

# Volume II Hazard Annex

## Windstorm

### Causes and Characteristics of Windstorms

Extreme winds occur throughout Oregon. The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge. High winds in the Columbia Gorge are well documented. The Gorge is the most significant east-west gap in the Cascade Mountains between California and Canada. Wind conditions in southeast Oregon are not as dramatic as those along the coast or in the Gorge yet can cause dust storms or be associated with severe winter conditions such as blizzards. A majority of the destructive surface winds striking Oregon are from the southwest. Some winds blow from the east but most often do not carry the same destructive force as those from the Pacific Ocean.

West winds generated from the Pacific Ocean are strongest along the coast and slow down inland due to the obstruction of the Coastal mountain range.<sup>227</sup> Prevailing winds in Oregon vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction. For example, the north-south orientation of the Willamette Valley channels the wind most of the time, causing predominately north and south winds.<sup>228</sup>

The Columbus Day storm in 1962 was the most destructive windstorm ever recorded in Oregon in terms of both loss of life and property. Damage from this event was the greatest in the Willamette Valley. The storm killed 38 people and left over \$200 million in damage. Hundreds of thousands of homes were without power for short periods, while others were without power for two to three weeks. More than 50,000 homes suffered some damage and nearly 100 were destroyed. Entire fruit and nut orchards were destroyed and livestock killed as barns collapsed and trees blew over. In Portland, the highest gusts were 116 miles per hour.

Although rare, tornados can and do occur in Oregon. Tornadoes are the most concentrated and violent storms produced by the earth's atmosphere. They are created by a vortex of rotating winds and strong vertical motion, which possess remarkable strength and cause widespread damage. Wind speeds in excess of 300 mph have been observed within tornadoes, and it is suspected that some tornado winds exceed 400 mph. The low pressure at the center of a tornado can destroy buildings and other structures it passes

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<sup>227</sup> US Department of Agriculture. Available on the World Wide Web <http://www.fsa.usda.gov/or/Notice/Flp104.pdf>

<sup>228</sup> Statesman Journal. February 8, 2002.

over. Tornadoes are most common in the Midwest, and are more infrequent and generally small west of the Rockies. Nonetheless, Oregon and other western states have experienced tornadoes on occasion, many of which have produced significant damage and occasionally injury or death. Oregon's tornadoes can be formed in association with large Pacific storms arriving from the west. Most of them, however, are caused by intense local thunderstorms. These storms also produce lightning, hail, and heavy rain, and are more common during the warm season from April to October.<sup>229</sup> Since 1957, five reported tornados have struck Marion County. Their impacts are described in the next section.

## History of Windstorms in Marion County

Windstorms have historically been a threat to Marion County. The following storms, though not exclusive to Marion County, caused particularly severe damage to the county.

### January 9, 1880

This windstorm was a major blow down event in the region and for Marion County, and was the most severe windstorm to strike the region until the Columbus Day Windstorm in 1962. Winds in Salem gusted up to 80 mph, blowing down many acres of trees, and damaging the roof of the Statehouse, Willamette University, and many other buildings. The City of Hubbard, in the North part of Marion County, saw a 10 acre woodlot completely flattened. It was reported that almost all property owners in Salem likely lost at least some vegetation. There were several reports of injuries throughout western Oregon of injuries due to flying debris. Following the storm, seven inches of snow fell in Salem.<sup>230</sup>

### April 1931

This storm, with winds up to 40 mph and gales up to 75 mph, blew moving vehicles off roadways in Salem and Woodburn.<sup>231</sup> The storm consisted of northeastern winds that blew tons of dust from Eastern Oregon down the Columbia Gorge where it then settled over much of the Willamette Valley. The dust reduced visibility to distances less than one mile. The sediment-filled winds also felled hundreds of trees causing road closures between Mill City and Detroit. The winds also caused several devastating fires. In Mehama, several buildings burned completely; including homes, a large store and the Stayton Bank. There were 22 home fires in the Salem area and

