

San Juan County Hazard Mitigation Plan 2018

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ADOPTION

The San Juan County Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) was adopted by the San Juan County Board of Commissioners on [date to be determined], and by the Town of Friday Harbor on [date to be determined.]

Section 1. INTRODUCTION

San Juan County is widely known for its natural landscapes, unique communities, and idyllic setting. Yet it is also an area vulnerable to a variety of natural hazards. There have been relatively few significant natural disasters impacting San Juan County since European settlement, but a comprehensive study of local history and data reveals extended periods of high winds, sub-freezing temperatures, and potential for wildland urban interface fires, and earthquakes, and tsunamis.

In interviews conducted during the development of this plan, many long-time residents remarked that big storms, drought periods, and wildfires weren't considered disasters, or even notable in the old days because island families were accustomed to these events "and knew to take care of each other."¹ Recorded accounts of natural disasters in local historical archives and newspapers echo this pioneer attitude toward adversity and self-reliance.

However, times change, and so have conditions in San Juan County. Rapid population growth since the 1990s has resulted in greater numbers of residents and visitors exposed to natural hazards which exist in the islands. These changes, combined with the isolation of the county's fifteen year-round inhabited islands, play a role in the vulnerability to natural hazards.

We cannot prevent the infrequent disastrous acts of nature, but we can implement strategies designed to reduce the property damage, disruption of services, devastation to the local economy, and the long-term risks to people that typically follow a natural disaster. This is hazard mitigation. The creation of the San Juan County Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) is a comprehensive assessment of local vulnerability to natural hazards—and mitigation measures which can be completed to protect families, homes, business and vitality of the community.

Disaster Mitigation Act 2000

Years of repeated destruction—and rebuilding—from floods, tornadoes, and hurricanes led the federal government to adopt the Disaster Mitigation Act of 2000 as an amendment to the Stafford Act. DMA2000 requires local governments to have in place a FEMA-approved hazard mitigation plan in order to apply for and/or receive project grants under the following hazard mitigation assistance programs:

- Hazard Mitigation Grant Program (HMGP) The Hazard Mitigation Grant Program (HMGP) provides funds to States, Territories, Tribal governments, local governments, and eligible private non-profits (PNPs) following a Presidential major disaster declaration.
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)

The DMA2000 seeks to facilitate cooperation among state and local authorities by promoting pre-disaster planning and sustainability as a strategy for disaster resistance.

By proactively investing time and resources in hazard mitigation, the goal is to significantly lessen the amount of time and funding needed for disaster recovery, repair, and reconstruction. Residents, public agencies, and local businesses will be better equipped to bring our community and local economy back to normal sooner, with fewer long-term psychological and economic consequences.

Why Plan for Natural Hazards in San Juan County?

Photographs, journal entries, and newspapers (dating from as early as the mid 1800's) show islanders dealing with severe winter storms, drought, wildfires, and earthquakes. Our vulnerability continues today. Wildland-urban interface fires are an ongoing threat, particularly when coupled with the potential for drought and limited water supplies. Despite the “banana belt” reputation of the islands, annual winter storms—with strong winds, rain, surface flooding, freezing temperatures, and snow—are regular occurrences that can result in power outages, disruption to transportation, limited access to medical and other essential services, and destruction of property. To this list add the potential for a Cascadia Subduction Zone earthquake and follow on tsunamis; events which have more recently received greater attention, study, and awareness.

It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the county. However, recent disasters nationally and internationally teach us that no area is safe from the forces of nature and that when disasters occur, outside help may be delayed. So we owe it to ourselves, and each other, to plan ahead—and in the best of island traditions, to become a more self-reliant, disaster resistant, sustainable community.

Section 2. THE PLANNING PROCESS

Multi-Jurisdictional Participation

The plan reflects the joint efforts of two government jurisdictions: San Juan County and the Town of Friday Harbor. While this is a multi-jurisdiction plan, the planning team has determined that the same natural hazards exist for both the Town of Friday Harbor, and Unincorporated San Juan County.

It should be noted that for the purposes of Comprehensive Planning under the Washington State Growth Management Act (GMA) the Town of Friday Harbor and San Juan County have established policies for joint county and town planning, including "contiguous and orderly development", and "siting essential public capital facilities of county or state wide significance" among other policies.



Goals of the NHMP

The following mitigation goals guided the Natural Hazard Mitigation Planning:

- Goal 1— Reduce natural hazard-related injury and loss of life.
- Goal 2— Reduce property damage.
- Goal 3— Increase public awareness and ability to respond to disasters.
- Goal 4— Maintain, enhance, and restore the natural environment's capacity to absorb and reduce the impacts of natural hazard events.

Mitigation Planning Team

The San Juan County Natural Hazards Mitigation Planning Team is composed of 22 representatives from the Town of Friday Harbor, San Juan County and various related organizations.

Brendan Cowan, *Director, SJC Department of Emergency Management*

Dave Halloran, *Assistant Director, SJC Department of Emergency Management*

Russ Harvey, *Director, SJC Public Works*

Colin Huntmer, *County Engineer, SJC Public Works*

Kendra Smith, *Environmental Resources Manager, San Juan County Public Works*

Kyle Dodd, *SJC Public Health Environmental Health Mgr.*

Mike Thomas, *San Juan County Manager*

Erika Shook, *Director, San Juan County Community Development*

Linda Kuller, *Planning Manager, Deputy Director, San Juan County Community Development*

Jason Ontjes, *Coordinator, San Juan County Noxious Weed Program*

Duncan Wilson, *Town of Friday Harbor Administrator*

Wayne Haefele, *Public Works Director, Town of Friday Harbor*

Mike Bertrand, *Building Official, Town of Friday Harbor*

Brad Creesy, *Fire Chief, San Juan Island Fire Department FPD 3*

J Havner, *Fire Chief, Lopez Fire Department, FPD 4*

Scott Williams, *Fire Chief, Orcas Fire and Rescue FPD 2*

Jon Shannon, *Fire Chief, Shaw Island Fire Department FPD 5*

Ron Garner, *FireWise Coordinator, San Juan Island Fire Department FPD 3*

Robert Walters, *Water Resources Manager/ Firewise Coordinator, San Juan Islands Conservation District*

Paul Kamin, *General Manager Eastsound Water User's Association*

Todd Nicholson - *Executive Director, Port of Friday Harbor*

Tami Hayes, *Harbormaster, Port of Friday Harbor*

Planning group members participated in the meetings shown below. Other meetings were held with individual planning group members.

Planning Group Meetings	
Date	Participants
April 24, 2018	Russ Harvey, Mike Bertrand, Brendan Cowan, Dave Halloran
May 7, 2018	Brendan Cowan, Russ Harvey, Kendra Smith, Mike Thomas, Erika Shook, Rick Hughes (County Council Member), Jamie Stephens (County Council Member), Bill Watson (County Council Chair), Amy Vira, Shannon Wilbur

Planning Process

The island community was presented with several ways to participate in the planning process. This included public meetings, a web based survey, a web based Hazard Mitigation submission form and discussion with interested members of the community. Specific information includes:

- **Public Meetings:** The Natural Hazard Mitigation Planning effort was introduced to the public at meetings on Lopez Island on February 25th and on Orcas Island on March 21. The focus of these meetings was natural hazard identification and general preparedness. The concept of mitigation planning was introduced to the attendees. Additional meetings specific to Natural Hazard mitigation were held on San Juan Island/Friday Harbor on May 21st, Orcas

Island May 23rd, and Shaw Island on May 13th. Additional meetings during which discussion about natural hazard mitigation occurred took place on 2/9/18, 3/7/18 and 4/14/18 on Orcas Island; 3/15/18 Lopez Island.

Meeting synopsis:

February 25, 2017, Lopez Island: Community meeting with preparedness discussion and feedback from Lopez Islander about their natural hazard concerns and how to mitigate for the hazards. Over 50 attendees.

March 21, 2017 Orcas Island: Community meeting with preparedness discussion and feedback from Orcas Islanders about their natural hazard concerns and how to prepare for and mitigate for these hazards. Over 70 attendees.

May 13, 2017 Shaw Island: Natural Hazards Planning meeting with Shaw Islanders. Mitigation and ideas for mitigation actions were the highlighted topics for discussion with these islanders. 15 attendees.

May 21, 2017 San Juan Island /Friday Harbor: Natural Hazards Planning meeting with San Juan Island and Friday Harbor residents. Mitigation and ideas for mitigation actions were the highlighted topics for discussion with these islanders. 3 attendees

May 21, 2017 Lopez Island: Natural Hazards Planning meeting with Lopez Island residents. Mitigation and ideas for mitigation actions were the highlighted topics for discussion with these islanders. 5 attendees.

February 9 2018 Orcas Island: Neighborhood and Community Club meeting with preparedness discussion and feedback from Deer harbor residents about their natural hazard concerns and how to prepare for and mitigate for these hazards. 75 attendees

March 7, 2018: Island wide Community meeting at the Seaview Theater in Eastsound with preparedness discussion and feedback from Orcas Islanders about their natural hazard concerns and how to prepare for and mitigate for these hazards. Over 200 attendees

March 15 2018 Lopez Island: Neighborhood meeting with preparedness discussion and feedback from Shark Reef area residents about their natural hazard concerns and how to prepare for and mitigate for these hazards. 40 attendees

April 14, 2018 Orcas Island: Neighborhood and Community Club meeting with preparedness discussion and feedback from Olga residents about their natural hazard concerns and how to prepare for and mitigate for these hazards. 30 attendees.

May 10, 2018 Lopez Island: Island wide Community meeting at the Lopez Community Center with preparedness discussion and feedback from Lopez Islanders about their natural hazard concerns and how to prepare for and mitigate for these hazards. Over 100 attendees.

These meetings often involved spirited discussion during question and answer periods. Questions frequently centered on how to increase household preparedness and how community members may enhance their ability to work together as neighborhoods within an island. It became apparent through these discussions that islanders have an increasing realization and sense of the potential for isolation from supplies and services typically sourced, or arriving from the mainland. These discussions have had the effect of highlighting the ongoing importance of the public education efforts typically engaged in by the San Juan County /Town of Friday Harbor Department of Emergency Management (DEM). Public Education is represented as a strategy in all of the mitigation actions proposed for each natural hazard category.

An important facet of the public meetings was the opportunity for the planning team members to have face to face interaction fellow community members. This has allowed for an empathetic element to be represented in the plan. This "knowing and meeting" of fellow islanders is considered by the planning team to have the plan serve the community much better than one in which the community is "known" only through statistical profiles developed with census or economic data.

- **Web Survey:** Emergency Management (DEM) published a survey to solicit input from the public about how the community has been affected by natural hazards and priority areas of

concern, The survey included questions from the FEMA Mitigation Planning Handbook as well as questions about household disaster preparedness. The survey received over 120 responses. Use of this survey provided excellent insight into how various natural hazards have affected residents of the county, priorities for mitigation and general support for a regulatory approach to natural hazard mitigation.

The survey informed the plan with the following information: The survey participants were most affected by drought, followed by wind and winter storms in equal numbers. Flood was next on the list, followed by earthquake. Storm related events were cited by over 40% of respondents and drought was cited by 20% of respondents. The citation of storm related events was expected, but the high number of participants citing drought was not an expected outcome. Consequently plan development has sought out additional drought mitigation measures in outreach to stakeholders.

- **Mitigation action submittal web form:** DEM prepared a web form for community members to submit mitigation actions. This form was completed by some community members but comments were returned as opposed to mitigation actions. The web form tool did not yield mitigation actions which were usable as submitted, however the information conveyed the residents opinions which were used to inform the planning group for decision making about mitigation actions.
- **Ferry outreach:** DEM staff engaged with community members while riding the inter-island ferry on several dates. A total of 10 ferry riders were interviewed. This outreach was unstructured, i.e. staff interviewed interested ferry riders with questions about perceived hazards and potential mitigations. Perhaps because of the venue, most riders were interested in the potential for tsunami. Consequently, these discussions focused on the originating location of earthquakes which may cause a tsunami affecting San Juan County. The interviewees generally commented on impacts to docks, marinas, the WA State ferries, and asked if vessels should attempt to relocate to deep water if there were sufficient time before arrival of a predicted tsunami. The content of these interviews are reflected in the Earthquake/Tsunami mitigation action "Implement Marina Improvements".

- The San Juan County Hazard Identification and Vulnerability Analysis (HIVA), an assessment of all classes of hazards (natural and man-made) to which the county is vulnerable. These include drought, earthquake, flood, landslide, severe storm, volcanic activity, wildland-urban interface fire, The HIVA was reviewed and analyzed by DEM staff for information applicable to the NHMP.
- Long-time local residents have been interviewed, both to promote awareness of the planning effort and to provide perspective on local natural disaster events and responses over time. These interviews helped to inform the plan about how island residents have been affected by various events over time and have provided perspective on the potential for a changing preparedness profile as new residents migrate to the islands.
- Policy, planning and program documents from Friday Harbor and San Juan County were reviewed for information relevant to the NHMP. These documents are further detailed in the Community Profile section.
- DEM staff completed a review of existing plans, studies, reports and other information. Discussions among DEM staff, interviews of agency officials, the outcome of the public survey determined that the following natural hazards present the highest level of concern for residents of San Juan County:
 - Severe storm
 - Earthquake/tsunami
 - Wildland fire
 - Flood
 - Drought

Wind and Winter storms were listed separately in the public survey, but after input from discussion at public meetings showed that consequences of such events have been very similar in San Juan County and the decision was made to combine these events under "severe storm".

Tsunami research, and discussions with WA State Department of Natural Resources staff have indicated that there is little threat of a tsunami affecting the San Juan Islands, which originates from a distant source earthquake. However, there is research showing a tsunami hazard which details the effects of a tsunami originating from a Cascadia

Subduction Zone earthquake. Considering that such a tsunami would be subsequent to a Cascadia Subduction Zone earthquake with a similar occurrence interval, response and recovery period, tsunami was included with earthquake as a hazard topic.

- DEM staff planned and coordinated the development of the San Juan County Natural Hazards Mitigation Plan (NHMP). Members of the Mitigation Planning Team were interviewed individually.
- Proposed mitigation strategies were identified with the use of information provided by the planning team, meetings and forums with community members, and from review of existing plans, studies, reports and technical information. Drafts of potential mitigation actions were confirmed through a group meeting of members of the planning team and, individual follow-up interviews with members of the planning team, and a review of the draft plan by members of the Natural Hazards Mitigation Planning Team.
- A Benefit to Cost assessment was completed by the Planning Team for final evaluation and prioritization of mitigation measures to be included in the plan.
- The draft plan was announced community-wide through local newspaper and local websites. A targeted email was sent to those who submitted a survey or mitigation idea and provided an email address for further contact. The public was invited to comment by email or telephone call to provide comment. Input from the community was incorporated into the final draft of the plan and then submitted to the State of Washington and FEMA.
- The plan was presented for adoption to the San Juan County Council, the Town of Friday Harbor Council, the State of Washington Department of Emergency Management, and FEMA for adoption.

Section 3. COMMUNITY PROFILE



Geography and Topography

San Juan County is Washington State's smallest by area, one of only two surrounded by water, and the only one without a direct link to the mainland by bridge.

The islands are situated in the Northern Salish Sea. To the East, Rosario Strait separates the islands from the Washington mainland and Whatcom and Skagit counties. To the west and northwest lie Vancouver Island and the Canadian mainland, separated by 43 miles of international boundary. To the South are Island County the Olympic Peninsula and Jefferson and Clallam counties.

There are 176 named islands in San Juan County, 15 islands with year-round residents. The four largest islands are Orcas, 56.9 square miles; San Juan, 55.3; Lopez 29.5 and Shaw with 7.7 square miles. Other inhabited islands include: Waldron, 5; Decatur, 4; Stuart, 3; and Henry Island with 1.6 square miles.

The topography of the San Juan archipelago is quite varied. Islands may rise abruptly out of the water, revealing a steep and rugged terrain, as on Orcas, where Mt. Constitution rises to 2,400 feet above sea level. Other areas, such as Lopez island, the landscape is gently rolling, smoothed by glaciers during the last ice age. The shoreline of the islands totals about 370 miles in length, and varies widely from open expanses of sandy beach to vertical cliffs.

The Town of Friday Harbor on San Juan Island is the only incorporated community. It is nearly one square mile in size.



WA State Ferries Map of Anacortes/San Juan Islands/Sydney BC route.

Vegetation

Early explorers described the landscape of the San Juan Islands and southern Vancouver Island as predominated by oak woodlands, grasslands, and mature fir and cedar forests. Shrubs were less common than they are today, as were stands of smaller fir and pines. In the past, low-intensity fires would burn through the grasslands, killing shrubs and small trees, but allowing the mature native trees (Western Red Cedar, Red Alder, Garry Oak, Big Leaf Maple, and Madrone) to survive². But by the early 1900s, due to human intervention, the intervals between fires had increased. As a result, the natural plant communities began to shift from open grassland and hardwood forest to primarily fast-growing evergreen trees, such as Douglas Fir, thickets of native Shore Pine, slower-growing cedars and dense shrubbery including introduced plants such as Scotch Broom, English Hawthorne and Gorse. This trend is also observed in agricultural lands that are no longer cultivated.

Water Supply

Water is a precious commodity in San Juan County. The annual precipitation is relatively low, underground aquifers are shallow, and aquifer recharge is less than 10% of precipitation. Surface reservoir impoundment is also limited. 40% of the County population is served by private wells and another 20% or served by small water system with less than 10 connections.. Lakes on San Juan, Orcas, and Blakely islands augment groundwater wells, providing potable water to roughly 40% of the population including residents in Friday Harbor, Eastsound, Doe Bay, Rosario, Olga and Roche Harbor. At least 12 saltwater-desalinization systems, providing over 500 connections, have been installed in San Juan County. Due to water resource challenges the County allows new development on both rainwater catchment and hauled water. In years with ample precipitation, a small number of seasonal streams run, and scattered natural and man-made ponds fill—each playing a critical role in providing agricultural water, storm water catchment, and aquifer recharge.

Climate and Weather Patterns

Due to its location and geography, San Juan County enjoys a climate generally milder than the rest of Western Washington. The islands are located within the “rain shadow” created by the Vancouver Island Range in British Columbia and the Olympic Mountains, on the Washington mainland.

Most storms in Washington move ashore from over the warm, moist Pacific Ocean and are directed eastward by winds high in the atmosphere, where they end up on a collision course with the coastal mountains. The moisture-laden air mass is forced to rise, and the resultant orographic lifting cools the air mass and increases cloud formation and precipitation along and near the mountains’ western slopes³. This accounts for the very high precipitation levels in the Olympic Mountains and, conversely, for San Juan County’s “banana belt” climate. The islands see about 250 days of sun annually, with typical late summer coastal fogs clearing by the afternoon. Summer high temperatures range between 60 and 75 degrees. While Seattle averages nearly 40 inches of precipitation per year, the San Juan islands receive an average of less than 30 inches, with wide variation throughout the county. The driest areas are the southern tip of Lopez and areas facing the Washington mainland. (Several varieties of cactus are found on some of the drier coasts and islets.) The wettest spots are found on Mt. Constitution on Orcas Island and the northwest end of San Juan Island.

Winter storms frequently bring powerful, sustained winds of 40-50 miles per hour, and are capable of causing significant damage. The National Weather Service issues high-wind warnings when winds are expected to average 40 miles an hour for at least one hour, and when wind gusts will be greater than 58 miles an hour. More rarely, a “nor’easter” will bring bitterly cold winds upwards of 70 miles per hour. A record low of –8 degrees occurred on January 13, 1950. Typically, residents experience 30 or so days of freezing or near freezing temperatures and average seven inches of short-lived snow each year. One exception is Mt. Constitution, which sustains longer periods of freezing temperatures and snow retention⁴.

Population Growth and Demographics

Since 1970, San Juan County has been among the fastest growing areas in Washington state. In the 1990s the county’s population grew by more than 40%— nearly double that of the rest of the state. This trend has slowed in recent years however, since 2005, the rate of growth has been about half of the rate for the state as a whole. The Washington Office of Financial Management and the State Ferry system released projections that predicted the county’s population would increase 71% between 2011 and 2030⁵.

According to 2015 Census estimates, about 14% (2,340) live in Friday Harbor on San Juan Island. The majority of the remaining residents (13,912) are concentrated in unincorporated parts of San Juan, Orcas, Lopez, and Shaw Islands.

Age, Income & Race

The residents of San Juan County make up an aging population, with a median age of 54.5 years; over 30% of the population is over 65. The islands are a popular place for upper-income households, vacation homes, and retirees. Workforce statistics in the 2010 census identified approximately 41% of residents as “not in the labor force”.

Personal income

In 2013, per capita personal income in San Juan County (\$58,718) was well above both state (\$47,717) and U.S. (\$44,765) averages. In San Juan County, a large portion of the residents are retired and collect non-wage income.

According to the U.S. Census Bureau, San Juan County's median household income was \$53,376, below state (\$59,478) and U.S. (\$53,046) medians over the period 2009 to 2013.

Over the 2009 to 2013 period, 10.8 percent of the resident population was living below the official poverty line. The statewide average was higher at 13.4 percent, while the national average stood at 15.4 percent, according to the U.S. Census Bureau.

In 2015, the median cost of a home was \$465,500, up from \$448,500 in 2004. Nearly 90% of the residents identify themselves as Caucasian or white, 6% Hispanic or Latino, 2.0% Asian and Pacific Islander, 1% American Indian and Alaska Native, and less than 1% Black or African American. Over seven hundred of the county's residents speak English "less than very well." 11.6% of residents live below the poverty line. Figures based on 2015 estimates.

Population Details

(Source: U.S. Census Bureau; Washington Office of Financial Management)

The estimated resident population of San Juan County is 16,180 for 2015. Its total growth from 2005 to 2015 was 6.6 percent, lower than the 12.1 percent growth rate observed for the state over the same period.

The only incorporated city in San Juan County is Friday Harbor (population 2,215 in 2015), up 6.1 percent in 10 years.

Population facts

(Source: U.S. Census Bureau; Washington Office of Financial Management)

	San Juan County	Washington state
Population 2015	16,180	7,061,410
Population 2005	15,180	6,298,822
Percent change, 2005 to 2015	6.6%	12.1%

Age, gender and ethnicity

(Source: U.S. Census Bureau QuickFacts)

Overall, San Juan County has considerably more individuals age 65 and older (29.4 percent) compared to 14.1 percent statewide. It also has a lower percentage of those under 18 (14.1 percent) compared to 22.7 percent statewide.

In 2014, females made up 51.9 percent of the estimated population.

San Juan County was less diverse than Washington state in terms of race and ethnicity, with smaller proportions of all racial or ethnic minorities compared to the state. About 95 percent of its population was white in 2014.

Demographics

(Source: U.S. Census Bureau QuickFacts)

	San Juan County	Washington state
Population by age, 2014		
Under 5 years old	3.0%	6.3%
Under 18 years old	14.1%	22.7%
65 years and older	29.4%	14.1%
Females, 2014	51.9%	50.0%
Race/ethnicity, 2014		
White	94.5%	80.7%
Black	0.6%	4.1%
American Indian, Alaskan Native	0.9%	1.9%
Asian, Native Hawaiian, Other Pacific Islander	1.6%	8.9%

Transportation

San Juan County is unique in that it is the only Washington county entirely surrounded by water and without a bridge connecting it to the mainland. San Juan, Orcas, Lopez, and Shaw Islands are all served by the Washington State Ferry System, which is the primary transportation link between the San Juan Islands and mainland U.S. and Canada. In 2016, the ferry system logged 2,008,438 domestic passengers, including car and walk-on riders, a 2 % increase over 2015 and a 5 year increase of over 17%. source: WSF Route Statements for Fiscal Years 2011 - 2016. Ferry service from Friday Harbor to Anacortes is approximately 90 minutes, nonstop, with six to seven different departure times possible, depending on the day of the week and time of year. By 2030 , the Washington State Ferry system has forecast a nearly 16% increase in ridership (both cars and passengers) over 2016 on for the San Juans-Anacortes route⁶ . Source "WSF Ridership and Demand - Final Long Range Plan 2009".

The Washington State Ferry System is also the primary delivery system for commercial products and materials destined for island businesses or sold directly to residents; and a handful of private vessels regularly barge commodities such as fuel, water, and gravel to both ferry and non-ferry served islands, year round. Public and private facilities for air travel are available throughout the county. The three biggest islands (San Juan, Orcas and Lopez) each have public airports administered by port authorities. Some of the other inhabited islands have private runways (typically grass strips) maintained for the take-off and landing of small planes. Two commercial flight services operate scheduled flights to and from Anacortes, Bellingham, and Seattle. San Juan County also has a high percentage of resident pilots and plane owners.

Besides the Washington State Ferry docks on San Juan, Orcas, Lopez, and Shaw, San Juan County has numerous public and private marinas, haul-out facilities, community and private docks. Many residents own boats of various types ranging from kayaks to working vessels and large live-aboard cabin cruisers. Live-aboard are permitted in most of the marinas, along with permanent and transient moorage.

The Port of Friday Harbor is the largest marina in the San Juan Islands with 464 moorages.

THE ECONOMY AND EMPLOYMENT

Historically, fishing and farming formed the economic mainstay for most inhabitants until the already well-established tourism economy took off in the 1970s. Some more colorful parts of the economic history of the San Juan includes smuggling, rum running and trade and manufacturing of other illicit commodities.

Due to a large tourism component in the economy, employment levels are highly seasonal. Using a 10-year average from 2004 through 2014, the following pattern emerges – peak private nonfarm employment occurs each year in July and August, with an average gain of about 1,700 jobs (34 percent) from the January low point of the jobs cycle. As of July 2015, peak employment to date reached 6,410.

Similar to the national economy, San Juan County's largest job-providing sector is private services, accounting for about 70 percent of all jobs. In 2014 the largest industry in terms of employment was leisure and hospitality. This is consistent with the county's orientation toward tourism. In 2014, leisure and hospitality hosted an average of 1,400 jobs or 25.8 percent. Other large industries include trade, transportation and utilities—which includes retail trade (16.6 percent), government (15.1 percent), education and health services (11.1 percent) and construction (10.9 percent). Source: Employment Security Dept, San Juan County Profile updated September 2015

Great numbers of tourists and weekend residents are attracted to the islands' natural beauty. In addition, the county has long been a location for summer homes, and is an increasingly popular retirement destination. In summer, the population of San Juan Island surges from approximately 7,000 to 20,000 people. Reflecting these numbers, the local economy is fueled by construction (second only to government as the biggest employer) and tourism, which is growing faster in San Juan County than in the rest of the state: 6.1% locally versus 4.2% statewide. In 2014, Accommodation and Food Service sales contributed over \$26 million dollars in wages to the local economy. Source: Census.gov

Employment Details

AVERAGE MONTHLY EMPLOYMENT AND TOTAL WAGES IN COVERED EMPLOYMENT -CY 2014

Industry	Employers	Av. # of Employees	Percent of Total	Wages Paid	Percent of Total
Agric., Forestry, Fishing & Hunting	14	52	1.0	\$2,051,899	1.2
Mining	*	*	*	*	*
Utilities	10	73	1.3	5,654,438	3.2
Construction	191	588	10.8	20,880,460	11.8
Manufacturing	33	189	3.5	6,877,998	3.9
Wholesale/Retail Trade	122	713	13.1	22,508,458	12.8
Transp. & Warehousing	20	109	2.0	2,722,238	1.5
Information	12	57	1.0	2,723,962	1.5
Fin., Ins., & Real Estate	55	232	4.3	7,351,959	4.2
Professional & Tech. Services	73	135	2.5	6,049,420	3.4
Mngmt of Companies & Enterprises	*	*	*	*	*
Administrative & Waste Services	63	215	3.9	5,733,007	3.3
Educational Services	17	191	3.5	6,749,898	3.8
Health Care & Social Assistance	80	409	7.5	11,131,944	6.3
Arts, Entertainment, & Recreation	34	194	3.6	5,849,555	3.3
Accommodation & Food Services	107	1,209	22.2	26,033,803	14.8
Other Svcs, except Public Admin.	86	257	4.7	7,292,406	4.1

Government	41	796	14.6	34,981,175	19.8
Not Elsewhere Classified	4	26	0.5	1,698,495	1.0
Total	962	5,445	100.0	\$176,291,115	100.0

Development Trends

This section was summarized from the San Juan County Economic Almanac.

By the 1960's, much of the traditional economy of farming, fishing and seafaring had dwindled. The economy continued to struggle through the 1960's even though other parts of the Puget Sound region south of the islands boomed.

The islands began to take on a new role in the region by marketing the county as a tourism and retirement destination to the more prosperous Seattle area. The seeds of these marketing efforts in the early 60's, have created a boom that has lasted for over 40 years. Recent infrastructure improvements in the areas of broadband connectivity have allowed an increase in the number of remote workers within the islands. The opening of the Peace Island Medical Center on San Juan Island in 2013 created a number of local long term jobs.

