after an earthquake should satisfy the special certification requirements of ASCE 7-10, which is referenced by the OSSC	$400,000
3) Provide electrical service to power lighting and ventilation fans in common areas and gymnasium on emergency power; heating is only provided for the commons, gymnasium, administrative wing and locker room area, does not provide conditioned air	Included in Total
4) Provide quick-connect stub-outs at building exterior to allow use of portable water tank and associated pump to supply water to key building areas: kitchen, locker rooms & showers, and drinking fountains in common spaces	$20,000
5) Provide two electrical outlets in kitchen on emergency power to allow hot plates for water boiling, etc.	$5,000
6) Provide natural gas seismic shutoff valve at meter	Negligible
7) Provide hardened water service line from Tualatin Valley Water District (TVWD) water line to building	TBD
8) Provide hardened sanitary sewer service line from Clean Water Services (CWS) sewer line to building	TBD
9) Provide seismic bracing/anchorage design of nonstructural components based on Risk Category III requirements except that those components required for use of the school as emergency shelter (as specified in Sections 6.5 and 6.6) satisfy Risk Category IV requirements	Negligible
Approximate Total	**$750,000**

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Acknowledgements

We would first like to acknowledge the Beaverton School District for their courageous response to *The Oregon Resilience Plan* and the challenge of a Cascadia Subduction Zone earthquake. Stepping up to this challenge, they are seeking to make their schools safe, be available as a community shelter, and be ready to re-open schools within 30 days following the earthquake. The District's willingness to engage community stakeholders such as the city and county emergency management agencies, Tualatin Valley Fire & Rescue, American Red Cross, and others has initiated a unique and useful collaboration that will bear fruit in the years to come.

We have appreciated the participation and contributions by the design teams (led by Boora Architects for the new High School at South Cooper Mountain and Mahlum Architects for the new Middle School at Timberland) and the Beaverton School District project management teams for both schools (Richard L. Steinbrugge, David Etchart, Leslie Imes, Patrick O'Harrow, Scott Johnson, and Ryan Hendricks). The goal of making the high school and middle school resilient was introduced to them after the start of the design process. Their participation and feedback allowed us to incorporate resilient design features that will make a difference.

As part of this project, the Beaverton School District convened a resilience workshop to bring together the various stakeholders to discuss what would be necessary to achieve the goals of utilizing the new high school and new middle school as emergency shelters and to generally improve the disaster resilience of Beaverton schools. We would like to thank the workshop participants and the organizations they represent for their time and participation in this groundbreaking resilience planning effort. Workshop participants included:

Jerry Abdie	KPFF Consulting Engineers
Bruce Barney	Portland General Electric
Aaron Boyle	Beaverton School District
Mike Britch	Tualatin Valley Water District
Brian Butler	Interface Engineering
David Chesley	Interface Engineering
Nate Cullen	Clean Water Services
Tiffany Delgado	Portland General Electric
David Etchart	Beaverton School District
Clint Fella	Oregon Office of Emergency Management
Karl Granlund	Beaverton School District
Jim Harold	Boora Architects
Scott Holum	Interface Engineering
Leslie Imes	Beaverton School District
Ruwan Jayaweera	PAE Engineers
Scott Johnson	Beaverton School District
Siobhan Kirk	Tualatin Valley Fire & Rescue
Michael Kummerman	NW Natural
Bobby Lee	Portland Metro Regional Solutions
Steve Muir	Washington County Emergency Management Cooperative
Michael Mumaw	City of Beaverton
Patrick O'Harrow	Beaverton School District
Curtis Peetz	American Red Cross
Scott Porter	Washington County Emergency Management Cooperative
Jeff Rubin	Tualatin Valley Fire & Rescue
Dick Steinbrugge	Beaverton School District
Brandon Watt	PAE Engineers
Dave Winship	City of Beaverton
Kurt Zenner	Mahlum Architects

Tualatin Valley Fire & Rescue graciously provided access to their Command & Business Operations Center to host the resilience workshop convened as part of this project. We would like to thank Deputy Chief Dustin Morrow and Tualatin Valley Fire & Rescue for their support.

Washington County is very interested in improving the resilience planning process by continuing the efforts to breakdown the silo mentality, as initiated by this project. We would like to thank the Assistant County Administrator for Washington County, Don Bohn and Washington County for their active engagement in this project.

Lastly, we would like to thank State Representative Tobias Read for his overwhelming support of this project and the goal of improving the resilience of Beaverton schools.

Note: The full Beaverton School District Resilience Planning report is available online at the Beaverton School District website:
https://www.beaverton.k12.or.us/depts/facilities/Documents/150710_Beaverton%20School%20Report.pdf