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<sup>229</sup> Taylor, George H., Holly Bohman, and Luke Foster. August 1996. A History of Tornadoes in Oregon. Oregon Climate Service. Corvallis, OR: Oregon State University. Available on the World Wide Web

<http://www.ocs.orst.edu/pubftp/reports/book/tornado.html>

<sup>230</sup> Reed, Wolf. "The January 9, 1880 'Storm King'" Office of the Washington State Climatologist. <http://www.climate.washington.edu/stormking>

<sup>231</sup> Oregon Statesman. April 22, 1931.

throughout the Willamette Valley forest fires, as large as 3,000 acres in Linn County, were whipped up by the winds.<sup>232</sup>

## **December 1951**

This mid-century storm with winds recorded at 57 mph and gusts up to 76 mph resulted in four Oregon deaths. Power outages for up to a day were recorded at Union Hill, Waldo Hill, Victor Point, Scotts Mills, Silverton Hills and Marquam. The North and South Santiam highways and the Siuslaw highway were closed due to fallen trees.<sup>233</sup>

## **October 12, 1962 (The Columbus Day Storm)**

The Columbus Day storm in 1962 produced sustained winds in Salem of 58 mph and gusts as high as 90 mph<sup>5</sup>. It was the most destructive windstorm ever recorded in Oregon, both in terms of loss of life and property damage. Damage was most severe in the Willamette Valley where the storm killed 38 people and was responsible for two deaths in Salem and four injuries in Silverton.<sup>234</sup> The storm caused upwards of \$200 million in damage (over \$800 million in today's dollars) statewide.<sup>235</sup> Approximately \$4 million (in 1962 dollars) in damage occurred in Salem, while that number doubled to \$8 million worth of damage in Marion County as a whole.<sup>236</sup> Hundreds of thousands of homes were without power for short periods of time, while others were without power for two to three weeks. More than 50,000 homes were seriously damaged, and nearly 100 were completely destroyed. In Salem, 40 schools were closed and 7,000 residents lost phone service. The storm destroyed fruit and nut orchards and killed scores of livestock.<sup>237</sup>

## **March 25-26, 1971**

This March windstorm produced winds up to 50 mph and hit the Hubbard and Scotts Mills area particularly hard while also causing power outages for approximately 60 homes in the Salem area.<sup>238</sup>

## **November 13-15, 1981**

November 1981 saw two successive windstorms on the 13th and 14th. Sustained winds in Salem reached 52 mph and gusts were recorded at 71 mph.<sup>239</sup> Eleven people were killed and \$50 million in damage was reported as a result of the two storms. Numerous injuries resulted from wind-blown

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<sup>232</sup> Oregon Statesman. April 23, 24 1931.

<sup>233</sup> Oregon Statesman. December 5, 1951.

<sup>234</sup> National Weather Service, Portland Bureau. Available on the World Wide Web <http://www.wrh.noaa.gov/Portland>.

<sup>235</sup> Ibid.

<sup>236</sup> Oregon Statesman. October 14, 1962.

<sup>237</sup> Oregon Statesman. October 15, 1962.

<sup>238</sup> Oregon Statesman. March 27, 1971.

<sup>239</sup> Statesman Journal. November 15, 1981.

debris in western Washington and Oregon.<sup>240</sup> Across the Pacific Northwest, hundreds of downed trees and power lines caused massive power outages and roof damage. The storm caused 500,000 Oregon residents to lose power,<sup>241</sup> 20,000 in the Salem area alone. The storm toppled 23 power poles on the Silverton Road and power outages in Salem resulted in seven school closures.<sup>242,243</sup>

## **December 12, 1995**

This windstorm caused such widespread damage from downed trees and power and communication outages that Governor Kitzhaber declared a state of emergency for all of western Oregon and called 150 National Guard Troops to assist residents and public utility crews.<sup>244,245</sup> The storm caused three deaths, one in Marion County. The windstorm resulted in \$800,000 of damage in Marion County, \$500,000 of which occurred in Woodburn alone.<sup>246</sup> Some of this damage included environmental damage as “millions of gallons of raw sewage” flowed into Salem area creeks and the Willamette River.<sup>247</sup>