Existing Plans & Policies

San Juan County has existing plans and policies that guide and influence land use, land development, and population growth. These plans, policies, zoning ordinances, and technical reports or studies already in existence have support from local residents, businesses and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and may be adapted to changing conditions and needs.

The San Juan County/Friday Harbor Natural Hazards Mitigation Plan includes a range of recommended action items that, when implemented, will reduce the county's vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the county's existing plans and policies. Linking existing plans and policies to the Natural Hazards Mitigation Plan helps identify what resources already exist that can be used to implement the action items identified in the Plan. Implementing the natural hazards mitigation

plan's action items through existing plans and policies increases their likelihood of being supported and getting updated, and maximizes the use of county and town resources.

Current plans and policies of San Juan County and Town of Friday Harbor include the following:

San Juan County

San Juan County Comprehensive Plan

- Date of Last Revision: 2010. SJC is currently updating the Comprehensive plan and is planned to be completed in 2018.
- Author/Owner: San Juan County
- Description: The Comprehensive Plan is the official policy guide for decisions about growth, development, and conservation of natural resources in San Juan County.
- Relationship to Natural Hazard Mitigation Planning: The San Juan County Comprehensive plan includes the following elements: Land Use, Element 2; Capital Improvement Plan, Element 3; Economic Development Plan, Element 10; and Transportation Plan, Element 6.

The Land Use element of the Comprehensive Plan states regarding Essential Public Facilities "Regulations and policies may not preclude the siting and construction of EPFs." When possible, EPFs shall comply with existing regulations and policies. The element makes provision for siting EPFs when full compliance is not possible. Element 2.2.D 3. adds "Essential public facilities should not be located within frequently flooded or geologically hazardous areas unless no practicable alternative exists."

2.2.F (7) Natural Resource Conservation

7. Protect the health, safety and welfare of the public by ensuring that areas susceptible to geological and hydrological hazards are not developed in a manner which would result in injury, loss of life, property damage or financial losses due to flooding, erosion, landslide, or steep slope failures.

2.5.B Critical Areas

Critical Areas are areas within San Juan County that are important to the healthy function of natural ecosystems, as well as areas that can be hazardous to people and

their property. Critical Areas include wetlands, fish and wildlife habitat conservation areas, critical aquifer recharge areas, geologically hazardous areas, and frequently flooded areas. The Washington Growth Management Act requires Counties to designate and protect critical areas.

11. Any regulation created pursuant to these policies should include provisions for reasonable use exceptions and nonconforming uses.

a. Geologically Hazardous Areas

Goal: To protect the public health, safety and welfare from threats resulting from incompatible commercial, residential, institutional or industrial development being sited in geologically hazardous areas.

Policies:

- i. Designate geologically hazardous areas in accordance with WAC 365-190-080(4).
- ii. Designate and classify areas on which development should be prohibited, restricted, or otherwise controlled because of danger from geological hazards based on the level of hazard or risk.
- iii. Require that significant geological impacts resulting from development are either mitigated or avoided within geologically hazardous areas.
- iv. Avoid locating essential public facilities such as hospitals and emergency response operations in geologically hazardous areas.

Policies:

- i. Protect the important hydrologic role of frequently flooded areas by designating those areas subject to frequent flooding or coastal inundation as special flood hazards. At a minimum, designate and protect the 100-year area of special flood hazard as defined and mapped by the Federal Emergency Management Agency.
- ii. Prevent or mitigate the impacts of development which may result in hazards to persons or property, or harm to hydrologic functions. In general, this will be accomplished through compliance with applicable building codes, the San Juan County Flood Hazard Ordinance and the requirements of the Unified Development Code.
- iii. Minimize expenditures of public money for costly flood control projects and minimize the need for rescue and relief efforts associated with flooding.

b. Frequently Flooded Areas

Goal: To protect the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas of special flood hazard.

Protect the health, safety and welfare of the public by ensuring that areas susceptible to geological and hydrological hazards are not developed in a manner which would result in injury, loss of life, property damage or financial losses due to flooding, erosion, landslide, or steep slope failures.

Community Wildfire Protection Plan

- Date of Last Revision: 2012
- Author/Owner: San Juan County
- Description: The plan analyzes risk from wildland fire to a community and proposes mitigation measures to reduce risk.
- Relationship to Natural Hazard Mitigation Planning: Information and mitigation actions from this plan have been included in this NHMP.

Shoreline Master Program

- Date of Last Revision: 2009
- Author/Owner: San Juan County
- Description: The Shoreline Master Program (SMP) is the local instrument by which San Juan County and the State Department of Ecology (DOE) jointly administer the 1971 Shoreline Management Act (SMA), Chapter 90.58 of the Revised Code of Washington (RCW).
- Relationship to Natural Hazard Mitigation Planning: Shoreline master programs help local communities plan for the future. They are a combination of policies, regulations, and permits that guide shoreline use within a town, city or county. They balance shoreline development with environmental protection, and provide for access to public shores and waters. In developing this balance of development, environmental protection, and public access, The SJC Shoreline Master Program includes policies related to Residential Development (18.50.330 Residential Development)

Drought Conservation Plan

- Date of Last Revision: 2017
- Author/Owner: San Juan Conservation District
- Description: This plan provides an overview of water management within the county, resource conditions and concerns, and conservation, mitigation, and adaptation strategies to address seasonal drought.
- Relationship to Natural Hazard Mitigation Planning: Contains recommendations for actions

Storm and Surface Water Capital Improvement Plan 2018-2023

- Date of Last Revision: 2018
- Author/Owner: San Juan County
- Description: This plan documents actions recommendations of the Water Resource Management & Storm & Surface Water Advisory Committees within the county.
- Relationship to Natural Hazard Mitigation Planning: Contains recommendations for actions recommended to protect the aquifer from contaminated storm water runoff while providing for aquifer recharge, and to protect infrastructure from damage caused by storm water and flooding.

San Juan County Revised Solid Waste and Moderate-Risk Waste Management Plan

- Date of Last Revision: 2017
- Author/Owner: San Juan County
- Description: This plan documents actions recommendations of the Water Resource Management & Storm & Surface Water Advisory Committees within the county.
- Relationship to Natural Hazard Mitigation Planning: Contains recommendations for actions regarding composting of vegetation which is included as a Wildland Fire mitigation action.

MacKaye Harbor Road Relocation Feasibility Study

- Date: 2017
- Author/Owner: San Juan County Public Works
- Description: This study details hazard and proposed mitigation for current and expected threats to the MacKaye Harbor road on Lopez island from severe storms and potential sea level rise.
- Relationship to Natural Hazard Mitigation Planning: The study contains details of alternatives and the most cost effective mitigation for the hazard to the MacKaye Harbor road from severe storms, erosion, and the threat of sea level rise.

The Town of Friday Harbor

Town of Friday Harbor Comprehensive Plan

- Date of Last Revision: 2015
- Author/Owner: Town of Friday Harbor
- Description: The Master Program provides, goals, policies and recommendations additional to all other ordinances of the Town of Friday Harbor.
- Relationship to Natural Hazard Mitigation Planning: The Comprehensive plan incorporates as Town Ordinance the Shoreline Master Program detailed below. Title 16, Chapter 16.04.070 "Subdivisions" contains language regarding subdividing property on which a hazardous "topographic condition" exists.

Town of Friday Harbor Shoreline Master Program

- Date of Last Revision: 2015
- Author/Owner: Town of Friday Harbor
- Description: The Master Program provides, goals, policies and recommendations additional to all other ordinances of the Town of Friday Harbor.
- Relationship to Natural Hazard Mitigation Planning: Appendix A "Restoration and Protection" to the plan contains potential "restoration actions" including "replacing creosote pilings".

Town of Friday Harbor Stormwater Management Plan including Capital Improvement Plan

- Date of Last Revision: 9/2005
- Author/Owner: Town of Friday Harbor
- Description: The Stormwater Management Plan contains a Capital Improvement Plan (CIP), Chapter 6, which is prepared in order to prevent flooding within the Town and thus minimize the environmental and property damage from flooding, erosion, and sedimentation. The emphasis of the CIP is to provide the Town of Friday Harbor with storm water facilities consisting of adequately sized ditches, piping and detention systems. In order for the facilities to operate properly, it is essential that appropriate operations and maintenance schedules are developed. Facilities maintenance and preferred management strategies are detailed in this chapter.
- Relationship to Natural Hazard Mitigation Planning: The CIP contains 14 projects. 7 projects are identified in years 1-6, 5 projects in years 7-20 and 2 projects for 21+ years. Chapter 7 of the Stormwater Management Plan details plan implementation. This chapter discusses methods of providing revenue for the storm water system's operation and maintenance program and capital improvement projects which were recommended in Chapter 6, Capital Improvement Plan.

Section 4. INTRO TO RISK ASSESSMENT

Disaster Declarations

A common way to assess San Juan County's susceptibility to natural hazards is to look at disaster declarations over the past 50 years (federal, state and local)—that have included our county—and to assume that these are the kinds of natural hazards we are likely to experience in the future. However, regional disaster declarations don't accurately reflect the actual conditions experienced locally. For example, a list of disaster declarations published by the Washington State Military Division of Emergency Management from 1956-2001 lists volcano (1980) on its short list of disaster events for San Juan County. What's more, disaster declarations alone do not begin to adequately represent the potential for events like earthquakes and tsunamis which occur on historical cycles of 50, 100, 500 or more years.

There have been 8 disaster declaration in San Juan County since 1953. 4 Severe Storm, 2 Flood, 1 Coastal Storm and 1 Volcano.

Year of Declaration Date	Quarter of Declaration Date	Month of Declaration Date	Title
1980	Q2	May	VOLCANIC ERUPTION, MT. ST. HELENS
1990	Q4	November	SEVERE STORMS & FLOODING
1991	Q1	March	SEVERE STORMS & HIGH TIDES
1997	Q1	January	SEVERE WINTER STORMS, LAND & MUDS SLIDES,FLOODING
2003	Q4	November	SEVERE STORMS AND FLOODING
2005	Q3	September	HURRICANE KATRINA EVACUATION
2006	Q2	May	SEVERE STORMS, FLOODING, TIDAL SURGE, LANDSLIDES, AND MUDSLIDES
2007	Q1	February	SEVERE WINTER STORM, LANDSLIDES, AND MUDSLIDES

A tabulation of events from the National Climatic Data Center's Storm Data database shows the following weather related events from 1966 to 2016: Coastal Flood, 2; Drought, 2; Heavy Rain, 2; Heavy Snow,14; High Wind, 64.

ASSESSING RISK

The following risk-assessment chapters provide a factual basis for identifying the kinds of natural disasters most likely to occur in our unique geographic area. The identification and description of these events are based on historical record and best available research.

Section 5. SEVERE STORM

Previous Occurrences

Weather data compiled at the Olga 2SE weather station since the mid-1800s indicate that storm conditions occur regularly: winds of 40 mph, a week or two of below-freezing temperatures, and short periods of snow can be expected every year. Anecdotally, local newspaper archives indicate that what we now consider an unusually severe storm was perhaps more frequent in the past.

The NOAA National Center for Environmental Information Storm Events Database⁷ lists 64 High Wind events during the period from 1966 to 2016.

Understanding San Juan County Storms

Storms Originating From the South: Most of our storms originate over the Pacific, moving in a southwest or southeast to northeast direction. Southwesterly Storms with sustained wind speeds around 50 miles per hour are powerful enough to cause significant damage and occur frequently. High-impact areas in San Juan County are primarily at the edges of expanses of open water and the exposed edges of timber stands. Locally, storms from the northeast are generally considered more destructive than southern storms, however two of the worst storms in island history, the 1962 Columbus Day Storm, and the 1993 Inauguration Day storm originated over the southern Pacific.

How Vulnerable is San Juan County?

All areas of San Juan County are vulnerable to severe local storms. The effects are generally loss of utilities, transportation problems, stranded travelers, and business, school, and government closures. The almost continuous exposure to seasonal heavy winds typically results in downed trees in wooded areas. Add snow, ice, and rain, and the problem is compounded by

traffic accidents, potential roof failures, and reduced capabilities for fire-fighting and emergency services.

Utilities

Electric power and land-based telephone/ Internet services are made possible by a series of submerged submarine cables that connect San Juan County substations to mainland systems. Areas where these cables cannot be buried beneath the sea floor, and where they come ashore at the substation, are points of particular vulnerability. San Juan County utilities are also affected by damage to surface power lines on the mainland.

Electrical power outages caused by downed trees on power lines are common with almost all types of severe storms. In January 2004 alone, there were ten wind-related power outages that cumulatively lasted more than 200 hours, affecting over 1000 residents on Orcas, Lopez, and Shaw Islands. Power-outage problems vary in degree, ranging from the risk of fire and electrocution caused by downed “hot” wires to the loss of heating, refrigeration, light, and residential and commercial cooking facilities. Most computers, telephones, cash registers, ATM's, and gasoline pumps are also not operable without electricity.

Transportation

Storms frequently wreak havoc on rural roads—both public and private. Downed trees challenge work crews responsible for clearing blocked thoroughfares and those providing essential services. Some homeowners may not own, or be capable of operating, chain saws and other equipment necessary to clear debris from private access roads and driveways. Under these conditions, travel becomes difficult, leading to school closures, disruption of public services, and potential isolation of those in need of medical services and necessary supplies. High winds may stop ferry service and delivery of trucked products. More frequently however, the ferries shut down during storms due to storm-related diminished ridership, making normal travel between islands and the mainland impossible for most. Local airports and air travel may also be affected, with stranded private and commercial planes, and delayed emergency Medevac flights.

Vulnerability assessment

During the fall and winter San Juan County is vulnerable to severe storms originating from the Pacific (wind and rain) or from the northeast (wind and freezing temperatures.)

Some storms are more severe and require assistance from a variety of governmental agencies or emergency responders such as: public works, fire service, emergency medical services, law enforcement and utility company personnel. In the past, frequent power outages were common, some lasting 3, 4 or more days. In the mid-1990's, OPALCO began a gradual process of undergrounding power lines and other utilities; today the incidence of power failure is less frequent and generally shorter in duration. , However the high voltage transmission lines cannot be buried, and remain vulnerable to wind/tree hazards. San Juan County remains vulnerable to downed trees in heavy winds, outages originating at power stations both here and on the mainland, impassable roads, limited transportation to the mainland, and periods of freezing temperatures.

At Risk Areas

The strongest winds and coldest weather come from the northeast, slamming the northern islands first. When this occurs, heavily timbered and mountainous Orcas Island almost always experiences significant damage. To a limited extent, Orcas shelters San Juan, Shaw, and Lopez Islands from the full brunt of these storms. However, northeasters, along with storms from the southwest, present a variety of hazards and continue to cause significant damage to all of the county's islands.

Probability and Risk

Based on past events, there is a **High Probability** of a severe storm event occurring in San Juan County. While the probability of such an event is high there is a **Low to Moderate Risk** associated with this hazard due to the relatively short duration and localized impacts of such events.

Conclusion

Because all areas of San Juan County are vulnerable to storm, high wind, extended periods of heavy rain, freezing temperatures and snow, individuals, families, businesses and local

government should be aware of the potential impacts and take the necessary precautions to reduce injury and property damage.

There are a number of ways to reduce the vulnerability to storms, minimize injury, and reduce property loss. Listed below are the potential mitigating activities identified during the creation of this plan. Rating and prioritization of these and other potential hazard-mitigation strategies follow in Sections Eleven and Twelve.

Potential Mitigations

1. [SS-1] Expand Education and Outreach -Providers of emergency services and other public agencies should continue to work collaboratively to educate year-round and seasonal residents about the potential for severe storm events in San Juan County. Targeted efforts to reach island tourists, the poor, and those with limited English proficiency are also recommended.
2. [SS-2] Promote Individual Self-Sufficiency -Residents should be prepared to be entirely self-sufficient for 14 days, stocking extra food, water, and medicines for each member of the household, pets and livestock. Providers of commercial lodging should be prepared to provide necessary supplies for guests who may become stranded.
3. [SS-3] Promote Weather-Watch Tools and Activities -Public safety agencies should encourage residents to purchase and use a NOAA weather radio, preferably one that works both on batteries and with a cranking mechanism for power. Residents should listen for weather and tide reports and high-wind warnings.
4. [SS-4] Encourage Heating and Power Alternatives -Residents and providers of commercial lodging should consider purchasing as back-up systems, alternative heating, cooking, and telephone equipment operable without electricity, emergency generators, as well as other less-costly emergency supplies like emergency candles and oil lamps. Education on the safe operation of emergency generators is encouraged.
5. [SS-5] Tree Damage -Encourage island residents to remove diseased and damaged tree limbs located close to buildings, driveways and parking areas; thin additional branches to make trees more wind resistant; keep a gas-powered chainsaw, with extra fuel, in operable condition.
6. [SS-6] Protect Utilities -Continue efforts by local utilities to bury telephone and power lines.
7. [SS-7] Road and Debris Clearing -Develop coordinated management plans to facilitate efforts (and avoided duplication of assignments) by County and Friday Harbor public works crews, private utility companies, and local residents to identify and prioritize publicly and privately maintained roads, streets and other access ways to be cleared and sanded during storm events.

8. [SS-8] Protect Marinas - Hardening and improvements to Port of FH dock and pier infrastructure. Primarily the replacement of traditional wooden creosote pilings with larger, longer steel pilings that would hold up much better to stresses of major windstorms and high impact currents of a tsunami event.
9. [SS-9] Orcas Landing Dock Improvements. This would provide hardening and improvements to pier and dock infrastructure, designed to withstand storms and water level increases from a tsunami.

Severe Storm Mitigation Actions					
Id#	Project Name	Jurisdiction	Benefit	Cost	Benefit/Cost Ratio :1
SS-1	Expand Education and Outreach	County and Town	3	1	3
SS-2	Promote Individual Self-Sufficiency	County and Town	3	1	3
SS-3	Promote Weather-Watch Tools	County and Town	3	1	3
SS-4	Encourage Heating and Power Alternatives	County and Town	3	1	3
SS-5	Tree Damage	County and Town	3	1	3
SS-6	Protect Utilities	County and Town	3	1	3
SS-7	Road and Debris Clearing	County and Town	3	1	3
SS-8	Protect Marinas	County and Town	3	1	3
SS-9	Orcas Landing Dock Improvements	County	3	2	1.50

Section 6. WILDLAND-URBAN INTERFACE FIRE

History

While wetter and cooler than the eastern part of Washington state, Western Washington has an extensive history of wildland-urban interface fires. In San Juan county, a 2003 study of nearly 500 acres on the south shore of Lopez Island revealed that almost every old-growth tree showed signs of fire scarring, providing evidence of frequent, low-intensity fires occurring in a regular pattern—as often as every eleven to fifteen years—up to the mid-1800s⁸.

Native American inhabitants of the San Juan islands used controlled burns to enhance the natural propagation of native plants important for food, such as camas bulbs. The arrival of non-native settlers in the San Juans altered this pattern. On San Juan Island, the need for wood to fuel the kilns used by the Roche Harbor Lime and Cement Company (founded in 1886) resulted in the dramatic clear-cutting of native hardwoods and conifers. Early photographs show a stark landscape, almost completely devoid of trees. By the early 1900s, the natural vegetation was rapidly changing from open grassland and hardwood forest (Madrone, Garry Oak, and Maple), to forests primarily composed of fast-growing Douglas fir, which take about 100 years to mature. The result is that today, with the decline in cultivated farmland and inadequate forest management practices, these same-aged trees have matured into unhealthy, overcrowded timber stands. So ironically, while the changes in vegetation and human intervention have decreased the frequency of fire in contemporary times, they have, conversely, increased the risk of more dangerous high-intensity or crown fires. Depending on the wind and other weather conditions, these fires can quickly spread into grassy valleys and developed areas.

Understanding Wildland-Urban Interface Fire

There have always been wildfires that burned large areas of isolated forest or other wildland areas. Today these fires are happening in America's backyards, as more people are living in homes surrounded by forests. This trend has created an extremely complex landscape known

as the wildland-urban interface, a terrain ripe for wildfires that threaten lives, homes, and businesses.

A key component in meeting the underlying need for protection of people and structures is the protection and treatment of hazards in the wildland-urban interface. The wildland-urban interface refers to areas where wildland vegetation meets urban developments or where forest fuels meet urban fuels such as houses. The WUI encompasses not only the interface (areas immediately adjacent to urban development), but also the surrounding vegetation and topography. Reducing the hazard in the wildland-urban interface requires the efforts of federal, state, and local agencies and private individuals⁹. “The role of [most] federal agencies in the wildland-urban interface includes wildland firefighting, hazard fuels reduction, cooperative prevention and education, and technical experience. Structural fire protection [during a wildfire] in the wildland-urban interface is [largely] the responsibility of Tribal, state, and local governments”¹⁰. The role of the federal agencies in San Juan County is and will be much more limited. Property owners share a responsibility to protect their residences and businesses and minimize danger by creating defensible areas around them and taking other measures to minimize the risks to their structures¹¹. With treatment, a wildland-urban interface can provide firefighters a defensible area from which to suppress wildland fires or defend communities against other hazard risks. In addition, a wildland-urban interface that is properly treated will be less likely to sustain a crown fire that enters or originates within it¹².

By reducing hazardous fuel loads, ladder fuels, and tree densities, and creating new and reinforcing existing defensible space, landowners can protect the wildland-urban interface, the biological resources of the management area, and adjacent property owners by:

- Minimizing the potential of high-severity ground or crown fires entering or leaving the area;
- Reducing the potential for firebrands (embers carried by the wind in front of the wildfire) impacting the WUI. Research indicates that flying sparks and embers (firebrands) from a crown fire can ignite additional wildfires as far as 1¼ miles away during periods of extreme fire weather and fire behavior¹³
- Improving defensible space in the immediate areas for suppression efforts in the event of wildland fire.

Three wildland-urban interface conditions have been identified (Federal Register Volume 66 No. (3), January 4, 2001) for use in wildfire control efforts. These include the Interface Condition, Intermix Condition, and Occluded Condition. Descriptions of each are as follows:

Interface Condition – a situation where structures abut wildland fuels. There is a clear line of demarcation between the structures and the wildland fuels along roads or back fences. The development density for an interface condition is usually 3+ structures per acre;

Intermix Condition – a situation where structures are scattered throughout a wildland area. There is no clear line of demarcation; the wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres; and

Occluded Condition – a situation, normally within a city, where structures abut an island of wildland fuels (park or open space). There is a clear line of demarcation between the structures and the wildland fuels along roads and fences. The development density for an occluded condition is usually similar to that found in the interface condition and the occluded area is usually less than 1,000 acres in size.

In addition to these classifications detailed in the Federal Register, San Juan County has included four additional classifications to augment these categories:

Rural Condition – a situation where the scattered small clusters of structures (ranches, farms, resorts, or summer cabins) are exposed to wildland fuels. There may be miles between these clusters.

High Density Urban Areas – those areas generally identified by the population density consistent with the location of incorporated cities, however, the boundary is not necessarily set by the location of city boundaries or urban growth boundaries; it is set by very high population densities (more than 7-10 structures per acre).

Non-WUI Condition – a situation where the above definitions do not apply because of a lack of structures in an area or the absence of critical infrastructure. This classification is not considered part of the wildland urban interface.

In summary, the designation of areas by the San Juan County steering committee includes:

Interface Condition: WUI

Intermix Condition: WUI

Occluded Condition: WUI

Rural Condition: WUI

High Density Urban Areas: WUI

Non-WUI Condition: Not WUI, but present in San Juan County

San Juan County's wildland urban interface (WUI) is mostly based on population density. Relative population density across the county was estimated using a GIS based kernel density population model that uses object locations to produce, through statistical analysis, concentric rings or areas of consistent density. To graphically identify relative population density across the county, structure locations are used as an estimate of population density. Aerial photography was used to identify structure locations in 2005. This existing structure layer was updated in 2011 using 2009 NAIP imagery and San Juan County's cadastral data. The resulting output identified the extent and level of population density throughout the county. By evaluating structure density in this way, WUI areas can be identified on maps by using mathematical formulae and population density indexes. The resulting population density indexes create concentric circles showing high density areas, interface, and intermix condition WUI, as well as rural condition WUI (as defined above). This portion of the analysis allows us to "see" where the highest concentrations of structures are located in reference to relatively high risk landscapes, limiting infrastructure, and other points of concern.

The WUI, as defined here, is unbiased and consistent and most importantly – it addresses all of the county, not just federally identified communities at risk. It is a planning tool showing where homes and businesses are located and the density of those structures leading to identified WUI categories. It can be determined again in the future, using the same criteria, to show how the WUI has changed in response to increasing population densities. It uses a repeatable and reliable analysis process that is unbiased.

The Healthy Forests Restoration Act makes a clear designation that the location of the WUI is at the determination of the county or reservation when a formal and adopted Community Wildfire

Protection Plan is in place. It further states that the federal agencies are obligated to use this WUI designation for all Healthy Forests Restoration Act purposes. The San Juan County Community Wildfire Protection Plan steering committee evaluated a variety of different approaches to determining the WUI for the county and selected this approach and has adopted it for these purposes. In addition to a formal WUI map for use with the federal agencies, it is hoped that it will serve as a planning tool for the county, state and federal agencies, and local fire districts.

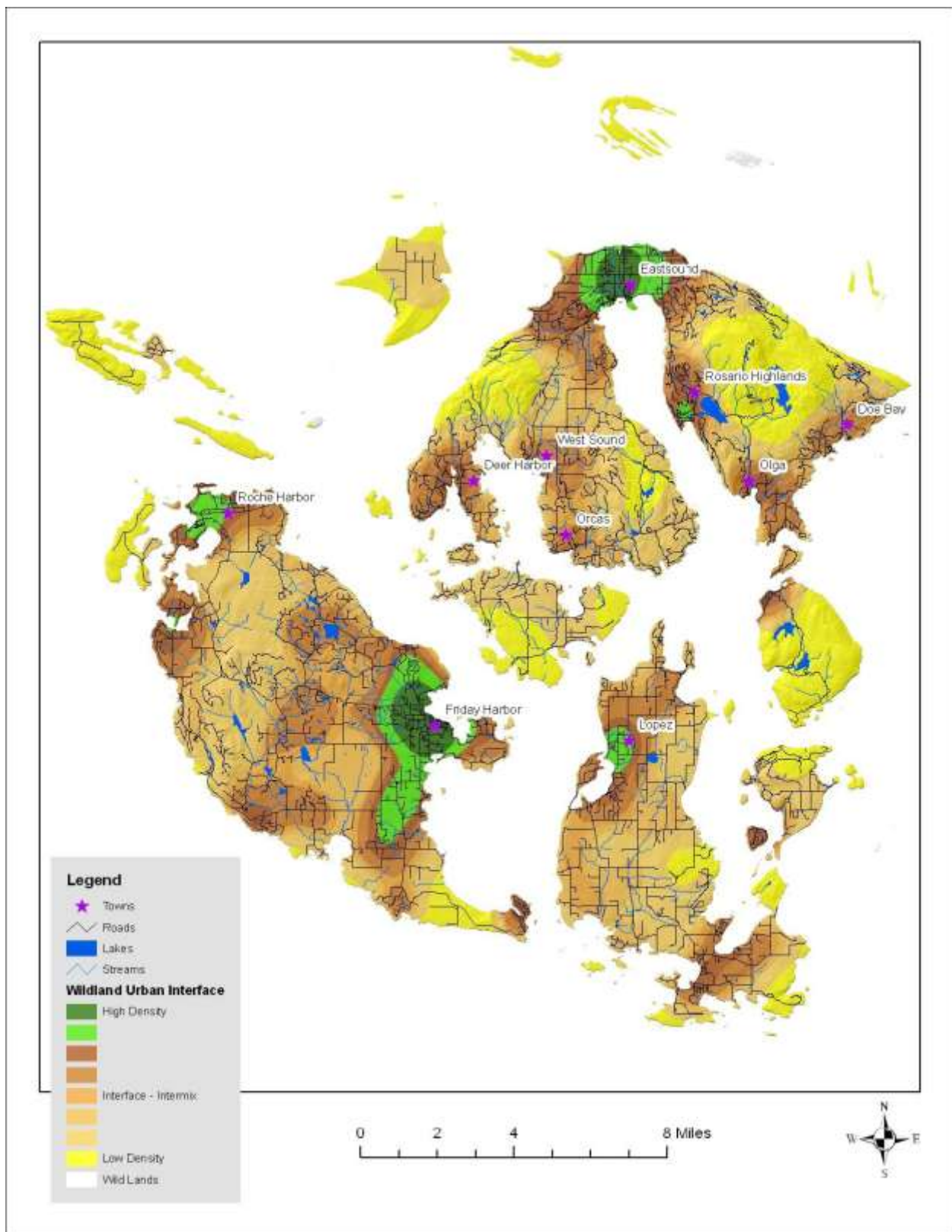


Figure: Wildland Urban Interface in San Juan County, Washington.