In Salem, the National Weather Service reported average winds of 40 mph with gusts up to 59 mph. In the region between Salem and Corvallis, 7,500 people lost phone service. In the Salem area, including Silverton and Woodburn, 20,000 people lost power; in the Stayton and Mill City area, that number was 10,000. In addition to power and phone outages, Interstate 5 was shut down to truck traffic for several hours and Highway 22 at Valley Junction was closed.<sup>248</sup>

## **February 7, 2002**

The most recent of large windstorm events arrived in the Willamette Valley with wind gusts up to 70 mph causing 27,000 power outages statewide.<sup>249</sup> The severity of this storm prompted President Bush to issue major disaster declarations for five Oregon counties. Nine other Oregon counties, including Marion County, were named contiguous counties, allowing family farmers to receive loans to address storm related damage.<sup>250</sup> Eastern Marion County was one of the areas hardest hit by this

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<sup>240</sup> Taylor, George H. and Raymond R. Hatton. 1996. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. Page 153.

<sup>241</sup> National Weather Service, Portland Bureau. Available on the World Wide Web <http://www.wrh.noaa.gov/Portland/windstorm.html>. Accessed March 2003.

<sup>242</sup> Oregon Statesman. November 17, 1981.

<sup>243</sup> Oregon Statesman. November 15, 1981.

<sup>244</sup> Statesman Journal. December 14, 1995.

<sup>245</sup> Statesman Journal. December 12, 1995.

<sup>246</sup> Statesman Journal. December 14, 1995.

<sup>247</sup> Davies, Janet. *The Statesman Journal*. December 13, 1995: page 1A, 2A.

<sup>248</sup> Statesman Journal. December 13, 1995.

<sup>249</sup> Statesman Journal. February 9, 2002.

<sup>250</sup> US Department of Agriculture. Available on the World Wide Web

storm. In Gates, the wind blew off the post office roof and Highway 22 east of Mehama was closed after trees blocked the roadway. A downed tree blocked Highway 99 near Jefferson and the Interstate 5 corridor between Salem and the Highway 34 exit experienced storm-related congestion.<sup>251</sup>

## **July 2003**

A major windstorm in Marion County caused approximately \$15,000 in property damage.<sup>252</sup>

## **December 2004**

A windstorm causes \$6,250 in property damage in Marion, Lane, and Polk Counties.<sup>253</sup>

## **January 2005**

Windstorms cause \$6,000 worth of property damage in Linn and Marion Counties. A storm total of \$15,000 in damages was spread out among Linn, Marion, Clackamas, Multnomah, and Washington Counties.<sup>254</sup>

## **February 2006**

A windstorm with gusts up to 77 mph caused \$227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties.<sup>255</sup>

## **May 2007**

A hail storm causes \$5,000 in damages in Marion County.<sup>256</sup>

## **March 2008**

Heavy winds measured at 40 mph causes \$15,000 in damage near Woodburn.<sup>257</sup>

## **June 2009**

A strong wind storm with 80 mph winds, and followed by a thunderstorm, brought down numerous trees along Highway 22 and caused approximately \$2,000 in damage.<sup>258</sup>

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<http://www.fsa.usda.gov/or/Notice/Flp104.pdf>

<sup>251</sup> Statesman Journal. February 8, 2002.

<sup>252</sup> U.S. Department of Commerce. National Climatic Data Center. Available from <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>.

<sup>253</sup> Hazards & Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from <http://www.sheldus.org>

<sup>254</sup> Ibid.

<sup>255</sup> Ibid.

<sup>256</sup> U.S. Department of Commerce. National Climatic Data Center. Available from <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>.

<sup>257</sup> Ibid.

<sup>258</sup> Ibid.

## Tornadoes in Marion County

The following list describes known tornados occurring in Marion County from 1925 through present. The National Climate Data Center (NCDC) storm events database (<http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms>) was the primary source of information for this history. Note that OPDR removed two tornados listed in the previously adopted version of the Marion County NHMP (the Sandy tornados) from the history as further review determined that neither event directly impacted Marion County. Between 1960 and 2006, tornados in Marion County caused approximately \$50,000 in property damage collectively. The December 2010 Aumsville tornado event is expected to result in damages exceeding \$1 million.

### **Salem area - November 11, 1925, 11:00 am**

Tornado with estimated beginning lat/lon 44°52'/123°11'<sup>259</sup>

### **NW Donald - October 26, 1984, 12:30 pm<sup>260</sup>**

Estimated beginning lat/lon 45°14' 122°53'

### **Aumsville – March 8, 1960, 5:15 pm**

A small F1 tornado with an estimated beginning lat/lon 45°01' 122°53' and width of seven yards traveled approximately one mile. There were no reports of injuries. The event resulted in \$2,500 in property damage to several farms and uprooted a number of trees.<sup>261</sup>

### **Aurora – October 26, 1984, 12:30 PM**

A small F0 tornado reportedly struck six-miles west of the town of Aurora. It had a path length of one-half mile and width of 67 yards. The tornado “destroyed a small machine shed on the Leighton Whitsett Case Road NE farm” and scattered its pieces over a half-mile area. Estimated damage from the storm was \$4,000.<sup>262</sup>

### **E Keizer - May 31, 1997, 10:10 am**

An F0 tornado touched down approximately one-mile east of Keizer. The 50-yard wide funnel traveled approximately 1.5 miles to a point roughly three-miles east-south-east of Keizer. According to the NCDC report, several witnesses reported seeing the tornado on the ground for about two minutes. The storm uprooted 30-40 foot tall trees and damaged a barn resulting in \$15,000 in repair costs.<sup>263</sup>

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<sup>259</sup> Information compiled by NOAA through the Oregon Historical Museum archives.

<sup>260</sup> Ibid

<sup>261</sup> National Climate Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms>

<sup>262</sup> Ibid

<sup>263</sup> Ibid

### **SW Turner - September 17, 1997, 10:35 am**

An F0 tornado touched down two miles southwest of Turner resulting in \$10,000 in minor damage to a rural subdivision. Damage was limited to fences, windows and trees. The tornado impacted an area 50-yards wide and one mile long.<sup>264</sup>

### **N Aumsville - September 17, 1997, 11:05 am**

A small tornado estimated at 10-yards wide and a half-mile long touched down near Aumsville. There were no reports of injuries or property damage.<sup>265</sup>

### **Silverton – November 12, 1997**

This tornado damaged a barn. Several timber units tumbled down in the Detroit Ranger District of the Willamette National Forest during this windstorm, which was cyclonic in nature in the eastern portion of the Santiam Canyon.<sup>266</sup>

### **Silverton October 3, 1998, 2:30 pm**

A Silverton Police officer reported seeing a small tornado touch down near Silverton. There were no reports of damage or injury.<sup>267</sup>

### **NE Salem December 16, 2006, 3:00 pm**

Immediately following a thunderstorm with frequent lightning and small hail, an F0 tornado touched down approximately eight miles northeast of Salem. The 50-yard wide funnel traveled approximately two-miles over rural agricultural land. Reports indicate that the tornado crossed an acre and a half of floodwater up to three feet deep and sucked all the water up into the funnel. The tornado then continued on and picked up a 12-inch diameter cedar tree and tossed it into a barn. After changing direction, the tornado picked up an RV causing it to land on its side. There were no injuries reported.<sup>268</sup>

### **Aumsville December 14, 2010, 11:44 am**

An EF2 tornado with wind speeds between 110 and 120 mph touched down on Main Street near the southerly boundary of the City of Aumsville. This was the largest tornado recorded in Marion County to date and the second largest in the state since 1950. According to a December, 23, 2010 NOAA storm survey report, the tornado traveled in a northeasterly direction and had a path length of approximately five-miles. An on-sight

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<sup>264</sup> National Climate Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms>

<sup>265</sup> Ibid

<sup>266</sup> Halemeier, Dave. Hydrogeologist, US Forest Service, Willamette National Forest, Detroit Ranger District. Personal Interview. February 3, 2005.