How Vulnerable Is San Juan County?

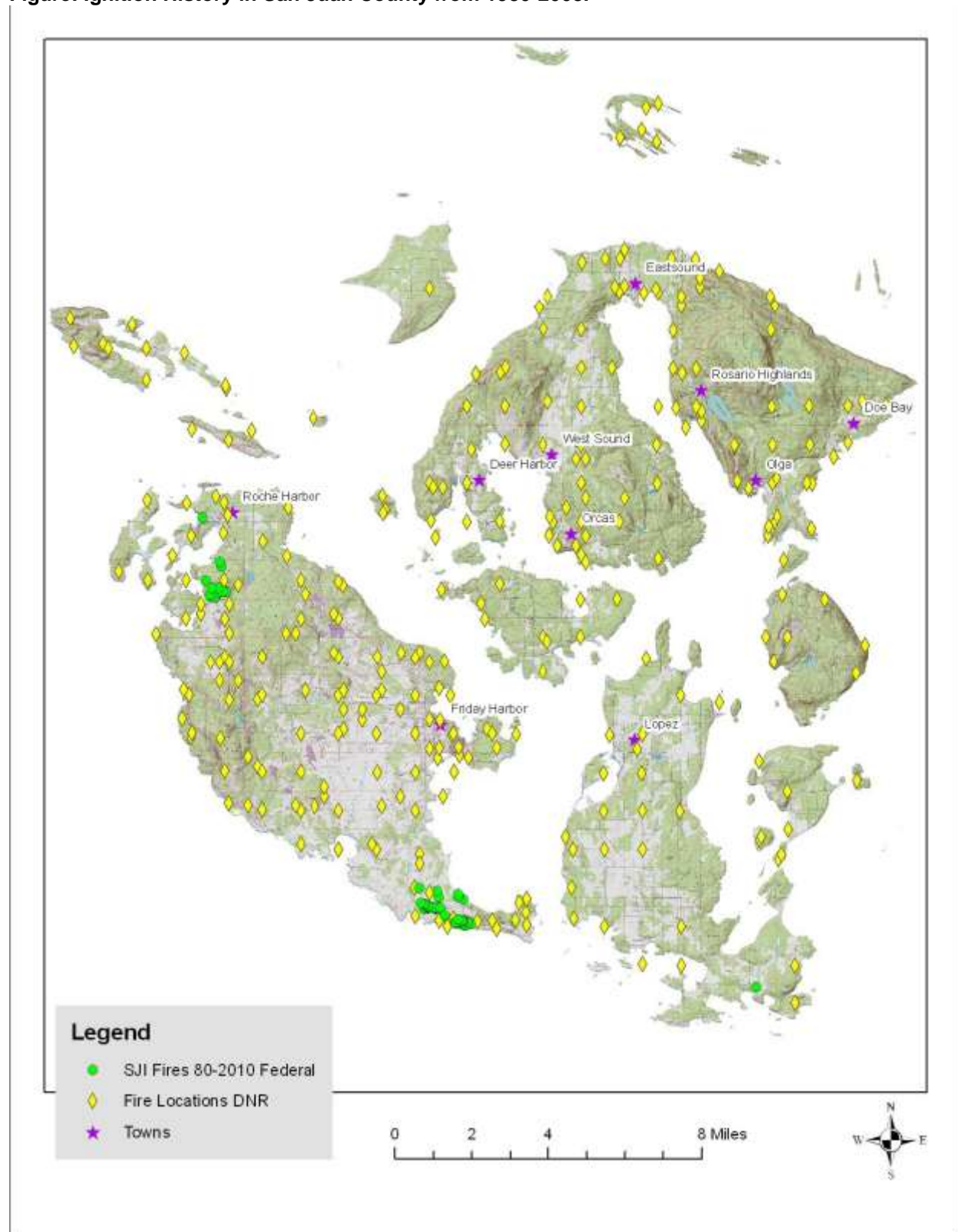
San Juan County has volunteer fire departments that are trained and well equipped. The local governments have adopted modern building and fire codes. Fire-prevention outreach programs are promoted year-round to residents and business owners. And while historically we have seen more frequent and larger fires, today's fires typically consume smaller areas and are generally extinguished within hours. Why, then, are we still at risk?

Since 1970, the county has been one of the fastest growing areas in the state. More people naturally mean more human activity, and some of these activities are fire risks: wood stoves, smoking cigarettes, fireworks, barbecues, and campfires. More people also bring increased demand for homes, lodging, commercial, and public service facilities. In response, new construction spreads into already populated island villages and existing residential enclaves, as well as onto isolated waterfront and water-view properties, and into rural grass and woodland areas—all escalating the probability of fire, property loss, and danger to residents and visitors.

In the 1930s, wildfires consumed an average of 40 to 50 million acres per year in the contiguous United States, according to US Forest Service estimates. By the 1970s, the average acreage burned had been reduced to about 5 million acres per year. Over this time period, fire suppression efforts were dramatically increased and firefighting tactics and equipment became more sophisticated and effective. For the 11 western states, the average acreage burned per year since 1970 has remained relatively constant at about 3.5 million acres per year.

The severity of a fire season can usually be determined in the spring by how much precipitation is received, which in turn determines how much fine fuel growth there is and how long it takes this growth to dry. These factors, combined with annual wind events can drastically increase the chance a fire start will grow and resist suppression activities. Furthermore, recreational activities are typically occurring throughout the months of July, August, and September. Occasionally, these types of human activities cause an ignition that could spread into populated areas and timberlands.

Figure: Ignition History in San Juan County from 1980-2008.



This map shows both state and federally reported fires. The federal fires (indicated by green dots) appear to be located primarily on National Park Service property and are likely planned ignitions.

Fire History

Fire was once an integral function within the majority of ecosystems in Washington. The seasonal cycling of fire across most landscapes was as regular as the July, August and September lightning storms plying across western Washington. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in plant composition¹⁴. These fires burned from 1 to 47 years apart, with most at 5- to 20-year intervals¹⁵. With infrequent return intervals, plant communities tended to burn more severely and be replaced by vegetation different in composition, structure, and age¹⁶. Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community, and ecosystem levels.

Fire history data (from fire scars and charcoal deposits) suggest fire, or lack thereof, has played an important role in shaping the vegetation throughout San Juan County. Native American inhabitants of San Juan County used fire to enhance the natural propagation of native plants important for food, such as camas bulbs. According to one study, the mean individual-tree fire return interval was 18.4 years from 1700-1879 (pre Euro-American settlement) and 103.8 years (post Euro-American settlement)¹⁷. On San Juan Island, the need for wood to fuel the kilns used by the Roche Harbor Lime and Cement Company resulted in dramatic harvest of native forests. By the early 1900's, the natural vegetation was rapidly changing from open grassland and hardwood forest (Madrone, Garry oak, and Maple) to Douglas fir.

Orcas Island - September 18th, 2008

The Island Sounder reported two fires on Orcas Island on September 18th, 2008. Due to high temperatures and dry conditions, a brush fire occurred as a result of a mower hitting a rock in the Crow Valley area. Initial attack efforts by Orcas Island Fire and Rescue contained the fire to about a half an acre. On the same day, a second wildfire was reported off of Dolphin Bay Road.

Again, successful initial attack operations suppressed the fire before significant damages could occur. Both events threatened nearby structures.

West Sound, Orcas Island - June 15th, 2009

A property owner was burning a brush pile when it got out of control around 3pm. The fire took five hours to contain and burned three and a half acres of both public and private lands. The fire came to within 300 feet of one home. Although the burn pile had a valid permit, prohibited materials contributed to the fire's spread in conjunction with a lack of water supply¹⁸.

Satellite Island Fire - July 28th, 2010

It took 16 firefighters through the night to bring this wildfire under control. Between 4 and 12 acres were consumed by the fire. The cause was unknown at the time the article was written. The island is uninhabited so no homes were threatened by the blaze¹⁹.

Previous Occurrences

Detailed records of wildfire ignitions and extents from the Washington Department of Natural Resources (DNR) and Bureau of Land Management (BLM) have been analyzed. In interpreting these data, it is important to keep in mind that the information represents only the lands protected by the agency specified and may not include all fires in areas covered only by local fire departments or other agencies.

The DNR (1970-2011) and BLM (1981-2009) database of wildfire ignitions used in this analysis includes ignition and extent data within their jurisdictions. During this period, the agencies recorded an average of 13 wildfire ignitions per year resulting in an average total burn area of 30 acres per year. According to this dataset, the vast majority of fires occurring in San Juan County are human caused; however, naturally ignited/unknown caused fires do occur.

The highest number of ignitions in San Juan County was witnessed in 1973 with 52 separate ignitions. However, the greatest number of acres burned in a single year occurred in 2003 with over 468 acres being burned, of which 463 acres were recorded by the National Park Service. When analyzed by decade from 1970-2010, the data shows that the total number of ignitions ranges from 5 to 25 ignitions per decade and the average number of acres burned per decade

jumps around as well, from 3 acres to 58 acres. The data suggests that weather, specifically droughts, may play a major role in the amount of acres burned annually in San Juan County.

Table: Summary of Cause from State and BLM databases 1970-2011.

General Cause	Number of Ignitions	Percent of Total Ignitions	Acres Burned	Percent of Total Acres
Human-Caused	435	88%	421	74%
Natural Ignition	11	2%	27	5%
Unknown	47	10%	122	21%
Total	493	100%	570	100%

Based on the agencies' combined datasets specific to San Juan County, there is a downward trend in the number of ignitions/year since 1970, and generally less than 50 acres burned/year. There are however, occasionally spikes in the total acres burned in any given year and could be a result of prescribed burning. It should be noted that if given the proper weather conditions, San Juan County could experience extreme wildfire activity.

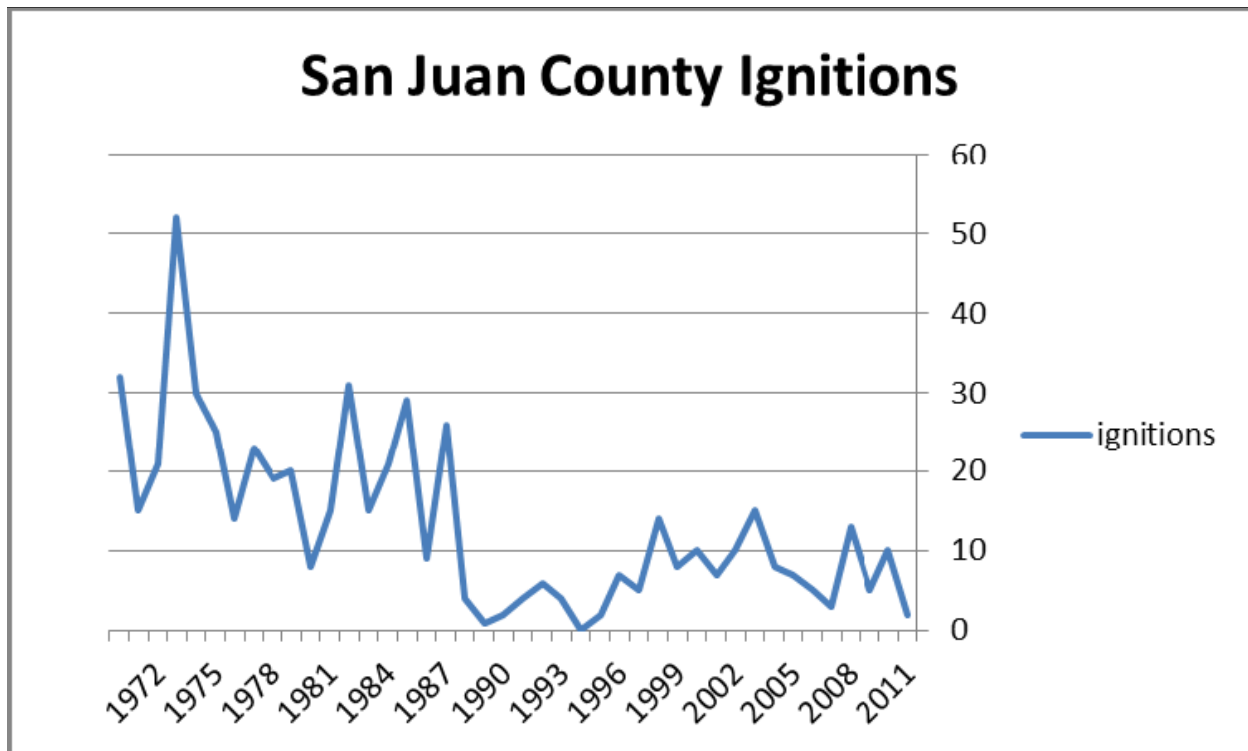


Figure: Summary of San Juan County Ignitions from 1970 to 2011.

The data reviewed above provides a general picture regarding the level of wildland-urban interface fire risk within San Juan County. There are several reasons why the fire risk may be even higher than suggested above, especially in developing wildland-urban interface areas.

1) Large fires may occur infrequently, but statistically they will occur. One large fire could significantly change the statistics. In other words, 40 years of historical data may be too short to capture large, infrequent wildland fire events.

2) The level of fire hazard depends profoundly on weather patterns. A several year drought period would substantially increase the probability of large wildland fires in San Juan County. For smaller vegetation areas, with grass, brush and small trees, a much shorter drought period of a few months or less would substantially increase the fire hazard.

3) The level of fire hazard in wildland-urban interface areas is likely significantly higher than for wildland areas as a whole due to the greater risk to life and property. The probability of fires starting in interface areas is much higher than in wildland areas because of the higher population density and increased activities. Many fires in the wildland urban interface are not

recorded in agency datasets because the local fire department responded and successfully suppressed the ignition without mutual aid assistance from the state or federal agencies.

Building Codes

The State of Washington mandates that local municipalities adopt and implement the building and public safety practices outlined in the new International Building Code (IBC) and International Fire Code (IFC). The Town of Friday Harbor and San Juan County have adopted both. These codes set forth the minimal building practices necessary to ensure public safety. However, to be effective these codes require adequate staff and budgetary resources for implementation, on-going inspection, and enforcement—resources that are not always available in rural communities. What's more, the IBC and the IFC were primarily written to address the conditions of the more typical American urban, suburban, and mainland rural environments. San Juan County presents a unique set of geographic and demographic circumstances. These and other special conditions are addressed in a third, but optional, set of fire and building codes known as the Urban-Wildland Interface (UWI) Code. This regulatory code has not been adopted by either San Juan County or the Town of Friday Harbor.

Rural Fire Departments

Unlike their urban and suburban counterparts, rural fire departments are largely staffed by trained volunteers rather than career firefighters. On San Juan, Orcas, Lopez and Shaw islands, volunteer firefighters undergo weekly fire training and field practice, utilize modern firefighting equipment, and are very effective in stopping the spread of fire and preventing injury. However, even they will admit that the volunteer system has inherent limitations. In the event of a fire, volunteer firefighters are paged from home, work, or other locations to report to their assigned fire stations, adding precious minutes to critical response times. Even with “mutual aid” agreements among the five fire districts in San Juan County (San Juan, Town of Friday Harbor, Orcas, Lopez, Shaw), the capacity to fight multiple fires in different locations at one time is extremely limited. Some inhabited islands in the county, specifically those not served by the WA State Ferry System—have only forest fire protection by the WA Department of Natural Resources. Most do not have any protection for structure fires.

The Island Landscape

San Juan County offers a combination of shoreline, valley acreage, and forested areas not available in other, more easily accessible urban settings. These same desirable characteristics make the county more vulnerable to fire. The majority of island homes are located outside of Friday Harbor and other island villages, in areas where rural density is zoned to protect open space. At the same time, new construction is typically sited to maximize privacy and take advantage of hilltop and ridges in the quest for prized views. These locations are especially prone to upward drafts, which escalate fire intensity. Water supplies adequate for fighting fires are limited or unavailable in isolated areas. Phone and radio communication are limited in many parts of the county. Private access roads and driveways are often narrow and crowded by dense overhanging and understory vegetation. Under these conditions it is difficult and dangerous for fire fighters and equipment to respond quickly and safely.

Topography

Fires burning in similar fuel types, will burn differently under varying topographic conditions. Topography alters heat transfer and localized weather conditions, which in turn influences vegetative growth and resulting fuels. Changes in slope and aspect can have significant influences on how fires burn. Generally speaking, north slopes tend to be cooler, wetter, more productive sites. This can lead to heavy fuel accumulations, with high fuel moistures, later curing of fuels, and lower rates of spread. In contrast, south and west slopes tend to receive more direct sun, and thus have the highest temperatures, lowest soil and fuel moistures, and lightest fuels. The combination of light fuels and dry sites leads to fires that typically display the highest rates of spread. These slopes also tend to be on the windward side of mountains. Thus, these slopes tend to be “available to burn” a greater portion of the year.

Slope also plays a significant role in fire spread, by allowing preheating of fuels upslope of the burning fire. As slope increases, rate of spread and flame lengths tend to increase. Therefore, we can expect the fastest rates of spread on steep, warm south and west slopes with fuels that are exposed to the wind²⁰.

Island Vegetation And Fire

With the decline in agriculture, some hay fields are no longer cut seasonally. As pasture grass cures, it becomes an efficient carrier of wind driven fire, spreading at a much greater rate than other fuel types. Often, hay fields are located adjacent to roads, providing opportunity for ignition from cigarettes, hot vehicle exhausts, road side mowing, and other human causes, potentially threatening nearby homes and farm buildings. Grass fires are generally considered “low intensity” fires, for while they can spread quickly they are also easier to extinguish than “high intensity” fires which are characterized by treetop-to-treetop conflagrations.

The decline of farming, and abandonment of field cultivation has also contributed to the proliferation of Douglas fir over the slower-growing and more fire-resistant native hardwood trees, such as the Madrone and Garry oak. Typically, these fir-dominated forested areas are not well-managed, resulting in a forest of predominantly same-aged conifers, accompanied by dense thickets of shade-tolerant understory shrubs. The result is a perfect environment for high-intensity crown fire.

Poor forest management and landscaping practices encourages the accumulation of combustible vegetative material in woodlands and near, against, and overhanging homes and other buildings. Mistakenly thought of as “natural” or “traditional” landscaping, these conditions actually increase vulnerability to fire. Early homesteaders understood the danger of fire in isolated rural settings. Cabins, houses, barns, and outbuildings, built with locally available materials (wood siding and wood shake roofs), were commonly situated close to roads, in areas cleared of trees, shrubs, and tall grass²¹.

Fuels

Fuel is any material that can ignite and burn. Fuels describe any organic material, dead or alive, found in the fire environment. Grasses, brush, branches, logs, logging slash, forest floor litter, conifer needles, and buildings are all examples. The physical properties and characteristics of fuels govern how fires burn. Fuel loading, size and shape, moisture content, and continuity and arrangement all have an effect on fire behavior. Generally speaking, the smaller and finer the fuels, the faster the potential rate of fire spread. Small fuels such as grass, needle litter and other fuels less than a quarter inch in diameter are most responsible for fire spread. In fact, “fine” fuels, with high surface to volume ratios, are considered the primary carriers of surface fire. This is apparent to anyone who has ever witnessed the speed at which grass fires burn. As

fuel size increases, the rate of spread tends to decrease due to a decrease in the surface to volume ratio. Fires in large fuels generally burn at a slower rate, but release much more energy and burn with much greater intensity. This increased energy release, or intensity, makes these fires more difficult to control. Thus, it is much easier to control a fire burning in grass than to control a fire burning in timber²². When burning under a forest canopy, the increased intensities can lead to torching (single trees becoming completely involved) and potential development of crown fires. That is, they release much more energy. Fuels are found in combinations of types, amounts, sizes, shapes, and arrangements. It is the unique combination of these factors, along with the topography and weather, which determines how fires will burn.

The study of fire behavior recognizes the dramatic and often-unexpected effect small changes in any single component have on how fires burn. It is impossible to speak in specific terms when predicting how a fire will burn under any given set of conditions. However, through countless observations and repeated research, some of the principles that govern fire behavior have been identified and are recognized.

Climate Change

Increasingly, individuals and government leaders world-wide are endorsing the position that global warming is occurring, and that it is creating a dryer, warmer environment. Longer, dryer summer months will exacerbate already serious wildland-urban interface conditions in San Juan County.

Vulnerability Assessment

While sparsely populated compared to much of Washington, the rural character of San Juan County is a perfect setting for wildland-urban interface fire. Whether one lives in a village, on a wooded shoreline, near a forest or cultivated field, or residential acreage, we are all vulnerable to fire.

Over the last 100 years, the incidence of fire has been greatly reduced. Volunteer fire departments on the more populated islands do an excellent job of containing those fires that do occur to relatively small areas. However, warm summer temperatures coupled with seasonal low rainfall amounts sometimes lead to summer drought conditions. These conditions are reached more often than most people realize, and the absence of large fires coupled with reduced burning has also resulted in greater fuel loading and the risk of catastrophic fire given

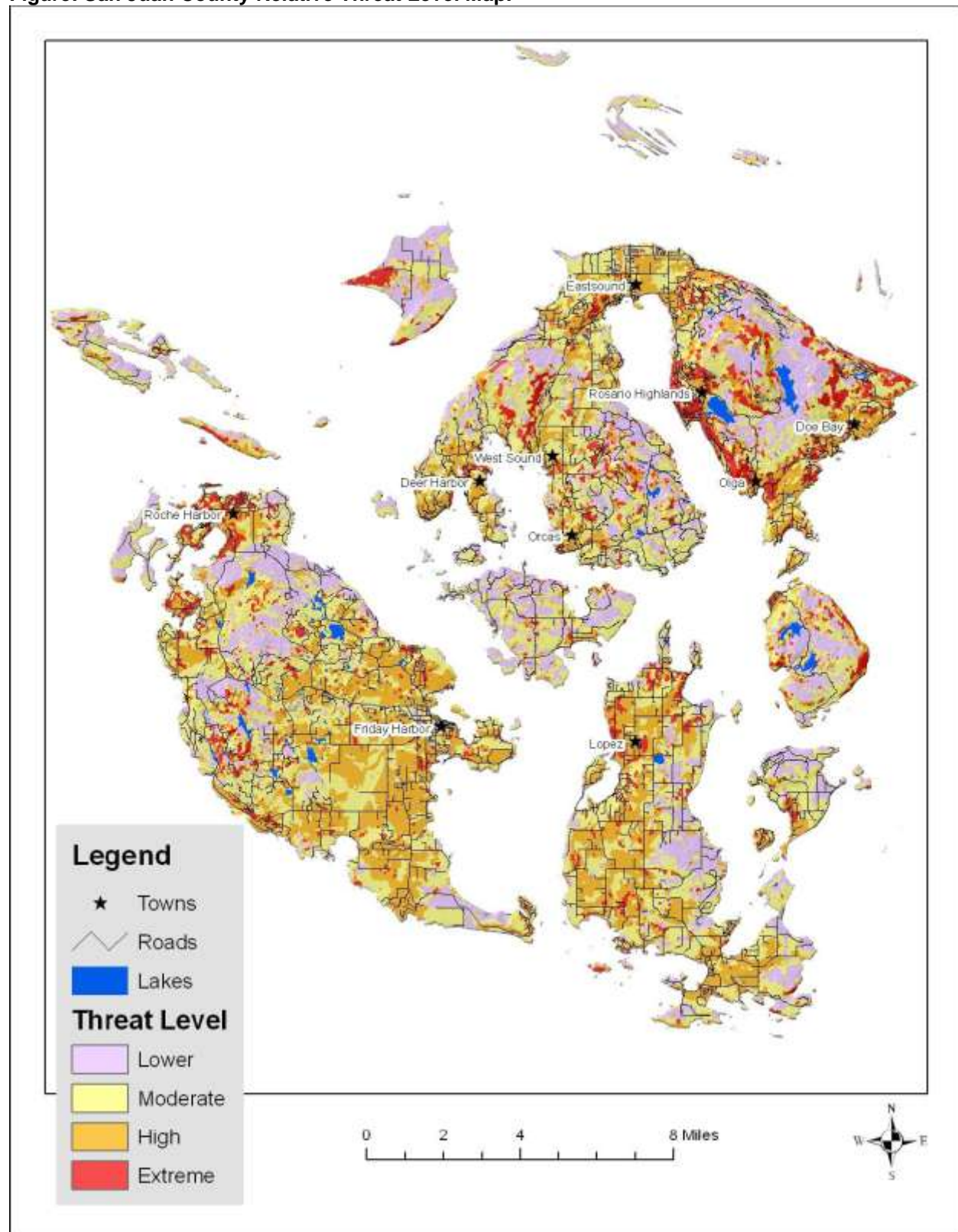
the right set of conditions. Fortunately, should a wildland-urban interface fire occur, the county's island topography and other factors would act to contain the fire from spreading county-wide.

As the local population continues to grow, the demand for new construction outside the village urban growth boundaries will put more people and structures at risk. However, this trend will likely lead to more incidents of fire than actual loss of life or injury. The greater threat is to the local economy which depends on tourism and the natural environment for jobs and economic growth. If a significant portion of the business community has been affected, the loss to local economy could be overwhelming. Reduction of payrolls and long-term layoffs during recovery from a fire could have a serious impact on the community's tax base.

At Risk Areas

All part of the county are at risk of wildland-urban interface fire. The following map shows relative risk within the county (note: the scale "lower to extreme" compares locations in the county and Friday Harbor relative to one another and does not relate to areas outside of San Juan County.

Figure: San Juan County Relative Threat Level Map.



Community Fire Risk Assessments

The majority of homes and structures within and surrounding San Juan County communities are along a spectrum from low to moderate to high risk of loss to wildland fire. Individual characteristics of each community and structure dictate the risk factors. The prevalence of tree and shrub fuels pose a moderate to high threat to homes surrounded by these fuels as fire typically spreads quickly through the grasses and burns at relatively high intensities in the brush and forest fuels, especially where declining forest health is a factor. Many homes are at low risk as a result of the management of fuels in the area immediately surrounding the structures and access routes. There are a number of individual homes that have a much higher risk to wildland fire loss largely due to the use of highly ignitable materials in home construction or the lack of defensible space surrounding the home. Home defensibility practices can dramatically increase the probability of home survivability. The amount of fuel modification necessary will depend on the specific attributes of the site. Considering the high spread rates possible in these fuel types, homes need to be protected prior to fire ignitions as there is little time to defend a home in advance of an active fire.

Island Communities

Much of the landscape in San Juan County was regularly burned by Native Americans pre Euro-American settlement. Research has suggested that at least portions of some islands were burned as often as every seven years (Sprenger and Dunwiddie, 2011) to enhance Camas and for driving game. There are a variety of theories as to why the Native Americans burned so frequently, but regardless of the reason, it is assumed that fire played a significant role in controlling fuel buildup while promoting desirable vegetative species across the islands. Many of the forests on the islands were cut down for fueling the Lime Kilns and for agriculture during the early 1900s. Fire was also seen as a destructive force in San Juan County and across the country. Active fire suppression efforts through the mid to late 1900s have allowed fuels to build up, which creates an extreme fire risk.

San Juan County is one of the leading counties, not only in the state, but in the country for the number of Firewise communities participating in this program.

Lopez Island

Lopez Island is the third largest island in San Juan County and covers approximately 30 square miles. Lopez Village, located on Fisherman Bay on the west side of the Island, is the only significant population center. Nearly all of the commercial activity occurs at or near Lopez Village; however, there are scattered businesses throughout the Island. Other population clusters include Port Stanley, Richardson, and Mackaye Harbor. Tourism is the primary industry, but there are also a number of small farms and marinas that contribute to the local economy.

Fuels Assessment

Lopez is generally flatter than most of the other major islands with Chadwick Hill on the south end and Lopez Hill near the center offering the only significant topography. A large portion of the interior of the Island is dominated by scattered agricultural fields and natural grasslands. These areas are generally managed through livestock grazing or crop production and are not a significant wildfire risk.

Lopez Island is approximately 10 miles long from the northern tip of Upright Head to Iowa Rock on the southern end of the Island, but only about 4-5 miles wide in most places. The southern end of the Island receives significantly less precipitation than the north end due to the rain shadow cast by the Olympic Mountains to the south. On average, the south end of Lopez Island receives approximately 19 inches of precipitation annually compared to approximately 28 inches on the north end of the Island. This difference has a significant impact on the vegetation type and fuel structures.