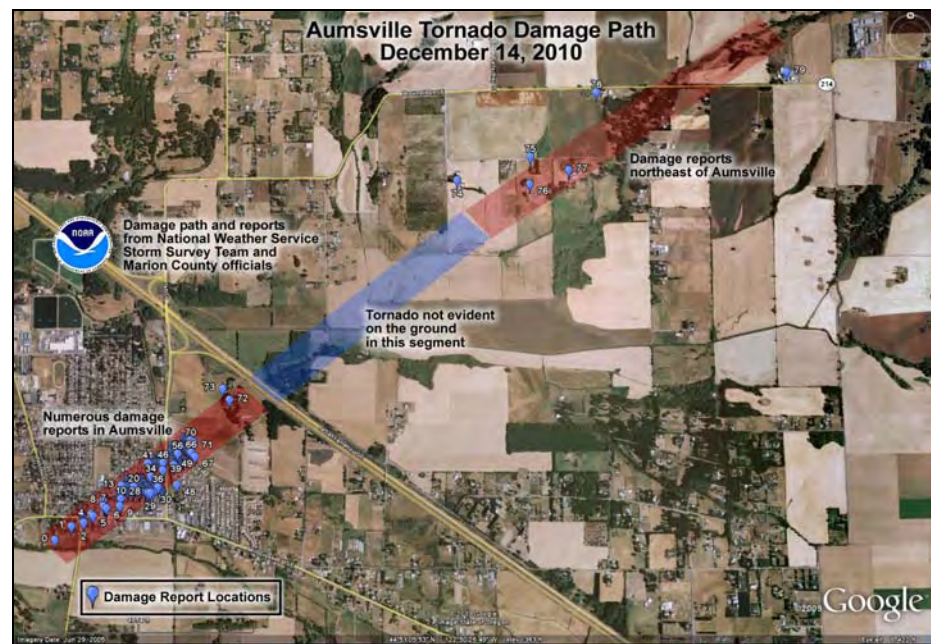
<sup>267</sup> National Climate Data Center, <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms>

<sup>268</sup> Ibid

ground assessment concluded that the tornado did not appear to be on the ground for the entire five-mile path length (refer to Figure WS 1.1 below).

The tornado damaged numerous residential and commercial structures, downed power and light poles, uprooted or snapped of over 30 large (average 18-24 inch diameter breast height) trees and resulted in two minor injuries from flying debris. The initial damage assessment conducted by Marion County Emergency Management in collaboration with local and state partners estimate total losses from the storm at over \$1.1 million.<sup>269</sup> Damage included the total destruction of two homes and one business and major damage to an additional six homes and one business. In all, 63 dwellings, seven business, eight outbuildings and a number of public facilities were impacted by this storm. At the time of this report, response and recovery activities in Aumsville are still underway; final damage reports and the extent of resources made available from local, state and federal sources are pending.

Figure WS 1.1 – Aumsville Tornado Damage Path



## Risk Assessment

### How are Hazard Areas Identified?

Windstorms in Marion County usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain.<sup>270</sup> They are primarily identified by the

<sup>269</sup> December 14, 2010 Aumsville Tornado Initial Damage Assessment Summary Form, Marion County Emergency Management.