Douglas-fir is the primary overstory species in the forested areas. However, on drier sites, particularly south and west facing slopes, understory vegetation consists of mostly oceanspray, baldhip rose, and Douglas fir and Grand fir regeneration. In some of these areas, vegetation management or limited soil availability has resulted in a grass understory condition. Lodgepole pine, Madrone, and grand fir make up minor components of the overstory on dry sites. Due to the ladder fuels in the understory as well as the typically dry condition, these forest types would likely carry a rapidly moving fire that could develop into a crown fire, particularly under the influence of wind. Examples of this forest and fuel type include the south aspect of Lopez Hill, much of the Chadwick Hill area, and the Iceberg Point area. A mosaic of low, mixed, and high severity would be anticipated depending on specific site and weather conditions.

On the wetter sites, including the majority of the north end of the Island as well as on most north facing slopes, Douglas-fir was still the primary overstory species; however, western red cedar and grand fir are also common. The understory vegetation in these areas was somewhat dependent on the degree of canopy closure. In areas where sunlight still penetrated the understory, vegetation was prolific and consisted primarily of salal, oceanspray, Douglas maple, red alder, swordfern, salmonberry, stinging nettle, and numerous other shrubs. Upright Head and the Odlin Park area are examples of this forest type. In areas where full canopy closure has occurred, very little understory vegetation was present, but there is typically an abundance of large diameter, dead and down material on the forest floor. Humphrey Head is an example of this type of forest condition.

Prior to white settlement (before 1860), native peoples burned Lopez Island in the vicinity of Iceberg Point and Point Colville on an average at least every 11-12 years. From 1860 to 1914, the fire interval rose to about 23 years, and since then, only one small fire has been recorded in each area. Due to fire exclusion, coniferous trees and non-native vegetation has invaded many historical grasslands. Portions of these grasslands may be suited for restoration to historical vegetative structures²³.

Infrastructure

The main north/south transportation routes are Center Road and Fisherman Bay Road, which both traverse the majority of the length of the Island. There are numerous east-west routes including Mud Bay Road, Aleck Bay Road, Islandale Road, Lopez Sound Road, School Road, and Cross Road. The majority of the Island is easily accessed by County-maintained roads; however, private residences are typically located on short private driveways or shared driveways. Private roads are often well surfaced, but lack adequate clearance for fire or medical apparatus. Many of the private roads were not constructed with accessibility for larger vehicles; thus, very few have turnouts or turnaround areas that would allow for safe ingress or egress in the event of a fire.

Communication via cell phones and radios is available on Lopez Island; however, there are several areas with none or very limited coverage.

Community Assessment

Lopez Island has a low to moderate risk of experiencing wildland fire. There are very few occurrences of natural ignitions, but the risk of a human caused fire is relatively high due to the

intense recreational use in some areas. Even a small fire would have a significant impact on the local population. The scattered nature of the residences throughout the Island as well as the severely limited access into many of them would impede suppression capabilities. Particularly in homes along the shoreline, narrow, poorly-designed, and overgrown driveways prevent firefighters from responding directly to home sites in the event of a wildfire. Furthermore, the majority of homes on Lopez Island are part-time residences and remain empty for the majority of the year. Additionally, very few homes in forested areas have created a defensible space. Trees and other vegetation typically surround and are often in contact with structures; thus, the risk of a structural fire causing a wildland fire is very high.

Although not likely an inclusive list, due to a combination of the fuel type, access issues, and the lack of defensible space, several housing clusters or developments were identified as having particularly high wildfire risk. These included Humphrey Head, Dusty Road, residences in the Mud Bay and Hunter Bay areas, Skid Road, and residences in the Lopez Sound area. Additionally, the Land Bank properties at Lopez Hill and Upright Head as well as land owned by the Bureau of Land Management near Chadwick Hill and Iceberg Point have significant risk of fire ignition due to their recreational use.

Structural and wildland fire protection is provided by San Juan County Fire District #4, which maintains 4 stations on Lopez Island. Fire District #4 has established mutual aid agreements with the other San Juan County Fire Districts as well as the Washington Department of Natural Resources; however, it is unlikely that these resources would be available in time to assist with initial attack.

Potential Mitigation Activities

The vegetation in close proximity to structures significantly increases the wildfire risk in many areas throughout Lopez Island. Increased awareness of wildland fire risk within communities and the creation of defensible space would help reduce the potential impact of wildfire. Additionally, access improvements including turnouts and adequate turnaround areas at homes would significantly increase Fire District #4's ability to respond as well as firefighter safety in general.

Homeowner education and participation in programs such as Firewise Communities USA would improve the defensibility of individual structures and communities. Additionally, prevention of

poorly designed access in new developments would help alleviate the creation of future fire risk issues.

Forest management activities such as thinning and prescribed burning would likely help reduce fuel build ups in undeveloped and recreational areas. Efforts to increase the resiliency of the forest to wildfire will help reduce the potential impact to nearby communities by reducing the likelihood of a stand replacing event.

Orcas Island

Orcas Island is the largest island in San Juan County with a land area of about 57 square miles. Eastsound is the largest population center on Orcas Island, but other villages include Orcas (the ferry landing area), Deer Harbor, Rosario, Olga, and Doe Bay. The topography as well as climate and fuel type is highly variable throughout the Island. Tourism is the primary industry; however, there are a number of small farms and natural resource-based manufacturing firms contributing to the local economy as well.

Fuels Assessment

The fuel types as well as structure and complexity of fuels is highly variable. The vast majority of Orcas Island is forested; however, there is a significant amount of agricultural fields and natural grasslands in the Crow Valley area. The east side of the Island receives significantly more precipitation (approximately 28 inches annually) than the west side of the Island due to the rain shadow effects of Vancouver Island to the west and the Olympic Mountains to the south. Additionally, at 2,409 feet, Mount Constitution also has an effect on local weather patterns. Douglas-fir is the primary overstory species in forested areas. On drier sites, particularly south and west facing slopes, understory vegetation consists of mostly oceanspray and Douglas-fir and grand fir regeneration. In some of these areas, vegetation management or limited soil availability has resulted in a grass understory condition. Lodgepole pine, Madrone, and Grand fir make up minor components of the overstory on dry sites. Madrone is more abundant at low elevations near the coastline. Due to the ladder fuels in the understory as well as the typically dry condition, these forest types would likely carry a rapidly moving fire that could develop into a crown fire, particularly under the influence of wind. Examples of this forest and fuel type include much of the Turtleback Mountain area, Deer Harbor, and west facing slopes of the Mount

Woolard and Buck Mountain areas. A mosaic of low, mixed, and high severity fires would be anticipated depending on specific site and weather conditions.

Dry, south aspects on Turtleback Mountain have a prominent contingent of Garry oak woodlands and native grassland. Oak woodland and savanna ecosystems' historic fire regime typically consisted of relatively low-intensity fires on a short fire return interval (5-25 years). With changes in land use, the fire return interval has been dramatically increased, which allows coniferous trees, such as Douglas-fir, to establish and overtop the oak trees that were once dominant. Under natural conditions fire in this fuel type would have burned at low to moderate intensity; however, the additional fuel build-up will result in an increased fire intensity.

Wetter sites on the east end of the Island consist of highly productive Douglas-fir as the primary overstory species; however, western red cedar, grand fir, lodgepole pine, and western hemlock are also common. The understory vegetation in these areas was somewhat dependent on the degree of canopy closure. In areas where sunlight still penetrated the understory, vegetation was prolific and consisted primarily of salal, ocean spray, maple, red alder, sword fern, salmonberry, stinging nettle, and numerous other shrubs. Examples of this forest type include the Rosario/Vusario area, Kahboo Hill, and Doe Bay. In areas where full canopy closure has occurred, very little understory vegetation was present. The communications site on Mount Constitution is an example of this type of forest condition.

Moran State Park is located on the east end of Orcas Island and includes over 5,000 acres of publicly accessible forestland. The forest type in this area transitions from a moist site Douglas-fir dominated uneven aged stand at low to mid elevations to a closed canopy condition at higher elevations. The higher elevation forests are dense with very little understory, but a large dead and down material fuel component. Fires in this fuel type would be stand replacing and likely result in damage to soil properties; however, these forests have a very long fire return interval.

Infrastructure

San Juan County's primary communications facility is located on Mount Constitution within Moran State Park. The area immediately surrounding the tower site has been cleared of vegetation; however, due to the steep topography and dense forest type, this site would likely be threatened in the event of a wildfire. Aerial fire suppression tactics is likely the only form of protection that would be possible due to the topography and limited road access.

Access routes on Orcas Island are limited to a handful of travel corridors including Olga Road, Orcas Road, Deer Harbor Road, Dolphin Bay Road, and Point Lawrence Road. Nearly all secondary access roads intersect these primary routes. Private residences are typically located

on short private driveways or shared driveways. Private roads are often well surfaced, but lack adequate clearance for fire or medical apparatus. Many of the private roads were not constructed with accessibility for larger vehicles; thus, very few have turnouts or turnaround areas that would allow for safe ingress or egress in the event of a fire.

Communication via cell phones and radios is available on Orcas Island; however, there are several areas with no or very limited coverage.

Community Assessment

Orcas Island has a low to moderate risk of experiencing wildland fire. There are very few occurrences of natural ignitions, but the risk of a human caused fire is relatively high due to the intense recreational use in some areas. Even a small fire would have a significant impact on the local population. The scattered nature of the residences throughout the Island as well as the severely limited access into many of them would impede suppression capabilities. Particularly in homes along the shoreline or on steep slopes, narrow, poorly-designed, and overgrown driveways prevent firefighters from responding directly to home sites in the event of a wildfire. Furthermore, many of the homes on Orcas Island are part-time residences; thus, they are empty for the majority of the year. Additionally, very few homes in forested areas have an established defensible space. Trees and other vegetation typically surround and are often in contact with structures; thus, the risk of a structural fire causing a wildland fire is very high.

Although not likely an inclusive list, due to a combination of the fuel type, access issues, and the lack of defensible space, several housing clusters or developments were identified as having particularly high wildfire risk. These included Rosario, Vusario, Highlands, Marina Heights, Kahboo Hill, Mount Entrance, Rustic Homestead, and Buck Mountain. Additionally, the Land Bank property at Turtleback Mountain and Moran State Park have significant risk of fire ignition due to their recreational use.

Structural and wildland fire protection is provided by San Juan County Fire District #2 (Orcas Fire and Rescue), which maintains 7 stations on Orcas Island. Fire District #2 has established mutual aid agreements with the other San Juan County Fire Districts as well as the Washington Department of Natural Resources; however, it is unlikely that these resources would be available in time to assist with initial attack operations.

Shaw Island

Shaw Island lies in the center of San Juan County and the San Juan Archipelago; it is the smallest of the four islands served by the Washington State Ferry system. With a land mass of 7.7 square miles, Shaw Island is very rural with a small year round population of 240 persons that only slightly increases during the summer tourist season. Most of the island is privately owned. The only visitor amenities are the Shaw Island Historical Museum, Washington State Ferry dock and small general store and Shaw Island County Park, which provides limited camping on a first come first serve basis.

The University of Washington owns approximately 866 acres of gifted property located in large separate areas on the island. Most noted are Cedar Rock Reserve, and Fred and Marilyn Ellis Biological Preserve. Cedar Rock Reserve on the south side of the island is a biological preserve maintained for biodiversity, education and research. This preserve is accessible by road and has administrative facilities and caretaker housing. Road improvement and extension or linking of the current road system through the preserve would facilitate access for firefighting equipment and escape in a wild fire situation. Fuels treatment within the preserve is also needed to reduce areas of heavy fuels and minimize the chance of wildfire occurrence. The other University of Washington property of significant size is the Fred and Marilyn Ellis Biological Preserve, located on a peninsula on the southwest side of the island. This property is a scientific preserve conveyed to the University of Washington with the conditions that the property forever remains untouched for the purpose of teaching and research in the biological and related sciences. This property can only be accessed by foot or boat.

The Island's topography is primarily gently sloping and rolling with areas of rocky outcropping. The shoreline is undulating craggy basalt rock with many small coves and deep bays. Shaw Island is covered with a second growth dry forest ecosystem mixed with small patches of open pastures and cleared farmland. Forested areas contain a lush overstory of Douglas fir, Grand fir, Western red cedar, and Shore pine mixed with isolated occurrences of Pacific madrone. Near the shoreline, the understory vegetation includes salal and oceanspray on the deep soil areas and grass and sedge on shallow rocky soils. Away from the shore, the forest vegetation is primarily dense shrub and salal with few areas of grass in the understory except in disturbed areas. Throughout the forest ecosystem, dead and down woody material is common on the forest floor in addition to low lying shrubs and forbs.

Infrastructure

Access through Shaw Island is made possible by way of approximately 12 miles of two lane paved road, and 3 miles of gravel road. The roads travel through the interior of the island

providing very little access to the shore and many of these roads abruptly dead-end near the shore or at other private roads. Vegetation is very dense along the roadways, especially the roads accessing rural residential areas. Access into individual homes is often limited for large firefighting equipment, due to narrow winding driveways and dense roadside vegetation.

Fuels Assessment

Although Shaw Island is heavily timbered and has a high accumulation of wildland fuels, it is felt that a fire would have to be very well driven by high winds to cause serious damage. The lush understory vegetation is relatively green retaining high fuel moistures. In the grass areas, fires burn well but generally will go out as soon as it reaches the tree line due to the high fuel moistures and relative humidity maintained in the forested areas.

Fire Protection Services

Shaw Island is within the San Juan County Fire Protection District #5. This is an all-volunteer fire department with 2 primary rural fire stations that house fire trucks and firefighting equipment. One fire house is located at the Shaw Island Community Center at the intersection of Blind Bay Road and Squaw Bay Road. The other is at the cross roads of Ben Nevis Loop and Neck Point Road. The department currently has 21 volunteer fire fighters and averages 15 calls per year.

Community Assessment

Residence on the island are widely scattered across the landscape in large secluded acreages, however a few smaller closely grouped subdivisions are present. The Copperhill Road area is an area of higher density rural residence that is built in a forested area on narrow winding roads. Access to this area, and these houses would be very difficult in a wildfire situation due to the narrow road and driveways, heavy encroaching forest fuels, and limited water for suppression. Neck Point Community, located on the west side of the island is an area of several scattered residence on a peninsula all accessed by one narrow paved access road, Neck Point Road. In a wildfire situation, access and escape from this area would be compromised by the heavy fuels present along Neck Point Road. Residences throughout the island live in close proximity to forests and wildland fuels.

Potential Mitigation Activities

Potential project areas on Shaw Island include home defensible space treatment and roadside fuels treatment in the Copperhill Road area. Roadside fuels treatment and access improvement into the Neck Point area, and access road extension and improvement along with fuels treatment in the University of Washington Cedar Rock Preserve.

San Juan Island

San Juan Island is the second largest island in the county with a land base of over 55 square miles and the largest in population. Friday Harbor, located on the east side of the island is the County Seat and the only incorporated town on the island. Friday Harbor is the major commercial center of the islands and provides a number of tourist attractions. There are numerous seasonal homes on the island but also a large contingent of year-round residents as well. Roche Harbor is located on the northwest side of San Juan Island and offers an extremely sheltered harbor.

The highest point on the island is Mt. Dallas at 1,080 feet and Cady Mountain comes in at just under 900 feet. Much of the island topography is relatively gentle with exception to the steep slopes of Mt. Dallas and Cady Mountain. Much of the eastern half of the island has been converted to agriculture.

Fuels Assessment

San Juan Island has generally gentle topography with the exception of Mt. Dallas and Cady Mountain. The eastern half of the island consists largely of agriculture. The western half of the island is where a majority of the forest and steeper terrain are located. The island experiences what is known as a 'rain-shadow' effect from the Vancouver Island mountains and Olympic Peninsula mountains. San Juan Island is approximately 15 miles long from Roche Harbor to Cattle Point and 7 miles wide at its widest point.

Much of the forested portions of the island are dominated by Douglas fir with Lodgepole pine/Shore pine, Grand fir and Madrone making up the remainder of the overstory. In areas where the canopy is dense there is minor understory growth, resulting in a fuel type that is primarily needle litter and coarse woody debris. Where there are openings in the canopy, sunlight penetrates to the forest floor allowing species such as; salal, oceanspray and even the seedlings of the various tree species to grow in the understory. The dense forest canopy and thick understory on San Juan, has resulted in a presumably unnatural buildup of fuels due to fire

suppression activities. Forest health is a variable on the island with some pockets of diseased and insect-infested trees scattered across the landscape. These pockets of dead and dying trees increase the risk of wildfire but do not dominate the risk assessment. A wildfire in these forested areas would be uncommon however, given drought conditions, these fuel types could burn with moderate to high intensity.

There is a significant percentage of grassland on San Juan Island. Grass tends to dry out faster during the dry months than forest litter and is considered a flashy fuel. The nature of flashy fuels is that they burn rapidly but at a lower intensity than forest litter. The concern with flashy fuels is response time, because they are easily controlled as long as response time is quick. A longer response time may allow the fire to spread into areas near homes or into the timber where it is harder to control. Fires that burn through this fuel type can be very intense and spread rapidly.

Infrastructure

Friday Harbor serves as the major port of the island and is used by the Washington State Ferry to transport visitors from the mainland. The Roche Harbor road travels northwest out of Friday Harbor and ends in Roche Harbor. There are a few main roads that access the rest of the island including: West Valley road, Beaverton Valley road, Douglas road, Bailer Hill road, and West Side road. There are numerous side roads that access private residence. There are a couple of airports/airstrips on the island and numerous marinas dotting the shoreline.

Fire Protection Services

San Juan Island Fire Rescue operates a fairly substantial Fire Department with eight fire stations and is primarily staffed with volunteer firefighters. This district utilizes a variety of land based vehicles and one small fire boat.

Individual homes and subdivisions continue to increase and expand into forested areas. This expansion places a heavy burden on the fire district due to ingress/egress and addressing issues.

Community Assessment

The roads that access most of the homes on San Juan Island are narrow and winding with few offering a secondary egress option for residents and firefighters. Many residents refuse to use highly visible address signs to identify their property which makes it difficult for firefighters to locate homes.

There are numerous homeowners and communities that do participate in the Firewise program to provide defensible space around their homes.

Potential Mitigation Activities

Continue homeowner education programs to advise homeowners/builders about ‘firesafe’ landscaping and home construction materials. Given the rural nature of this community and observations made while visiting with local residents, it is obvious that many living here are very aware of the need for fuels mitigation. Builders should be encouraged to provide alternative or secondary routes out of communities to prevent homeowners from becoming trapped. Hazardous fuels reduction around San Juan Island’s public infrastructure (i.e. watersheds, communication sites, etc.) should be implemented to limit losses in the event of a wildfire. Purchase firefighting apparatus (both land and marine based) to provide adequate fire suppression resources for the expanding communities.

Probability And Risk

Based on past events, there is a Moderate Probability of a major conflagration event on any of San Juan County’s many islands. At the same time, the island topography and small population results in a Low Probability for cumulative area and population at risk.

Conclusion

Despite the relatively low probability of risk, the realities of limited rural fire suppression services and the frequency and potentially destructive nature of fire events should provide ample cause for individuals, families, and businesses to take the necessary precautions to reduce injury and property damage.

Potential Mitigations

This section of the plan identifies potential mitigation actions, including treatments that can be implemented in the county to pursue the goal of reducing the hazard from wildland fire in San Juan County and the Town of Friday Harbor. As there are many land management agencies and thousands of private landowners in San Juan County, it is reasonable to expect that

differing schedules of adoption will be made and varying degrees of compliance will be observed across various ownerships.

The primary land management agencies in San Juan County, specifically the USDI Bureau of Land Management, National Park Service, and WA Department of Natural Resources were participants in the Community Wildland Protection Plan and contributed to its development. Much of the information in the Wildland Fire section of this plan is taken from the CWPP as are most of the proposed mitigation actions. Where available, their schedule of land treatments have been considered in this planning process to better facilitate a correlation between their identified planning efforts and the efforts of San Juan County.

San Juan County encourages the building of disaster resistance in normal day-to-day operations. By implementing plan activities through existing programs and resources; the cost of mitigation is often a small portion of the overall cost of a project's implementation.

All risk assessments were made based on the conditions existing during 2012. Therefore, the recommendations in this section have been made in light of those conditions. However, the components of risk and the preparedness of the county's resources are not static. It will be necessary to fine-tune this plan's recommendations regularly to adjust for changes in the components of risk, population density changes, infrastructure modifications, and other factors.

Wildland Fire Mitigation Actions									
Id#	Map Id#	Project Name	Jurisdiction	# of Acres	# of Structures	Priority Rating	Benefit	Cost	Benefit/Cost Ratio
WF-1		Expand Education and Outreach	County and Town				3	1	3.00
WF-2		Practice of FireWise landscaping	County and Town				3	1	3.00
WF-3		Alternatives to Backyard Debris Burning	County and Town				3	1	3.00
WF-4		Code Adoption & Analysis	County and Town				2	1	2.00
WF-5		Urban-Wildland Interface (UWI) Fire Code Adoption	County and Town				2	1	2.00
WF-6		Outer Island Summit	County				2	1	2.00
WF-7	1	Johns Island Roadside Fuels Management	County	93	19	High	1	2	<1
WF-8	2	Johns Island Defensible Space	County	188	28	Medium	1	2	<1

WF-9	3	Waldron Island Defensible Space, Roadside Fuels, & Access Improvement Project	County	2,345	216	High	3	3	1.00
WF-10	4	Patos Island Fuel Treatments	County	28	1	Medium	1	2	<1
WF-11	5	Mt. Constitution Communication Site Fuels Treatment	County	187	10	High	3	3	1.00
WF-12	6	Eastsound Watershed Forest Management and Defensible Space.	County	829	132	High	3	3	1.00
WF-13	7	Rosario Highlands Defensible Space	County	1,050	289	High	3	3	1.00
WF-14	8	Turtleback Forest Management/Restoration	County	1,639	7	Medium	1	3	<1
WF-15	9	Spring Point Defensible Space and Roadside Fuels	County	1,251	255	High	3	3	1.00
WF-16	10	Doe Bay Area Gorse Treatment	County	10	312	Medium	2	1	2.00
WF-17	11	Trout Lake Watershed Forest Management and Access Improvement	County	891	21	Medium	3	3	1.00
WF-18	12	Henry Island Fuels Breaks	County	356	1	High	1	3	<1

WF-19	13	Mt Dallas Defensible Space Treatments	County	613	114	Medium	3	3	1.00
WF-20	14	Cedar Rock Preserve Vegetation Management	County	220	-	Medium	1	3	<1
WF-21	15	Ben Nevis-Biendl Road Defensible Space and Roadside Fuels	County	153	40	Medium	3	3	1.00
WF-22	16	Neck Point Roadside Fuels Treatments and Access Improvement	County	126	59	High	2	3	<1
WF-23	17	Humphrey Head Defensible Space and Access Improvement	County	138	35	High	2	3	<1
WF-24	18	Upright Head Defensible Space	County	241	77	High	2	3	<1
WF-25	19	Chadwick Hill Fuel Break and Forest Management	County	437	2	Medium	1	3	<1
WF-26	20	Iceberg Point Fuel Break	County	135	1	Medium	1	3	<1
WF-27	21	Pavey Road Defensible Space and Roadside Fuels Treatment	County	246	84	High	2	3	<1
WF-28	22	Lopez Hill Forest Management	County	476	2	Medium	1	3	<1
WF-29	23	Channel Road Defensible Space	County	215	66	High	2	3	<1

WF-30	24	Fish Bay Peninsula Defensible Space	County	228	78	High	2	3	<1
WF-31	25	Decatur Northwest Defensible Space	County	600	87	High	2	3	<1
WF-32	26	Eagle Lake Defensible Space	County	512	55	High	2	3	<1
WF-33	27	Raccoon Point Defensible Space	County	230	54	High	2	3	<1
WF-34	28	Crane Island Defensible Space and Roadside Fuels Treatments	County	231	62	High	2	3	<1
WF-35	29	Waldron Island Garry Oak Restoration	County	340	-	Medium	1	3	<1
WF-36	30	North 40 Defensible Space	County	190	100	Medium	2	3	<1
WF-37	31	Lost Prairie Forest Management and Restoration Treatments	County	146	-	Medium	1	3	<1
WF-38	32	Neil Bay Drive Defensible Space	County	104	35	Medium	2	3	<1
WF-39	33	Stuart Island Infrastructure Protection/Fuels Treatment	County	5	3	High	1	1	1.00
WF-40		Annual Tall Grass Order To Mow	Town			High	3	1	3.00
WF-41		Additional Brush Truck and Water Tender Capacity Lopez Island	County			High	3	3	1.00

WF-42		Support upgrading emergency service communication infrastructure	County and Town			High	3	3	1.00
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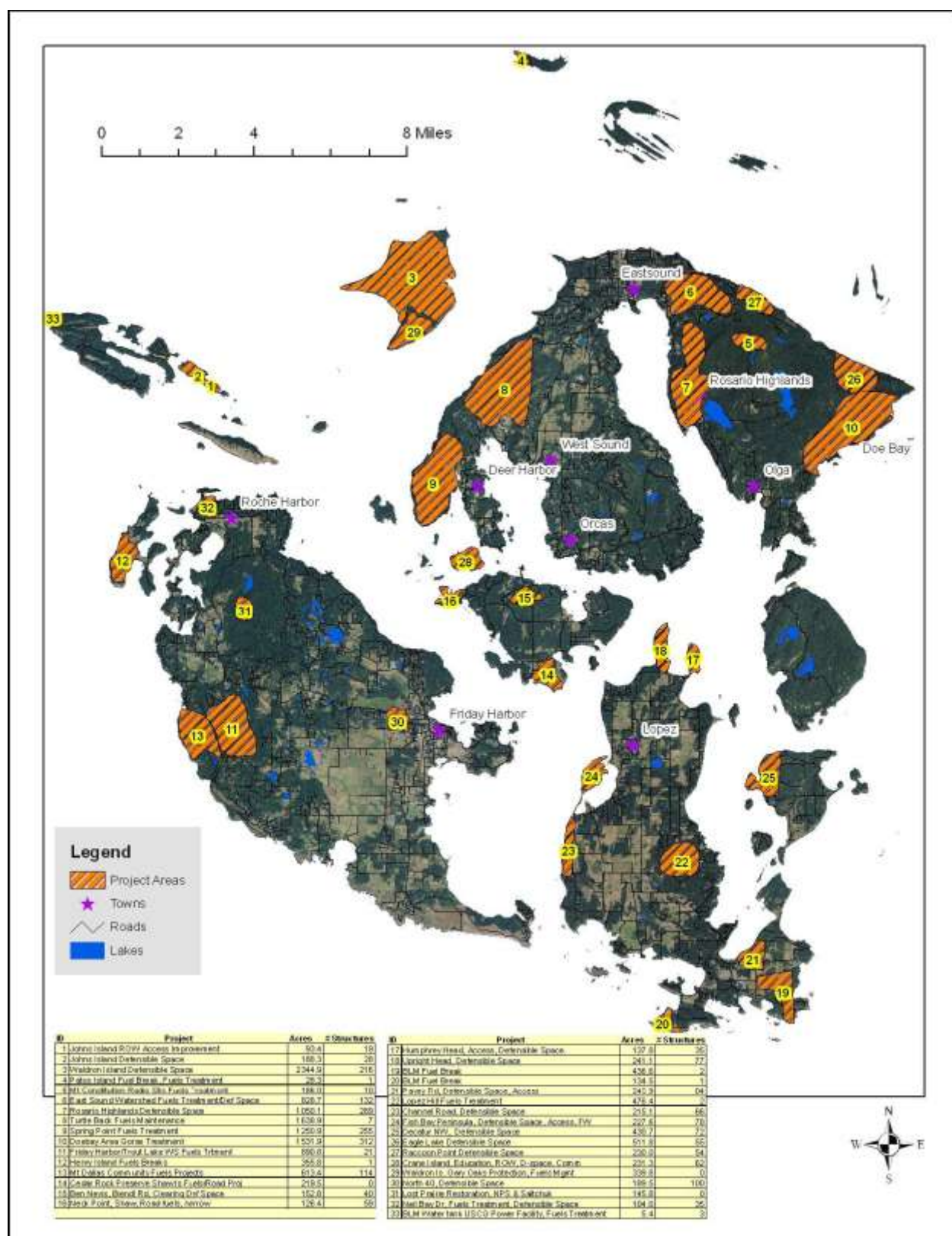


Figure: Potential WUI Treatments

Mitigation Recommendations

There are a number of ways to reduce the vulnerability to fire, minimize injury, and reduce property loss. Listed below are the potential mitigating activities identified during the creation of this plan.

Proposed Project Areas

The following project areas were included by the NHMP as being the most likely to be successfully completed from among the many proposed. Most of the sites were visited during the field assessment phase of CWPP development. The areas where these projects are located were noted as having multiple factors contributing to the potential wildfire risk to residents, homes, infrastructure, and the ecosystem. Treatments within the project areas will be site specific, but will likely include homeowner education, creation of a wildfire defensible space around structures, fuels reduction, and access corridor improvements. All work on private property would be performed with consent of, and in cooperation with the property owners. Specific site conditions may call for other types of fuels reduction and fire mitigation techniques as well. Defensible space projects may include, but are not limited to commercial or pre-commercial thinning, pruning, brush removal, chipping, prescribed burning, installation of greenbelts or shaded fuel breaks, and general forest and range health improvements. The NHM planning group recognizes that while the projects listed here are considered to be those most achievable and cost effective, others in the island's communities may have other priorities. In recognition of change in conditions over time, change in capabilities, change in land ownership or other factors which are beyond the control of the planning group or outside the scope of the plan, community members are encouraged to review the other project ideas not highlighted below for adoption and action outside of this plan. Any of the 42 identified projects may be just what a specific community needs to mitigate a hazard.

1. [WF-1] Expand Education and Outreach - Providers of emergency services and other public agencies should continue to work collaboratively to educate building and landscape contractors, realtors, and the general public about the potential for wildland-urban interface fire in San Juan County. Outreach and incentive programs should be developed to encourage residents and business owners to implement mitigation strategies at home and

in places of work or commerce. Targeted efforts to reach island tourists, the poor, and those with limited English proficiency are also recommended.

2. [WF-2] Encourage the practice of FireWise landscaping concepts in residential areas - Educate and involve residential property owners in fire-risk reduction by implementing FireWise programs throughout San Juan County.
3. [WF-3] Create Alternatives to Backyard Debris Burning - Create a county-wide program of woody debris chipping or large scale composting, as an alternative to backyard burning. Supply a chipper that can be checked out, or create a mobile system utilizing different temporary locations throughout the year where homeowner debris can be reduced to mulch. Offer incentives for using this alternative or launch with an extended county-wide burn ban. The County Solid Waste advisory Committee is exploring composting with solid waste disposal vendors in the county as an alternative to burning this debris. There is one facility located on Lopez island which is capable of composting large woody debris. Initial mitigation actions include Identification of public and private land suitable for these compost operations and land use designation adjustments required to facilitate this activity.
4. [WF-16] Doe Bay Area Gorse Treatment. The San Juan County Noxious Weed Control Board is actively working with landowners to help prevent the spread of gorse and to identify any new populations. So far, the County has been somewhat successful in preventing new populations by manual digging out the plants prior to seed dispersal. However, this method is very labor intensive and will not be effective in the long-term. Additional funding is needed to enable removal of established populations and the resulting fire hazards to residents, firefighters and structures in the Doe Bay area.
5. [WF-17] Trout Lake Watershed Forest Management and Access Improvement. In order to protect the watershed, implementation of fuels management projects, roadside fuels treatments, and establishment of fuel breaks will aid in reducing the wildfire potential in and out of the area. Fuels management projects designed to reduce understory fuel loading will reduce the rate of fire spread, should it occur. shaded fuel breaks in key places will help protect the watershed as well as other residents from fire that may originate from a home site. In addition to this, a program educating the nearby residents in fuels treatment and installation of defensible space around their property will help reduce the potential for fires and fire escape. The objective here is to reduce the potential for wildfire spread outside and inside the watershed, and improve the ability to suppress a fire inside the watershed should one develop.
6. [WF-13] Orcas Rosario Highlands Defensible Space. Vegetation thinning is the key to reducing home loss in the Highlands, starting in the home ignition zones. Further treatment of the mixed conifer stands within the Highlands needs to be conducted, including tree and/or ladder fuel removal. Further wildfire education within the development that deals specifically with home preparation and other wildfire mitigation issues, including: Clearing of dead vegetative material and heavy concentrations of live material from at least ten feet around each house. Removing dry needles and other vegetative debris from gutters. Separating wood fences and walkways attached to homes with metal flashing. Storing wood and other flammable items away from the house. Removing vegetative and other flammable materials from beneath decks and porches. Keeping exterior walls free of dead and/or dry vegetation. Cleaning roofs and gutters. Homeowners also need education concerning home preparation during a wildfire event.

Among other things, safe zones---or safe homes---should be identified for shelter for the residents.

7. [WF-11] Mt. Constitution Communications Site Fuels Treatment. This project proposes to thin vegetation in the area surrounding the communications facilities, including tree and/or ladder fuel removal. The site contains critical communications infrastructure for both local, state and federal agencies, and private broadcast radio, television, and other telecommunications providers.
8. [WF-40] Town of Friday Harbor "Annual Tall Grass Order to Mow". This is an ongoing and simple, low cost and effective action which is recognized by the NHMP group as supporting the goals of the mitigation plan.
9. [WF-41] Additional Brush Truck and Water Tender Capacity Lopez Island. An additional brush truck and water tender is sought on Lopez island to support wildland fire suppression.
10. [WF-42] Support upgrading emergency service communication infrastructure. Public safety agencies in the County and Town have long observed that inadequate radio communications sometimes hamper effective response to wildland fires. This is exacerbated by the fact that many new fire starts occur in areas which are difficult to access and have worse communications.

Section 7. FLOOD

Previous Occurrences

During the 1996-97 winter storms, areas throughout Washington State not normally prone to flooding experienced surface water flooding due to high tides, strong winds, and inadequate storm water drainage systems. Floods contaminated domestic water supplies, damaged property, blocked roads, and eroded shoreline. Since 1971, every County in Washington State including San Juan has received a Presidential Disaster Declaration for flooding.

Five Presidential Disaster Declarations for San Juan County have included either Flooding, Tidal Surge, or High Tides.

The Vulnerability Assessment section, pages 73-74, contains additional information about locations and frequency of flooding. This is largely based on anecdotal information as little information exists in the local media documenting these conditions.

The National Climatic Data Center documents two Coastal Flood events between 1966 and 2016²⁴.

Local records include DR - 1641 which included a project to repair damage to Crescent Beach Rd. caused by over road flooding as the result of tides and high winds. On September 24, 2013, over 2 inches of rainfall was recorded in a span of 1 hour. This caused localized flooding in which 5 Eastsound business were affected.

Understanding Local Flood Conditions

In San Juan County, flooding typically occurs during the rain and storm season, any time from fall to spring. It is most likely to result from a combination of heavy rain and the accumulation of runoff surface water (storm water runoff); and/or high tides coupled with severe wind (storm surge). Storm water runoff floods are typically the result of man-made environmental changes, such as altered wetlands, undersized drainage systems, and the increase of impermeable surfaces in conjunction with new construction. Less common or rare are floods resulting from shoreline erosion; structural failure of dams and ponds; and, potentially, tsunamis.

Without rivers, significant creeks, or melting mountain snowpack as contributing factors, flooding is not a frequently occurring natural hazard in San Juan County. Homes and other structures are generally built well above the high-tide line, out of range of most coastal flooding caused by storm surge. However, the recently completed RISKMap suggests that there are as many as 30 Friday Harbor, and 905 residences within the "Special Flood Hazard Area".

Coastal Flooding & Storm Surge

Storm surge is coastal flooding caused by extremely high winds and low pressure. The wind pushes the water rapidly, building it up into unusually large waves. At the same time, the low pressure causes the water level to rise, exacerbating the wave buildup caused by the winds.

High astronomical tides topped with surge and waves caused by strong winds during winter storms are also responsible for coastal flooding. The greatest concern for surge is with wind out of the southwest, which causes water to pile up in embayments and sounds. Since a majority of the shoreline is rocky bluffs, flooding primarily occurs in the low - lying coastal and estuary areas.

The shape of the ocean floor may affect how high the waves of the storm surge are when they reach land. Storm waves are generally broken up by the interference of riptides— strong surface current flowing outwards from a shore. However, at slack tide (the occurrence of relatively still water that occurs between high and low tide) when riptides are not active, storm waves are free from such interference, and can contribute to coastal flooding.

Surface Flooding

Is characterized by localized surface water accumulation. Most often this occurs in developed areas where existing storm water drainage systems are unable to deal with heavy amounts of rainfall, snowmelt or unusual structural events that result in flooded parking lots, basements, roadways and other low-lying areas.

Inland, there are an equally small number of sites where surface flooding may occur in low-lying areas during periods of prolonged and heavy rain. This is a function of soil saturation and drainage basins not large enough to handle the runoff that would, under normal rain conditions, empty out into the sea. New construction can exacerbate this situation by increasing the amount of impermeable pavement and roof surfaces, taxing natural and man-made drainage systems, and diverting water to places previously safe from flooding.

Studying Flood Hazards with the Risk MAP Program

FEMA created new FIRMs for San Juan County that included updated flood modeling along the San Juan County coastline. In addition to new FIRMs, flood risk assessment products were developed and used in this risk report. Depth grids were created for the 1-percent-annual-chance flood for the coastal areas. Depth grids were generated from the coastal flood model and show the level of flooding in feet for each pixel and each flood frequency. Depth grids were used in this risk assessment to determine which properties are affected by flooding. The 1-percent-annual-chance depth grid for the project area is shown in Map 2-1 for the coastal areas.

Community	Total Estimated Building Value	Total Number of Buildings	Building Dollar Loss for a 1% Annual Chance Flood Event	Loss Ratio (Dollar Losses/Total Building Value)	Number of Buildings within the VE Zone	Number of Buildings within the AE or A zones	Number of Buildings within the Special Flood Hazard Area	Percent of Buildings in the Special Flood Hazard Area
Friday Harbor	\$187,190,569	1,313	\$385,552	0.21%	0	30	30	2.28%
Unincorporated San Juan County	\$7,239,075,466	24,170	\$32,899,488	0.45%	239	666	905	3.74%
Total	\$7,426,266,035	25,483	\$33,285,040	0.45%	239	696	935	3.67%

Vulnerability Assessment & Content

Certain inland & lowland areas of San Juan County are vulnerable to tidal flooding or storm surge when specific conditions occur simultaneously: high tide, heavy rain, high winds.

Surface Flooding

San Juan: San Juan Valley floods in the area where the drainage crosses Bailer Hill Road, closing the road every ten years or so for up to a couple of days.

Lopez: Odlin Park and a large wetland on the west side of Richardson Road, north of Vista Road, backs up into and across the road about every ten years.

Orcas: Some areas of Crow Valley experience localized flooding into mostly agricultural areas. There are no developed communities in these areas, and some them are already designated as wetlands.

Coastal Flooding

Orcas

Crescent Beach

According to Russ Harvey, Director of SJC Public Works, Crescent Beach is the spot for some of the most consistent flooding on Orcas Island, occurring in ten year cycles or less. In 2006 FEMA awarded \$35,000 to the County for repair of road damage and clearing flood related debris. Crescent Beach Road is a primary access route to Eastsound commercial business for residents living on the east side of Orcas Island; when the road is closed due to flooding, residents follow a detour on Mt. Baker and North Beach roads to access the Eastsound Village and essential services.

Deer Harbor

Areas along the shoreline, adjacent to the inner harbor

Olga

Some small areas immediately adjacent to Buck Bay, including at the end boundary of the hamlet.

Lopez**Fisherman Bay**

Flood hazards areas have been mapped along the shoreline and extending into Fisherman Bay from the “crossroads” area. The northern-most shoreline of Fisherman Bay is also a flood-prone area, as is the narrow peninsula that forms the bay.

Port Stanley

At Port Stanley a tide gate controls water flow between the beach and an estuary with a row of homes and a road in between. When conditions are aligned (high tide, storm surge, recent heavy rains adding to the Hummel Lake watershed that empties into the estuary) the tidegate system can become overwhelmed or plugged by debris and water can back up in the estuary, flooding the yards and drainfields of the residents. This occurs less often than Crescent Beach, but with rising sea levels and continued upland development, it continues to be a concern. There is little danger of the road being cut off at this location.

Islandale

This is the one hamlet in which flooding may be a significant problem. The area of shoreline east of MacKaye Harbor and extending inland across the shoreline road is mapped as a Flood Hazard Area. A second area of flooding is found extending inland from Aleck Bay toward the County Park. The area along MacKaye Harbor Road lies at or close to sea level and is separated from the harbor by the raised causeway on which the road runs. This area is mapped as a FEMA Special Flood Hazard Area (Zone A). Homes currently exist in this location; additional development of parcels here may exacerbate conditions while subjecting an even greater number of people and properties to the dangers of flooding.

Probability and Risk

Based on past events, there is a **Low Probability** of significant flooding occurring in San Juan County. Likewise, there is a **Low Risk** associated with flooding events that will occur.

Conclusion

While flooding is infrequent in San Juan County, some areas are at risk when conditions are right. When floods do occur, they can damage structures, crops, land, flood-control systems, roads, utilities, and, more rarely, cause injury or loss of life. Flooding in developed areas could significantly impact residences and infrastructure. Both the Town of Friday Harbor and San Juan County have implemented programs and taken steps to reduce flooding. These measures are proving effective. At the same time, environmental conditions on a global level may result in entirely new and challenging flood scenarios.

Recent Progress: In recent years, both the Town and the County have taken measures to reduce the occurrence and impact of surface flooding. Both have created stormwater utility districts, and are resizing drainage culverts and other storm water infrastructure as they come up for scheduled maintenance or replacement²⁵. In Friday Harbor, upgrading drainage infrastructure has been so successful that one public works employee believes that the new storm drains could withstand a storm comparable to that of December 1996 without flooding.

Climate Change: Population growth, increased development, and demand for waterfront property are exacerbating the potential for flood damage, both from coastal and surface flooding. In addition, recent scientific findings show that climate change and glacial melting are raising sea levels. In a 10 year span, 1995 to 2005, average sea levels around the world have risen more than one inch—twice as fast as during the previous 50 years²⁶.

The report "Sea Level Rise Vulnerability in San Juan County, Washington" Prepared by Coastal Geologic Services Inc. for Friends of the San Juans, cites a review of regional sea level rise projections reported by the National Research Council (NRC) for the coasts of California, Oregon, and Washington²⁷. Standard projections and ranges were reported to capture the range of model outputs from multiple carbon emissions scenarios across three planning horizons; 2030, 2050, and 2100

The NRC scenarios were specifically created for Seattle, Washington. The moderate projection reported represents the Intergovernmental Panel on Climate Change (IPCC) A1B scenario²⁸,

adapted to the Pacific Coast from gridded data by Pardaens et al. ²⁹. The high projections used the averaged values for the A1FI model outputs. All NRC- regional SLR projections were originally reported in cm relative to year 2000, but have been translated to feet for use in this study. The table below shows these projected sea level rise values.

Table: Moderate and high sea level rise projections by the National Research Council (NAS 2012). Moderate scenario = mean SLR for the Pacific Coast from Pardaens et al. (2010) for the A1B scenario. High scenario = upper extent of the means for B1 and A1FI. ³⁰

SLR Projections	Year 2050	Year 2100
Moderate (IPCC A1B) Scenario	0.54 ft1	2.03 ft
High (IPCC A1FI) Scenario	1.57 ft	4.69 ft

As a result of this potential rise in sea level, homes that were once outside mapped flood plains could experience flood risk in the future.

Potential Mitigations

There are a number of ways to reduce vulnerability to flooding, minimize injury, and reduce property loss. Listed below are the potential mitigating activities identified during the creation of this plan. Rating and prioritization of these and other potential hazard-mitigation strategies follow in Sections Eleven and Twelve.

1. [F-1] Continued Public Education and Outreach -San Juan County should continue to educate those who live or work in identified flood zones about the National Flood Insurance Program (where applicable), viable mitigation strategies for at-risk residential and agricultural property, as well as response and recovery procedures for public roads and facilities.
2. [F-2] Early Warning -The National Weather Service and National Ocean Survey provide flood and tidal-flood watch and warning information to the public through a number of media sources. Residents should also be encouraged to obtain and utilize weather radios during storm season. Local government agencies should continue to monitor weather conditions and prepare protocols for public notification when flooding is predicted.
3. [F-3] Flood Mapping -Nationally, 35-40 % of National Flood Insurance Program claims come from outside the mapped flood plains. The current FEMA flood-zone maps used by local planning officials are currently in the update process and being converted to the digital format.

4. [F-4] Building Codes & New Construction -San Juan County and the Town of Friday Harbor have local ordinances in place to regulate and direct development in known flood plain areas. However, the continued rapid population growth in San Juan County—and predicted rising sea level—make it imperative to enforce building regulations and, in some cases, restrict development in flood-prone areas and sensitive watersheds. Where new construction is allowed, make Low Impact Development (LID) practices mandatory
5. [F-5] Storm Water Drainage -The Town of Friday Harbor and San Juan County have adopted storm water utility or districts. Both should continue efforts to prioritize drainage systems for upgrade, identify funding sources for improvements, and develop a timetable for implementing surface water/drainage projects.
6. [F-6] Prune Alley Road Improvements - Project Objective: Construct complete street improvements in accordance with current Eastsound Street Standards with design considerations for parking, lighting, landscaping, pedestrian and accessibility accommodations, utility relocations and storm drain improvements. Project is 100% funded with local road funds. Estimated cost : \$2.57 million.
7. [F-7] A Street Road Improvements, Eastsound - Project Objective: Construct complete street improvements in accordance with current Eastsound Street Standards with design considerations for parking, lighting, landscaping, pedestrian and accessibility accommodations, utility relocations and storm drain improvements. Project is 100% funded with local road funds. Estimated cost : \$1 million.
8. [F-8] San Juan Valley Road Improvements, San Juan Island - Project Objective: Structural reconstruction of a failing road base with considerations for road widening. Project Need: The roadway surface is rough with humps and sags caused by settlement, and slumps at the edge of pavement. The underlying material is peat and portions of the road need major reconstruction. Because the underlying material is peat, this road is at risk of failure as a result of earthquake. Project is 100% funded with local road funds. Estimated cost : \$.275 million.
9. [F-9] MacKaye Harbor Road Relocation, Lopez Island - Project Objective: The project has two phases to protect the county road from coastal erosion processes and projected sea level rise and to maintain access to public and private lands. Project Need: The shoreline bluff along the Agate Beach section of MacKaye Harbor Road has been eroding from tidal and storm action. Bluff erosion has advanced to within a foot of the county road. MacKaye Harbor Road provides the only access to Agate Beach County Park, the National Monument at Iceberg Point, tribal lands and to approximately 100 private residences. As the erosion advances, it will cause loss to portions of the road, and eventually, cause loss of the entire road. Phase 1 is to relocate the 0.2 mile segment of MacKaye Harbor Road fronting Agate Beach, inland approximately 300 feet from the eroding bluff as conceptualized in the 2017 "MacKaye Harbor Road Relocation Feasibility Study". The project includes the construction of two 11- foot lanes with 1-ft shoulders and transitions into the existing road at each end of the project. Utility relocation, road reclamation, parking and a multi modal trail are elements included in the project. Phase 1 cost estimate is \$920,546.Phase II completes the relocation of the remaining 0.7 miles of the road and the cost estimate ranges from \$3.1 million to \$11 million. Estimated cost \$3.1 Million

10. [F-10] Douglas Road Improvements, San Juan Island - Project Objective: Reconstruct the roadway to include 11 foot lanes with 4 foot shoulders and reconstruct the intersection at 'The Oaks' into a radial 'T' intersection. Project Need: The road has limited vertical and horizontal sight distance and little to no shoulder. A deep ditch on the south side of the road near False Bay Drive destabilizes the road structure. Flooding often occurs in this area where False Bay Creek drains the majority of San Juan Valley across Bailer Hill Road. Douglas Road to Bailer Hill Road is a major transportation link on San Juan Island providing a direct route from Friday Harbor to the west side of San Juan Island. Funding: 10 % local Road Funds, 90% State RAP (Rural Arterial Program funding pending). Estimated cost is \$2.06 million.
11. [F-11] Hunter Bay Marine Facility, Lopez Island - Project Objective: Repair or replace the existing pier, gangway and float. Project Need: The Hunter Bay dock and float no longer have available capacity to meet the Level of Service (LOS) as established in the San Juan County Code.
12. [F-12] Griffin Bay Marine Facility, San Juan Island - Project Objective: Reestablish the fully functional marine access facility. Initial work will remove derelict structures. Possible improvements include improving the access road, reconstructing the pier, establishing a boat ramp, and improving barge access to provide for a comprehensive essential public facility. Environmental improvements may include removal of creosote pilings and portions of a rock bulkhead. Project Need: The existing facility is in disrepair and barge access is currently limited to a maximum of three times per year. There is great potential to establish a vital marine asset to San Juan Island with emergency access, commercial ,and recreational facilities. Funding:100 % local Road Funds. Estimated cost: \$0.625 million.
13. [F-13] Westsound Marine Facility, Orcas Island - Project Objective: Remove eleven creosote-treated timber piles and cross-bracing and replace with eight new galvanized steel pipe piles. Replace the two existing floats with a single heavy duty timber float with foam-filled HDPE floatation drums and high-traction fiberglass grate deck. Install new aluminum gangway. Project Need: The existing transition bridge that spans the gap between the two independent floats is subject to failure and requires high maintenance. The weight of the floats and the large motions they experience during storms causes damage to the pile retainers. Funding: ?100 % local Road Funds. Estimated cost: \$0.230 million.
14. Town of Friday Harbor Stormwater improvement projects. These projects are planned in order to prevent flooding in the Town and minimize environmental and property damage from flooding, erosion, and sedimentation. Highest priority was given to projects for drainage installations which could not convey a 2 year storm, and last priority was given to projects that could would accommodate a 25 year storm. Details of the projects may be found at the Friday Harbor website:
<<http://www.fridayharbor.org/town%20documents/StormwaterManagementPlan/chapter%206.pdf>>
15. [F-14] FIRM map ordinance. The County should pass an ordinance adopting updated FIRM maps. This is a requirement to continue to participate in the national Flood Insurance Program.

Project Number*	Project Description	Estimated Project Costs ⁽¹⁾
[F-15] 3.	Larson Street	\$ 472,000
[F-16] 4.	680/690 Larson Street	\$ 165,000
[F-17] 5.	Marble Street and Tucker Avenue	\$ 59,000
[F-18] 7.	Friday Avenue to Outfall	\$ 121,000
[F-19] 9.	Linder/Nelson/Franck/"C"/Nichols Streets	\$ 395,000
[F-20] 11.	West Street Diversion from Second Street to First Street	\$ 73,000
[F-21] 12.	Caines Street Diversion from Spring Street	\$ 70,000
[F-22] 14.	Marguerite Place and Guard Street	\$ 232,000
TOTAL ESTIMATED PROJECT COST \$1,587,000 * Completed projects were removed from this list and the original list numbering retained from the Friday Harbor CIP appears below the bracketed number. (1) April 2005 ENR Index Cost, DDI – 8194.11		

Flooding Mitigation Actions

Id#	Project Name	Jurisdiction	Priority Rating	Benefit	Cost	Benefit/Cost Ratio
F-1	Continued Public Education and Outreach	County and Town		3	1	3
F-2	Early Warning -The National Weather Service	County and Town		3	1	3
F-3	Flood Mapping	County and Town		3	1	3
F-4	Building Codes & New Construction	County and Town		3	1	3
F-5	Storm Water Drainage	County and Town		3	1	3
F-6	Prune Alley Road Improvements	County		3	1	3
F-7	A Street Road Improvements, Eastsound	County		3	1	3
F-8	San Juan Valley Road Improvements, San Juan Island	County		3	1	3
F-9	MacKaye Harbor Road Relocation, Lopez Island	County		3	3	1
F-10	Douglas Road Improvements, San Juan Island	County		3	3	1
F-12	Griffin Bay Marine Facility, San Juan Island	County		3	3	1
F-13	Westsound Marine Facility, Orcas Island	County		3	3	1
F-14	Pass Ordinance to adopt new FIRM Maps	County		3	1	3
F-15	Larson Street	Town		3	3	1
F-16	680/690 Larson Street	Town		3	3	1
F-17	Marble Street and Tucker Avenue	Town		3	3	1
F-18	Friday Avenue to Outfall	Town		3	3	1
F-19	Linder/Nelson/Franck/"C"/Nichols Streets	Town		3	3	1
F-20	West Street Diversion from Second Street to First Street	Town		3	3	1
F-21	Caines Street Diversion from Spring Street	Town		3	3	1
F-22	Marguerite Place and Guard Street	Town		3	3	1

Participation in National Flood Insurance Program (NFIP)

The Town of Friday Harbor does not participate in the NFIP program and San Juan County does participate in the NFIP. The Community Rating System implements local mitigation, floodplain management, and outreach activities which exceed the minimum NFIP requirements. As of 10/1/2017, San Juan County does not participate in the Community Rating System program ([fact sheet link](#)) available to jurisdictions which participate in the NFIP.

The Director of San Juan County Department of Community Development is the County's floodplain administrator.

There are no (0) Repetitive Loss Properties identified in San Juan County.

San Juan County Loss Statistics (as of 1/31/2018)					
Community	Total Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments
Unincorporated SAN JUAN COUNTY*	4	2	0	2	\$26,407.09

San Juan County Policy Statistics (as of 1/31/2018)				
	Community	Policies in-force	Insurance In-force whole \$	Written Premium In-force
SAN JUAN COUNTY	Unincorporated SAN JUAN COUNTY*	117	34,586,400	132,233

See the FEMA FLOOD INSURANCE STUDY NUMBER 530149CV001A VERSION NUMBER 2.3.2.1 dated 8/12/2016 retrieved at <http://www.sanjuan.co.com/DocumentCenter/View/10306> for detailed information. This report contains detailed information about proposed revisions to FIRM maps for San Juan County. The updated FIRM maps are scheduled to be finalized during the summer of 2018.

Section 8. DROUGHT

Previous Occurrences

With a temperate climate and normally ample rainfall, western Washington is not generally considered a drought-risk region. However, examination of weather data reveals that the region as a whole has been affected by drought and near drought conditions. San Juan County has experienced drought conditions six times since 1925, with four droughts lasting two to four years: 1928-30, 1976-79, 1985-88, 1993-94, 2002 and 2015. In April 2015 Governor Inslee declared a statewide drought emergency. San Juan County Palmer Drought Severity Index showed "severe drought -3.00 to -3.99)" between July and October of 2015³¹.

Understanding Drought Conditions in San Juan County

Precipitation

Located in the rain shadow of the Olympic Mountains, San Juan County is drier than many of the coastal mainland counties to the east. Precipitation records from the Olga 2SE weather station, dating from 1890 to present, indicate that the average annual rainfall is approximately 29 inches (compared to Seattle's 39 inches) per year. However, annual precipitation varies greatly across the islands, generally increasing from 19 inches in the south to 30 inches at the northern end of the county. The amount of rainfall is also influenced by elevation: from 19 inches at the low-lying southern end of Lopez to over 45 inches atop Mt. Constitution on Orcas Island. December is usually the wettest month and July the driest³².

Geography

The islands of San Juan County are surrounded by seawater. Watershed catchment areas are limited, there are no rivers, and, with a few exceptions, streams are intermittent. Under these conditions, even moderate drought conditions can limit the supply of available fresh water.

Water Sources

Nearly all fresh water users in San Juan County depend on surface or groundwater systems. Forty percent, including residences and businesses in the town of Friday Harbor and the most of the county's island villages, rely on surface water reservoirs.

Most of the Islands' larger water systems depend on surface water. According to the San Juan County Water Resource Management Plan, 40 percent of the county's population receives its drinking water from surface water systems. Of the county's nine water systems with at least 100 connections, seven utilize surface water.

Water System	Island	Source Type	Source	Connections
FRIDAY HARBOR, TOWN OF	San Juan	Surface Water	Trout Lake	1,808
EASTSOUND WATER USERS ASSOCIATION	Orcas	Surface AND Ground Water	Purdue Lake	1,300
ROSARIO	Orcas	Surface Water	Cascade Lake	223
ROCHE HARBOR WATER SYSTEM INC	San Juan	Surface Water	Briggs Lake	445
DOE BAY WATER USERS ASSOC	Orcas	Surface Water	Mountain Lake	276
OLGA WATER USERS INC	Orcas	Surface Water	Cascade Creek/Mountain Lake	130
FISHERMAN BAY WATER ASSOCIATION	Lopez	Groundwater		152
ORCAS HIGHLANDS ASSOCIATION, INC.	Orcas	Surface Water	Cascade Lake	117
CAPE SAN JUAN WATER DISTRICT	San Juan	Groundwater		143

Prior to the 1990s, surface water systems, specifically Trout Lake (Friday Harbor), Briggs Pond (Roche Harbor), and Cascade and Mountain lakes (Rosario, Doe Bay, Olga) were the primary sources of drinking, irrigation, and stock water for the majority of the county's residents. Today, the balance has shifted to a greater reliance on groundwater aquifers.

San Juan County now has over 5,000 groundwater wells, or one for every three people³³. These wells are dependent on water stored in underground aquifers. There are multiple groundwater aquifers on each of the larger islands in the San Juan Islands. Water levels in these aquifers fluctuate seasonally, being drawn down during the summer and refilled during the winter.

Drought Here?