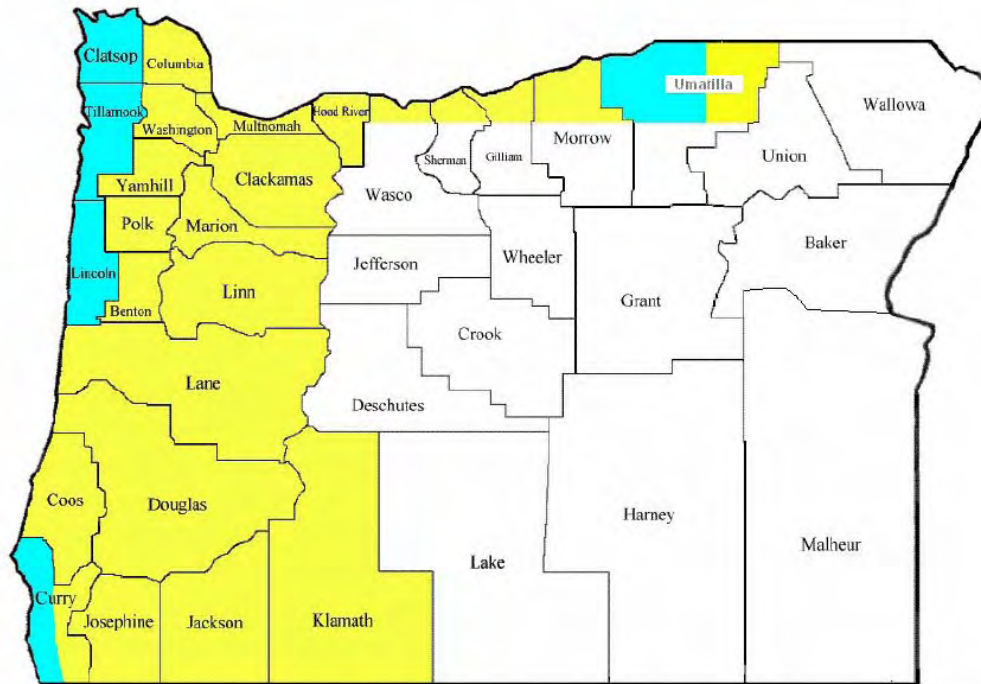
<sup>270</sup> State of Oregon Natural Hazards Mitigation Plan. Oregonshowcase.org, March 2006. [http://www.oregonshowcase.org/downloads/pdf/stateplan/OR-SNHMP\\_wind\\_chapter\\_2009.pdf](http://www.oregonshowcase.org/downloads/pdf/stateplan/OR-SNHMP_wind_chapter_2009.pdf)



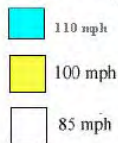
National Weather Service. The National Weather Service uses weather forecast models to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon.<sup>271</sup>

Tree damage associated with windstorms is very place sensitive. For identifying the hazards posed to structures, Figure 3 below shows the maximum wind speed that structures 33 ft above the ground would expect to be exposed to.

**Figure 3 Oregon Building Codes Wind Speed Map**



- a. All areas with full exposure to the ocean winds shall be designated 110 mph areas
- b. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet above ground for Exposure C category.
- c. Areas in Multnomah and Hood River Counties with full exposure to Columbia River Gorge winds shall be designated 110 mph areas.



Source: State of Oregon Natural Hazards Mitigation Plan

## Probability of Future Occurrence

The recurrence interval of a windstorm on the order of the Columbus Day Storm is about 100 years. A windstorm on the order of the February 2002 windstorm has a recurrence interval of 10-12 years. The hazard history section details 14 severe windstorms and tornadoes affecting Marion

<sup>271</sup> "Some of the Area's Windstorms." National Weather Service, Portland.  
<http://www.wrh.noaa.gov/pqr/paststorms/wind.php>

County in the last 130 years. While other storms could have been included with more background information available, those included average out to one windstorm or tornado every 9.3 years.

The Marion County steering committee determined that based on this information, the probability of a windstorm occurring is **high**, meaning that Marion County will be affected by a windstorm or tornado within a 10-35 year period. This high rating is consistent with the 2006 Marion County Hazard Analysis.

## Vulnerability Assessment

Windstorms can cause power outages, transportation, and economic disruptions. Structures most vulnerable to high winds in Marion County include insufficiently-anchored manufactured homes and older buildings with roof structures not designed for anticipated wind loads. Fallen trees and debris are common and can block roads for long periods, in addition to bringing down power and/or utility lines. As noted in the hazard history section above, almost all major wind storms in Marion County have caused some damage to property.