A small percentage of residential consumers (500 connections) receive water from twelve six privately owned and operated desalinization plants, paying almost three times the cost per gallon as do surface-water users³⁴. An even smaller amount of available water is provided by rainwater catchment in storage tanks on individual properties. (The capacity of water catchment systems is generally quite limited; the water is used primarily for irrigation.) Regardless of source, all areas of San Juan County are vulnerable to drought; this is true regardless of which water system one uses. Cases of prolonged or severe drought would result in low reservoir levels, diminished aquifers, and seawater intrusion in wells throughout the county.

How Vulnerable is San Juan County?

Drought conditions have been documented in San Juan County six times since 1925, with four droughts lasting two to four years: 1928-30, 1976-79, 1985-88, 1993-94, 2002 and 2015. In April 2015 Governor Inslee declared a statewide drought emergency. San Juan County Palmer Drought Severity Index showed "severe drought (-3.00 to -3.99)" between July and October of 2015.³⁵

These conditions in San Juan County have been viewed as inconvenient and have not been severe enough to warrant description as a disaster. Increasingly however, water availability is being considered a critical resource issue. Two factors increase the vulnerability to water shortage and drought: (1) all of the water sources depend on rainfall and not runoff, and (2) increasing development threatens aquifer viability, water quality and reservoir levels. When demand (both human and that of the natural environment) exceeds availability fire danger increases and the local economy may be effected.

Lopez Well Study

A 1997 study conducted by the United States Geological Survey found chloride concentrations of 100 mg/L or more in 46% of Lopez Island's 185 sample wells, indicating possible seawater contamination. Fresh ground water in most coastal areas of Washington generally contains less than 10mg/L of chloride.³⁶

Well Failures

Drought reduces the ability of aquifers to replenish (or recharge) stored water. The USGS estimates of recharge for San Juan County are the lowest in western Washington³⁷. Even in non-drought years, some existing residential wells are insufficient to provide water year-round, and require periodic deliveries by one of four private water haulers. Costly and potentially unreliable, water from local suppliers will be more expensive—or in short supply—during drought periods.

In 1982, a USGS study of San Juan County found that seawater intrusion was strongly suspected in 9% of the wells studied, with most of these located in the southern parts of Lopez and San Juan islands. An elevated chloride level in well water can be an indicator of seawater intrusion—the reduction in the amount (or level) of fresh water stored in an aquifer. This is particularly true for wells drilled in glacial material. A 2002 follow-up study on Lopez Island found that the level of chloride had increased, signaling a possible decline in the amount of fresh water available from groundwater wells on that island.

Fire Danger

Prolonged drought conditions are problematic for native evergreen trees accustomed to moist soil conditions. Drought-induced environmental stress damages the forest ecology: trees become more susceptible to pest infestation and their health declines. Locally, drought-related forest decline has been noted anecdotally by islanders interviewed during the research phase of this plan. Drought, and its impact on soil moisture and forest vegetation, may in time lead to long-term burn bans throughout the county, an increased risk of wildland-urban interface fires, and the unavailability of water to fight them.

The increased risk of wildland fires due to climate change also has the potential to adversely impact surface water reservoirs. Soils and groundcover in burned areas are less stable and more susceptible to erosion. Runoff from burned areas can adversely impact reservoir water quality. Most of San Juan County's largest water systems do not have a backup water source, relying predominately on surface water. These systems could be adversely affected if their reservoirs were fouled by runoff choked with sediment from burned surroundings. While there are few lightning strikes in the San Juan Islands compared to east of the Cascades, other factors contribute to forest fire risk in the islands, including development in hard-to-reach areas, limited water resources for fire-fighting in the summertime, campfires, and fuel buildup as a result of a long era of fire suppression.

Economy

In addition to potential financial losses to county farmers, severe drought, and drought-related fires, may adversely affect tourism-related businesses. Shortages of potable water will particularly burden those businesses that provide lodging, possibly forcing them to raise their rates to cover water-surcharge fees or buy additional water when wells run short.

Electric Rates

Regional drought conditions would most likely reduce the annual snow pack normally accumulated at high elevations in the Cascade Mountains, thereby reducing normal stream flows in mainland rivers and creeks. A substantial reduction in stream flows could severely affect the generation of electricity from hydroelectric dams and result in increased electricity rates for residents and businesses regionally.

Vulnerability assessment

At Risk Areas

The entire population of the county is vulnerable to the effects of drought. In some areas of the county, individual ground water systems or wells will be compromised before others leading to water shortage and the demand for hauled water. Drought conditions will impact farmers before other economic sectors, as the land becomes parched and ground water becomes more expensive or unavailable. For the general population, increased dependence on water hauled from mainland sources will increase the vulnerability to disruption to transportation systems or infrastructure damage.

Probability and Risk

With five documented drought periods since 1925, , there is a perceived **Low Probability** of drought occurring in San Juan County. Similarly, drought is considered **Low Risk** in comparison with other natural disaster typical of this area.

Conclusion

Drought can result in increased fire danger and limited water for fire suppression, water shortages, agricultural losses, and groundwater well failure. Periodic or seasonal drought will continue to be the norm in San Juan County, particularly if the warnings about global warming prove true and remain unaddressed.

Potential Mitigations

Mitigating the impact of drought is limited to three areas: water conservation and protection of water quality; enhancement of existing resources; and development of new water systems and resources. Listed below are the potential mitigating activities identified during the creation of this plan and in the 2004 San Juan County Water Resources Management Plan. Rating and prioritization of these and other potential hazard-mitigation strategies follow in Sections Eleven and Twelve.

1. [D-1] Continue Public Education and Outreach Activities -Providers of emergency services and other public agencies should continue to work collaboratively to educate year-round and seasonal residents, and island visitors, about water scarcity and the potential consequences of drought in San Juan County. Outreach and education programs should encourage residents and business owners to implement water conservation and other mitigation strategies at home and in places of work or commerce. Targeted efforts to reach island tourists, the poor, and those with limited English proficiency are recommended.
2. [D-2] Aquifer Monitoring - Provide funding to maintain and expand the County's groundwater monitoring capacity. The groundwater monitoring networks on Lopez and in Eastsound require continued attention to remain functional. The data from these networks also requires regular analysis to detect trends and provide early warning signs of over-withdrawal or changing conditions. There are no data loggers recording groundwater levels on other islands in San Juan County Island \$50,000 over 10 years for 10 data loggers and data analysis.
3. [D-3] Aquifer Management -Convene a forum of consumers, water system managers, representatives of regulating agencies and decision-makers to: analyze the development, management, and usage practices, of private water systems and individual wells; assess the impact of current practices on aquifer quality and sustainability; and develop strategies to promote aquifer sustainability.
4. [D-4] Planning and Development -Manage water resource planning and new development to ensure ground water systems/aquifers do not become overdrawn, and to prevent seawater intrusion in existing wells.
5. [D-5] Promote Alternatives - Study the feasibility and environmental impact of additional desalinization systems, increased use of catchment systems, and the use of non-potable (gray) water. Review and revise existing municipal codes to allow and encourage the permitting of alternatives.

6. [D-6] Encourage Conservation -Promote conservation among surface-water consumers and individual well owners by establishing baseline usage levels, monitoring systems, and disincentives for over-consumption.
7. [D-7] Policy - Change policy so that new well developers are required to show no detrimental effect to existing wells, placing the burden of proof on new well developers as opposed to existing well owners.
8. [D-8] Policy - Require water haulers to file an annual report describing where they are delivering potable water, to aid in long range water management.
9. [D-9] Aquifer Monitoring - Purchase a FLAT-TAPE, or COAXIAL WATER LEVEL METER for loan to homeowners and Class B water system users to measure and report well water depth. \$500.00 each, excluding per use maintenance costs.

Drought Mitigation Actions						
Id#	Project Name	Jurisdiction	Priority Rating	Benefit	Cost	Benefit/Cost Ratio
D-1	Continue Public Education and Outreach Activities	County and Town		2	1	2
D-2	Aquifer Monitoring	County and Town		2	1	2
D-3	Aquifer Management	County and Town		2	1	2
D-4	Planning and Development - Manage water resource planning	County and Town		2	1	2
D-5	Promote Alternatives	County and Town		2	1	2
D-6	Encourage Conservation	County and Town		2	1	2
D-7	Policy - Change policy re: new well development	County and Town		2	1	2
D-8	Policy - Require water haulers to file an annual report	County and Town		2	1	2
D-9	Aquifer Monitoring - Purchase a FLAT-TAPE	County		2	1	2

Section 9. Earthquake & Tsunami

Previous Occurrences

Although no significant earthquakes have occurred in San Juan County in recent memory, increasing geological and seismological evidence indicates that catastrophic earthquakes occurred repeatedly throughout the Pacific Northwest over the past 2000 years. The majority of these earthquakes originated in the Cascadia Subduction Zone, which is at least 75 miles off the coast of Washington. These earthquakes, along with the tsunami, events that sometimes followed, caused extensive flooding along the coastlines of Washington, Oregon, and California³⁸. Some of the geologic evidence includes:

- Accumulation of landslide deposits below the surface of Lake Washington.
- Large rock avalanches on the Olympic Peninsula.
- Possible tsunami deposits at West Point in Seattle and at Cultus Bay on Whidbey Island.

Native people throughout the Pacific Northwest have recorded, through storytelling and myth, consistent evidence of a 9.0 earthquake and tsunami occurring here around 1700. These reports—which are consistent with contemporary scientific findings from tree-ring dating and sediment analysis—describe phenomena common to earthquake and tsunami: ground shaking, saltwater intrusion, dropping land surfaces, water receding and rising, stranded marine life, and countless dead³⁹. In 1996, Japanese scientists released findings indicating that this same cataclysmic event produced tsunami waves that crossed the Pacific and devastated coastal villages in Japan.

During the past 125 years, over 20 damaging earthquakes occurred in the state of Washington. The most recent of these, the February 2001 Nisqually earthquake, registered a magnitude of 6.8 on the Richter Scale and injured 700 people. Though some distance from the epicenter, in Skagit County alone the public and private damages from the Nisqually quake totaled almost a million dollars. In San Juan County, residents felt the earthquake, but damages were insignificant. There is record of numerous low magnitude earthquakes originating near the San Juan islands - most notably a cluster ranging from 2.8 to 3.1 magnitude January 29-30, 2017.

Though felt by many, there were no reports of damages. These low magnitude earthquakes typically occur every one or two years.

Understanding Earthquakes

An earthquake is a naturally induced shaking of the ground caused by dramatic geological events, such as a shift of rock along a fracture (fault) in the earth's crust, or by volcanic eruption. Earthquakes may also be triggered by the natural movement of continental and submarine land masses or plates.

The earth's surface, or crust, is divided into eight major tectonic plates. These massive plates move slowly over the surface of the earth at a rate of a few centimeters each year. When tectonic plates collide, they create geologic stress that builds up, eventually releasing energy as earthquakes. And earthquake can be caused by volcanic activity, but most are generated by movements along fault zones associated with plate boundaries.

Tectonic Plates

The earth's surface, or Crust, is divided into eight major plates. These massive plates move slowly over the surface (crust) of the earth at a rate of a few centimeters each year. When tectonic plates collide, they create geologic stress that builds up eventually releasing energy as earthquakes. An earthquake can be caused by volcanic activity, but most are generated by movements along fault zones associated with plate boundaries.

Three tectonic plates are responsible for the major earthquake zones with consequences for San Juan County and the region. One is the Juan de Fuca Plate. Farther west is the Pacific Plate, and to the east is the North American Plate. Where the Juan de Fuca Plate meets the North American Plate, the middle plate is being forced to move downward and under the North American Plate. This tectonic *plate convergent boundary* is called the Cascadia Subduction Zone (CSZ). It extends from southern British Columbia to northern California. The Cascade Mountain Range, made up of both active and inactive volcanoes, marks the edge of the subducting Juan de Fuca Plate. Coastlines bordering subduction zones are at the greatest risk of significant local tsunamis⁴⁰.

Ninety percent of the world's earthquakes, regardless of geologic type, occur in the Circum-Pacific Belt (along the coasts of North and South America), and can happen at any time of the day. In the U.S., Alaska has the highest number of quakes, while California experiences the worst damage. Washington State lies between the two.

Moderate to large earthquakes can trigger landslides (both on land and submarine) and tsunamis. They can cause structural damage and building collapse, disrupt gas, electric, and phone service, and rupture sewer and water mains. Earthquakes may weaken reservoirs, fracture septic tanks, crack well casings, and frequently cause fires when propane and natural gas lines are compromised.

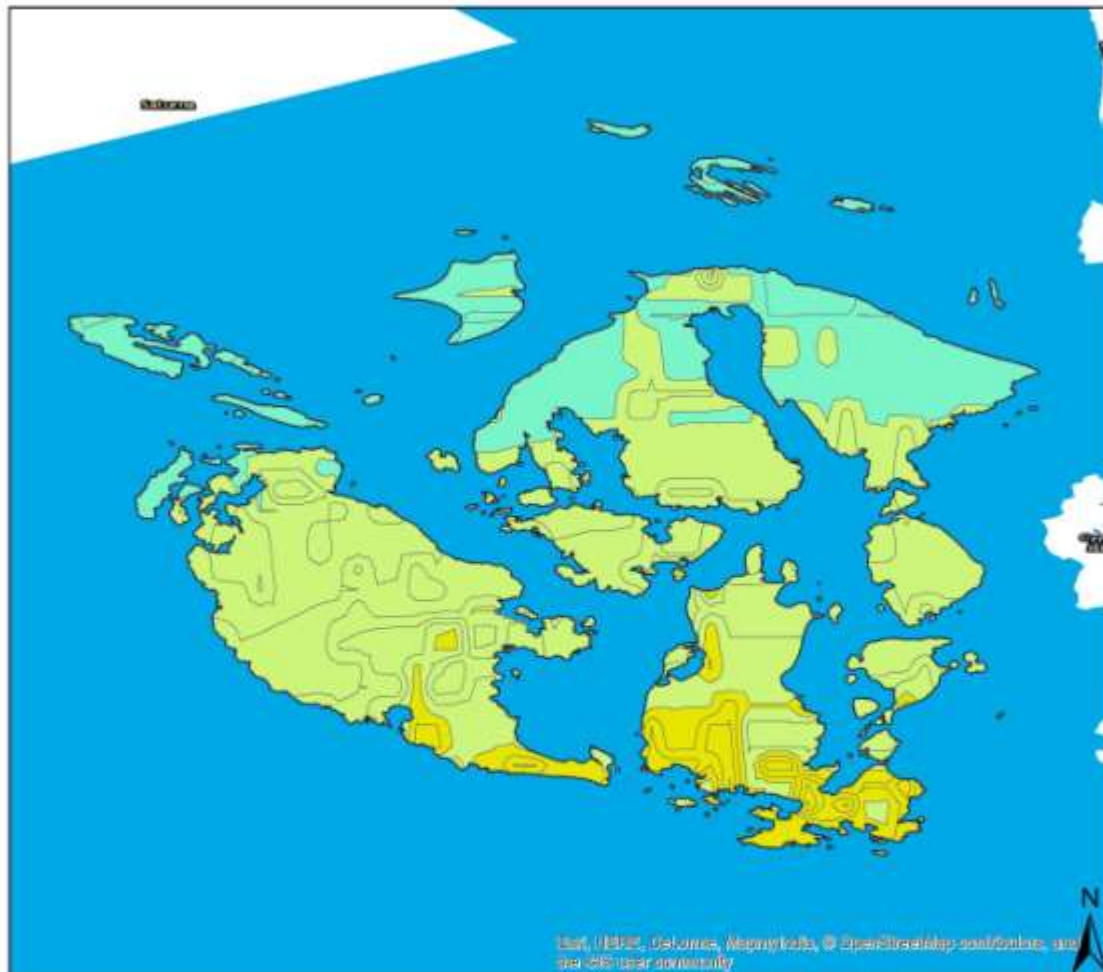
Liquefaction: Liquefaction is a phenomenon in which strong earthquake shaking causes soft soil or man-made landfills to rapidly lose strength and behave like quicksand. Liquefaction typically occurs in artificial fills and in areas of loose sandy soils that are saturated with water, such as in low-lying coastal areas. When soil strength is lost during liquefaction, the consequences can be catastrophic. Movement of liquefied soils can rupture pipelines, move road alignments, and pull apart the foundations and walls of buildings.

ShakeMaps

A Hazus earthquake risk assessment was completed for Cascadia M9, Devils Mountain (West) M7.4, and Southern Whidbey Island M7.4 scenario earthquakes, all of which may cause moderate to significant damage in San Juan County. Additional earthquakes have been modeled on other sources that could impact San Juan County, but none of them generate shaking intensity greater than strong shaking (MMI Shaking Intensity VI) – see the WA State Department of Natural Resources [Seismic Hazards catalog](#) for additional information:

Maps depicting shaking intensity and ground motion following an earthquake, called ShakeMaps, have been produced reflecting potential earthquake scenarios which may affect San Juan County and the Town of Friday Harbor. The following ShakeMaps are available for San Juan County:

SHAKEMAP



MAP SYMBOLOLOGY

EXPECTED INTENSITY	V	MODERATE
	VI	STRONG
	VII	VERY STRONG

THIS MAP DISPLAYS INSTRUMENTAL INTENSITY DURING A MAGNITUDE 7.4 SOUTH WHIDBEY ISLAND FAULT EARTHQUAKE.

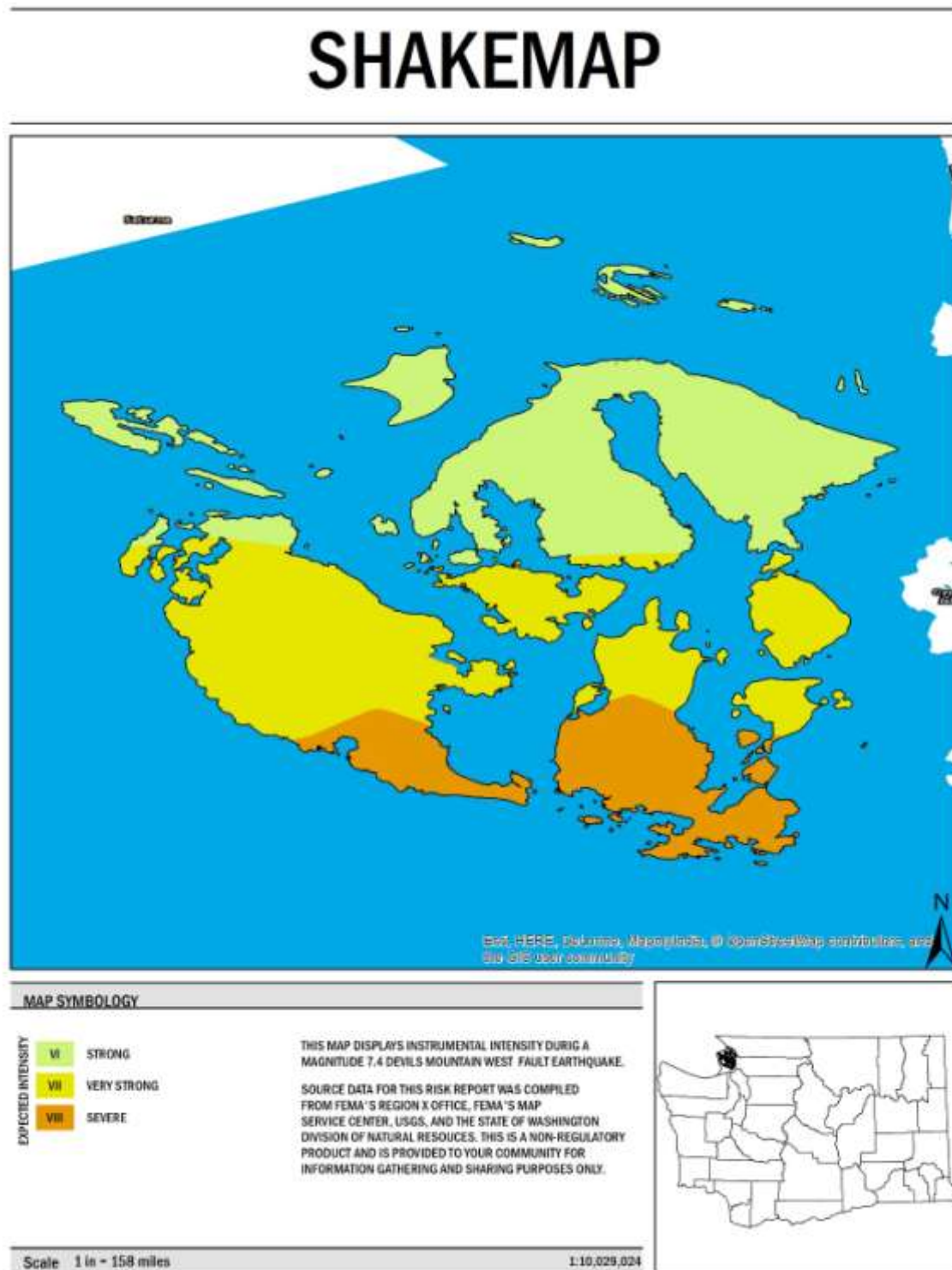
SOURCE DATA FOR THIS RISK REPORT WAS COMPILED FROM FEMA'S REGION X OFFICE, FEMA'S MAP SERVICE CENTER, USGS, AND THE STATE OF WASHINGTON DIVISION OF NATURAL RESOURCES. THIS IS A NON-REGULATORY PRODUCT AND IS PROVIDED TO YOUR COMMUNITY FOR INFORMATION GATHERING AND SHARING PURPOSES ONLY.

Scale 1 in = 158 miles

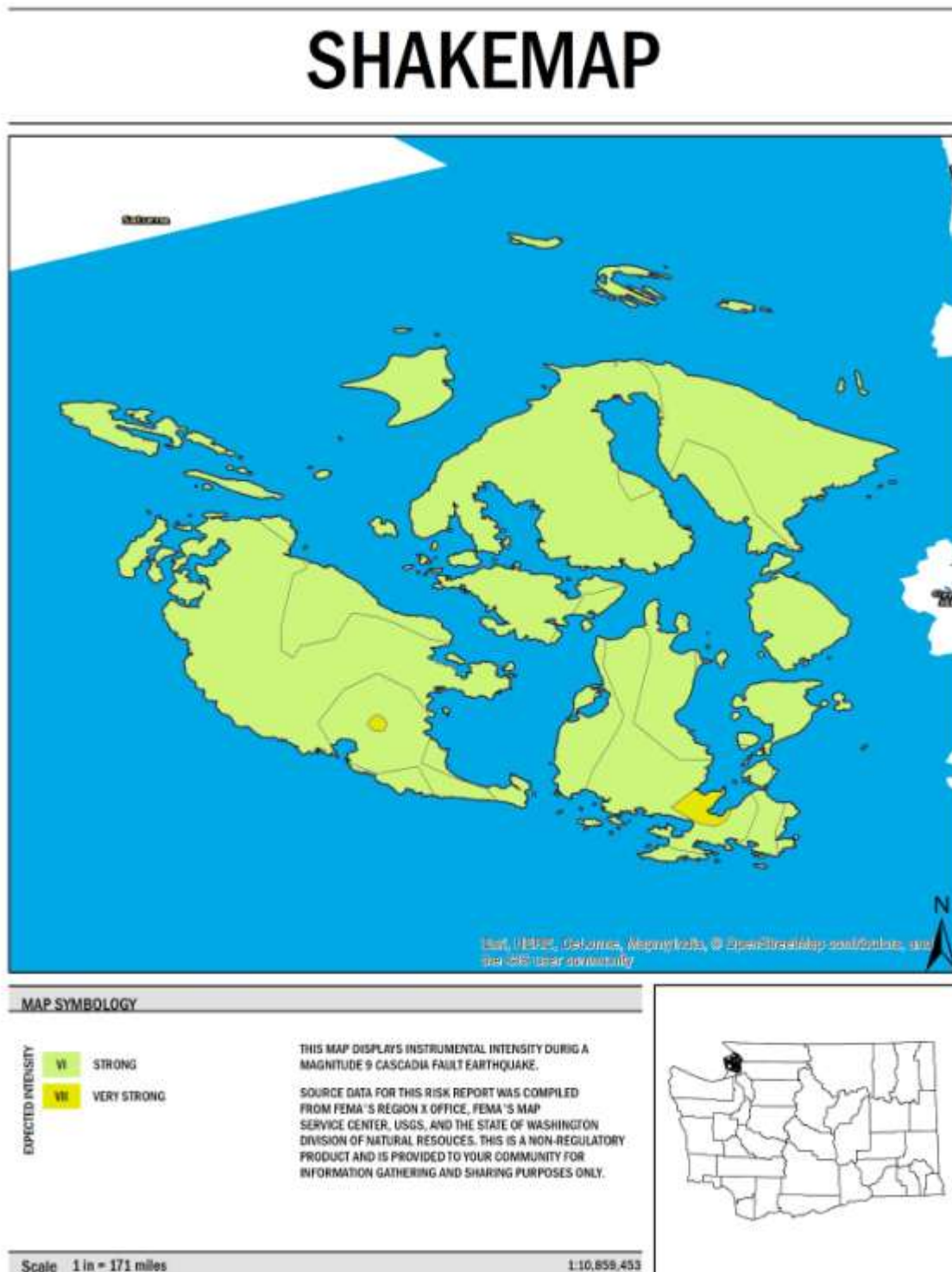
1:10,029,024



Map: ShakeMap showing the Modified Mercalli shaking intensity for Southern Whidbey Island fault M7.4 Earthquake



Map: ShakeMap showing the Modified Mercalli shaking intensity for Devils Mountain M7.4 (West) Fault Earthquake



Map: ShakeMap showing the Modified Mercalli shaking intensity for Cascadia M9 Earthquake.

Earthquake Risk Assessment Overview

The earthquake risk assessment was completed using local county assessor parcel data and ShakeMap scenarios described above. For this study, individual building/parcel data from the county was incorporated into Hazus, which allowed losses to be reported at the building level. The results are summarized in the table below. The table displays the total estimated building value by community, and percent of buildings and number of buildings located within the moderate to high liquefaction zone. In addition, building losses and loss ratios are reported for Cascadia M9.0, Devils Mountain M7.1, and Southern Whidbey M7.4 earthquake events. Loss ratios are calculated by dividing the dollar loss by the total building value. The loss values are for building losses only (additional damage to infrastructure and building contents are not captured in this table).