The Marion County Steering Committee determined that the county's vulnerability to windstorms is **high**, meaning that more than 10% of the population or regional assets would be affected by a windstorm. This rating is consistent with the 2006 Marion County Hazard Analysis.

## Risk Analysis

A risk analysis estimating the potential loss of life and property from a windstorm in Marion County has not been completed at this time. However, given the high probability of a windstorm occurring and the county's high vulnerability, a risk analysis should be completed when data is available (see Multi-Hazard Action # 8).

## Community Hazard Issues

### What is susceptible to damage during a hazard event?

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Positive wind pressure is a direct and frontal assault on a structure, pushing walls, doors, and windows inward.

Negative pressure also affects the sides and roof: passing currents create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact and remove the building protective envelope (doors, windows, and walls), internal pressures rise and result in roof or leeward building component failures and considerable structural damage. The effects of winds are magnified in

the upper levels of multi-story structures. The Marion County Steering Committee identified buildings such as unanchored manufactured homes, multi-story retirement homes, and buildings in need of roof repair as the structures most vulnerable to wind storms in Marion County. Buildings adjacent to open fields or adjacent to trees are also more vulnerable to wind storms than more protected structures. The effects of wind speed are shown in Figure 6.

**Figure 6 Effects of Wind Speed**

Wind Speed (Mph)	Wind Effects
25-31	Large branches will be in motion.
32-38	Whole trees in motion; inconvenience felt walking against the wind.
39-54	Twigs and small branches may break off trees; wind generally impedes progress when walking; high profile vehicles such as trucks and motor homes may be difficult to control.
55-74	Potential damage to TV antennae; may push over shallow rooted trees, especially if the soil is saturated.
75-95	Potential for minimal structural damage, particularly to unanchored mobile homes; power lines, and signs; and tree branches may be blown down.
96-110	Moderate structural damage to walls, roofs and windows; large signs and tree branches blown down; moving vehicles pushed off roads.
111-130	Extensive structural damage to walls, roofs, and windows; trees blown down; mobile homes may be destroyed.
131-155	Extreme damage to structures and roofs; trees uprooted or snapped.
Greater than 155	Catastrophic damage; structures destroyed.

Source: Washington County Office of Consolidated Emergency Management

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Bedroom communities such as Silverton and Stayton could potentially be isolated if roads are blocked by fallen trees.

Windstorms can cause flying debris which can also damage utility lines. Overhead power lines can be damaged even in relatively minor windstorm events.

Industry and commerce can suffer losses from interruptions in electric service and from extended road closures. They can also sustain direct

losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

## Existing Mitigation Activities

### Marion County Activities

Marion County has adopted the International Building Code which sets standards for structures to withstand 80 mph winds.

### State Programs

As noted in Oregon's Natural Hazard Mitigation Plan, the Oregon Department of Forestry and the NW Chapter of the International Association of Arboriculture provides informational materials on how to recognize and prevent tree hazards, as well as workshops on this topic. They include continually-updated information for homeowners on how to identify potentially damaging trees in the event of a windstorm.<sup>272</sup>

## Windstorm Mitigation Action Items

The following actions have been identified by the Marion County steering committee, and are recommended for mitigating the potential effects of windstorms in Marion County. Please see full action item worksheets in Appendix A.

**WS1:** Initiate a comprehensive program to reduce or eliminate tree hazards to all critical utilities in Marion County. This program includes a prioritization of critical facilities, an assessment of potential tree hazards, and a program to trim, and/or remove tree hazards in designated critical areas.

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<sup>272</sup> State of Oregon Natural Hazards Mitigation Plan. Oregonshowcase.org, March 2006. [http://www.oregonshowcase.org/downloads/pdf/stateplan/OR-SNHMP\\_wind\\_chapter\\_2009.pdf](http://www.oregonshowcase.org/downloads/pdf/stateplan/OR-SNHMP_wind_chapter_2009.pdf)