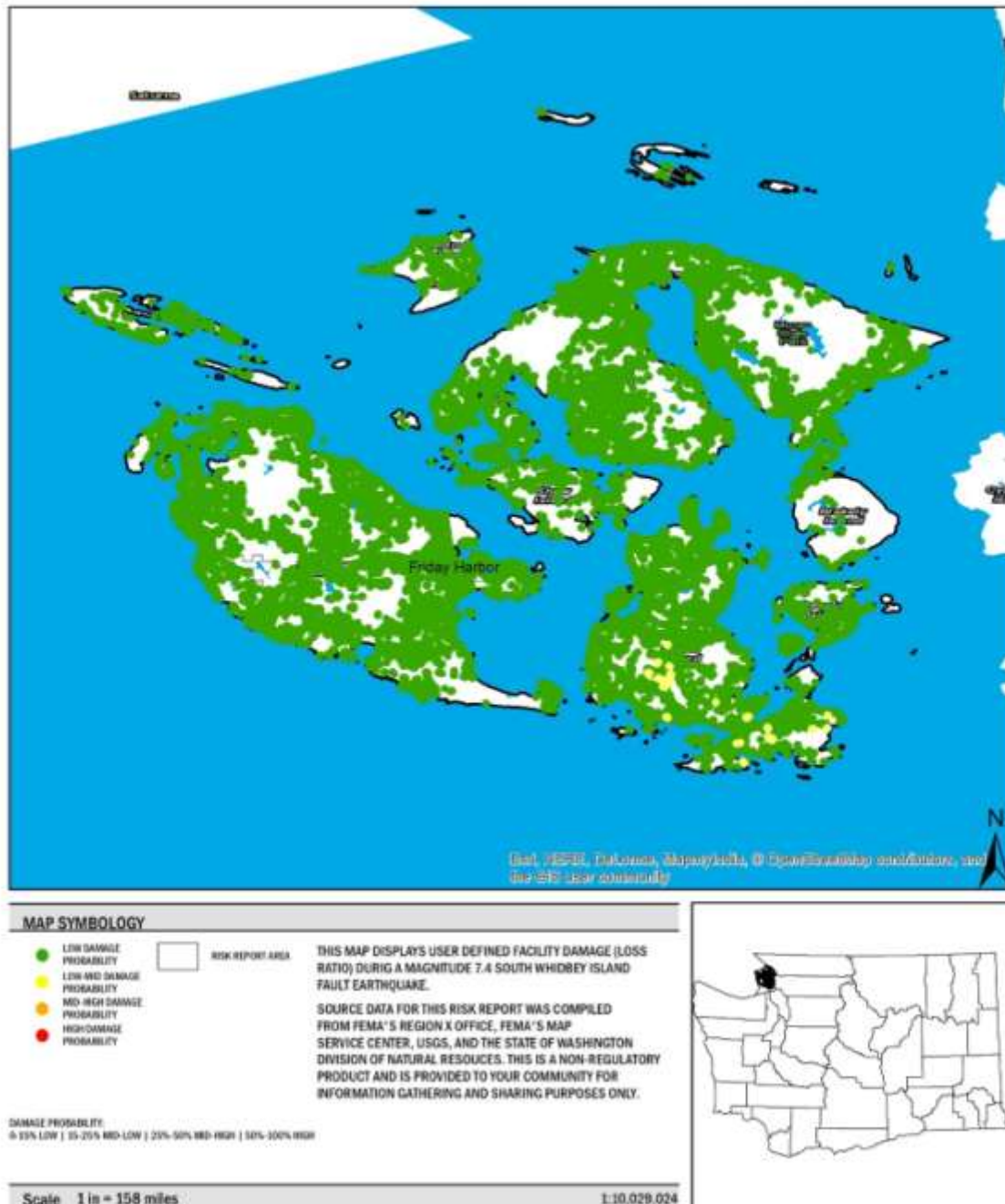
Table: Hazus Earthquake Results for Selected Scenario Earthquakes

Community	Total Estimated Building Value	Total Number of Buildings	Number of Buildings in the Moderate – High Liquefaction Zone	Percent of Buildings in the Moderate-High Liquefaction Zone	Building Dollar Loss for a Southern Whidbey M7.4 Event	Loss Ratio (Dollar Losses/ Total Building Value) Southern Whidbey M7.4 Event	Building Dollar Loss for a Devils Mountain West M7.4 Event	Loss Ratio (Dollar Losses/ Total Building Value) Devils Mountain West Fault M7.4 Event	Building Dollar Loss for a Cascadia M9 Event	Loss Ratio (Dollar Losses/ Total Building Value) Cascadia M9 Event	Community
Friday Harbor	\$187,190,569	1,313	0	0.00%	\$1,143,204	0.61%	\$12,722,418	6.80%	\$1,890,616	1.01%	Friday Harbor
Unincorporated San Juan County	\$7,239,075,466	24,170	1900	7.86%	\$66,071,177	0.91%	\$419,981,828	5.80%	\$194,674,751	2.69%	Unincorporated San Juan County
Total	\$7,426,266,035	25,483	1900	7.46%	\$67,214,381	0.91%	\$432,704,246	5.83%	\$196,565,367	2.65%	Total

Unincorporated San Juan County has the largest percentage of buildings located in the moderate-high liquefaction zone. The Devils Mountain (west) fault generates the largest amount of damages, which would total almost \$433 million, which is equivalent to 5.8 percent of damage to the building stock. The losses reported above are for building losses. Therefore, additional damage to infrastructure and building contents were not included in the table above. These losses should be considered as a minimum. The significant earthquake building loss

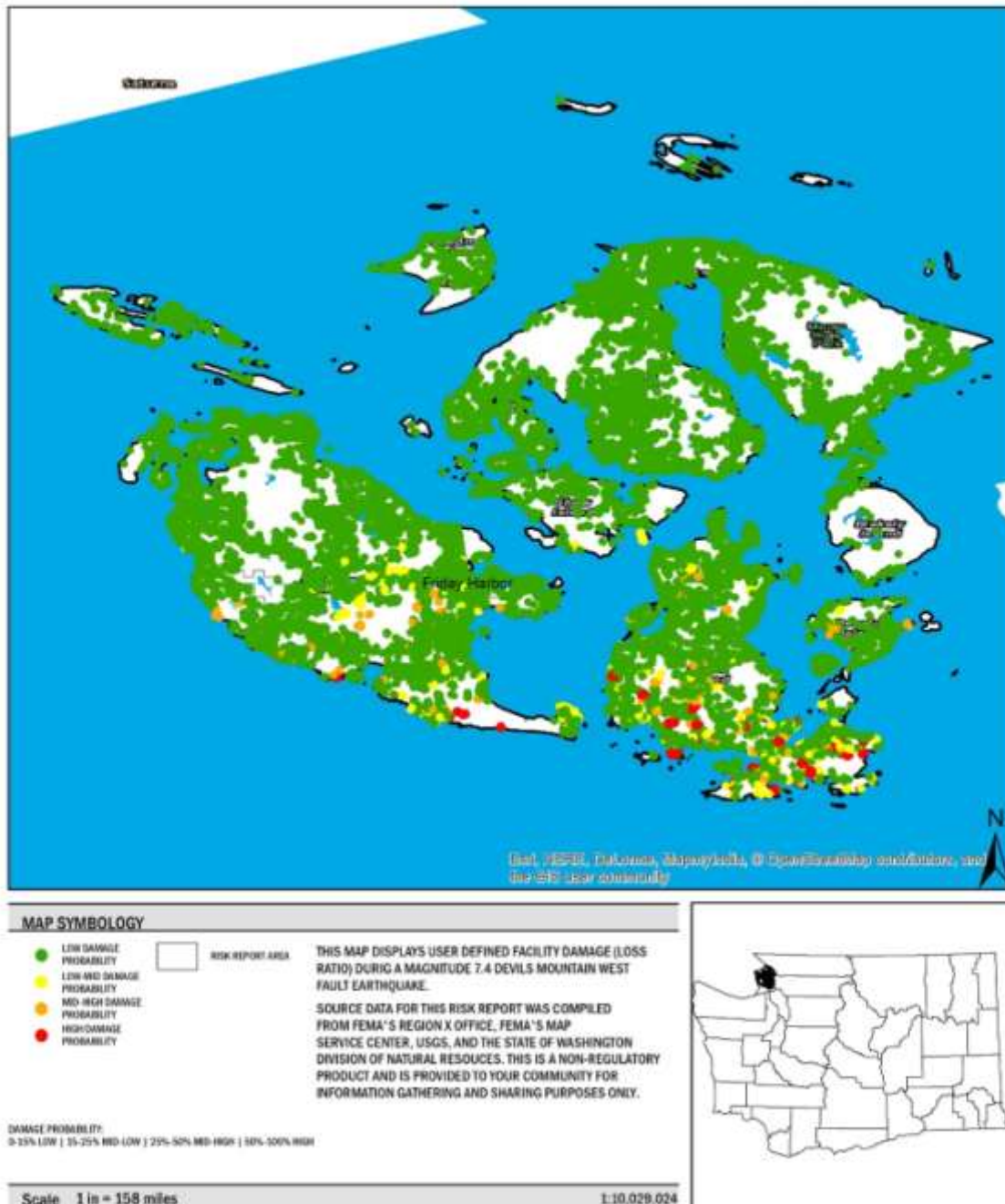
ratios are shown below in the following three maps showing countywide exposure to the three potential scenario earthquakes.

EARTHQUAKE DAMAGE



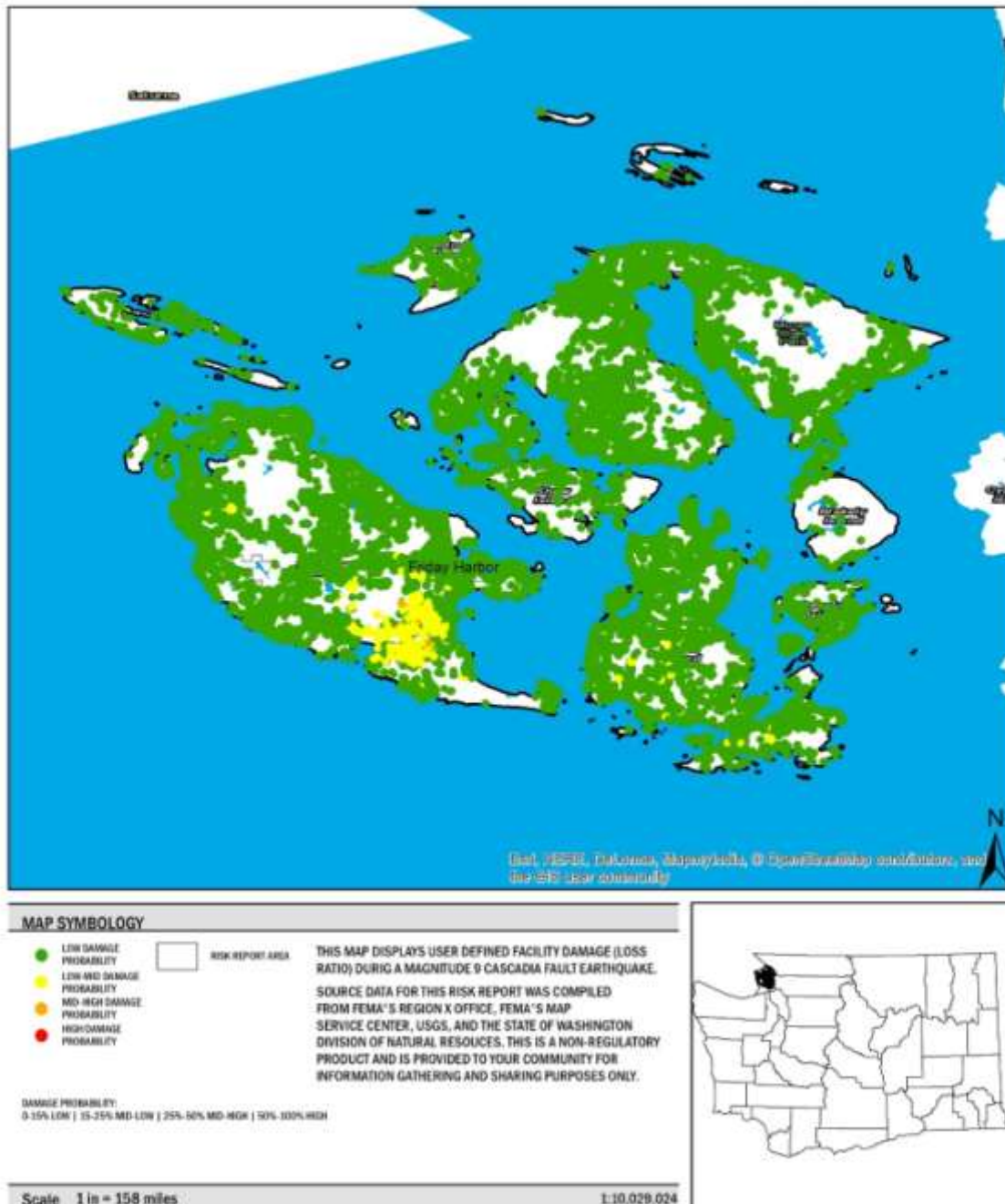
Map: Building damage percent (loss ratio) for Southern Whidbey M7.4 Earthquake

EARTHQUAKE DAMAGE



Map: Building damage percent (loss ratio) for Devils Mountain (West) M7.4 Earthquake.

EARTHQUAKE DAMAGE



Map: Building damage percent (loss ratio) for Cascadia M9 Earthquake Scenario

Table: Pre-Code versus Moderate Code Buildings in San Juan County

Community	Number of Pre-Code Buildings (before 1949)	Number of Low Code Buildings (1950 - 1974)	Number of Moderate Code Buildings (1975 - 2003)	Number of High Code Buildings (after 2004)	Total Number of Buildings	Percentage of Pre-Code Buildings
Friday Harbor	16	1261	17	19	1313	1.22%
Unincorporated San Juan County	2905	4037	14775	2453	24170	12.02%
Total	2921	5298	14792	2472	25483	11.46%

Note: Pre-code buildings are those that were built prior to 1975. Moderate code are those built after 1975. These dates were chosen based on when the seismic provisions were incorporated into the building code statewide, which was 1975. Please note that the analysis in Hazus used the following dates: Pre-code are any buildings prior to 1941. Moderate Code were any buildings after 1941, which is the default Hazus methodology. Please refer to the appendix for additional information.

High loss ratios in earthquake events are typically attributed to the number of pre-code structures in each community. Because of their age and pre-code status, these buildings will not perform as well in an earthquake. Table 9 identifies the loss ratios following three earthquake scenarios. Friday Harbor has the highest loss ratio from a Devils Mountain (West) M7.4, with a loss ratio of 6.8 percent, with unincorporated San Juan County has have a 5.8% loss ratio. . The losses related to these earthquake scenarios are largely due to the proximity to the faults. The majority of structures in the Unincorporated San Juan County are designated pre-code. In addition Friday Harbor has many low code buildings. Due to the age of these buildings and the absence of building codes at time of construction, they may not perform as well in an earthquake compared to structures built after code implementation.

Understanding Tsunami

A tsunami is a series of traveling ocean waves of extremely long period, generated primarily by earthquakes or sea floor slumping occurring below or near the ocean floor. Not all earthquakes generate tsunamis. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and cause vertical movement of the seafloor over a large area. The amount of vertical and horizontal motion of the sea floor, the area over which it occurs, the simultaneous occurrence of slumping of underwater sediments due to the shaking, and the efficiency with which energy is transferred from the earth's crust to the ocean water are all part of the mechanism generating tsunamis. Underwater volcanic eruptions and landslides may also generate tsunamis.

How Fast?

In the deep ocean, destructive tsunamis can appear to be small—often only a few tens of centimeters or less in height—and cannot be seen nor felt on ships at sea. But they are capable of “wave crest to wave crest” distances of 60 miles apart and can travel at about 600 miles per hour in the open ocean. (A tsunami may traverse the distance from Japan to the coast of Washington State in 10 hours or less) As the tsunami reaches shallower coastal waters, wave amplitude can increase rapidly, sometimes approaching 30 feet or more, striking land with great force.

Tsunami waves generated by a Cascadia Subduction Zone earthquake directly off the coast of Washington State could reach the shoreline of the Washington coast in less than 30 minutes, traverse the Strait of Juan de Fuca and arrive at Haro Strait and the west side coast of San Juan island as soon as 30 to 45 minutes later. Even more distant tsunami waves from a Cascadia Subduction Zone earthquake located off the shore of Northern California or Northern British Columbia may reach the coast of Washington State in two hours or less. Once the tsunami arrives, the area will experience waves and crests every ten to 60 minutes, and often the first wave may not be the largest. Danger from a tsunami may last for a dozen or more hours after the first wave.

Marine Slumping: The major tsunami produced by the 1964 Alaska earthquake was generated by a broad (700 km-long) zone of sea-floor slumping (the movement of submarine sediment) along the Alaska-Aleutian Subduction Zone. The tsunami waves this created arrived at Kodiak Island about 30 minutes after the earthquake. Secondary slump-related tsunamis produced by submarine slides in Prince William Sound arrived at Valdez only minutes after the earthquake. Over 90% of the deaths from the 1964 earthquake were a result of these locally-initiated tsunami waves⁴¹.

Water Levels: Tsunamis can cause rapid changes in water level and unpredictable, dangerous currents in harbors and ports. The wave impact and scoring action can damage breakwaters and piers. Ships moored in harbors may be swamped, sunk, or left stranded on shore. Docks and floats attached to pilings shorter than ten feet can be separated and lost. Oil and fuel tanks

near the waterfront are particularly vulnerable to damage, which can result in the spreading of hazardous materials or fire.

Debris Damage: All debris entrapped by the incoming swell becomes a fast moving battering ram as the wave progresses. Analysis of the 1964 Alaska tsunami revealed that much of the damage was caused by boats, beach logs, and cars carried by the wave. Communities may be disrupted due to tsunami damage until debris can be cleared, wharves and piers rebuilt, and utilities restored⁴².

How Vulnerable Is San Juan County?

Historical evidence, combined with contemporary scientific study and understanding of these phenomena, support the proposition that San Juan County is vulnerable to similar events which may occur in the future.

Earthquake: According to the Federal Emergency Management Agency (FEMA), Washington is second only to California among states susceptible to earthquake loss. Of the more than 1000 earthquakes recorded in the state annually, the majority occur in the Puget Sound region, from Western Washington to Vancouver Island. Most of these earthquakes are so small that only very sensitive instruments can detect them; a smaller number cause shaking and damage.

There are well documented earthquake faults near San Juan County including the South Whidbey, and Devils Mountain faults. Recent LIDAR mapping completed in the county, suggest that faults exist along the western edge of San Juan Island and the middle of Orcas Island and north of Orcas Island and present potential risk to area inhabitants and essential infrastructure.

Tsunami: Most low-lying coastal areas along the west coast of the United States and Canada are vulnerable to tsunami. The Washington coast and the Strait of Juan de Fuca are vulnerable to some distant tsunamigenic sources generated throughout the western Pacific Ocean, the Aleutian Islands, or by a Cascadia Subduction Zone earthquake. These areas are also at risk from tsunamis generated by local crustal earthquakes and by surface and submarine landslides.

Tsunami - How High?

In October 2016, tsunami inundation modeling of San Juan County was completed and inundation maps were published for the County. In this “worst case” scenario, a magnitude 9.0

coastal earthquake resulted in a tsunami traveling east through the Strait of Juan de Fuca. The model showed tsunami waves reaching the western shore of San Juan Island, in under two hours. The study shows that inundation varies throughout the affected areas with wave heights ranging from just above normal to as much as 18 feet above normal water levels. Not all areas of the shoreline show inundation with the majority of the shoreline showing little to no increase in water level.⁴³

Tsunami Risk Assessment Overview

The tsunami model for San Juan County is based on a Cascadia magnitude 9.0 (M9) earthquake. The earthquake scenario adopted for this study was developed by Witter and others and designated Scenario L1. It was one of a number of scenarios that were compared to paleoseismic data and found to be the best fit for a tsunami inferred to capture 95% of Cascadia tsunami hazard in the last 10,000 years (Witter and others, 2011).

The arrival time and duration of flooding are key factors to be considered in evacuation strategies. For a Cascadia subduction zone tsunami, the first wave crest is generally predicted to arrive about 2 hours after the earthquake in San Juan County. The maximum flooding depth, velocity, and extent will depend on tide height at the time of tsunami arrival, but is modeled at mean high water.

Liquefaction: The Washington State Department of Natural Resources has mapped the surface geology of San Juan County in an attempt to identify areas that could be susceptible to liquefaction as a result of earthquake shaking. While no part of the county was rated “high susceptibility,” there are small pockets countywide with “moderate to high” assessments, and more sizeable areas rated “moderate” to “low-moderate.”

Tsunami: People, property and structures in low-lying (below 10-20 feet) shoreline locations areas and harbors will be at more risk than those on higher ground.

Local high-risk areas include Crescent Beach Rd, Mackaye Harbor, Cattle Point, the entrance to Fisherman’s Bay, and a host of other low-lying areas. Notably, the model shows Eastsound as exposed to very little inundation, while 1/2 mile east, Crescent Beach may be exposed to nearly 20 feet of inundation.

Liquefaction: Small pocket areas on Stuart, San Juan, Henry, Lopez, Decatur, Blake, Shaw, Waldron, and Orcas islands were identified as “moderate to high” risk for liquefaction. With few

exceptions, all of these areas are along the coast or inlet shorelines. Much larger areas on San Juan, Waldron, Orcas, Lopez, and Decatur are labeled “moderate” to “low-moderate” risk.

Vulnerability Assessment

For this assessment, the building data was compared to the geographic extent of the tsunami generated by Scenario L1. The results of the risk assessment are shown in the following table.

Table: Building exposure associated with a Cascadia M9 earthquake-induced tsunami along San Juan County coastal region

Community	Total Estimated Building Value	Building Value in Tsunami Zone	Total Number of Buildings	Number of Buildings in Tsunami Zone	Percent of Buildings in Tsunami Zone
Friday Harbor	\$187,190,569	\$4,015,500	1313	6	0.46%
Unincorporated San Juan County	\$7,239,075,466	\$127,110,607	24170	506	2.09%
Total	\$7,426,266,035	\$131,126,107	25483	512	2.01%

Most of the built environment in communities along the coast will be affected from a tsunami generated by the Cascadia M9 event. Within San Juan County, 512 buildings are expected to be affected by the tsunami. This totals close to \$131 million in building value.

At- Risk Areas

Earthquake: All parts of San Juan County are at risk of structure failure or destruction, injury or death, disruption of essential services and commerce, and impact on the local and regional economy. Low-lying soft-soil or loose-bank areas are at greater risk of structural collapse, than are rocky areas.

Probability And Risk

Using the best available science, there is a **Low Probability** of earthquake or tsunami occurring in San Juan County within the next five years. And while the probability of such an occurrence is low, the potential **Risk is Moderate to High** when considering the extent of the area impacted and likelihood of widespread structural damage.

Conclusion

In addition to damaging homes, businesses, property, and the environment, significant geologic events occurring in San Juan County could result in the following problems for our infrastructure and essential services:

Utilities: Above-and below-ground and submarine cables could be damaged or destroyed. These include telephone, electricity, water and sewer systems, private wells and reservoir-based water systems.

Transportation: Transportation routes and/ or systems including roads, ferry terminals, marinas and floats/docks, airports, and landing strips may be damaged or destroyed.

Emergency Services: Emergency services could be totally overwhelmed and unable to respond due to damaged facilities and/or equipment, a lack of personnel, or damaged transportation routes.

Critical Facilities: Critical Facilities, such as 911 centers, the medical center, fire stations, the Friday Harbor water and wastewater treatment plants, may be damaged.

Medical Services: Access to medical services, medications, medical supplies, and other health services may be unavailable or limited.

Consumer Goods: Consumer goods may be in short supply or unavailable. Banking services and access to cash may be disrupted. Gasoline may be unavailable or in short supply.

State and Federal Assistance: The arrival of outside resources to assist with emergency response (delivery of food, medical supplies, and consumer goods) and post-disaster rebuilding (debris removal, repair of homes and critical facilities) may be delayed by damage to the transportation infrastructure.

The Economy: Tourism and other economic sectors may experience disruption and loss of revenue, which would affect the local economy.

Potential Mitigations

There are a number of ways to reduce vulnerability to future geologic events, minimize injury, and reduce property loss. Listed below are the potential mitigating activities identified during the creation of this plan. Rating and prioritization of these and other potential hazard-mitigation strategies follow in Sections Eleven and Twelve.

1. [ET-1] Project Impact Initiative- Countywide. Implement a "Home Retrofit Program" similar to the 1998 Phinney Neighborhood Association in Seattle, WA. funding was used to develop the "Home Retrofit Program," a comprehensive program to reinforce a typical Pacific Northwest home's ability to withstand earthquake movement.
See<<https://www.hsdil.org/?view&did=7054>>, and
<<https://www.seattle.gov/Documents/Departments/Emergency/Preparedness/HazardSpecific/Earthquake/HomeRetrofit/HRBook1-overview.pdf>>
2. [ET-2] Rapid Observation of Vulnerability and Estimation of Risk - Install a cloud based instance of the ROVER web based assessment software and complete survey of all critical infrastructure in the county and Town of Friday Harbor.
3. [ET-3] Expand Public Education and Outreach Efforts: Providers of emergency services and other public agencies should continue to work collaboratively to educate the public about the potential for earthquake, tsunami, and other geologic events in San Juan County. Targeted efforts to reach island tourists, low income residents, and those with limited english proficiency are also recommended.
4. [ET-4] Promote Greater Self-Reliance: As a general rule, residents should be prepared to survive on their own for a minimum of 14 days. This is especially true given San Juan County's relative isolation and limited transportation options to and from the mainland. Each residence or place of lodging should have enough food, water, medicines and other basic provisions to last each person and pet for 14 days.
5. [ET-5] Implement Tsunami Notification and Evacuation Plans: Implement evacuation plans that include multiple ways to alert the public, and publicized "safe zones" that anticipate water levels thirty or more feet above the normal high-tide level. Complete the posting of Tsunami warning signs in low-land areas county-wide.
6. [ET-6] Survey Existing Structures for Earthquake Vulnerability: The participating HMP jurisdictions should take steps to conduct a county-wide survey of existing public and private commercial, civic and multi-family structures for earthquake vulnerability. The purpose of the survey would be to more accurately assess the level of current earthquake vulnerability, to educate property owners, and to formulate a multi-year program to mitigate areas of greatest potential risk. (See number 2 above)

7. [ET-7] Conduct Structural Analysis of County Dams and Reservoirs: Complete a survey and structural analysis of all San Juan County dams and reservoirs, including: Trout Creek, Purdue, Cascade and Mountain lake systems. Identify funding and implement necessary safety improvements.
8. [ET-8] Implement Marina Improvements: Ensure that all marine pier pilings extend ten feet or more above the high tide line in order to prevent pier and vessel losses.
9. [ET-9] Plan and Implement Logistical Back-up Protocols and Facilities for Government Operations and Communications Systems: To ensure that government and communication systems will be functional as soon as possible after a significant geologic event, back-up systems and protocols should be identified and implemented to provide for emergency command centers; offsite government facilities and resources, protection of government records; off-site systems and protocols for backing up municipal records; and repairs to, or emergency replacement of, communication towers. Develop emergency plans with vendors to ensure delivery of fuel supplies for utility plant back-up generators.
10. [ET-10] Rebuild barge landing ramp at Jenson Beach - Repair and construction of appropriate barge/landing facility at site of former Jackson Beach gravel pit. Lack of available sites for landing of supplies and material following a disruption to routine transportation networks would make this a priority for response and recovery.
11. [ET-11] Install automatic shutoff valves on gas and water systems.
12. [ET-12] Structural Retrofit and Seismic upgrade to the San Juan County Courthouse containing administrative offices, the Sheriff's Department, E911 dispatch facility, and communications infrastructure of the county government.

Earthquake/Tsunami Mitigation Actions						
Id#	Project Name	Jurisdiction	Priority Rating	Benefit	Cost	Benefit/Cost Ratio
ET-1	Project Impact Initiative	County and Town		3	1	3
ET-2	Rapid Observation of Vulnerability and Estimation of Risk	County and Town		3	1	3
ET-3	Expand Public Education and Outreach Efforts	County and Town		3	1	3
ET-4	Promote Greater Self-Reliance	County and Town		3	1	3
ET-5	Implement Tsunami Notification and Evacuation Plans	County and Town		3	1	3
ET-6	Survey Existing Structures for Earthquake Vulnerability	County and Town		3	1	3
ET-7	Conduct Structural Analysis of County Dams and Reservoirs	County and Town		3	1	3
ET-8	Protect Marinas	County and Town		3	1	3
ET-9	Plan and Implement Logistical Back-up Protocols	County		3	3	
ET-10	Rebuild barge landing ramp at Jenson Beach - Port initiative	County and Town		3	2	1.5
ET-11	Install automatic shutoff valves on water systems	County and Town		3	2	1.5
ET-12	Structural retrofit and seismic upgrades for San Juan County Courthouse and Admin building	County		3	2	1.5

Section 10. Determining Vulnerability

Purpose

The San Juan County Multi-Jurisdictional Natural Hazard Mitigation Plan (NHMP) is specifically intended to assist policy makers, local agencies, businesses, and residents to evaluate and better prepare for natural disasters. The probability and vulnerability (risk) assessments in this section provides the basis for the proposed mitigation strategies.

Methodology

The hazard categories evaluated during the course of the planning process included: Severe Storm Wildland-Urban Interface Fire Flood Drought Earthquake/Tsunami.

Using a tool developed by the San Juan County Department of Emergency Management, the members of the NHMP Planning Group were asked to rate each identified hazard category for:

Probability of Occurrence Within Five Years, Percentage of Area at Risk, and Percentage Population at Risk.

For each of the rating factors listed above, three levels of risk were defined and quantified: high (5), medium (3) and low (1).

Each member of the NHMP Planning Group was asked to complete a vulnerability rating tool. The cumulative numerical score for each category of disaster was then divided by the total number of assessments submitted to produce a numerical average. This score determined the overall probability and vulnerability— or risk level—for each disaster category.

Natural Hazard Probability And Risk Ratings

Severe Storm: Based on past events, there is a High Probability of a severe storm event occurring in San Juan County. While the probability of such an event is high there is a **Low to Moderate Risk** associated with this hazard due to the relatively short duration and localized impacts of such events.

Wildland-Urban Interface Fire: Based on past events, there is a Moderate Probability of a WUI Fire event on any of San Juan County's many islands. At the same time, the island topography and small population results in a **Low Risk** for cumulative area and population at risk.

Flood: Based on past events, there is a **Low Probability** of significant flooding occurring in San Juan County. Likewise, there is a **Low Risk** associated with flooding events that will occur.

Drought: Despite growing evidence of climate change and recent drought events, there is a perceived **Low Probability** of drought occurring in San Juan County. Similarly, drought is considered **Low Risk** in comparison with other natural disaster typical of this area.

Earthquake/Tsunami: Using the best available science, there is a **Low Probability** of earthquake or tsunami occurring in San Juan County within the next five years. And while the probability of such an occurrence is low, the potential **Risk is Moderate to High** when considering the extent of the area impacted and likelihood of widespread structural damage.

Tool 1: Determining Vulnerability

Background

The San Juan County Multi-jurisdictional Natural Hazard Mitigation Plan (NHMP) is specifically intended to assist policy makers, local agencies, businesses, and residents to evaluate and better prepare for natural disasters.

The cumulative results of the risk/vulnerability assessment tools in this section are one of the measures used to prioritize the mitigation strategies that the plan will identify.

Rating Vulnerability and Risk Today

The purpose of this tool is to measure your perception of "risk and vulnerability" for each of the identified natural hazards today.

Directions: For each of the question/rows below, indicate the numeric level of probability or risk for each disaster category.	Severe Storm	Fire	Flood	Drought	Earthquake Tsunami
1. Probability Rating Probability of Occurrence Within Five Years High =High probability (5 points) Medium =Could happen (3 points) Low =Unlikely, but possible (1 point)					
Directions: For each of the question/rows below, indicate the numeric level of risk for each disaster category.	Severe Storm	Fire	Flood	Drought	Earthquake Tsunami
Percentage of Population at Risk High =County-wide injury/death (30% or more of total county population) 5 points					

<p>Medium= Island-wide or multiple area injury/ death (5-29% of total county population at risk) 3 points</p> <p>Low=Area specific injury/death (less than 5% of the total county population at risk) 1 point</p>					
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<p>Directions: For each of the question/rows below, indicate the numeric level of risk for each disaster category.</p>	Severe Storm	Fire	Flood	Drought	Earthquake /Tsunami
<p>Number of Properties at Risk High=County--wide property damage (5)</p> <p>Medium=Widespread damage to property on particular island or large area (3)</p> <p>Low=Damage to small number of properties (1)</p>					
2. Total					

Section 11. PROPOSED HAZARD MITIGATION STRATEGY

Purpose

Throughout the course of creating this plan, a large number of interesting and potentially effective mitigation strategies were identified; some are works already in progress, others are long overdue. Almost all of the proposed strategies were received positively by planning group members regardless of jurisdiction or professional focus, and more than one member remarked on the difficulty of narrowing the plan's mitigation focus.

Nonetheless, the task given us was to choose ten strategic priorities with the aim of reducing risk and preventing loss to the greatest number of people, the broadest area and concentration of essential facilities, and to do so in the most practical and cost-effective means possible. To this end, the natural hazard mitigation goals listed in this portion of the plan are intended to help guide the direction and prioritization of future natural hazard mitigation activities at the local level.

Prioritization Methodology

In NHMP Sections Five through Nine, potential hazard-mitigation strategies were identified. In order to prioritize these strategies for recommendation for adoption and implementation, the Natural Hazards Mitigation Planning Team was asked to review the mitigation actions from the cumulative list in each of the 5 natural hazard categories. First, they were asked to complete a basic Benefit/Cost analysis using general estimates for the public benefit divided by the cost of implementation. Cost estimates were defined as Low (under \$5,000) assigned value of "1", Moderate (between \$5,000 and \$25,000) assigned value of "2" and High (over \$25,000) assigned value of "3". Benefit values were defined as Low (under \$5,000 in avoided damages, or benefiting just a few people) assigned value of "1", Moderate (between \$5,000 and \$25,000 in avoided damages, or benefiting people on a neighborhood scale) assigned value of "2" and High (over \$25,000 in avoided damages, or benefiting many people - island or county scale) assigned value of "3".

Cost estimates

- **Low** (under \$5,000) assigned value of "1"
- **Moderate** (between \$5,000 and \$25,000) assigned value of "2"
- **High** (over \$25,000) assigned value of "3"

Benefit estimates

- **Low** (under \$5,000 in avoided damages, or benefiting just a few people) assigned value of "1"
- **Moderate** (between \$5,000 and \$25,000 in avoided damages, or benefiting people on a neighborhood scale) assigned value of "2"
- **High** (over \$25,000 in avoided damages, or benefiting many people - island or county scale) assigned value of "3"

Using this approach, projects with positive benefit versus cost ratios (1:1 or higher) are considered cost-beneficial and are prioritized accordingly.

The Planning Group then considered the following additional factors before recommending mitigation actions for adoption:

- Vulnerability factor from the section above
- Multi-hazard applicability
- Community hazard rank based on information returned by the web survey
- Achievability based on barriers to successful implementation such as political concerns, general complexity of the potential project or any other perceived barriers.

The final factor was availability of a sponsoring agency, or jurisdiction. Proposed mitigations having a sponsor or considered likely to attract a sponsor were given higher priority.

The strategies receiving the highest overall score for each jurisdiction are summarized below.

Recommendations For Adoption

The mitigation actions proposed for adoption with this plan include:

Severe Storm

SS-1	Rapid Observation of Vulnerability and Estimation of Risk	County and Town
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SS-2	Expand Public Education and Outreach Efforts	County and Town
SS-3	Promote Greater Self-Reliance	County and Town
SS-4	Encourage Heating and Power Alternatives	County and Town
SS-7	Road and Debris Clearing	County and Town
SS-8	Protect Marinas	County and Town
SS-9	Orcas Landing Dock Improvements	County

Wildland Fire

WF-1	Expand Education and Outreach	County and Town
WF-2	Practice of FireWise landscaping	County and Town
WF-3	Alternatives to Backyard Debris Burning	County and Town
WF-11	Mt. Constitution Communication Site Fuels Treatment	County
WF-13	Rosario Highlands Defensible Space	County
WF-16	Doe Bay Area Gorse Treatment	County
WF-17	Trout Lake Watershed Forest Management and Access Improvement	County
WF-40	Annual Tall Grass Order To Mow	Town
WF-41	Additional Brush Truck and Water Tender Capacity Lopez Island	County
WF-42	Support upgrading emergency service communication infrastructure	County and Town

Flooding

F-1	Continued Public Education and Outreach	County and Town
F-2	Early Warning -The National Weather Service	County and Town
F-3	Flood Mapping	County and Town
F-4	Building Codes & New Construction	County and Town
F-5	Storm Water Drainage	County and Town

F-6	Prune Alley Road Improvements	County
F-7	A Street Road Improvements, Eastsound	County
F-8	San Juan Valley Road Improvements, San Juan Island	County
F-9	MacKaye Harbor Road Relocation, Lopez Island	County
F-10	Douglas Road Improvements, San Juan Island	County
F-12	Griffin Bay Marine Facility, San Juan Island	County
F-13	Westsound Marine Facility, Orcas Island	County
F-14	Pass Ordinance to adopt new FIRM Maps	County
F-15	Larson Street	Town
F-16	680/690 Larson Street	Town
F-17	Marble Street and Tucker Avenue	Town
F-18	Friday Avenue to Outfall	Town
F-19	Linder/Nelson/Franck/"C"/Nichols Streets	Town
F-20	West Street Diversion from Second Street to First Street	Town
F-21	Caines Street Diversion from Spring Street	Town
F-22	Marguerite Place and Guard Street	Town

Drought

D-1	Continue Public Education and Outreach Activities	County and Town
D-2	Aquifer Monitoring	County and Town
D-3	Aquifer Management	County and Town
D-4	Planning and Development -Manage water resource planning	County and Town
D-5	Promote Alternatives	County and Town
D-6	Encourage Conservation	County and Town
D-7	Policy - Change policy re: new well development	County and Town
D-8	Policy - Require water haulers to file an annual report	County and Town
D-9	Aquifer Monitoring - Purchase a FLAT-TAPE	County

Earthquake

ET-1	Project Impact Initiative	County and Town
ET-2	Rapid Observation of Vulnerability and Estimation of Risk	County and Town
ET-3	Expand Public Education and Outreach Efforts	County and Town
ET-4	Promote Greater Self-Reliance	County and Town
ET-5	Implement Tsunami Notification and Evacuation Plans	County and Town
ET-6	Survey Existing Structures for Earthquake Vulnerability	County and Town
ET-7	Conduct Structural Analysis of County Dams and Reservoirs	County
ET-8	Protect Marinas	County and Town
ET-9	Plan and Implement Logistical Back-up Protocols	County
ET-10	Rebuild barge landing ramp at Jenson Beach - Port initiative	County and Town
ET-12	Structural Retrofit and Seismic upgrade to the San Juan County Courthouse and administrative offices.	County

Section 12. NHMP IMPLEMENTATION

The following table shows the implementation status for each mitigation action recommended by the Natural Hazard Planning Group and adopted. This includes the applicable jurisdiction; the office, department or agency responsible for implementing the action; potential funding sources; and timeframe for completion, either short term: 1 to 3 years, or long term: over 4 years.

Id#	Project Category / Name	Jurisdiction: County/Town	Lead Department /Agency	Time Frame For Completion - Short 1-3 years or Long over 4 years	Potential Funding Sources
	Severe Storm				
SS-1	Rapid Observation of Vulnerability and Estimation of Risk	County and Town	DEM, Director	Short	1
SS-2	Expand Public Education and Outreach Efforts	County and Town	DEM, Director	Short	1
SS-3	Promote Greater Self-Reliance	County and Town	DEM, Director	Short	1
SS-4	Encourage Heating and Power Alternatives	County and Town	DEM, Director	Short	1
SS-8	Protect Marinas	County and Town	Port of FH Executive Director	Long	1
SS-9	Orcas Landing Dock Improvements	County	County PW Director	Long	1
	Wildland Fire				
WF-1	Expand Education and Outreach	County and Town	DEM Director	Short	1,3
WF-2	Practice of FireWise landscaping	County and Town	DEM Director	Short	1,3
WF-3	Alternatives to Backyard Debris Burning	County and Town	DEM, County PW Solid Waste Program Administrator	Long	1,3
WF-11	Mt. Constitution Communication Site Fuels Treatment	County	Orcas Fire and Rescue, Fire Chief	Long	3,4

WF-13	Rosario Highlands Defensible Space	County	Orcas Fire and Rescue, Fire Chief	Long	3,4
WF-16	Doe Bay Area Gorse Treatment	County	County Noxious Weed Control, Weed Coordinator	Long	1,3,4
WF-17	Trout Lake Watershed Forest Management and Access Improvement	County	San Juan Island Fire, Fire Chief	Long	1,3,4
WF-40	Annual Tall Grass Order To Mow	Town	Friday Harbor Planning Director	Short	1
WF-41	Additional Brush Truck and Water Tender Capacity Lopez Island	County	Lopez Island Fire and Rescue, Fire Chief	Long	1,3
WF-42	Support upgrading emergency service communication infrastructure	County and Town	County Sheriff and PW Director	Long	1,3
	Flooding	County			3
F-1	Continued Public Education and Outreach	County and Town	DEM Director	Short	2
F-2	Early Warning -The National Weather Service	County and Town	DEM Director	Short	2
F-3	Flood Mapping	County and Town	Co. Planning, Director	Short	1
F-4	Building Codes & New Construction	County and Town	Co. Planning, Director	Long	1
F-5	Storm Water Drainage	County and Town	Co. PW Director	Long	1,2,3
F-6	Prune Alley Road Improvements	County	Co.PW Director	Long	1,2,3
F-7	A Street Road Improvements, Eastsound	County	Co.PW Director	Long	1,2,3
F-8	San Juan Valley Road Improvements, San Juan Island	County	Co. PW Director	Long	1,2,3

F-9	MacKaye Harbor Road Relocation, Lopez Island	County	Co. PW Director	Long	1,2,3
F-10	Douglas Road Improvements, San Juan Island	County	Co.PW Director	Long	1,2,3
F-12	Griffin Bay Marine Facility, San Juan Island	County	Co. PW Director	Long	1,2,3
F-13	Westsound Marine Facility, Orcas Island	County	Co. PW Director	Long	1,2,3
F-14	Pass Ordinance to adopt new FIRM Maps	County	Co Planning Director	Long	1,2,3
F-15	Larson Street	Town	Town PW Director	Long	1,2,3
F-16	680/690 Larson Street	Town	Town PW Director	Long	1,2,3
F-17	Marble Street and Tucker Avenue	Town	Town PW Director	Long	1,2,3
F-18	Friday Avenue to Outfall	Town	Town PW Director	Long	1,2,3
F-19	Linder/Nelson/Franck/"C"/Nichols Streets	Town	Town PW Director	Long	1,2,3
F-20	West Street Diversion from Second Street to First Street	Town	Town PW Director	Long	1,2,3
F-21	Caines Street Diversion from Spring Street	Town	Town PW Director	Long	1,2,3
F-22	Marguerite Place and Guard Street	Town	Town PW Director	Long	1,2,3
	Drought				
D-1	Continue Public Education and Outreach Activities	County and Town	County HD, Environmental Health Manager	Short	1
D-2	Aquifer Monitoring	County and Town	County HD Environmental Health Manager	Short	1,2
D-3	Aquifer Management	County and Town	County HD Environmental Health Manager	Long	1,2
D-4	Planning and Development -Manage water resource planning	County and Town	County Planning Director	Long	1,2
D-5	Promote Alternatives	County and Town	County HD Environment	Short	1

			al Health Manager		
D-6	Encourage Conservation	County and Town	County HD Environmental Health Manager	Short	1
D-7	Policy - Change policy re: new well development	County and Town	County Planning Director	Long	1
D-8	Policy - Require water haulers to file an annual report	County and Town	County HD Environmental Health Manager	Long	1
D-9	Aquifer Monitoring - Purchase a FLAT-TAPE	County	County HD Environmental Health Manager	Short	1,2
	Earthquake				
ET-1	Project Impact Initiative	County and Town	DEM Director	Long	4
ET-2	Rapid Observation of Vulnerability and Estimation of Risk	County and Town	DEM, Director	Short	3
ET-3	Expand Public Education and Outreach Efforts	County and Town	DEM, Director	Short	1,2,3
ET-4	Promote Greater Self-Reliance	County and Town	DEM, Director	Short	1
ET-5	Implement Tsunami Notification and Evacuation Plans	County and Town	DEM, Director	Short	1,3
ET-6	Survey Existing Structures for Earthquake Vulnerability	County and Town	DEM, Director	Short	3
ET-7	Conduct Structural Analysis of County Dams and Reservoirs	County	DEM, Director	Long	3
ET-8	Protect Marinas	County and Town	Port of FH, Exec. Director	Long	1,3
ET-9	Plan and Implement Logistical Back-up Protocols	County	County IT, IT - IS Manager	Short	1
ET-10	Rebuild barge landing ramp at Jensen Beach - Port initiative	County and Town	Port of FH Director	Long	1,3

ET-12	Structural Retrofit and Seismic upgrade to the San Juan County Courthouse and administrative offices.	County	County Facilities Director	Long	1,2,3
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Funding Sources

1. Local funding including fees, taxes, special levies, County or Town current expense budgets.

2. State funding sources

Biennial Municipal Stormwater Grants of Regional or Statewide Significance

The State of Washington Department of Ecology offers a series of stormwater project grants for increasing stormwater management systems capacities.

Public Participation Grants (PPG)

WA State Department of Ecology. PPG provide funding to citizen groups and not-for-profits public interest organizations. PPG can be used for the investigation and cleanup of contaminated sites and improving recycling and waste management. PPG can fund up to \$120,000 for a two-year project.

Coordinated Prevention Grants (CPG)

CPG protects human health and the environment by reducing human exposure to toxins; reducing waste; ensuring management of solid and household hazardous waste; and promoting energy and resource conservation. CPG provides funding assistance to local governments for planning and implementing programs in their local solid and hazardous waste management plans.

Integrated Planning Grants

WA State Department of Ecology. These grants provide funding to local governments to conduct assessments of brownfield properties and develop integrated project plans for their cleanup and adaptive reuse.

Shorelands and Environmental Assistance (SEA)

WA State Department of Ecology. The Shoreline Management Act establishes a cooperative program between local and state governments for the management of fresh and saltwater shorelines.

Floodplains by Design grant program

The State of Washington Department of Ecology administers a floodplain management grant program that supports planning, mapping, and projects to reduce loss of life and property from riverine flooding.

3. Federal funding sources

Flood Mitigation Assistance Program

The FMA program is designed to aid in the buyout of RL and SRL properties as well as assist in the funding of flood mitigation projects and activities.

U.S. Army Corps of Engineers Floodplain Management Services

Under the authority provided by **Section 206** of the 1960 Flood Control Act (PL 86-645), as amended, the Corps of Engineers can provide the full range of technical services and planning guidance that is needed to support effective flood plain management.

Hazard Mitigation Grant Program

The HMGP is managed by FEMA and administered by WA EMD.

Pre Disaster Mitigation Grant Program

PDM is managed by FEMA and is a nationally competitive grant program.

Community Development Block Grants – Disaster Recovery: U.S. Department of Housing and Urban Development Post-disaster; availability is subject to Congressional appropriation. Flexible grants to local municipalities, counties, and states to facilitate recovery from

Presidentially declared disasters, especially in low-income areas.

U.S.D.A National Forest Service - National Fire Plan Community Assistance Grants

This funding has been made available to finance projects identified in mitigation plans, but has not been offered since 2016. Note: in Washington, only counties in the eastern part of the state were eligible to apply.

4. Private funding

The National Fish and Wildlife Foundation, Developing the Next Generation of Conservationists,

Integration with Other Plans

The Natural Hazards Mitigation Planning Group intends that the NHMP inform and provide essential information to other allied plans maintained by the County and by the Town of Friday Harbor. Among these plans are Capital Improvement plans of both jurisdictions, and the County Comprehensive Plan. Natural Hazard Mitigation Plans are non-regulatory, versus the regulatory nature of Comprehensive plans. Because of this difference, integration with the Comprehensive plan may allow for additional success towards meeting the goals of the NHMP which would not be possible without plan integration.

To best provide for integration of plans, the NHMP integration process will seek to include background information on natural hazards, including history of past events and potential impacts; identify hazard prone areas located in the island communities; add relevant natural hazard goals, objectives and projects, while supporting policies of other plans to achieve common goals.

To help achieve sensible integration of plans, NHMP maintenance and updates will seek common membership of planning groups to best leverage the expertise of local subject matter experts.

DEM will seek to coordinate the update NHMP schedule with the updates to other plans as

much as possible to assist with effective integration.

DEM will seek integration of the NHMP with Land Use elements and critical areas ordinances of the County Comprehensive Plan during future updates, so that vulnerability to natural hazards may be reduced in future land use and development.

Section 12. NHMP MAINTENANCE

The San Juan County/Friday Harbor Department of Emergency Management (DEM) will monitor and review the plan annually and after any event associated with an identified vulnerability which causes substantial damage, injury or death, to assess the plan using the following criteria:

- Identification of successfully completed mitigation projects which were proposed in the plan.
- Progress towards completion of any targeted strategies/mitigation actions.
- Re-evaluation of the action plans to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability).
- Recommendations for new mitigation actions.
- Changes in or potential for new funding options
- Impact of any other planning programs or initiatives within the partnership that involve hazard mitigation. DEM will review these other plans for changes which may affect the NHMP, and opportunities to include the NHMP in these plans:

- San Juan County Comprehensive Plan
- Community Wildfire Protection Plan
- Shoreline Master Program
- Drought Conservation Plan
- Town of Friday Harbor Comprehensive Plan
- Town of Friday Harbor Shoreline Master Program
- Town of Friday Harbor Stormwater Management Plan including Capital Improvement Plan

DEM will maintain a web form with which community members may submit comments and suggestions for improvements to the plan.

DEM will explore the feasibility of including the NHMP updates as part of the County Comprehensive Plan update process so that there is a conjoined, symbiotic process benefitting both plans.

The plan will be updated on a five year cycle using information generated by the annual/event associated reviews and as informed by public comment. The five year update will contain all changes in strategy, identified hazards, project updates and incorporate any new data applicable to the plan. The 5 year update will include a public meeting process and opportunity for public input.

August, 2019	First Annual review
August, 2020	Second Annual review
August, 2021	Third Annual review
August, 2022	Fourth Annual review
Year 5, January - December, 2023	Plan update and resubmission

End Notes

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- ¹ Interview, Vern & Sydney Coffelt, Orcas Island, April 2005
- ² Prehistoric Cultural Resources of San Juan County, Washington, by Gary C. Wessen
- ³ Northwest Marine Weather: From the Columbia River to Cape Scott, Jeff Renner, Published by The Mountaineers, 1011 SW Klickitat Way, Seattle, WA., 98134, 1993
- ⁴ San Juan County HIVA, San Juan County Department of Emergency Management, 2004
- ⁵ WSF Plans for 71% County Population Increase by 2030, San Juan Islander, 09.22.05.
- ⁶ WSF Plans for 71% County Population Increase by 2030, San Juan Islander, 09.22.05
- ⁷ NOAA National Center for Environmental Information Storm Events Database
<https://www.ncdc.noaa.gov/stormevents>
- ⁸ Fire History Analysis from Fire Scars Collected at Iceberg Point and Point Colville on Lopez Island. Authors: Donald W. Spurbeck, David S. Keenum. Pacific Northwest Research
- ⁹ Norton, P. Bear Valley National Wildlife Refuge Fire Hazard Reduction Project: Final Environmental Assessment. Fish and Wildlife Services, Bear Valley Wildlife Refuge. June 20, 2002
- ¹⁰ USFS. 2001. United States Department of Agriculture, Forest Service. Wildland Urban Interface. Web page. Date accessed: 25 September 2001. Accessed at: <http://www.fs.fed.us/r3/sfe/fire/urbanint.html>
- ¹¹ USFS. 2001. United States Department of Agriculture, Forest Service. Wildland Urban Interface. Web page. Date accessed: 25 September 2001. Accessed at: <http://www.fs.fed.us/r3/sfe/fire/urbanint.html>
- ¹² Norton, P. Bear Valley National Wildlife Refuge Fire Hazard Reduction Project: Final Environmental Assessment. Fish and Wildlife Services, Bear Valley Wildlife Refuge. June 20, 2002
- ¹³ McCoy, L. K., et al. Cerro Grand Fire Behavior Narrative. 2001
- ¹⁴ Johnson, C.G. 1998. Vegetation Response after Wildfires in National Forests of Northeastern Oregon. 128 pp
- ¹⁵ Barrett, J.W. 1979. Silviculture of ponderosa pine in the Pacific Northwest: the state of our knowledge. USDA Forest Service, General Technical Report PNW-97. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 106 p.
- ¹⁶ Johnson, C.G.; Clausnitzer, R.R.; Mehringer, P.J.; Oliver, C.D. 1994. Biotic and Abiotic Processes of Eastside Ecosystems: the Effects of Management on Plant and Community Ecology, and on Stand and Landscape Vegetation Dynamics. Gen. Tech. Report PNW-GTR-322. USDA-Forest Service. PNW Research Station. Portland, Oregon. 722pp
- ¹⁷ Sprenger, C. B.; Dunwiddie, P. W. 2011. Fire History of a Douglas-Fir-Oregon White Oak Woodland, Waldron Island, Washington. Northwest Science, 85(2):108-119
- ¹⁸ Islandsounder.com. <http://www.islandsounder.com/news/47660027.html>. Accessed May, 2012
- ¹⁹ SanJuanJournal.com. <http://www.sanjuanjournal.com/news/99460014.html>. Accessed May, 2018
- ²⁰ Auburn University website https://fp.auburn.edu/fire/topos_effect.htm. Accessed on July 30, 2012
- ²¹ This concept was confirmed by Tom Hauser, Landscape Historian for the Washington State Department of Archaeology and Historic Preservation, 11.29.05
- ²² Gorte, R. 2009. Congressional Research Service, Wildfire Fuels and Fuel Reduction

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- ²³ Spurbeck, Donald W. and David S. Keenum. July 2003. *Fire History Analysis from Fire Scars Collected at Iceberg Point and Point Colville on Lopez Island, Washington*. Pacific Northwest Research Station, Okanogan and Wenatchee National Forests.
- ²⁴ NOAA National Center for Environmental Information Storm Events Database
<https://www.ncdc.noaa.gov/stormevents>
- ²⁵ Interviews: Russ Harvey, Roads Maintenance Manager, San Juan County Public Works
- ²⁶ Sea Levels Rise Fast: 1 Inch in 10 Years, The Seattle Times, 07.10.05
- ²⁷ National Academy of Sciences, 2012. Sea Level Rise for the Coasts of California, Oregon and Washington: Past, Present and Future. http://www.nap.edu/catalog.php?record_id=13389
- ²⁸ Intergovernmental Panel on Climate Change website, accessed May 2018
<http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=3>
- ²⁹ Pardaens, A.K., J.M. Gregory, J.A. Lowe, 2010. A model study of factors influencing projections of sea level over the twenty-first century, *Climate Dynamics*, 36, 2015-2033.
- ³⁰ A. J. MacLennan, J. F. Waggoner, J. W. Johannessen, and S. A. Williams, Coastal Geologic Services Inc. 2013 Sea Level Rise Vulnerability in San Juan County, Washington Prepared for: Friends of the San Juans, 18 p.
- ³¹ National Climate Data Center <https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/>
- ³² Geology and Water Resources of the San Juan Islands, Water Supply Bulletin No. 46, Edited by Robert H. Russell, Water supply and Waste Section, Washington State Department of Social and Health Services, 1975
- ³³ WA State Dept. of Ecology Well Log database
<https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/default.aspx> accessed May 2018
- ³⁴ San Juan County Water Resource Management Plan, WRIA 2, revised and adopted by the San Juan County Board of County Commissioners, October 2004
- ³⁵ <https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/>
- ³⁶ Is Seawater Intrusion Affecting Ground Water on Lopez Island, WA?" USGS Fact Sheet 057-00
- ³⁷ San Juan County Water Resource Management Plan, WRIA 2, revised and adopted by the San Juan County Board of County Commissioners, October 2004
- ³⁸ Tsunami Hazard Mitigation Implementation Plan: A Report to the Senate Appropriations Committee, prepared by the Tsunami Hazard Mitigation Federal/State Working Group (Washington, California, Alaska, Oregon and Hawaii), April 1996
- ³⁹ Cascadia Megathrust Earthquakes in Pacific Northwest Indian Myths and Legends, draft of academic thesis, Ruth S. Ludwin, University of Washington, Department of Earth and Space Sciences
- ⁴⁰ Tsunami Hazard Mitigation Implementation Plan: A Report to the Senate Appropriations Committee, prepared by the Tsunami Hazard Mitigation Federal/State Working Group (Washington, California, Alaska, Oregon and Hawaii), April 1996
- ⁴¹ Tsunami Hazard Mitigation Implementation Plan: A Report to the Senate Appropriations Committee, prepared by the Tsunami Hazard Mitigation Federal/State Working Group (Washington, California, Alaska, Oregon and Hawaii), April 1996
- ⁴² Tsunami Great Waves website, www.prh.noaa.gov/itic/library/pubs/great_waves/tsunami. U.S. National Oceanic & Atmospheric Administration (NOAA), the UNESCO Intergovernmental Oceanographic Commission (IOC), the International Tsunami Information Center (ITC), and Laboratoire de Géophysique, France (LDC)

⁴³ NOAA Time Eastern Strait of Juan de Fuca, Washington, Mapping Project: Procedures, Data Sources, and Products. NOAA Technical Memorandum OAR PMEL-127. Authors A.J. Venturato, V.V. Titov, H.O. Mofjeld, F.I. González, Pacific Marine Environmental Laboratory, Seattle, WA., and the National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research

References

San Juan County documents accessed at www.sanjuanco.com

- San Juan County Comprehensive Plan
- Shoreline Master Program
- Drought Conservation Plan
- Storm and Surface Water Capital Improvement Plan 2018-2023
- Solid Waste and Moderate-Risk Waste Management Plan
- MacKaye Harbor Road Relocation Feasibility Study

Town of Friday Harbor documents accessed at www.fridayharbor.org

- Town of Friday Harbor Shoreline Master Program
- Town of Friday Harbor Stormwater Management Plan including Capital Improvement Plan

Other references

- NOAA National Center for Environmental Information Storm Events Database
<https://www.ncdc.noaa.gov/stormevents>
- San Juan County Economic Almanac <https://www.sanjuansedc.org/>
- U.S. Census Bureau QuickFacts San Juan County WA
<https://www.census.gov/quickfacts/fact/table/sanjuancountywashington/PST045216>
- Washington Office of Financial Management <https://www.ofm.wa.gov/washington-data-research/county-and-city-data/san-juan-county>
- Community Rating System Fact Sheet https://www.fema.gov/media-library-data/1507029324530-082938e6607d4d9eba4004890dbad39c/NFIP_CRS_Fact_Sheet_2017_508OK.pdf
- FEMA FLOOD INSURANCE STUDY NUMBER 530149CV001A VERSION NUMBER 2.3.2.1
<http://www.sanjuanco.com/DocumentCenter/View/10306>
- Community Wildfire Protection Plan https://www.dnr.wa.gov/publications/rp_burn_cwpp_sanjuanco.pdf